



Food and Agriculture
Organization of the
United Nations



World Health
Organization

ISSN 0259-2517

FAO
PLANT
PRODUCTION
AND
PROTECTION
PAPER

172

Pesticide residues in food 2002

**Joint FAO/WHO Meeting on
Pesticide Residues**

REPORT 2002

Rome, 2002

Pesticide residues in food - 2002

**Report of the Joint Meeting of the
FAO Panel of Experts on Pesticide Residues
in Food and the Environment
and the WHO Core Assessment Group on Pesticide Residues
Rome, Italy
16- 25 September 2002**

ISBN 92-5-104858-4

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T- toxicological evaluation; R- residue and analytical aspects

* New compound

** Evaluated within the periodic review program of the Codex Committee on Pesticide Residues

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ABBREVIATIONS WHICH MAY BE USED
(Well-known abbreviations in general use are not included)

*	at or about the limit of quantification
ADI	acceptable daily intake
ai	active ingredient
AUC	area under the curve for concentration–time
bw	body weight
CCN	Codex classification number (for compounds or commodities)
CCPR	Codex Committee on Pesticide Residues
CXL	Codex level
2,4-D IPE	(2,4-dichlorophenoxy)acetic acid isopropyl ester
DT ₅₀	time to 50% decomposition
DT ₉₀	time to 90% decomposition
ECD	electron capture detection
F	fat
F ₁	first filial generation
F ₂	second filial generation
FAO	Food and Agricultural Organization of the United Nations
GAP	good agricultural practice
GC	gas chromatography
GLC	gas–liquid chromatography
GPC	gel-permeation chromatography
GEMS/Food	Global Environment Monitoring System–Food Contamination Monitoring and Assessment Programme
GSH	glutathione
HPLC	high-performance liquid chromatography
HR	highest residue in the edible portion of a commodity found in trials used to estimate a maximum residue level in the commodity
HR-P	highest residue in a processed commodity calculated by multiplying the HR of the raw commodity by the corresponding processing factor
IARC	International Agency for Research on Cancer
IEDI	international estimated daily intake
IESTI	international estimate of short-term dietary intake
JECFA	Joint Expert Committee on Food Additives
JMPR	Joint Meeting on Pesticide Residues
LC	liquid chromatography
LC ₅₀	median lethal concentration
LD ₅₀	median lethal dose
LOAEL	lowest-observed-adverse-effect level
LOAEC	lowest-observed-adverse-effect concentration
LOD	limit of detection
LOQ	limit of quantification
MDL	method detection limit
MLD	minimum level of detection
MRL	maximum residue limit
MS	mass spectrometry
MS/MS	tandem mass spectrometry

NOAEL	no-observed-adverse-effect level
NPD	nitrogen–phosphorus detector
OECD	Organization for Economic Co-operation and Development
PF	processing factor
PHI	pre-harvest interval
P_{ow}	octanol–water partition coefficient
RfD	reference dose
STMR	supervised trials median residue
STMR-P	supervised trials median residue in a processed commodity calculated by multiplying the STMR of the raw commodity by the corresponding processing factor
TRR	total radiolabelled residue
TMDI	theoretical maximum daily intake
UV	ultraviolet radiation
W	the previous recommendation is withdrawn
WHO	World Health Organization

USE OF JMPR REPORTS AND EVALUATIONS BY REGISTRATION AUTHORITIES

Most of the summaries and evaluations contained in this report are based on unpublished proprietary data submitted for use by JMPR in making its assessments. A registration authority should not grant a registration on the basis of an evaluation unless it has first received authorization for such use from the owner of the data submitted for the JMPR review or has received the data on which the summaries are based, either from the owner of the data or from a second party that has obtained permission from the owner of the data for this purpose.

PESTICIDE RESIDUES IN FOOD
REPORT OF THE 2001 JOINT FAO/WHO MEETING OF EXPERTS

1. INTRODUCTION

A Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group (JMPR) was held at FAO Headquarters, Rome (Italy) from 16 to 25 September 2002. The Panel Members of FAO and WHO had met in preparatory sessions from 11 to 15 September.

The Meeting was opened by Dr. Mahmoud Solh, Director of the Plant Production and Protection Division, on behalf of the Directors General of FAO and WHO. Dr. Solh noted that the Meeting will be considering a number of important issues that will result in recommendations to the Codex Committee on Pesticide residues (CCPR). He also noted that the 34th Session of the CCPR asked the JMPR to address several issues such as guidance on setting MRLs for spices and to continuously update the principles of risk assessment. He mentioned that a joint WHO/FAO project will provide an opportunity to harmonize approaches across all classes of chemicals in food.

Dr. Solh emphasized the need to speed-up MRL establishment since delay could cause trade vulnerabilities especially in developing countries, which rely mostly on Codex MRLs. However, he also recognized that JMPR has a limited capacity to fully serve the needs of the CCPR and its member governments. He was aware that a critical review of the JMPR had been carried out with a view to speeding-up its evaluation process as well as the review of the Codex process of setting international standards.

The Meeting was held in pursuance of recommendations made by previous Meetings and accepted by the governing bodies of FAO and WHO that studies should be undertaken jointly by experts to evaluate possible hazards to humans arising from the occurrence of residues of pesticides in foods. The reports of previous Joint Meetings (see Annex 5) contain information on acceptable daily intakes (ADIs), maximum residue limits (MRLs), and the general principles that have been used for evaluating pesticides. The supporting documents (residue and toxicological evaluations) contain detailed monographs on these pesticides and include evaluations of analytical methods.

During the Meeting, the FAO Panel of Experts was responsible for reviewing residue and analytical aspects of the pesticides under consideration, including data on their metabolism, fate in the environment, and use patterns, and for estimating the maximum levels of residues that might occur as a result of use of the pesticides according to good agricultural practice. The estimation of maximum residue levels and supervised trials median residues (STMR) values for commodities of animal origin was elaborated. The WHO Core Assessment Group was responsible for reviewing toxicological and related data and for estimating ADIs where possible.

The Meeting evaluated 26 pesticides, including two new compounds and eleven compounds that were re-evaluated within the periodic review program of the Codex Committee on Pesticide Residues (CCPR) for toxicity or residues or both.

The Meeting allocated ADIs and acute reference doses (RfDs), estimated MRLs and recommended them for use by the CCPR, and estimated STMR and highest residue (HR) levels as a basis for estimating dietary intakes.

The Meeting devoted particular attention to estimating the dietary intakes (both short-term and long-term) of the pesticides reviewed in relation to their ADIs or acute RfDs. In particular, for compounds undergoing a complete evaluation or re-evaluation, it distinguished between those for which the estimated intake is below the ADI and those for which the intake might exceed the ADI. Footnotes are used to indicate those pesticides for which the available information indicates that the ADI might be exceeded, and footnotes are used to denote specific commodities in which the available information indicates that the acute RfD of the pesticide might be exceeded. A proposal to make this distinction and its rationale are described in detail in the reports of the 1997 JMPR (Annex 5, reference 80, section 2.3) and 1999 JMPR (Annex 5, reference 86, section 2.2).

2. GENERAL CONSIDERATIONS

2.1 NEEDS OF JMPR

The JMPR is undergoing a very critical period at the moment. The current system, which relies heavily on voluntary contributions by individuals of their own time, is not sustainable with the increasing workloads and the complexity of modern evaluations (reference is made to the JMPR Reports of 1998 and 1999). This system has become unsustainable and without additional resources it will fail sooner rather than later. These circumstances are known and have been noted during 34th Session of the CCPR in 2002.

At its 2002 meeting, the CCPR confirmed that the JMPR was essential to the continued independent international evaluation of pesticide residues.

The Meeting noted with interest the efforts that are being made by FAO and WHO to increase resources for JMPR from their regular budgets. However, it stressed in this context the need for immediate additional support and welcomed the proposal made by the Chairman of the CCPR for the establishment of a temporary advisory group to FAO and WHO, called "Friends of the JMPR," to support the efforts of the Organizations as an intellectual resource to strengthen the JMPR regarding fundraising, staff secondment, etc. Such a group could also enhance within governments the understanding and comprehension of the workload and the responsibilities of the individual members of the JMPR.

Various efforts to increase efficiency have been implemented over the last years, other initiatives are being considered by the Meeting, as the impact and consequences, e.g. for industry or the evaluation process itself, are not clearly defined yet. Various proposals have been made in the FAO/WHO Consultant's report, reference is made to CX/PR 02/14. In this context, it is 10 years since the Periodic Review of Old Compounds was introduced. That program effectively doubled the work of the JMPR, but proportionate resources did not become available. Therefore, the Periodic Review Program should be re-examined. Lengthening the period between the previous evaluation and scheduling for periodic review (presently 10 years) would reduce the back-log.

It should be noted that the implementation process for changes itself requires considerable resources and the implementation could become counter-productive if it is no more than the introduction of one suggested change after another without an overall strategic direction.

The Meeting recommended that FAO, WHO and the Codex Alimentarius Commission prepare a strategic plan for JMPR reflecting upon the clear message from the CCPR regarding JMPR's role, the growing importance of WTO agreements, the proposals in the Consultants report and the ongoing overall FAO/WHO Codex evaluation. The plan would provide a framework for the proposed changes.

The plan should provide: (a) A re-examination of the objectives of JMPR, its practices and its information and data requirements, (b) a description of the situation in 5 and 10 years time and what will be expected of JMPR, (c) an estimate of the resources needed for effective operation as envisaged in (b), and (d) an implementation process and recognition of implementation costs.

2.2 FURTHER GUIDANCE ON DERIVATION OF THE ACUTE RfD

Introduction

On several occasions the Joint Meeting has considered how and when to establish an acute reference dose (acute RfD) and has established such values for a number of pesticides since 1995. The Meeting has followed the basic principle that the establishment of an acute RfD should be considered on a case-by-case basis for all compounds that are evaluated. The 2001 JMPR recommended that WHO establish a working group, consisting of scientists who have developed the concepts of the acute RfD at JMPR, in national governments, and in the European Commission. The working group was asked to develop a working paper that builds on the experience that had been gained, emphasising the general agreement that has been reached among the various groups involved. The guidance by the present Meeting described below is based on the working paper that was prepared.

Background on estimation of short-term dietary intake

Short-term dietary intake assessments carried out by the JMPR estimate pesticide residue intake over a single day. Two population groups are modelled, based on available consumption data:

- general population and
- children (1-6 years of age).

The decision on whether a short-term risk assessment should be performed has been driven in the past by the toxicity of the compound and whether it was necessary to derive an acute RfD. The establishment of an acute RfD triggers the calculation of short-term intake and a short-term risk assessment. However, there might be certain use patterns that would be unlikely to give rise to residues and in such cases a full intake assessment might not be necessary.

Definition of the acute RfD

The 2001 Joint Meeting noted that the definition of the acute RfD, which relates to consumption either at a single meal or over a whole day, should be re-addressed. A revised working definition of the acute RfD was adopted at the present Meeting:

- The acute RfD of a chemical is an estimate of the amount of a substance in food and/or drinking-water, normally expressed on a body-weight basis, that can be ingested in a period of 24 hours or less without appreciable health risk to the consumer on the basis of all known facts at the time of the evaluation.

This definition differs from the previous one with respect to the duration of intake. This change was made because consumption data are available on a daily basis and cannot be further divided into individual meals.

General considerations in establishing an acute RfD

Most of the scientific concepts applying to the establishment of ADIs apply equally to acute RfDs (e.g. consideration of the scientific quality of studies). The decision to establish an acute RfD should normally be based on toxicological grounds, because an acute RfD is a toxicological reference value. Therefore, the establishment of an acute RfD should be considered for all

substances. In considering whether an acute RfD for a pesticide is necessary, it is not advisable to take into account current agricultural practice and related residues for existing crop use because with different application rates or new applications on other crops (or other crop groups), higher residue values and/or higher dietary intakes may arise.

Stepwise process for establishing acute RfDs

1.1 Evaluate the total database and establish a toxicological profile on the active substance.

2.1 Consider principles for **not** establishing an acute RfD:

- No findings indicative of acute effects are seen at doses up to 500 mg/kg bw² in, for example, reproductive toxicity, developmental toxicity, immunotoxicity, or neurotoxicity studies AND
- No substance-related mortality is observed at doses up to 1000 mg/kg bw in single-dose oral studies.

If mortality is the only trigger, the cause should be confirmed as being relevant to human intake of residues in food (e.g. not due to gastrointestinal haemorrhage from a corrosive compound).

If an acute RfD is not established, the reasons must be justified and explained. If the above criteria do not exclude the establishment of an acute RfD, it should be based on the most appropriate effect.

3.1 The appropriate effect and NOAEL should be selected:

- Select the most relevant toxicological effects (see section on toxicological effects).
- Select the most relevant study in which these effects have been examined.
- Identify the NOAELs for these effects.
- Select the relevant effect providing the lowest NOAEL.

An effect from a repeated-dose or long-term toxicity study might be used for the establishment of an acute RfD if a NOAEL for the most relevant end-point has not been identified after administration of a single dose. This is likely to be a conservative approach, which should be stated. The normal safety factor should be applied. A special single-dose toxicity study may be necessary to refine the acute RfD if the estimation of short-term intake exceeds such a conservatively established acute RfD.

² The upper limit for an acute RfD was considered with reference to the potential range of dietary intakes of acutely toxic pesticides. A rough estimate of such intake could be produced by assuming that a 50 kg person consumes 500 g of fruit in a single sitting. The fruit consists of a single large item (e.g. small melon) that has been treated with a pesticide having an MRL of 20 mg/kg. Trials data show that a variability factor of 5 is applicable. The estimated intake could be as high as $[20 \text{ mg/kg (MRL)} \times 5 \text{ (variability)} \times 0.5 \text{ kg (mass)}] / 50 \text{ kg} = 1 \text{ mg/kg bw}$. Another estimate on grapes confirmed the order of this estimate.

Other issues to consider include: (1) a small number of pesticide-commodity combinations have MRLs in excess of 20 mg/kg, although they might not have a toxicity profile relevant to the establishment of an acute RfD; (2) infants and small children often have a higher level of food consumption than adults relative to body weight; and (3) for certain commodities, a variability factor greater than 5 might be applicable. These considerations dictate that any cut-off value for acute RfDs should be greater than 1 mg/kg bw. An acute RfD of 5 mg/kg bw should cover all eventualities, which would normally be based on a NOAEL in an animal study of 500 mg/kg bw per day and a safety factor of 100.

4.1 Derive the acute RfD using appropriate safety factors (see section on safety factors)

Toxicological effects relevant for derivation of the acute RfD

A number of effects could be due to a single exposure to a compound. The list below is not necessarily comprehensive and the omission of a toxicological effect does not mean that it should be discounted when considering the establishment of an acute RfD:

- Clinical signs, behavioral signs, pharmacological effects, or effects on target organs observed in single-dose studies or early in studies with repeated doses.
- Acute neurotoxicity, e.g. acute delayed polyneuropathy or inhibition of acetylcholinesterase activity.
- Clinical chemical or haematological effects, e.g. methaemoglobin formation, haemolysis, or anaemia.
- Reproductive or developmental effects, e.g. teratogenicity or developmental neurotoxicity.
- Hormonal or other biochemical alterations observed in studies with repeated doses which might conceivably be elicited by a single exposure.
- Direct effects on the gastrointestinal tract. Such findings should be assessed carefully to determine their relevance to human exposure. Are they due to irritation or a pharmacological action? Are they related to the method of administration (present with bolus dosing but not by dietary admixture)?

The relevance of these effects should be considered on a case-by-case basis.

The route of administration should be considered carefully to minimise influences that are not relevant to the intake of residues (e.g. effects induced by gavage or the vehicle).

Safety factors

A number of situations could justify the use of safety factors higher or lower than the default values of 100 and 10 on the basis of animal and human data, respectively; some of these were considered in Annex 5 of the 2000 JMPR Report:

- An increased safety factor should be used when a NOAEL has not been identified and a LOAEL is used as the basis for the acute RfD; the selection of a safety factor between 1 and 10 will depend upon the magnitude and severity of the effect and the steepness of the dose-response curve.
- An extra safety factor has often been adopted for the 'seriousness' of the effect. However, the degree of severity of an effect may be somewhat subjective and it would not be feasible to grade all possible toxicological effects by their severity. Therefore, if a toxicological effect is judged to be irreversible or particularly severe, this should be a trigger to consider the finding in more detail before choosing an appropriate safety factor (see following point).
- Depending on a detailed consideration of the following questions, it may be appropriate to include an additional safety factor:
 - Has the study shown an adequate margin between the NOAEL and the LOAEL?

- Is the finding supported by data from other studies or from a knowledge of the mechanism of action of the compound?
- When the effect under consideration is due to reversible interaction of the compound with a pharmacological target (e.g. a receptor or ion channel) or due to direct irritation, then the concentration of the substance rather than total intake should determine the magnitude of the effect, i.e. the maximum plasma concentration achieved (C_{max}) is more relevant than the plasma concentration integrated over time (area-under-the-curve, or AUC). A reduction in toxicokinetic variation by two-fold may be justified, leading to an overall default factor of 25 for animal studies (i.e. 5 x 5 instead of 10 x 10 for inter- and intraspecies factors) and 5 (instead of 10) for human studies³.
- The establishment of acute RfDs is well-suited to the derivation and application of chemical-specific adjustment factors⁴. Such compound-specific adjustment factors, when available, should inform the selection of an appropriate safety factor. The use of compound-specific adjustment factors has been considered in some detail in a document prepared by the International Programme on Chemical Safety (IPCS)⁵.

Different acute RfDs for different population groups

Preferably, one acute RfD should be established. Children (1 – 6 years of age) are frequently cited as being a more susceptible group of consumers because they have a higher food consumption than adults on a body-weight basis. However, examination of currently available information shows that the general population has a higher consumption of some groups of commodities than children on a body-weight basis. The current database used at the international level permits estimates of short-term dietary intake for the general population and for children (1 - 6 years). If developmental effects on the fetus provide the lowest NOAEL from the toxicological database for a chemical, then these effects are normally not relevant for children and two acute RfDs should be established. One acute RfD should be derived on the basis of the developmental effects and another acute RfD should be established at the same time that is applicable to the general population. The acute RfD for the general population would be used to assess dietary risk to children aged 1 to 6 years. The acute RfD based on developmental effects would be applicable to women of child-bearing age in the general adult population.

Use of human data

Human data on a pesticide, whether from volunteer studies or from other investigations of human exposures in the workplace or environment, can be extremely valuable in placing the animal data in context and, when available, should always be evaluated even when they are not used to derive an acute RfD. However, when performing a risk assessment on a pesticide, the entire database should be considered and the most appropriate studies and safety factors used to derive reference values.

³ JMPR (2000) Proposed guidance for interpretation of data generated in studies with single oral doses (for use in establishing acute RfDs for chemical residues in food and drinking water). FAO/WHO Pesticide Residues in Food. Report 2000, Annex 5, pp. 197-198

⁴ WHO (1994) Assessing human health risks of chemicals: Derivation of guidance values for health-based exposure limits (Environmental Health Criteria 170), Geneva

⁵ IPCS (2001) Guidance document for the use of data in development of chemical-specific adjustment factors (CSAFs) for interspecies differences and human variability in dose/concentration response assessment. International Programme on Chemical Safety, July 2001. Document WHO/PCS/01.4 (document available at: www.ipcsharmonize.org/documents/CSAF_Guidance5.PDF)

Evaluators should consider the following issues in determining whether to use a volunteer study in the derivation of an acute RfD:

- The initial consideration should be scientific merit. A poorly designed or conducted study in humans (as with experimental animals) should not be used for establishing an acute RfD.
- The acceptable group size will depend on factors such as inter-individual variation in response and the level of change considered not to be adverse. The studies should be assessed with particular consideration of their power to detect critical effects.
- The IPCS Guidance for the use of chemical-specific adjustment factors proposed a minimum group size of 5⁶. Studies using small group sizes might be useable, e.g. by combining results from two or more dose levels or applying an increased safety factor.
- The critical end-points identified in animal studies should be investigated appropriately in human studies.
- If only one sex or a particular age group has been used, the general applicability of the results should be ascertained, if possible, using data from studies in animals.
- As recommended by the 1998 JMPR, recent studies in humans should include clear statements that they were performed in accordance with internationally accepted ethical standards. For older studies, ethical considerations should take into account both current standards and the standards pertaining at the time the study was performed.
- Studies that have not been performed in accordance with ethical principles but are scientifically valid should be used only if the findings indicate that acceptable human exposure is lower than the level that would be determined without the use of such a study.

When an acute RfD is below the ADI

Based on the revised working definition, it was considered inappropriate for an ADI to have a value higher than the acute RfD. If, during the derivation of an acute RfD it becomes apparent that a previously derived ADI is higher than the acute RfD, then the full toxicological database should be re-evaluated and the reference values should be reconciled. Such a situation can occur for a number of reasons, such as the availability of additional studies, or for compounds producing more severe effects when given by gavage than in the diet. Because short-term consumption data are for a 24-hour period, this is a precautionary approach for rapidly reversible effects (e.g. inhibitors of cholinesterase activity by carbamates) for which the acute RfD is applicable to a shorter period.

2.3 RECONSIDERATION OF ACUTE RfDs

The Government of the Netherlands has asked JMPR to reconsider decisions on acute toxicity on several pesticides (bentazone, dimethipin, permethrin, 2-phenylphenol, propargite, DDT, dodine, and imazalil) that were considered in 1999-2001. In addition, the Government of the Federal Republic of Germany has requested reconsideration of the acute RfD established for fenpropimorph by the 2001 JMPR.

The present Meeting considered these comments and concluded that for some pesticides reconsideration of previous JMPR assessments of acute toxicity could not be fully considered without undertaking full evaluations of the toxicological data on those particular compounds. The

⁶ IPCS (2001) Guidance document for the use of data in development of chemical-specific adjustment factors (CSAFs) for interspecies differences and human variability in dose/concentration response assessment. International Programme on Chemical Safety, July 2001. Document WHO/PCS/01.4 (document available at: www.ipcsharmonize.org/documents/CSAF_Guidance5.PDF)

recommendations of the Meeting, which are listed below, were made in view of the recent guidance for establishing acute RfDs prepared by JMPR (see section 2.2).

Bentazone

The 1999 JMPR concluded that it was unnecessary to establish an acute RfD for bentazone because it does not exhibit an acute toxic hazard to humans. The Netherlands proposed that an acute RfD of 1 mg/kg bw be established, based on a 13-week study in dogs with a NOAEL of 1000 ppm, equal to 40 mg/kg bw per day, for haematological effects and a safety factor of 40.

The Meeting concluded that the proposal by the Netherlands might have merit, but that insufficient information was available. Thus, bentazone should be placed on the agenda of a future Meeting for submission of appropriate data and reconsideration of the need for an acute RfD.

DDT

The 2000 JMPR concluded that it was not necessary to establish an acute RfD for DDT because peaks of dietary intake above the PTDI are not likely to occur. The Netherlands disagreed with this conclusion because the decision to establish an acute RfD should solely be based on toxicological grounds and not aspects of dietary intake. The JMPR guidance on the derivation of the acute RfD indicates that *the decision to establish an acute RfD should normally be based on toxicological grounds* (see section 2.2). DDT, which was evaluated as an environmental contaminant by the 2000 JMPR, is an exception for which dietary intake was an important consideration.

The Meeting confirmed the 2000 JMPR decision not to establish an acute RfD for DDT.

Dimethipin

The 1999 JMPR established an acute RfD of 0.02 mg/kg bw on the basis of a NOAEL of 20 mg/kg bw per day and a LOAEL of 40 mg/kg bw per day for skeletal malformations (scoliosis) in a developmental toxicity study in rabbits and a safety factor of 1000 due to the severity of the effect and the small margin between the NOAEL and LOAEL. The Netherlands has proposed that a safety factor of 100 would be appropriate, as maternal toxicity was observed at 40 mg/kg bw per day.

The Meeting agreed that a 1000-fold safety factor may be excessive, but that insufficient information was available to make a decision. Thus, dimethipin should be placed on the agenda of a future Meeting for submission of appropriate data and reconsideration of its acute toxicity.

Dodine

The 2000 JMPR established an acute RfD for dodine of 0.2 mg/kg bw based on the NOAEL of 20 mg/kg bw per day in a 1-year study in dogs and a safety factor of 100. The Netherlands proposed that the acute RfD be based on the lowest LD₅₀ value and a safety factor of 1000.

The present Meeting concluded that it is inappropriate to use lethality to establish an acute RfD and that the acute RfD that was established by the 2000 JMPR is consistent with the recent JMPR guidance on derivation of the acute RfD, which indicates that when there are no pertinent available toxicity data to establish an acute RfD a conservative approach should be taken by using a NOAEL from a repeated-dose study for the effects that might arise from a single exposure (see section 2.2).

The Meeting confirmed the acute RfD of 0.2 mg/kg bw established by the 2000 JMPR.

Imazalil

The 2000 JMPR concluded that it was unnecessary to establish an acute RfD for imazalil. The Netherlands pointed out toxicological alerts for establishing an acute RfD for imazalil have been identified, including maternal toxicity, fetal deaths, and resorptions.

The Meeting concluded that the Netherlands proposal may have merit, given the refinement of methods for establishing acute RfDs (see section 2.2). The Meeting recommended that imazalil be placed on the agenda of a future Meeting for submission of appropriate data and reconsideration of its acute toxicity.

Fenpropimorph

The 2001 JMPR established an acute RfD of 1 mg/kg bw, based on the NOAEL of 100 mg/kg bw in an acute neurotoxicity study in rats and a safety factor of 100. Germany did not agree with this decision and has proposed that the NOAEL of 15 mg/kg bw per day for teratogenicity in the rabbit be considered as the basis for the acute RfD. The Meeting concluded that the proposal by Germany may have merit and recommended that a full evaluation of the toxicological database be conducted on fenpropimorph at a future Meeting to determine the appropriate end-point and NOAEL for the establishment of an acute RfD.

Permethrin

The 1999 JMPR concluded that an acute RfD is unnecessary because of the low acute toxicity of technical permethrin. The acute oral LD₅₀ in rats is 220 mg/kg bw for material with a *cis:trans* ratio of 80:20, while the LD₅₀ is 6000 mg/kg bw for material with a *cis:trans* ratio of 20:80. The acute oral toxicity of permethrin with a 40:60 *cis:trans* ratio was dependent on the vehicle in Long Evans and Wistar strains of rats, with LD₅₀ values of 6000 and 8900 mg/kg bw, respectively, when no vehicle was used and 1200 mg/kg bw in both strains when administered in corn oil. Therefore it is apparent that the concentration of the *cis* isomer and the nature of the vehicle significantly affect the acute oral toxicity of permethrin (in rats).

The Netherlands has proposed that an acute RfD be established on the basis of an acute neurotoxicity study in rats. In this study, technical grade permethrin (*cis:trans* ratio of approximately 40:60) was administered as a 1% (w/v) solution or as a suspension in corn oil to 10 Sprague-Dawley rats per sex per group at 0, 10, 150, or 300 mg/kg bw. At 300 mg/kg bw, females exhibited clinical signs consistent with neurotoxicity (tremors, staggered gait, splayed hind limbs, exaggerated hind-limb flexion, and hypersensitivity to sound) but had recovered by day 3. Whole-body tremors, staggered gait, splayed hind limbs, abnormal posture while moving, exaggerated hind-limb flexion, and convulsions on the first day were observed at the highest dose in each sex. No other treatment-related effects occurred. The NOAEL was 150 mg/kg bw based on the occurrence of these clinical signs. The Netherlands proposed that an acute RfD of 1.5 mg/kg bw be established on the basis of this NOAEL and a safety factor of 100.

In view of the on-going refinement of methods for establishing acute RfDs that has been undertaken by JMPR (see section 2.2), it would now appear appropriate to establish an acute RfD for permethrin for the following reasons: (i) clear evidence (clinical signs) of neurotoxicity in rats

following a single oral dose of 300 mg/kg bw, which falls under the limit dose of 500 mg/kg bw suggested in the guidance document; (ii) the occurrence of neurotoxicity following a single dose is considered to be an effect highly relevant for establishing an acute RfD; and (iii) evidence of neurotoxicity in rats at a dose level much lower than the LD₅₀. Therefore, the Meeting established an acute RfD of 1.5 mg/kg bw based on the NOAEL of 150 mg/kg bw in rats (clinical signs of neurotoxicity) following a single oral dose and a safety factor of 100.

2-Phenylphenol

The 1999 JMPR concluded that it was unnecessary to establish an acute RfD for 2-phenylphenol and its sodium salt because of its low acute toxicity. The Netherlands proposed an acute RfD of 2 mg/kg bw based on the NOAEL of 100 mg/kg bw per day for local irritating properties found in a developmental study in rabbits (and supported by emesis in the dog), and by applying a safety factor of 50. Repeated emesis was observed following administration of 2-phenylphenol at doses >400 mg/kg bw per day by gelatine capsule for 1-2 days or by gastric intubation for up to 9 days. Emesis was observed throughout a 4-week study in dogs and in a 2-year study in dogs given 2-phenylphenol by gastric intubation for one year. While emesis was observed in the various studies in dogs, no clinical signs including dehydration or diarrhea nor histopathological changes were seen. In a dietary study in dogs, only effects on body weight and food consumption were reported. Given that the dog is particularly prone to emesis, this effect was probably due to the bolus dosing. The ulceration and haemorrhaging found in the gastric mucosa of rabbits in a developmental toxicity study in which 2-phenylphenol was administered by gavage was likely to be due to the repeated bolus dosing and not to a single exposure. Pathological effects in the gastrointestinal tract were not found in other toxicity studies on 2-phenylphenol. No other toxicological alerts for acute toxicity, including teratogenicity, have been observed with this pesticide.

The Meeting confirmed the 1999 JMPR conclusion that an acute RfD is unnecessary for 2-phenylphenol.

Propargite

The 1999 JMPR concluded that an acute RfD for propargite was unnecessary. The Netherlands agreed with this but sought clarification on the relevance of findings in developmental toxicity studies.

Four developmental toxicity studies were available, two in rats and two in rabbits. All studies used propargite of 85% purity; hence, the more severe findings in the early studies did not appear to be linked to purity of the administered material.

In the first study in rats, the NOAEL for maternal toxicity was 25 mg/kg bw per day, with missing sternbrae and hyoid at 25 mg/kg bw per day and above. An increase in incomplete ossification of the vertebrae was seen in all treatment groups, but this was not considered to be treatment-related because there was no dose-response relationship and the findings were not statistically significant. In the second study in rats, the NOAEL was 25 mg/kg bw per day for both maternal and fetotoxicity; the fetal findings of the first study were not reproduced.

In the first study in rabbits using dose levels of 0, 2, 6, 10, or 18 mg/kg bw per day, extensive maternal toxicity (including anorexia and adipsia) was seen at 6 mg/kg bw per day and above from day 8 onwards. Only 4 of 17 dams at 18 mg/kg bw per day survived to day 29. Litter size was reduced at 10 and 18 mg/kg bw per day due to increased resorptions. Fetal weight was reduced about 10% at 18 mg/kg bw per day. The incidence of anomalies was significantly

increased at ≥ 10 mg/kg bw per day (fetal incidences 1, 2, 3, 6, & 14%). Among the findings was an increase in incomplete skull closure and misaligned/fused sternebrae, neither of which exhibited a clear dose-response relationship. In a second study in rabbits, maternal toxicity (body-weight loss in the second half of the study) was evident at 8 mg/kg bw per day. At 10 mg/kg bw per day body-weight loss occurred throughout the study, four animals aborted, and there were signs of toxicity. The only finding of note in fetuses was an increase in fused sternebrae. The fetal incidences of fused sternebrae were 0, 2, 0.8, 0, 2, and 8% at 0, 2, 4, 6, 8, and 10 mg/kg bw per day. The incidences at the four lower doses did not show any dose-response relationship and were within the cited historic control level (up to 5%). The incidence at the top dose level appeared to be treatment-related, possibly associated with maternal toxicity. Fused sternebrae is a skeletal anomaly that is not clearly linked to a specific time during development and was not observed at 18 mg/kg bw per day in the first study. The overall pattern and incidence of findings in these studies indicated they are not relevant to an acute exposure.

Propargite was irritating to the skin at a dose of 0.1 mg/kg bw (concentration unknown). The maternal toxicity produced in the developmental toxicity studies was possibly linked to irritancy to the gastrointestinal tract following gavage dosing. In the acute toxicity studies (the only other studies using gavage dosing) there were reports of dark red areas, thickened mucosa and red foci in the stomach. No non-neoplastic gastrointestinal lesions were seen in dietary studies with propargite, although there was an indication of unpalatability in studies in dogs.

The effects seen in the developmental toxicity studies with propargite appeared to be secondary to gastrointestinal irritation associated with gavage dosing. Such local effects are not normally considered to be relevant to the establishment of an acute RfD when dietary administration does not produce such irritant effects. Therefore, the Meeting confirmed the 1999 JMPR decision that an acute RfD is unnecessary.

2.4 DEVELOPMENTAL NEUROTOXICITY STUDIES

Questions are sometimes raised about the adequacy of the usual toxicological databases for assessing the safety of pesticides to developing fetuses, infants, and children. In recent years, developmental neurotoxicity studies have been performed on several neurotoxic chemicals. In contrast to other toxicity studies, a developmental neurotoxicity study comprehensively examines neuropathological and neurobehavioural parameters (e.g. functional observation battery, motor activity, learning and memory, and sensory function) in young animals. The 1999 JMPR agreed that it would be useful to compare the critical NOAELs identified in developmental neurotoxicity studies with those identified from the conventional data packages. Available information on the results of developmental neurotoxicity studies summarized in a working paper prepared for the present Meeting were reviewed. The objective of the evaluation was to examine the impact of developmental neurotoxicity studies on the establishment of acute RfDs and ADIs.

Developmental neurotoxicity studies on 14 pesticides that had been evaluated by the US Environmental Protection Agency were reviewed. Both generic and chemical-specific experimental developmental neurotoxicity study designs were considered. Summaries of the NOAELs, LOAELs, and the toxicity end-points of each study and four related studies (developmental toxicity, multigeneration reproductive toxicity, and acute and short-term neurotoxicity studies) that had been performed on each chemical were compared.

The comparison showed that, in general, the majority of the developmental neurotoxicity studies did not identify significantly lower NOAELs and LOAELs compared to those of the other four related studies. The Meeting also observed that currently available data indicate that, with

organophosphorus pesticides, functional and pathological effects in the treated animals were not seen at lower doses than those at which cholinesterase inhibition was observed.

The Meeting identified several critical issues and concerns in conducting a developmental neurotoxicity study, including the introduction of artifacts due to stress resulting from directly dosing the pups and to bolus (gavage) administration. The Meeting believed that should the toxicological profile of a chemical indicate a concern for developmental neurotoxicity end-points, appropriate testing parameters could be incorporated into a multigeneration reproductive toxicity study.

A monograph summarizing the information on developmental neurotoxicity studies that was reviewed by the present Meeting was prepared.

2.5 DRAFT REPORT OF THE OECD/FAO ZONING STEERING GROUP

The Meeting was informed that the draft report of the OECD/FAO Zoning Steering Group was on the Agenda for the next meeting of the OECD Working Group on Pesticides, and recalled that several JMPR members had been involved in one or more meetings of the zoning group.

The meeting noted that the objective of the zoning group was "to define and design world-wide geographic zones for conducting pesticide residue field trials, where, within each zone, pesticide residue behavior would be expected to be comparable and therefore where residue trials data would be considered equivalent and therefore acceptable for regulatory purposes".

As the work of the zoning group addressed the question of the global acceptability of comparable residue trials, the Meeting looked forward to considering the final report once it has been adopted by the OECD Working Group on Pesticides.

In addition, the Meeting noted there were other recommendations from the 1999 York Workshop on Developing Minimum Data Requirements for Elaborating MRLs and Import Tolerances that could be of relevance to JMPR and expressed the hope that these could also be finalized and made available for consideration.

2.6 DATA REQUIREMENT FOR EVALUATION OF RESIDUE TRIALS SUBMITTED BY GOVERNMENTS

For estimating maximum residue levels of pesticide residues in commodities moving in international trade, results of supervised trials representing the typical agriculture practices and the growing and climatic conditions prevailing in all exporting countries should ideally be considered. The Codex Committee on Pesticide Residues has repeatedly requested national Governments to provide information reflecting their GAP.

Several Governments have submitted residue data derived from supervised trials often without the essential details needed to support their evaluation.

The FAO published the revised manual on 'Submission and evaluation of pesticide residues data for the estimation of maximum residue levels in food and feed' (FAO Plant Production and Protection Paper 170, 2002, <http://www.fao.org/waicent/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/default.htm>). Chapter 3 of the manual provides detailed guidance on data requirements.

The Meeting invited national Governments to consult the relevant sections for details when preparing their submissions.

Data submissions sometimes did not contain essential details such as:

1. The submission of information on national GAP in the format of the Table XI.2

- Important for generic pesticides produced by several manufacturers;
- Crops included in crop groups should be named individually;
- Individual commodities should preferably be referenced to the Codex Classification of Food and Animal Feed.

2. Results of supervised trials

Examples of essential information to be given:

- target and actual dose applied;
- application methods and their relevance to the registered uses;
- method of sampling, size of sample (number of primary samples, total mass of sample), consider Appendix V and Codex Sampling procedure (ftp://ftp.fao.org/codex/standard/en/cxg_033e.pdf);
- storage conditions of the samples during the period from sampling to analysis, time between sampling and analysis;
- portion of commodity analyzed (Appendix VI of the manual);
- summary of trials in the form of table XI.3.

3. Analysis

- Report all significant residues for MRL compliance and dietary intake assessment individually as far as technically possible.
- Report residues measured and recovery values obtained at different concentration levels. If residues measured were adjusted for average recovery report both values. (The adjustment should never be done with a single procedural recovery.)
- Distinguish analytical replicates from results of replicate samples taken from the same plot.
- Describe the analytical method used in the trial; include the validation data, typical chromatograms for blank and treated samples.

2.7 GUIDANCE FOR SUBMISSION OF PESTICIDE RESIDUE MONITORING DATA ON SPICES

The 34th Session of the CCPR (2002) requested the JMPR to develop guidance for the submission of monitoring data for setting MRLs or EMRLs for spices (ALINORM 03/24 par 209). The request was made in response to the proposal of the paper of South Africa in cooperation with India, Egypt, Indonesia and the Spice Trade Associations, Sri Lanka and the International Trade Centre (UNCTAD/WTO). It pointed out that most of the spices moving in international trade were produced by millions of small-scale farmers, frequently on farms of less than 10 ha, and usually by inter-cropping. The presence of residues was, therefore, frequently associated with products used for pest control on the main crop rather than on the spices themselves.

The Meeting noted that the CCPR invited South Africa and its drafting partners to prepare a document for consideration at its next meeting on the criteria to be applied for the use of monitoring data for setting MRLs, and compiled the basic information required for estimating maximum residue levels based on monitoring data.

The JMPR has already recognized that it is not possible to carry out supervised trials on all varieties and cultivars of crops, or even on all crop species on which a pesticide may be used. The 1978 JMPR concluded that comprehensive selective surveys, which included many of the essential features of supervised trials, could be of great value in estimating maximum residue levels, and submission of such data for consideration was encouraged.

The Meeting confirmed a previous JMPR conclusion that monitoring studies on samples of unknown history may be used for estimating EMRLs but such data would be less valuable for estimating maximum residue levels.

The Meeting considered the range of pesticide residues detected in Egypt in a few spice species and the number of analyses in India between 1992 and 2001 and concluded that without having the detailed results it cannot be judged whether the estimation of maximum residue levels would be possible.

The Meeting recommends to CCPR to invite both exporting and importing Member Governments to submit their monitoring data on pesticide residues.

For preparing their submissions the data submitters are advised to consult the relevant parts, especially 'Estimation of extraneous maximum residue levels in Chapter 5, of the revised FAO manual on 'Submission and evaluation of pesticide residues data for the estimation of maximum residue levels in food and feed' (FAO Plant Production and Protection Paper 170, 2002, <http://www.fao.org/waicent/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/default.htm>). The submissions should contain all relevant information on the current and past uses of pesticides in spices. Results below the LOQ should be reported but only for those pesticides that were specifically looked for and for which MRLs are sought.

The data should be summarised in the following format, but all relevant details must be provided as well:

Origin (Country/ Location/year)	Crop	Pesticide	Residue measured [mg/kg]	Recovery %	Comments

Comments should include all relevant information such as:

- Reference to analytical method used,
- Residue components included in the reported result (residue definition);
- If reported results were adjusted for recovery, the method of adjustment.

The individual results should also be presented in an electronic Excel spreadsheet file.

When the CCPR agrees to establish MRLs based on monitoring data, the JMPR would evaluate the data submission and would prepare guidelines for performing selective field surveys to support elaboration of MRLs for spices for which sufficient data are not currently available.

CCPR should also provide information on the number of monitoring data and the geographical spread that could be considered acceptable by the members for estimating maximum residue levels.

GEMS/Food has provided dietary consumption data for a limited number of spices. CCPR should indicate if it is acceptable to use the current GEMS/Food total spice-consumption data for risk assessment of those spices not specifically listed.

2.8 STATISTICAL METHODS FOR ESTIMATION of MRLs

The Meeting welcomed the initiative of the OECD Secretariat and the Working Group on Pesticides to contribute to the development of a statistically based approach for the estimation of MRLs. The method proposed by the statistician hired by OECD was tested for 107 pesticide-commodity data sets. It overestimated the residues in most cases. The Meeting recognized the difficulties of the statistical treatment of scattered small data sets and presently did not see the ways for proceeding further with this approach.

2.9 VARIABILITY OF RESIDUES IN NATURAL UNITS OF CROPS (see also Annex 7)

In the International Workshop on Acute Risk Assessment the need for additional data on grapes and leafy vegetables was identified. The European Crop Protection Association (ECPA) decided to sponsor studies in grapes and lettuce. A separate study was initiated in Hungary by the FAO/IAEA Training and Reference Centre for Food and Pesticide Control.

Grape field trials were carried out in typical vine growing areas of Southern France (2), the Rhine valley in Germany (2) and the Tokaj region in Hungary. The active substances of the products belonged to the classes of anilinopyrimidines, triazoles, pyrethroids, organophosphorus compounds, acylalanine - phenylamides and dicarboximides and were applied once in a tank mix. The application methods were following the normal farming practice. Samples were taken either following stratified random design according to the abundance of fruits at the lower, middle and upper parts of the vines or cluster of bunches, or uniformly from fields where stratified random sampling was not feasible. 120 individual grape bunches or clusters of typically 2- 4 bunches were taken from each treated plot 7 days after application and analyzed individually. The average weight of sampled units (bunch or cluster) were 400 and 563 g in France, 149 and 222 g in Germany and 213 g in Hungary. The 120 residue data points represent 97.5% of the population with 95% probability.

The LOQ of analytical methods enabled the detection of the majority of residues except those of the triazole pesticide which was present at concentrations \leq LOQ in 42 - 61% of the bunches in the German trials and 23% in one trial in France. As the within field variability of the residues was in the range of 36-60% in the French and German trials and between 60-100% in the Hungarian trials, on an average, the contribution of the relative uncertainty of the analytical methods to the variability of the results was negligible.

In addition to the 120 bunches, the upper, middle and lower segments of 9 grape bunches were analyzed separately in Hungary in order to estimate the within-bunch variability of the residues. The within bunch variability factors were calculated as the ratio of the maximum residue measured in a segment and the average residue in the whole bunch. Since the maximum within bunch variability factors were similar for the three type of pesticides, the typical within bunch variability factor was calculated as the average (2) of the three values (1.7, 2.1, 2.2).

The reported large portions sizes in various countries [Australia 513 g (children 342 g), Netherlands 400 g (children 200 g), USA 322 g (children 240g), UK 190 g (children 158g)] are

substantially smaller than the 600-1100 g weight of clustered bunches in French trials. In order to get a more realistic estimate for the variability factor from the French trials, the residues measured in clustered bunches were multiplied by the average within-bunch variability factor (2) and the weight of the bunches were divided by 2. The original and the recalculated values are summarized below.

	Anilino-pyrimidine	Triazole	Pyrethroid	Organophosphate	Dicarboximide
France original	2.5, 2.8	3.6, 3.6	2.3, 2.7	2.3, 2.5	2.3, 3.1
France adjusted	2.3, 3.7	2.5, 3.1	2.3, 3.6	2.3, 2.4	2.2, 3.6
Germany	2.6, 2.9	2.3, 2.4	2.3, 2.8	2.5, 3.3	2.7, 5.7
Hungary	Metalaxyl			Chlorpyrifos	Vinclozoline
	3.5			8.5	8.5

The variability factors obtained for various pesticides in the French and German trials were similar. The higher variability observed in the Hungarian trial may be the result of the different cultivation and spraying methods, and the layout of the experimental site that included 5 treated rows, while only a single row was treated in France and Germany.

In other commodities for which more data sets were available (PSD UK), a similar spread of variability factors was found (number of data sets in brackets): apple: 2.1-9.0 (16); kiwi: 2.1-7.2 (9); plum 2.7-7.6 (8).

The various pesticides applied in the tank mixture showed similar variability at each location, with the exception of metalaxyl. Such a phenomenon is not unique. Though most of the active ingredients showed similar distribution patterns in data sets of various commodity-pesticide combinations, a different distribution pattern was also reported in the case of a post-harvest tank-mix application of various pesticides on apples.

Considering the ongoing field trials in various locations, the Meeting decided that, until the additional results can be evaluated, the currently applied generic variability factor of 7 would be applied for estimating the acute exposure of pesticide residues in grapes.

In head lettuce Locness, Einstein and Nadine varieties were treated in field trials at closely located sites in Southern France and in Southern Germany. Pesticides belonging to the classes of anilino-pyrimidines, triazoles, pyrethroids, organophosphates, carbamates and dicarboximides were applied by a knapsack sprayer with a lance in a tank mix in France, and with an air supported boom sprayer in Germany. 120 individual lettuce heads were taken from each treated plot 3 days after application. The LOQ of the analytical methods enabled the detection of all residues.

Ranges of variability factors calculated for various active ingredients:

	Anilino-pyrimidine	Triazole	Pyrethroid	Organophosphate	Dicarboximide	Carbamate
France	2.1, 2.1	1.6, 2.0	1.8, 1.9	1.3, 1.6	1.8, 2.0	2.1, 2.1
Germany	1.3, 2.2	1.4, 1.8	1.3, 2.2	1.3, 2.8	1.5, 2.4	1.5, 1.7

The between-field variability of average residues in these four trials (40-66%) was about the same as those observed in other trials performed in France, Germany and Italy according to GAP (40-50%), indicating that the trials carried out with unit crops represent the likely variability of residues.

The Meeting concluded that a variability factor of 3 would properly represent the variability of residues in head-lettuce and head-cabbage and recommended this factor for calculation of acute exposure for these commodities. The default variability factor will however be used for leaf-lettuce and other leafy vegetables.

2.10 INTAKE CALCULATION FOR MEAT AND FAT

The 2001 JMPR decided to use the residue levels in bovine muscle tissue for estimating the dietary intake of fat-soluble compounds. Previously, residue levels in trimmable fat were adjusted by a default factor and were then used to estimate the dietary intake for meat (JMPR Report, 2001).

The 34th CCPR (The Hague, The Netherlands, 2002) requested clarification from the JMPR on the derivation of the residue value used for dietary intake calculations for meat. Some Delegations and NGOs expressed the opinion that the new JMPR procedure ignores the contribution from fat, which can be the major source of residue for fat-soluble pesticides (ALINORM 03/24).

The Meeting noted an input from the USA in response to the request of the 34th CCPR for information on the practices of national governments (ALINORM 03/24, paragraph 31). The USA was of the opinion that the previous JMPR procedure should be retained for fat-soluble pesticides. It was noted that many fat-soluble pesticides will not be detected in lean muscle, and that dietary exposure from such pesticides will be underestimated if only the residue in meat is considered.

The JECFA JMPR Informal Harmonization Meeting in Rome in 1999 agreed that JMPR meat would be made equivalent to JECFA muscle by specifying removal of the trimmable fat from the muscle during sample preparation. Thus, the JMPR MRL for meat is without the trimmable fat. For non-fat soluble pesticides, meat with trimmable fat removed should be analyzed. For fat-soluble pesticides, it was decided that the trimmable fat should be analyzed, thus providing the basis for the JMPR MRL for meat (fat). (FAO/WHO Report: JECFA/JMPR Informal Harmonization Meeting, 1 – 2 February 1999); JMPR Report, 1999, General Consideration 2.3)

Based on the recommendations of the Harmonization Meeting as adopted by the 1999 JMPR, it would be acceptable to use values determined from the analysis of meat with trimmable fat removed for dietary intake calculations purposes for non-fat soluble pesticides. For the fat soluble pesticides, the values determined from the analysis of the trimmable fat should be included in the dietary intake calculations.

For fat soluble pesticides, it would exaggerate the dietary risk to use the meat (fat) estimate, i.e, dietary consumption is not 100% trimmable fat. As consumed, meat contains variable amounts of fat. Some processed meats, such as sausage, may contain very high percentages of fat, and the fat content on hamburger (ground beef) may range from 10 - >30% . Historically, the JMPR has used an average fat content of 20% for bovine meat and 10% for poultry meat.

For dietary intake calculations for pesticides, the Meeting considered that 20% of the cattle meat consumption value/large portion should be considered to contain residue at the level of fat and that 80% of the meat consumption value/large portion should be considered to contain residue at the level of meat with trimmable fat removed. The corresponding numbers for poultry are 10% and 90%, respectively. This procedure would apply to both fat-soluble and non-fat-soluble pesticides.

Where adequate data are not available, e.g., TMDI situations, the dietary intake calculation would be based on the MRL for meat (fat) for fat soluble pesticides and the MRL meat for non-fat soluble pesticides. For mammalian animals, 20% of the meat consumption would be used for fat-soluble pesticides and 80% of meat consumption would be used for non-fat soluble pesticides. For poultry, the corresponding values are 10% and 90%.

The new procedure can be illustrated with an example from the considerations of the 2002 JMPR. For deltamethrin, the cattle fat residue values from *dietary* exposure were a HR of 0.19 mg/kg and an STMR of 0.16 mg/kg. The cattle muscle residue values were a HR of 0.027 mg/kg and an STMR of 0.01 mg/kg. The poultry fat values residue values were a HR of 0.09 mg/kg and an STMR of 0.038 mg/kg. The poultry muscle residue values were a HR of 0.02 mg/kg and an STMR of 0.02 mg/kg. The following tables illustrate the new calculation procedure for meat.

DELTA METHRIN (135): International Estimate of Daily Intake													
ADI=0.01 mg/kg bw or 600 µg/person; 550 µg/person for Far East													
		MRL	STMR or STMR- P	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
Code	Commodity	mg/kg	mg/kg	diet	intake	diet	intake	diet	Intake	Diet	intake	Diet	Intake
MM 95	Meat (mammals other than marine)			37		32.8		23.8		47		155.5	
	<i>Muscle (meat consumption X 80%)</i>		0.01	29.6	0.3	26.2	0.3	19.0	0.2	37.6	0.4	124.4	1.2
	<i>Fat (meat consumption X 20%)</i>		0.16	7.4	1.2	6.56	1.0	4.76	0.8	9.4	1.5	31.1	5.0
PM110	Poultry meat			31		13.2		5.5		25.3		53	
	<i>Muscle (meat consumption X 90%)</i>		0.02	27.9	0.6	11.8	0.2	4.95	0.1	22.7	0.5	47.7	1.0
	<i>Fat (meat consumption X 10%)</i>		0.04	3.1	0.1	1.32	0.1	0.55	0.0	2.53	0.1	5.3	0.2
			TOTAL =		2		2		1		2		7
			% ADI =		0%		0%		0%		0%		1%

DELTAMETRIN (135): Estimate of short-term intake (IESTI) for children up to 6 years													
Acute RfD = 0.03 mg/kg bw or 30 ug/kg bw													
Code	Name	STMR or STMR P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, µg/kg bw/day	% acute RfD
				Count ry	Body weight, kg	Large portion, g	Unit weight g	Count ry	Edible portion, g				
MM 95	Meat (mammals other than marine)					204					1	0.7	2
	<i>Muscle (meat consumption X8 0%)</i>		0.03	AUS	19	163					–	0.3	
	<i>Fat (meat consumption X2 0%)</i>		0.19	AUS	19	41					–	0.4	
PM110	Poultry meat					247					1	0.3	1
	<i>Muscle (meat consumption X9 0%)</i>		0.02	FRA	17.8	222.00					–	0.2	
	<i>Fat (meat consumption X10%)</i>		0.09	FRA	17.8	25.0					–	0.1	
												MAX IESTI	2

2.11 MAXIMUM RESIDUE LEVELS FOR ANIMAL COMMODITIES – GROUP MRLS

When residues occur in crops and animal feeds there is the potential for residues to transfer to animals. In such situations it is difficult to control the species of livestock which will be exposed. The Meeting recognized that the practice followed in selecting the species for which maximum residue levels for animal tissues, milk and eggs will be recommended has not always been consistent. In some evaluations, maximum residue levels have only been recommended for the animal species for which feeding trials have been available while in other cases, results from dairy cattle or laying hen feeding studies have been extrapolated to make recommendations for mammalian (or cattle, goat, sheep and pig) and poultry commodities respectively.

The Meeting also recognized that:

- it is current practice in many countries (e.g. the EU, the USA and Australia) to extrapolate cattle feeding studies to other ruminants and pigs and to extrapolate laying hen feeding studies to poultry.
- not recommending maximum residue levels for other animal commodities leads to these potential commodities not being accounted for in the dietary intake estimates.
- lack of recommendations of maximum residue levels for “other species” ignores the potential for residues and may lead to problems in trade.
- it is not practical for JMPR/CCPR to require studies not required by individual countries.

Information extracted from recent JMPR monographs for selected compounds has been used to derive transfer factors (residue in tissue ÷ nominal feeding level) from metabolism studies where the dosing was for 3 or more days and animal feeding studies (mean transfer factors). Where possible the feeding levels used to estimate the transfer factors were selected to be as close as possible to each other for the different species dosed with the same compound. The tabulated transfer factors for goats and sheep are the same (within the uncertainty associated with the estimates) or lower than those for cattle.

Tissue transfer factors for various pesticides

Compound	Nominal feed level (ppm)	Tissue	Transfer factor				Reference
			Pigs	Sheep	Goats	Cows	
piperonyl butoxide	100	Fat		-	0.0013	0.002	JMPR 2001
piperonyl butoxide	100	liver			0.001	0.001	JMPR 2001
piperonyl butoxide	100	kidney			0.0001	<0.0005	JMPR 2001
Spinosad (A+D)	10	Fat			0.3	0.57	JMPR 2001
Tebufozide	60c ¹ 50g	Fat			0.002	0.004	JMPR 2001
Tebufozide	60c 50g ¹	kidney			0.0003	0.0005	JMPR 2001
Diphenylamine	30c 45g	Fat			0.00009-0.0002	0.0002	JMPR 2001
Diphenylamine	30	liver			0.00006-0.0001	0.001	JMPR 2001
Fipronil (parent+4950+46136)	0.43c 2g	Fat			0.05	1.2	JMPR 2001
Fipronil (parent)	0.43c 10g	Fat			0.0013	0.077	JMPR 2001
Fenthion	20c 500g	Fat			0.001	0.005	JMPR 2000
Captan (THPI)	100c 50g	kidney			0.0012	0.001-0.004	JMPR 2000
Captan (THPI)	100c 50g	Fat			0.0005-0.002	0.0003-0.001	JMPR 2000
Captan (THPI)	30c 50g	kidney			0.0012	0.002-0.005	JMPR 2000
Captan (THPI)	30c 50g	Fat			0.0005-0.002	0.0003-0.002	JMPR 2000
Bifenthrin	5-15 c 50 ² g	Fat			0.03	0.07-0.17	JMPR 1992
Chlorpyrifos	10c 15-19g 10p ¹	Fat	0.005-0.018		0.005-0.009	0.007-0.015	JMPR 2000
Cypermethrin	50	Fat				0.06	JMPR 1981
Cypermethrin	50	Fat				0.013-0.039	JAFC 1997 45 4850
Endosulfan (α- + β-endosulfan + endosulfan sulphate)	30c 25g + 6.3s ¹	Fat		0.05	0.002	0.36	US EPA IRED, Res Rev 1967, 4

¹ c = cow, g = goat, s = sheep, p = pig

² assumed 60 kg bw and a feed consumption of 4% bw

It is apparent that there is significant variability in transfer factors for groups of animals from the same species, see cypermethrin (usually in a single experiment the variation is not as large as between different groups of animals/experiments).

For the pesticides examined, the transfer factors for cattle are usually greater than those for goats/sheep. In some cases the transfer factor for goats is much smaller than for cattle. While the use of the cattle feeding study (transfer factors for cattle) to estimate maximum residue levels should result in estimated levels that would cover likely residues in goats and sheep, the converse is not always true. It is apparent that caution must be used in making conclusions about the likelihood of significant residues in cattle tissues and milk based solely on lactating goat studies.

Taking account of the above and noting that estimates of animal dietary burden are approximations, the Meeting decided that generally it would use cattle feeding studies to recommend maximum residue levels for mammalian commodities to cover the potential exposure of an animal to a pesticide in the diet. The suite of maximum residue levels recommended should be selected from: MM 0095 Meat (from mammals other than marine mammals)⁷, MO 0098 Kidney of cattle, goats, pigs and sheep, MO 0099 Liver of cattle, goats, pigs and sheep and ML 0106 Milks. Where residues in liver and kidney are essentially the same or nil, an option is to recommend a MRL for MO 0105 Edible offal (Mammalian).

No information was available to support the extrapolation of oral dosing/feeding studies in chickens or laying hens to poultry, however, as chickens are such a major part of the group poultry, it is reasonable to extrapolate from chickens to poultry. Maximum residue levels should be recommended for poultry and selected from: PM 0110 Poultry meat⁸, PO 0111 Poultry, Edible offal⁹ and PE 0112 Eggs.

The Meeting also noted that extrapolation based on direct animal treatment is generally not justified as there are significant species differences in residue transport through skin and in animal behavior (e.g. grooming in cattle but not in sheep) that have implications for possible residues in tissues.

DELTA METHRIN (135): international estimate of short-term intake (IESTI) for general population													
Acute RfD=0.05 mg/kg bw or 50µg/kg bw													
Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, µg/kg bw/day	% acute RfD
				Count	Body weight, kg	Large portion, g	Unit weight, g	Count	edible portion, g				
MM 0095	Meat (mammals other than marine)					521					1	0.5	1

⁷ muscular tissues with trimmable fat removed. For fat-soluble pesticides a portion of adhering fat is analysed and MRLs apply to the fat.

⁸ muscular tissues including adhering fat and skin from poultry carcasses as prepared for wholesale or retail distribution. For fat-soluble pesticides a portion of adhering fat is analysed and MRLs apply to the poultry fat.

⁹ such edible tissues and organs, other than poultry meat and poultry fat, from slaughtered poultry as have been passed fit for human consumption. Examples: liver, gizzard, heart, skin etc.

	<i>Muscle(meat consumption x 80%)</i>		0.03	AUS	67	417					–		
	<i>Fat(meat portionX20%)</i>		0.19	AUS	67	104					–	0.3	
PM110	Poultry meat					472					1	0.2	0
	<i>Muscle (meat consumptionX90%)</i>		0.02	AUS	67	425.00					–	0.1	
	<i>Fat (meat consumption X10%)</i>		0.09	AUS	67	47.0					–	0.1	
												MAX IESTI =	1

The Meeting concluded that the mixed 20% fat/80% muscle values for cattle and other mammalian animals and the mixed 10% fat/90% muscle values for poultry should be used for dietary intake calculations for meat in order to provide a more realistic estimation of the dietary exposure of consumers.

2.12 POLICY ON MRLs FOR COMMODITIES OF ANIMAL ORIGIN WHEN RESIDUES ARE UNLIKELY TO OCCUR IRRESPECTIVE OF RESIDUE LEVELS IN FARM ANIMAL DIETS

When residues occur in commodities that may be fed to farm animals and when suitable farm animal metabolism and feeding studies are available JMPR recommends MRLs for meat, milk and eggs.

Some compounds are very readily metabolised or are quickly broken down in the presence of animal tissues, eggs or milk. In such cases the parent compound and sometimes their primary metabolites are not found in animal tissues, eggs or milk when animals are exposed to residues in their feed, irrespective of the feeding levels. Consequently, monitoring programs are unlikely ever to detect residues of such compounds in animal commodities.

When suitable farm animal metabolism and feeding studies and analytical methods are available for such compounds JMPR currently recommends MRLs at or about the LOQ for the animal commodities. These recommended MRLs alert users of Codex MRLs that the situation has been fully evaluated and that, for the commodities of trade, residues should not occur above the stated LOQ.

Some national governments take a different approach and do not set MRLs where residues are never expected to occur in animal commodities and where monitoring would be of no use for enforcing GAP.

The Meeting requested CCPR to advise which is the preferred approach for Codex MRLs for animal commodities where residues are unlikely to occur:

- MRLs recommended at or about the LOQ; or
- no MRL recommendations.

2.13 USE OF THE TERMS "BOUND RESIDUE" AND "NON-EXTRACTABLE RESIDUE"

In evaluations, the term "residue" can be applied to any component derived from the pesticide applied, including the parent compound and primary metabolites.

For non-experts, and even a significant proportion of people with some experience and knowledge of pesticides, the terms "bound residue" and "non-extractable residue" tend to be construed as referring to "hidden" residues that are capable of regenerating the component(s) of the residue definition. Reference to such residues can therefore be interpreted as an indication that residue levels are widely under-estimated by analysis, because the "bound" or "non-extractable" residues may liberate toxic components from ingested food.

"Bound" or "non-extractable" residues can be difficult or expensive to identify with certainty but there are relatively few known cases where it has been shown that such residues are truly capable of liberating toxic components from ingested food.

In the interests of improving risk communication, the use of these terms should be restricted to cases where they relate to the liberation of toxic components from ingested food.

In referring to studies based on the use of radiolabelled pesticides, it is preferable to use the term "unextracted radiolabel" to describe the components which were not extracted and identified.

3. DIETARY RISK ASSESSMENT FOR PESTICIDE RESIDUES IN FOOD

Assessment of risk of long-term dietary intake

Risks associated with long-term dietary intake were assessed for compounds for which MRLs and STMRs were considered at the present Meeting. Dietary intakes were calculated by multiplying the concentrations of residues (STMRs or STMR-P values or recommended MRLs) by the average daily *per capita* consumption estimated for each commodity on the basis of the GEMS/Food diet^{1,2,3}. Theoretical maximum daily intakes (TMDIs) were calculated when only recommended or existing MRLs were available. International estimated daily intakes (IEDIs) are derived only when STMR or STMR-P values are used in the calculation. Dietary intakes were estimated from combinations of recommended MRLs and STMR or STMR-P values. Codex MRLs that have been recommended by JMPR for withdrawal were not included in the estimation.

Long-term dietary intakes are expressed as a percentage of the ADI for a 60-kg person, with the exception of the intake calculated for the Far East, in which a body weight of 55 kg is used⁴. The estimates are summarized in Table 1. The percentages up to and including 100% are rounded to one significant figure and values above 100% to two significant figures. When the percentages for the compounds for which IEDIs are calculated are greater than 100%, the information provided to JMPR does not allow estimation that the dietary intake would be below the ADI. The detailed calculations of long-term dietary intake are given in [Annex 3](#).

The Meeting drew attention to the calculation of the dietary intake of both fat soluble and non fat soluble pesticides in meat. For mammals, 20% of meat consumption value should be considered to contain residue at the concentration level in fat and that 80% of the meat consumption should be considered to contain residue at concentration level in meat with the trimmable fat removed (muscle). For poultry, the percentages are 10 and 90%, respectively (General Consideration 2.10)

The dietary intake of esfenvalerate was considered together with fenvalerate, as these compounds have the same residue definition.

A group ADI was established at this Meeting for matalaxyl and metalaxyl M. The dietary intake was considered for metalaxyl using existing MRLs. No intake calculation was performed for metalaxyl M as no residue data was available.

Calculations of dietary intake can be further refined at the national level by taking into account more detailed information, as described in the Guidelines for predicting intake of pesticide residues¹.

Table 1. Summary of risk assessments of long-term dietary intake conducted by the 2002 JMPR

Code	Name	ADI (mg/kg bw)	Intake range (% of maximum ADI)	Type of assessment
095	Acephate	0-0.01	4-50	TMDI + IEDI
008	Carbaryl	0-0.008	10-60	IEDI
096	Carbofuran	0-0.002	10-30	IEDI
144	Bitertanol	0-0.01	2-10	IEDI
135	Deltamethrin	0-0.01	20-30	IEDI

Code	Name	ADI (mg/kg bw)	Intake range (% of maximum ADI)	Type of assessment
130	Diflubenzuron	0-0.02	1-6	IEDI
119	Fenvarelate +			
204	Esfenvarelate	0-0.02	50-70	TMDI + IEDI
205	Flutolanil	0-0.09	0-1	IEDI
048	Lindane	0-0.005	70-160	TMDI
138	Metalaxyl	0-0.08	2-10	TMDI
100	Metamidophos	0-0.004	4-40	TMDI + IEDI
206	Imidacloprid	0-0.4	0-2	IEDI
126	Oxamyl	0-0.009	2-10	IEDI
056	2-Phenylphenol	0-0.4	0	IEDI
103	Phosmet	0-0.01	0-40	IEDI
062	Piperonyl butoxide	0-0.2	20-40	IEDI
113	Propargite	0-0.01	2-10	IEDI
162	Tolyfluanid	0-0.08	0-2	IEDI
143	Triazophos	0-0.001	30-100	TMDI

Assessment of risk of short-term dietary intake

Risks associated with short-term dietary intake were assessed for compounds for which MRLs were recommended and STMR values estimated at the present Meeting and for which an acute reference dose (acute RfD) has been established, in commodities for which data on consumption were available. The procedures for calculating the short-term intake were defined primarily at the Geneva Consultation (WHO, 1997b) and refined at subsequent meetings⁵ (Annex 5, reference 89). Data on the consumption of large portions were provided by Australia, France, The Netherlands, Japan, the United Kingdom and the USA. Data on unit weight and per cent edible portion were provided by France, the United Kingdom and the USA. The body weights of adults and children aged ≤ 6 years old were provided by Australia, France, the Netherlands, the United Kingdom and the USA. The consumption, unit weight and body weight data used for the short-term intake calculation were compiled by GEMS/FOOD and are available at www.who.int/fsf/Chemicalcontaminats/Acute_Haz_Exp_Ass.htm. The documents are dated 04/15/2000.

International estimated short-term intake (IESTI)

Depending on the data on consumption, the IESTI for each commodity is calculated from the equation defined for each case, as described below. The following definitions apply to all equations:

- LP highest large portion provided (97.5th percentile of eaters), in kg of food per day
- HR highest residue in composite sample of edible portion found in data from supervised trials data from which the MRL or STMR was derived, in mg/kg
- HR-P highest residue in the processed commodity, in mg/kg, calculated by multiplying the HR in the raw commodity by the processing factor
- bw body weight, in kg, provided by the country for which the large portion, LP, was used

- U unit weight in edible portion, in kg, provided by the country in the region where the trials which gave the highest residue were carried out; calculated allowing for the per cent edible portion
- v variability factor
- STMR supervised trials median residue, in mg/kg
- STMR-P supervised trials median residue in processed commodity, in mg/kg

Case 1.

The concentration of residue in a composite sample (raw or processed) reflects that in a meal-sized portion of the commodity (unit weight is < 25 g). This case also applies to meat, liver, kidney, edible offal and eggs.

$$IESTI = \frac{LP * (HR \text{ or } HR-P)}{bw}$$

Case 2.

The meal-sized portion, such as a single piece of fruit or vegetable, might have a higher residue than the composite (unit weight of the whole portion is > 25 g). The variability factors, v, shown below are applied in the equations. When sufficient data are available on residues in single units to calculate a more realistic variability factor for a commodity, the calculated value should replace the default value. Recent residue data on unit crops made possible the refinement of the variability factor for head lettuce and head cabbage (General Item 2.9)

Commodity characteristic	v
Unit weight is > 250 g, with the exception of head cabbage	5
Unit weight is ≤ 250 g	7
Unit weight is ≤ 250 g, from granular soil treatment	10
Leafy vegetables with unit weight is ≤ 250 g, with the exception of head lettuce	10
Head lettuce and head cabbage	3

When data are available on residues in a single unit and thus allow estimation of the highest residue in a single unit, this value should be used in the first part of the equation for case 2a, with no variability factor, and the HR value derived from data on composite samples should be used in the second part of the equation. For case 2b, the estimated highest residue in a single unit should be used in the equation with no variability factor.

Case 2a

The unit weight of the whole portion is lower than that of the large portion, LP.

$$IESTI = \frac{U * (HR \text{ or } HR-P) * v + (LP-U) * (HR \text{ or } HR-P)}{bw}$$

Case 2b

The unit weight of the whole portion is higher than that of the large portion, LP.

$$IESTI = \frac{LP * (HR \text{ or } HR-P) * v}{bw}$$

Case 3

When a processed commodity is bulked or blended, the STMR-P value represents the probable highest concentration of residue. This case also applies to milk.

$$\text{IESTI} = \frac{\text{LP} * \text{STMR-P}}{\text{bw}}$$

A risk assessment for short-term dietary intake was conducted for each commodity–compound combination by assessing the IESTI as a percentage of the acute RfD. When the maximum residue level was recommended for a Codex commodity group (i.e. citrus fruit), intakes will be calculated for individual commodities within the group. The selected commodities should include the one (s) that will lead to the highest intake.

The Meeting drew attention to the calculation of the dietary intake of both fat soluble and non fat soluble pesticides in meat. For mammals, 20% of meat large portion should be considered to contain residue at the concentration level in fat and that 80% of the meat large portion should be considered to contain residue at the concentration level in the meat with the trimmable fat removed (muscle). For poultry, the percentages are 10 and 90%, respectively (General Consideration 2.10)

The present Meeting concluded that acute RfDs might be necessary for captan, folpet, bentazone and imazalyl, but these have not yet been established. The Meeting recommended that these compounds be evaluated for establishment of acute RfDs in near future.

Acute RfDs were established for acephate, lindane, methamidophos, oxydemeton methyl, permethrin and triazophos, but short-term intake was not calculated as no information on STMRs and HRs were available for these compounds.

Earlier Meetings concluded that acute RfD are unnecessary for bitertanol, diflubenzuron, piperonyl butoxide, 2-phenyl-phenol and propargite. This conclusion was confirmed at this Meeting for the two latter compounds. On the basis of data received by the present Meeting, the establishment of acute RfDs was considered to be unnecessary for flutolanyl, metalaxyl and metalaxyl-M. Therefore, as residues are unlikely to present an acute risk to consumers, intake of these compounds was not estimated.

The percentage of the acute RfD for the general population and for children are summarized in Table 2. They are rounded to one significant figure for values up to and including 100% and to two significant figures for values above 100%. If the percentage is greater than 100%, the information provided to the JMPR does not allow an estimation that the short-term dietary intake of the residue in that commodity would be below the acute RfD. The detailed calculations of short-term dietary intake are given in [Annex 4](#).

Table 2. Summary of risk assessments of short-term dietary intake conducted by the 2002 JMPR

Code	Compound	Acute RfD (mg/kg bw)	Commodity	Percentage of acute RfD	
				General population	Children ≤ 6 years old
117	Aldicarb	0.003	Banana	40	110
008	Carbaryl	0.20	Cherries	50	130

Code	Compound	Acute RfD (mg/kg bw)	Commodity	Percentage of acute RfD	
				General population	Children ≤ 6 years old
			Grapes	420	1100
			<i>Stone fruits,</i>		
			Apricot	40	130
			Peaches	80	170
			Plums	50	140
			Other commodities	0-40	0-80
096	Carbofuran	0.009	All commodities	2-20	4-60
135	Deltamethrin	0.05	<i>Leafy vegetables,</i>		
			Chinese cabbage	60	120
			Spinach	50	130
			Other commodities	0-20	0-30
119	Esfenvalerate	0.02	All commodities	0-3	0-10
106	Ethephon	0.05	Cantaloupe	30	110
			Peppers	90	110
			Pineapple	70	130
			Tomato	60	200
			Other commodities	4-30	7-90
085	Fenamiphos	0.003	Carrot	40	110
			Grapes	80	210
			Peppers	220	260
			Pineapple	120	320
			Tomato	170	600
			Watermelon	100	260
			Other commodities	0-40	0-70
206	Imidacloprid	0.4	All commodities	0-4	0-20
126	Oxamyl	0.009	Apple	430	1300
			Cucumber	190	400
			Grapefruit	610	1100
			Lemon	200	730
			Mandarins	390	1400
			Melons, except	300	650
			watermelons	390	1600
			Oranges, sweet, sour	610	1100
			Peppers	190	660
			Tomato		
			Other commodities	0-10	0-30
103	Phosmet	0.02	Blueberry	120	390
			<i>Citrus fruits,</i>		
			Grape fruits	80	150
			Orange, sweet	170	62
			Nectarine	780	2200
			<i>Pome fruits,</i>		
			Apple	1200	3500
			Pear	910	3000
			Other commodities	0-80	0-2
162	Tolyfluanid	0.50	All commodities	0-20	0-70

References:

- ¹ WHO (1997) *Guidelines for predicting dietary intake of pesticide residues*. 2nd revised edition, GEMS/Food Document WHO/FSF/FOS/97.7, Geneva
- ² WHO (1997) *Food consumption and exposure assessment of chemicals*. Report of a FAO/WHO Consultation. Geneva, Switzerland, 10–14 February 1997, Geneva
- ³ WHO (1998). *GEMS/FOOD Regional Diets. Food Safety Issues*. WHO/FSF/98.3. Geneva.
- ⁴ Codex Alimentarius Commission, 1997, CX/PR 98/5
- ⁵ Pesticide Safety Directorate 1998. *Pesticide Residues Variability and Acute Dietary Risk Assessment*. York.

4. EVALUATION OF DATA FOR ACCEPTABLE DAILY INTAKE (ADI) FOR HUMANS, MAXIMUM RESIDUE LEVELS (MRL) AND SUPERVISED TRIALS MEDIAN RESIDUE (STMR) VALUES

4.1 ACEPHATE (095)

TOXICOLOGY

The Joint Meeting previously evaluated the toxicity of acephate (*O,S*-dimethyl acetylphosphoramidothioate) in 1976, 1982, 1984, 1987, 1988 and 1990. It was re-evaluated by the present Meeting within the periodic review programme of the Codex Committee on Pesticide Residues. The Meeting reviewed new data on acephate that were not previously reviewed and relevant data from the previous evaluations.

Acephate is a racemic organophosphorus insecticide. Inhibition of cholinesterase activity is the basis for its major toxic effects; however, other toxic effects have been observed at higher doses. Methamidophos, the primary metabolite of acephate in plants, birds and mammals, is a significantly more potent inhibitor of cholinesterase activity than acephate.

After oral administration at a dose of 25 mg/kg bw per day for 8 days to rats, [¹⁴C]acephate was rapidly absorbed and uniformly distributed. The highest concentrations of radiolabelled residues were found in liver and skin. Most of the radioactive material recovered was excreted within 12 h. Urine contained 82–95% of the administered dose, 1–4% was exhaled, and 1% was found in faeces. Less than 1% was found as a residue in tissues and organs 72 h after the last dose. Unchanged acephate (73–77%), *O,S*-dimethyl phosphorothioate (3–6%) and *S*-methyl acetylphosphoramidothioate (3–4%) were identified in urine, but no methamidophos was found.

After oral administration of acephate at a dose of 100 mg/kg bw per day for 4 days, rats converted a portion to methamidophos. Both acephate and methamidophos are highly water-soluble and are rapidly metabolized and excreted. There was no tendency for acephate or methamidophos to accumulate. Three hours after the last dose, the carcass contained 0.6–1.6% and the excreta (chiefly urine) 1.1–1.5% of the final dose of acephate as methamidophos.

The pharmacokinetics of acephate were similar in men and women given a single oral dose. The time to maximum concentration in plasma (T_{max}) was 1–4 h for both acephate and methamidophos. The terminal elimination half-life was between 3.5 and 6.6 h for acephate and between 3.5 and 12 h for methamidophos. Most of the recovered acephate and methamidophos were found in urine during the first 12 h after dosing. Methamidophos accounted for about 1.3% of the amount recovered in urine, independently of the dose administered.

A single oral dose of 40 mg/kg bw of [¹⁴C-acetyl]acephate was administered on day 18 of gestation to rats and to dams immediately after delivery. Fetuses contained a total of 0.72% of the radioactivity, and more was recovered from the placenta than from the fetuses. A total of 0.96% of the administered dose was recovered in suckling pups after administration to lactating dams.

The LD₅₀ values were 1000–1400 mg/kg bw after oral administration in rats and > 10 000 mg/kg bw after dermal administration in rabbits. The LC₅₀ value was > 15 mg/l of air (4 h, nose-only) in rats. The clinical signs of toxicity corresponded to those typical of cholinergic poisoning. Acephate was not irritating to the eyes or skin of rabbits, and was not a dermal sensitizer in the maximization test in guinea-pigs. WHO has classified acephate as 'slightly hazardous'.

The inhibitory effects of acephate and its main metabolite on cholinesterase activity have been investigated extensively both in vivo and in vitro in several species, including humans. It is likely that the inhibitory effect of acephate is due to its conversion to methamidophos. No significant sex or species difference in cholinesterase inhibition was observed in vivo.

The NOAEL for acephate given as a single dose by gavage to rats was 2.5 mg/kg bw, on the basis of a 30–34% reduction in brain cholinesterase activity in females at 5 mg/kg bw. The Meeting considered that the 13–22% reduction in cholinesterase activity at 2.5 mg/kg bw in various regions of the brain was not a toxicologically significant effect. No treatment-related clinical signs were observed at doses up to 5 mg/kg bw. Behavioural effects and decreased erythrocyte cholinesterase activity were found at doses of 10 mg/kg bw and above.

Several studies of toxicity in rats and dogs given repeated doses provided useful information for assessing the effects of acephate on brain cholinesterase activity. These are discussed below.

In a 90-day study of neurotoxicity in rats given 0, 5, 50 or 700 ppm, equal to 0, 0.33, 3.3 and 49 mg/kg bw per day, regional brain cholinesterase activity was reduced in a dose-related, statistically significant manner in all treated groups, with inhibition of 9–28% at 5 ppm, 24–55% at 50 ppm and 63–82% at 700 ppm. Brain cholinesterase activity was inhibited by more than 20% in only one of three measurements in the hippocampus and the olfactory region of female rats at 5 ppm. This dose, equal to 0.33 mg/kg bw per day, was therefore considered not to have an adverse effect. Females at 700 ppm showed significantly decreased mean ambulatory and total motor activity counts and decreased cholinesterase activity in erythrocytes.

In a 13-week study of toxicity in rats given 0, 2, 5, 10 or 150 ppm in the diet, equal to 0.12, 0.21, 0.58 and 8.9 mg/kg bw per day, statistically significant inhibition of brain cholinesterase activity was observed in all treated groups. The inhibition was similar in males and females. Erythrocyte cholinesterase activity was inhibited (by 32–48%) only in rats at 150 ppm. No other signs of toxicity related to treatment were observed. The NOAEL was 10 ppm, equal to 0.58 mg/kg bw per day, on the basis of more than 20% inhibition of brain and erythrocyte cholinesterase activity in rats at 150 ppm.

In a 1-year study of toxicity in beagle dogs given 0, 10, 120 or 800 ppm of acephate in the diet, equal to 0.27, 3.1 and 20 mg/kg bw per day, statistically significant inhibition of brain cholinesterase activity was observed in males, by 17% in those at 10 ppm, 53% at 120 ppm and 68% at 800 ppm, and in females, by 49% at 120 ppm and 66% at 800 ppm. Erythrocyte cholinesterase activity was significantly inhibited at the two higher doses in animals of each sex. Despite severe inhibition of brain cholinesterase activity at the two higher doses in all treated animals, the signs usually associated with inhibition of cholinesterase activity were not observed.

In a 28-month study in rats given 0, 5, 50 or 700 ppm in the diet, equivalent to 0, 0.25, 2.5 and 35 mg/kg bw per day, erythrocyte cholinesterase activity was reduced to a lesser extent than that in brain. At termination at 28 months, brain and erythrocyte cholinesterase activity in the rats given 700 ppm was inhibited by 71% and 57% in males and by 69% and 46% in females, respectively, while in rats fed 50 ppm, the respective cholinesterase activities were inhibited by 50% and 26% in males and by 37% and 21% in females. Males at the highest dose showed hyperactivity, increased incidence of aggressive behaviour, decreased body-weight gain and significantly decreased food use efficiency.

As marginal, but statistically significant, changes in brain cholinesterase activity were observed at 5 and 10 ppm in these studies in rats and dogs, a more detailed analysis was undertaken. The dose–response curve was found to be flat at these dietary concentrations, while clinical signs occurred at much higher doses. These marginal effects on brain cholinesterase activity were therefore considered to be of equivocal toxicological relevance. The Meeting concluded that the overall NOAEL was 10 ppm, equal to 0.58 mg/kg bw per day identified in the 13-week study in rats.

Acephate was not carcinogenic in a 28-month study in rats given 0, 5, 50 or 700 ppm in the diet. In a 104-week study in mice given 0, 50, 250 or 1000 ppm in the diet, acephate induced tumours at the highest dose, which was clearly toxic, causing lesions in the liver, lung and nasal cavity, significantly decreased body-weight gain and significant changes in organ weights. As noted by the 1978 Joint Meeting, the apparent increase in the incidence of liver tumours may have been the result of excessively high doses and is therefore of minimal concern.

An extensive range of studies of genotoxicity both *in vitro* and *in vivo* has been performed with acephate. The Meeting concluded that the existing database was adequate to characterize the genotoxic potential of acephate and concluded that it is unlikely to be genotoxic *in vivo*.

In view of the lack of genotoxicity *in vivo* and the finding of liver tumours only in female mice and only at concentrations at which severe toxicity was observed, the Meeting concluded that acephate is not likely to pose a carcinogenic risk to humans.

In two multigeneration studies of reproductive toxicity in rats given diets containing acephate at 0, 50, 150 or 500 ppm or 0, 25, 50 or 500 ppm, reproductive toxicity was observed only at parentally toxic doses, with reductions in live litter size and number of litters born at 150 ppm and 500 ppm, equivalent to 10 and 33 mg/kg bw per day, respectively. Postnatal survival and postnatal growth were reduced at 500 ppm. Body weight and/or body-weight gain were affected at this dose in both pups and parental animals.

Studies of developmental toxicity were conducted in rats given a dose of 0, 5, 20 or 75 mg/kg bw per day and in rabbits at 0, 3, 10, 30 or 100 mg/kg bw per day, with NOAELs of 20 and 3 mg/kg bw per day, respectively. In rats, growth retardation (considered to be a developmental effect) occurred at 75 mg/kg bw per day, a dose at which maternal food consumption and body-weight gain were also affected. In rabbits, slight developmental effects occurred at low incidence at 10 mg/kg bw per day, a dose that also caused maternal toxicity. The Meeting concluded that acephate is not teratogenic.

The Meeting concluded that the existing database was adequate to characterize the potential hazard of acephate to fetuses, infants and children.

When tested in hens, acephate did not induce delayed polyneuropathy after single or repeated doses.

Volunteers received single oral doses of acephate (purity, 99%) of 0, 0.35, 0.7, 1 or 1.2 mg/kg bw for men and 0 or 1 mg/kg bw for women. No inhibition of erythrocyte cholinesterase activity was reported in either sex, even at the highest doses. No clinically significant changes were seen in vital signs or on electrocardiography, haematology, clinical chemistry, urine analysis or physical examination. In view of the lower sensitivity of erythrocyte than brain cholinesterase activity to inhibition by acephate observed in experimental animals, the Meeting considered that this study was only supportive for establishing an acute reference dose (acute RfD).

In a study in volunteers given repeated doses, a mixture containing acephate and methamidophos (4:1 or 9:1 ratio) was administered, and plasma and erythrocyte cholinesterase activities were measured throughout the 21-day test period. Although this study was not conducted according to current standards, erythrocyte cholinesterase activity was not inhibited at 0.3 mg/kg bw per day of the 9:1 mixture, equivalent to a dose of acephate of 0.27 mg/kg bw per day, in either sex. In view of the lower sensitivity of erythrocyte than brain cholinesterase activity to inhibition by acephate observed in experimental animals, and as this study was not conducted according to current standards, the Meeting considered that it was only supportive for establishing reference values.

The Meeting established an ADI of 0–0.01 mg/kg bw on the basis of the NOAEL of 10 ppm, equal to 0.58 mg/kg bw per day, in the 13-week study in rats and a safety factor of 50. As marginal but statistically significant inhibition of brain cholinesterase activity was observed in rats and dogs at 5 and 10 ppm, the Meeting considered an additional safety factor of 2 to be appropriate. Since there were no relevant sex or species (including human) differences in inhibition of cholinesterase activity or in kinetics and the effect was dependent on the C_{max} , a fourfold reduction in the safety factor was considered to be appropriate (see report of 2000 JMPR, Annex 5). On this basis, the Meeting used an overall safety factor of 50 ($100 \times 2/4$). The Meeting noted that the ADI provides a margin of safety of 30 for inhibition of erythrocyte cholinesterase activity after repeated doses of a mixture containing acephate and methamidophos (9:1 ratio) to humans. This was considered to be adequate to cover the difference in sensitivity between erythrocyte and brain cholinesterase activity to inhibition by acephate observed in vivo in experimental animals.

The Meeting established an acute RfD of 0.05 mg/kg bw on the basis of the NOAEL of 2.5 mg/kg bw in female rats in the study of acute neurotoxicity (considered to be appropriate, since no sex differences were observed in other studies) and a safety factor of 50, considered to be appropriate for the reasons given above for the ADI. The Meeting noted that the acute RfD provides a margin of safety of 20 for inhibition of erythrocyte cholinesterase activity after administration of a single dose of acephate to women.

A toxicological monograph summarizing the data that had become available since the previous evaluation and relevant data from previous monographs and monograph addenda was prepared.

Toxicological evaluation

Levels relevant to risk assessment

Species	Study	Effect	NOAEL	LOAEL
Mouse	104-week study of toxicity and carcinogenicity ^a	Toxicity	50 ppm, equal to 7 mg/kg bw per day	250 ppm, equal to 36 mg/kg bw per day
		Carcinogenicity	250 ppm, equal to 36 mg/kg bw per day	1000 ppm, equal to 140 mg/kg bw per day
Rat	13-week study of toxicity ^a	Toxicity	10 ppm, equal to 0.58 mg/kg bw per day ^b	50 ppm, equal to 2.5 mg/kg bw per day
		Toxicity	5 ppm, equivalent to 0.25 mg/kg bw per day ^b	50 ppm, equivalent to 2.5 mg/kg bw per day
	28-month study of toxicity and carcinogenicity ^a	Carcinogenicity	700 ppm, equivalent to 35 mg/kg bw per day ^c	–
		Parental toxicity	50 ppm, equivalent to 3.3 mg/kg bw per day	150 ppm, equivalent to 10 mg/kg bw per day
	Two-generation study of reproductive toxicity ^a	Pup toxicity	50 ppm, equivalent to 3.3 mg/kg bw per day	150 ppm, equivalent to 10 mg/kg bw per day
		Developmental toxicity ^d	Maternal toxicity	5 mg/kg bw per day
Acute neurotoxicity ^{d,e}	Embryo- and fetotoxicity	20 mg/kg bw per day	75 mg/kg bw per day	
		2.5 mg/kg bw per day	5 mg/kg bw per day	
Rabbit	Developmental toxicity ^d	Maternal toxicity	3 mg/kg bw per day	10 mg/kg bw per day
		Embryo- and fetotoxicity	3 mg/kg bw per day	10 mg/kg bw per day
Dog	52-week study of toxicity ^a	Toxicity	10 ppm, equal to 0.27 mg/kg bw per day ^b	120 ppm, equal to 3.1 mg/kg bw per day
Human	Single-dose study ^f	Toxicity	1 mg/kg bw per day ^c	–
Human	21-day study ^f	Toxicity	0.27 mg/kg bw per day ^c	–

^aDietary administration

^bMarginal effects of equivocal toxicological relevance on brain cholinesterase activity

^cHighest dose tested

^dAdministration by gavage

^eTested only in females

^fUsed only for establishment of reference values

Estimate of acceptable daily intake for humans

0–0.01 mg/kg bw

Estimate of acute reference dose

0.05 mg/kg bw

Studies that would provide information useful for continued evaluation of the compound

- Further observations in humans.

List of end-points relevant for setting guidance values for dietary and non-dietary exposure*Absorption, distribution, excretion and metabolism in mammals*

Rate and extent of oral absorption:	Extensive and rapid
Distribution:	Widely distributed
Potential for accumulation:	None
Rate and extent of excretion:	Rapid and nearly completely, mainly via urine
Metabolism in animals	Limited
Toxicologically significant compounds (animals, plants and environment)	Acephate and methamidophos

Acute toxicity

Rat, LD ₅₀ , oral	1000–1400 mg/kg bw
Rabbit, LD ₅₀ , dermal	> 2000 mg/kg bw
Rat, LC ₅₀ , inhalation	> 15 mg/l air (4 h, nose-only)
Skin irritation	Not irritating
Eye irritation	Not irritating
Skin sensitization	Not sensitizing (Magnusson & Kligman)

Short-term studies of toxicity

Target / critical effect	Nervous system/inhibition of cholinesterase activity
Lowest relevant oral NOAEL ^a	13-week study in rats: 10 ppm (equal to 0.58 mg/kg bw per day)

Genotoxicity

Unlikely to be genotoxic in vivo

Long-term studies of toxicity and carcinogenicity

Target/critical effect	Nervous system/inhibition of cholinesterase activity
Lowest relevant NOAEL ^a	28-month study in rats: 5 ppm (equivalent to 0.25 mg/kg bw per day)
Carcinogenicity	Not likely to pose a carcinogenic risk to humans

Reproductive toxicity

Target for reproductive toxicity / critical effect	Number of pups and postnatal survival decreased at parentally toxic doses
Lowest relevant NOAEL for reproductive toxicity	50 ppm (equivalent to 3.3 mg/kg bw per day)
Target for developmental toxicity / critical effect	Decreased fetal body weight and reduced ossification (rat) and slight developmental effects (rabbit) at maternally toxic doses; not teratogenic
Lowest relevant NOAEL for developmental toxicity	Rabbit: 3 mg/kg bw per day

Neurotoxicity

	No signs of delayed polyneuropathy (hens)
NOAEL for acute neurotoxicity, rat ^a	2.5 mg/kg bw
NOAEL for short-term neurotoxicity, rat ^a	5 ppm (equivalent to 0.33 mg/kg bw per day)

Other toxicological studies

Brain cholinesterase activity in rats and dogs more sensitive to acephate than plasma or erythrocyte cholinesterase activity in vivo; studies on the metabolite methamidophos are reported separately.

Human data^b

In a study with single oral doses in volunteers, no inhibition of erythrocyte cholinesterase activity was seen at 1 mg/kg bw; in an older study with repeated oral doses, no inhibition of erythrocyte cholinesterase activity was seen at 0.27 mg/kg bw per day.

<i>Summary</i>	<i>Value</i>	<i>Study</i>	<i>Safety factor</i>
ADI	0.01 mg/kg bw	13-week study in rats	50
Acute reference dose	0.05 mg/kg bw	Acute study of neurotoxicity in rats	50

^a Marginal effects of equivocal toxicological relevance on brain cholinesterase activity

^b Used only for establishment of reference values

Dietary risk assessment

The theoretical maximum daily intake (TMDI) and international estimated daily intakes (IEDI) of acephate in the five GEMS/Food regional diets, on the basis of existing MRLs and STMR levels, represented 4–50% of the ADI (Annex 3). The Meeting concluded that the intake of residues of acephate resulting from uses that have been considered by the JMPR is unlikely to present a public health risk.

4.2 ALDICARB (117)

RESIDUE AND ANALYTICAL ASPECTS

Aldicarb [2-methyl-2-(methylthio)propionaldehyde *O*-methylcarbamoyloxime] was last evaluated for residues at the 2001 JMPR, when recommendations were made for banana and potato. The Meeting used a variability factor of 5 for the calculation of the short-term intake of aldicarb for banana.

Additional residue data in individual banana fingers and composite samples were provided. Individual banana finger residue data were received from two trials conducted in Guadalupe (2 bagged and 2 unbagged bananas), one trials each conducted in Martinique, Cameroon and Ivory Coast (bagged banana, 2 different PHIs), thereby yielding 6 sets of data.. Samples were taken between 134-221 days, within $\pm 30\%$ of 180 days PHI indicated on the label.

In general, the average residues were close to or below the LOQ of the methods used at PHIs of 150 days and beyond, which did not allow the estimation of the spread of residues. However, residues at or above PHIs 134 days were 0.07, 0.08, 0.09 and 0.1 mg/kg. The results also indicated that neither the bagging nor the position of the fingers within a bunch had significant effect on the residue level at one site.

Considering that the treatment used in the trials (soil application at about 2 g a.i./plant) provides a relatively uniform dose, the compound is rapidly taken up by and uniformly distributed within the plant, the Meeting agreed to use the trial data (72 residue data in individual fingers from 6 sets of data) where the average residues were above the LOQ to calculate the variability factor. Taking into account all residue measurements (215 data points) the database satisfied the requirements (97.5th percentile with 95% confidence) of the recommended procedure of the FAO/WHO Expert Consultation.

The variability factor was calculated as:

$$v = \frac{R_{\max}}{\bar{R}_s}$$

where R_{\max} is the maximum residue observed at one site and \bar{R}_s is the average residue calculated from the residues measured in the banana fingers taken from the site. The factors and the average residues mg/kg, shown in parentheses were: 1.85 (0.014 mg/kg), 1.83 (0.071 mg/kg), bagged: 1.66 (0.080 mg/kg), 1.58 (0.013 mg/kg), 1.2 (0.012 mg/kg), 1.16 (0.015 mg/kg). The 6 factors represent four sets of bagged and two sets of unbagged bananas.

The highest residues (0.1, 0.09 mg/kg) observed in composite samples were 6.7-7.4 times greater than the residues observed in these trials. As the residues were at the sites very often below the limit of quantitation, the calculated average residue is higher than the true mean that resulted in a lower variability factor than can be expected at other sites.

Since the variability factor was calculated from the average residue in one composite sample, the typical relative uncertainty of average residues in composite samples, derived from a large number of data sets (CV= 0.21, Ambrus, 2002), was taken into account to calculate the 95% confidence intervals (1.2- 3.17) for the variability factor of 1.85.

As the variability factor should be estimated with 95% confidence, the Meeting recommends to apply the estimated variability factor of $3.17 = 3$ for banana. The estimated value is valid only for this particular application, as foliar treatment of banana indicates variability factors between 7-10. The Meeting noted that the residue value of 0.30 mg/kg obtained when the variability factor of 3 is applied to the highest residue in composite sample (0.10 mg/kg), is about 2 times as higher than the highest residue value measured in an individual banana finger (0.149 mg/kg).

The Meeting noted that the between fields variability of residues was about 88% among the 10 sites within the $\pm 25\%$ PHI interval. Furthermore, 143 results of 215 residue values were below the limit of quantitation (<0.01 mg/kg for each residue component), and only 12-24 individual fingers per site were analysed from the three sites with detectable residues (altogether 72). Although the database was sufficient to calculate a variability factor, the Meeting concluded that it did not provide sufficient information for reliable judgement of the likely maximum residue value in single finger that could be used for direct calculation of acute exposure, as it was done in 2001 JMPR for potato, when over 2000 residue values from 37 residue trials were used.

DIETARY RISK ASSESSMENT

Long-term intake

Currently, the ADI for aldicarb is 0.003 mg/kg body weight/day. The dietary intake estimation for aldicarb was assessed at the 2001 JMPR.

Short-term intake

Currently, the acute RfD for aldicarb is 0.003 mg/kg bw. The international estimate of short term intake (IESTI) for aldicarb was calculated for banana. The results are shown in Annex IV. The IESTI for banana was 40% of the acute RfD for the general population and 110% of the acute RfD for children. The information provided to the Meeting precludes an estimate that the dietary acute intake of banana by children would be below the acute reference dose.

4.3 BITERTANOL (144)

RESIDUE AND ANALYTICAL ASPECTS

Bitertanol [1-(biphenyl-4-yloxy)-3,3-dimethyl-1-(1*H*-1,2,4-triazol-1-yl)butan-2-ol] was evaluated for residues by the 1999 JMPR as a periodic review compound. An MRL of 1 mg/kg was recommended among other commodities for nectarines and peaches. The existing CXL for apricot was withdrawn because no GAP was submitted. The 34th Session of the CCPR in 2002 decided to retain the CXL of apricot for the current period as extrapolation from peach was possible and information on GAP in France will be submitted to the JMPR. The French government provided information on use of bitertanol in apricots in France to the Meeting.

Identical GAP data in France for peaches and nectarines as well as for apricots were submitted. The Meeting extrapolated the residue evaluation made in 1999 for peaches/nectarines to apricot and recommended a maximum residue level of 1 mg/kg and an STMR of 0.2 mg/kg.

DIETARY RISK ASSESSMENT

Long-term intake

The International Estimated Daily Intakes of bitertanol based on the STMRs estimated for 23 commodities (22 evaluated in 1999), for the five GEMS/Food regional diets were in range of 2 - 10 % of the ADI (Annex 3). The Meeting concluded that the long-term dietary intake of residues of bitertanol is unlikely to present a public health concern.

Short-term intake

The 1998 JMPR decided that an acute RfD is unnecessary. The Meeting therefore concluded that the short-term dietary intake of bitertanol residues is unlikely to present a public health concern.

4.4 CARBARYL (008)

RESIDUE AND ANALYTICAL ASPECTS

Carbaryl (1-naphthyl methylcarbamate) has been re-evaluated several times after its first evaluation in 1965. The 2001 Toxicological evaluation established an ADI of 0.008 mg/kg body weight/day and an acute reference dose of 0.2 mg/kg body weight. The compound is scheduled for periodic review at this Meeting. The Meeting received from the manufacturer data on metabolism in laboratory and farm animals, metabolism in plants, environmental fate in soil and water, bioaccumulation in fish, analytical methods, use pattern, residues in food in commerce or at consumption and national MRLs. Supervised trials were submitted on citrus fruit, pome fruits, stone fruits, grapes, olives, eggplant, tomato, sweet corn, pepper, lettuce, spinach, soybeans, carrots, beets, turnips, sweet potato, asparagus, field corn, rice, sorghum, wheat, and sunflower. Processing studies in various crops and a cattle feeding study were also submitted.

The Government of Australia submitted GAP information and residues in food in commerce or at consumption. The Government of Thailand submitted GAP information, summary of analytical method and summarized supervised trials residue data on cabbage, chili pepper, sweet corn, kale and soybean dry. The Government of the Netherlands submitted GAP information and national MRLs.

Metabolism in animals

In a rat metabolism study of 1-naphthyl-¹⁴C Carbaryl, animals received single intravenous (IV) 1.02 mg/kg dose (Group A); single oral dose of 1.21 mg/kg (Group B); 14 daily non-radiolabeled doses of 1.0 mg/kg followed by a single radiolabeled dose of 1.21 mg/kg on the 15th day (Group C) and single oral dose of 48.0 mg/kg (Group D). The majority of the radioactivity (70-80%) was

eliminated within 12 hours for the low dose groups and within 24 hours for the high dose group. Urine was the primary elimination route in all dosing groups, with 84.5% to 95.0% of the administered dose recovered, followed by the faeces, with 7 to 12.5% of the radioactivity. A maximum of 0.02% of the dose was recovered from tissues, and from 0.10 to 0.90 % TRR in carcass. The metabolism of ^{14}C -carbaryl was similar regardless of the route of administration, dose level or sex. The major metabolite identified in the faeces was 5,6-dihydro-5,6-dihydroxycarbaryl. In urine, free carbaryl accounted for 0.2 % TRR and the main metabolites were free and conjugated 1-naphthol (14.5% TRR), 5-hydroxycarbaryl (12.8% TRR), and 5,6-dihydro-5,6-dihydroxycarbaryl (8.2% TRR).

A summary of studies conducted in dairy cattle fed carbaryl were submitted. In two studies with 450 ppm in the diet for 2 weeks, carbaryl, 1-naphthol or conjugates of 1-naphthol residues were not found in the milk and one study did not detect carbaryl in tissues of cattle fed with 200 ppm carbaryl for 27 days. In another study, milk of a treated goat was shown to consist mainly of conjugated carbamate metabolites and 5,6-dihydro-5,6-dihydroxycarbaryl.

In the 4th study, carbaryl was fed to lactating cows at levels up to 100 ppm in the feed for 14 days. At each feeding level, approximately 0.2% of the dose was secreted in the milk, and the major metabolites in the milk were 5,6-dihydro-5,6-dihydroxy-carbaryl (34% of total radioactivity in milk), 1-naphthyl sulphate (26%) and the sulphate conjugate of 5-methoxy-6-hydroxy-carbaryl (23%). 1-naphthyl sulphate was the major metabolite in kidney (29.3%) and lung (27.3%) and 5,6-dihydro-5,6-dihydroxy-carbaryl the major metabolite in muscle and heart (38.6 and 31.3 % of total radioactivity, respectively)

The metabolism of carbaryl in hens was studied after oral administration of 1-naphthyl- ^{14}C Carbaryl to laying hens treated twice a day, for 7 consecutive days at 8.8 ppm and 10.5 ppm of carbaryl in the diet. In average, 97.7 % of the radioactivity was recovered in the excreta. Tissues contained only 0.17% of the administered dose, mostly concentrated in kidney (0.268 $\mu\text{g/g}$ ^{14}C -carbaryl eq) and liver (0.187 $\mu\text{g/g}$ ^{14}C -carbaryl eq). Egg yolk contained up to 0.176 $\mu\text{g/g}$ ^{14}C -carbaryl eq, being 1-naphthol sulfate the major metabolite (0.078 $\mu\text{g/g}$ ^{14}C -carbaryl eq). Desmethyl carbaryl was the major metabolite in liver (0.017 $\mu\text{g/g}$ ^{14}C -carbaryl eq), and 1-naphthol the major in abdominal fat (39.1 $\mu\text{g/g}$ ^{14}C -carbaryl eq). The highest concentration of free carbaryl was found in fat (26.9% TRR, 0.004 $\mu\text{g/g}$ ^{14}C -carbaryl eq).

The metabolic pathway of carbaryl in animals involves hydroxylation of the N-methyl group, hydrolysis of the carbamate ester, and hydroxylation of the naphthalene ring through epoxide formation. The main metabolites formed are 1-naphthol, 4-hydroxycarbaryl, 5-hydroxycarbaryl, 3,4-dihydro-3,4-dihydroxycarbaryl, 5,6-dihydro-5,6-dihydroxy-carbaryl and 5-methoxy-6-hydroxy-carbaryl (cow). The metabolites are subsequently conjugated to form water-soluble glucuronides and or sulphates. Metabolism through GSH conjugation forms 5,6-dihydro-5-(S-cysteinyl)-6-hydroxycarbaryl or a positional isomer.

Metabolism in plant

Greenhouse-grown radishes were treated five times with ^{14}C -carbaryl at 2.0 kg/ha and harvested at 7 days PHI. In the tops, most of the radioactivity was found in the acetone:water (50:50) rinse

(37.9% TRR) and in the internal organic extracts (42.8% TRR), with carbaryl representing the single radioactive component (total of 121 $\mu\text{g/g}$ ^{14}C -carbaryl eq). In roots, 36.34 %TRR remained in the organosoluble extract, all being carbaryl (1.34 $\mu\text{g/g}$ ^{14}C -carbaryl eq). The major identified metabolites in aqueous extracts of radishes were 5,6-dihydro-5-(S-cysteinyl)-6-hydroxycarbaryl or a positional isomer (<3% TRR - 1.51 $\mu\text{g/g}$ ^{14}C -carbaryl eq in the tops and 0.076 $\mu\text{g/g}$ ^{14}C -carbaryl eq in the roots) and 4-hydroxycarbaryl glycoside (1.97 $\mu\text{g/g}$ ^{14}C -carbaryl eq in the tops). Nonextractable residues (8.3 % TRR in the tops and 43.4%TRR in roots) were separated into cellulose and lignin fractions after buffer extractions and enzyme treatments. The radioactivity in the cellulose fraction was the largest portion in the root (0.694 mg/g ^{14}C -carbaryl eq), and in tops accounted for 3.27 $\mu\text{g/g}$ ^{14}C -carbaryl eq.

Leaf lettuce was treated with four applications of 1-naphthyl- ^{14}C carbaryl at 1.96 kg/ha and harvested at 8 days PHI. Most of the radioactivity was found in the rinse (64.0% TRR, 23.53 $\mu\text{g/g}$ ^{14}C -carbaryl eq) and organosoluble extract (29.9% TRR, 10.3 $\mu\text{g/g}$ ^{14}C -carbaryl eq), and showed to be unchanged carbaryl. Glycoside conjugates of 1-naphthol, hydroxycarbaryl and hydroxymethylcarbaryl were the main metabolites found in the aqueous extract (0.13 to 0.25 $\mu\text{g/g}$ ^{14}C -carbaryl eq).

Soybean plants were treated four times with at 1.7-2.1 kg/ha ^{14}C -carbaryl and soybean forage and mature plants (seed and hay) were harvested at 7 and 47 days PHI. Carbaryl accounted for 96.2% of the radioactivity in the external rinse and organosoluble extract of forage (156.3 $\mu\text{g/g}$ ^{14}C -carbaryl eq), 94.5% of organic extracts of hay (149.9 $\mu\text{g/g}$ ^{14}C -carbaryl eq) and 85.4% TRR in bean (0.9 $\mu\text{g/g}$ ^{14}C -carbaryl eq). In beans, most of the radioactivity was in the aqueous phase (83.2% TRR, 18.25 $\mu\text{g/g}$ ^{14}C -carbaryl eq). Hydroxymethyl carbaryl hexose conjugate was the main metabolite in forage (7.3% TRR, 20.4 $\mu\text{g/g}$ ^{14}C -carbaryl eq) and hay (12.2% TRR, 50.3 $\mu\text{g/g}$ ^{14}C -carbaryl eq). In bean, the main metabolite was tentatively assigned as 1-naphthyl malonyl glucoside (26.1 % TRR, 5.72 $\mu\text{g/g}$ ^{14}C -carbaryl eq). The radioactivity remained in the nonextractable residues ranged from 14.5 to 25.6 %TRR in all matrices, mostly in the cellulose fraction (3.1 to 7.8% TRR). Protease was the most effective enzyme treatment in removing radioactivity (1.7 to 5.0% TRR).

Apple fruit on the tree was painted once or twice with 50:50 acetone :water solution containing radiolabeled carbaryl (specific activity of 6.56 mCi/mM), at 10 $\mu\text{Ci/apple}$ and harvested at 28 or 53 days after treatment. The surface residues of samples from all treatments is mainly carbaryl (93.6% TRR in average) and traces of 1-naphthol, (hydroxymethyl)carbaryl and one minor unidentified material. Carbaryl was also the main internal residues in the fruit internal extracts, with concentration in the pulp approximately 2 times higher (20.1 to 45.8% TRR) than in the peel (9.5 to 21.9% TRR). Conjugates of 1-Naphthol, 4-hydroxycarbaryl and 5-hydroxycarbaryl were the major metabolites, with TRR ranging from 1.9 to 8.3% in peel and pulp.

The metabolic pathway for carbaryl in plants includes methyl and ring hydroxylation, carbamate ester hydrolysis, N-demethylation, followed by conjugation to form water-soluble glycosides. The main metabolites are free and or conjugated 1-naphthol, 4-hydroxycarbaryl, 5-hydroxycarbaryl, 7-hydroxycarbaryl, 5,6-dihydro-5,6-dihydroxycarbaryl, 5,6-dihydro-5,6-dihydroxy-1-naphthol, desmethylcarbaryl, and (hydroxymethyl)carbaryl, in addition to 5,6-dihydro-5-(S-cysteinyl)-6-hydroxycarbaryl, or a positional isomer.

Environmental fate

Soil

The photolytic degradation of 1-naphthyl-¹⁴C carbaryl following surface application to a 1-mm layer of sandy loam soil at 9.8 ± 0.3 mg/kg (equivalent to ~ 11.2 kg a.i./ha.) was studied. The soil plates were exposed to artificial sunlight regime of approximately 12 hr light and 12 hr dark per day for 30 days, at $25 \pm 1^\circ\text{C}$. Carbaryl concentration declined from 97.5% to 58.5% by the end of the 30-day period, with a calculated half-life of 41 days. Non-extracted ¹⁴C-residues represented 32.4% of the applied dose at 30 days and contained a mixture of not identified highly polar materials.

Carbaryl rapidly degraded under aerobic conditions in sandy loam soil treated with 11.2 mg/kg 1-naphthyl-¹⁴C, with a calculated half-life of 4.0 days. Total volatiles (¹⁴CO₂) ranged from 0.1 % at day 1 to 59.7% TRR at the end of the study (day 14). 1-naphtol was the only major degradation product identified in the extractable fraction, reaching a maximum of 34.5% TRR at day 1 (0.35 $\mu\text{g/g}$ ¹⁴C-carbaryl eq), dropping to 2.8 % TRR by day 2 (0.03 $\mu\text{g/g}$ ¹⁴C-carbaryl eq). Unextractable residues reached 17.7 % TRR by day 14.

The adsorption/desorption characteristics of carbaryl were determined in four soils and one sediment at 0.27, 1.02, 2.51, 5.01 and 10.0 ppm of 1-naphthyl-¹⁴C Carbaryl in 0.01 M calcium chloride. Each soil system was shaken in a water bath for 4 hours at 24-26 °C (adsorption phase) after what the remained solution was removed, 0.01 M CaCl₂ solution added to the soil pellet and the system treated as before (desorption phase). No measurable adsorption occurred with the loamy sand soil (0.05% organic matter, OM). The Freundlich adsorption coefficients (K values) correlated well ($r^2 = 0.95$) with the organic matter, being 1.74 in sandy loam soil (1.43% OM), 2.04 in clay loam sediment (1.4% OM), 3.0 in silty loam soil (2.4% OM), and 3.52 in silty clay loam soil (3.38 % OM). Freundlich K values for desorption ranged from 6.72 in sandy loam to 7.66 in silty clay loam (7.01 average). K_{oc} were 385 and 485 in silty soils (medium mobility) increasing to 800 and 827 in sandy loam soil and clay loam sediment, respectively, showing a higher mobility in these soils.

Another carbaryl adsorption study was conducted on sand, sandy loam, silt loam, and silty clay loam soils as well as an aquatic sediment using 1-naphthyl-¹⁴C Carbaryl at 1, 2, 3, 4 and 5 mg/kg concentration. Carbaryl adsorption to soils and aquatic sediment increased with the carbaryl concentration in solution and with the organic matter content of the soil.

The organic matter content did not affect the carbaryl mobility in soil thin-layer. R_fs were 0.11 in silty loam soil (5.3% OM), 0.17 in sandy loam and loam soils (OM 0.8 – 3.0%), and 0.23 in silty clay loam soil (3.6% OM). This last soil had the pH of 6.3, while the pH in the other soils ranged from 5.0 to 5.8.

In an aged-residues column leaching study, ¹⁴C-labeled and non-labelled carbaryl (equivalent to 3 kg/ha) was placed on top of a 30 cm length glass column (5.2 cm i.d.) packed with moist sandy loam and allowed to age for 30 days. Only 0.61% of the applied radioactivity eluted with the leachate after 46 days and 28.7% of TRR remained in the soil at this time, being 18.9% in

the top 5 cm of the column. The remaining ^{14}C (70.7%) was probably lost as volatile degradation products.

Water and water/sediment

The photodegradation of 1-naphthyl- ^{14}C Carbaryl at 10.1 mg/l exposed to artificial sunlight for 360 hours of continuous irradiation was studied in sterile water buffered at pH 5 and $25 \pm 1^\circ\text{C}$. Carbaryl concentrations declined from 97.0% to 33.4% TRR, with a half-life of 10.3 days. 1-naphthol was the only darkness period was calculated using the degradation rate constants under irradiated and no-irradiated conditions.

The hydrolysis of 1-naphthyl- ^{14}C Carbaryl (10 mg/l) was studied at 25°C under dark and sterile conditions at pH 5, 7, and 9. No evidence of hydrolytic degradation of carbaryl was detected in the pH 5 test samples (calculated $t_{1/2}$ of 1277 days). Carbaryl degraded to 1-naphthol in pH 7 with a half-life of 12 days, and at pH 9 with a half-life of 3.2 hours. No other individual degradation product accounted for more than 2% of the radioactivity

The degradation of carbaryl was studied under anaerobic conditions in a pond water/sediment system treated with the ^{14}C -carbaryl at 10 mg/l and maintained in the dark at $25 \pm 1^\circ\text{C}$ up to 126 days. Total radioactivity in methylene chloride water extracts ranged from 81.4 % at day 0 declining to 5.4% at day 14, after what maintained from 2.9 to 5.4 % up to 26 days. Radioactivity in the sediment methanol : water extracts increased from 6.7 % at day 0 to 51.9% at day 1, declining to 32.8% at the end of the study. Unextracted residues reached a maximum of 23.6% of the applied radioactivity by Day 126. The calculated half-life was 72.2 days, with 1-naphthol being the major degradation product present, reaching an average maximum concentration of 26.3% TRR in sediment at day 94 (0.26 $\mu\text{g/g}$ ^{14}C -carbaryl eq). None of other metabolites detected exceeded 2.5% of the applied dose.

An aerobic pond sediment/water degradation study of 1-naphthyl- ^{14}C Carbaryl at 10 mg/l was conducted for 30 days at $25 \pm 1^\circ\text{C}$ in the dark. The radioactivity in aqueous phase steadily decreased from 77.9% on day 0 to 2.6% on day 30. Extractable ^{14}C from the sediment ranged from 24.6% TRR at day 0 to 30.6 on day 30. Residues bound to sediment reached a maximum at day 21 (65% TRR), and it was fractionated to fulvic acid, humic acid and humin (average of 4.0, 18.9 and 24.3 % TRR, respectively). The half-life of carbaryl under the experimental conditions was estimated to be 4.9 days. 1-Naphthol was the major primary metabolite detected, reaching a maximum concentration at day 2 of 12.3 % TRR in water and in of 9.5% TRR in sediment. Several other degradation products were detected in water at levels from 2.2 to 4.6% TRR after 2 days, and in sediment extract, up to 19.3% TRR at day 14. None of the degradation products were identified, but the pathway is proposed to involve 1,4-naphthoquinone as an intermediate.

In summary, carbaryl undergo photodegradation during a 12 h artificial light/12 h dark regime in soil and water with half lives of 41 and 21 days, respectively, and of 10.3 days in water under continuous light. Under natural sunlight, the calculated half life in soil was 4 hours. Carbaryl is rapidly hydrolysed under basic condition ($t_{1/2} = 3.2$ hours), much slower at pH 7 (12 days) and is very stable under pH 5. In a water/sediment system, carbaryl degrades with a half-life of 72.2 days under anaerobic conditions and of 4.9 days under aerobic conditions. The main metabolite formed in all systems studied was 1-naphthol, which can degrade to 1,4-naphthoquinone under

aerobic conditions. The compound adsorption capacity in soil increases with the organic matter content, and can be insignificant in soils with <0.1% organic matter. Carbaryl can be classified as having a medium to high mobility in soil.

Accumulation in confined rotational crops

A confined rotational crop study was conducted with 1-naphthyl-¹⁴C Carbaryl applied to a sandy loam soil at exaggerated rates of 17.3 - 18.0 kg a.i./ha. The plots were aged for 30, 120, or 365 days and subsequently planted with lettuce, radish, and wheat. The soil layer up to 7.5 cm showed the highest level of ¹⁴C-residues, with 15 to 21 ppm of carbaryl equivalents at day 0, which decreased to < 6 µg/g ¹⁴C-carbaryl eq in subsequent days. Residues in the 7.5 to 15 cm layer were <0.1 µg/g ¹⁴C-carbaryl eq in the 30 and 120 days plot and up to 2.37 µg/g ¹⁴C-carbaryl eq in the 365 days plot.

Total radioactive residue levels decreased in every crop at subsequent planting intervals, except wheat straw. Lettuce harvested at maturity had 0.103 ppm ¹⁴C-carbaryl equivalents in the 30 DAT plot, 0.09 ppm at the 120 DAT plot and 0.019 µg/g ¹⁴C-carbaryl eq at the 365 DAT plot, being most of the radioactivity present in aqueous soluble fraction and as insoluble residues. Total radioactivity in radish matrices harvested at immature (whole plant) and mature stage (tops and root) varied from 0.022 to 0.109 µg/g ¹⁴C-carbaryl eq. Total residues in wheat grain and straw ranged from 0.043 to 0.155 µg/g ¹⁴C-carbaryl eq, most of it being insoluble residues. Organosoluble residues accounted for 2 to 11% TRR in all crops. No compound was identified in any radioactive fraction. Radioactivity removed after protease and acid hydrolysis ranged from 0.055 to 0.002 µg/g ¹⁴C-carbaryl eq.

In summary, carbaryl concentration in crops planted in aged soils can be considered insignificant, which is supported by its limited mobility and rapid degradation in soil.

Methods of residue analysis

Single residue methods for carbaryl in animal, vegetal and soil matrices were provided. No multiresidue method was submitted.

In a method for the determination of carbaryl in chicken, using reverse phase HPLC equipped with a post column hydrolysis system and fluorescent detector, the compound is extracted by maceration with methanol, the extract is cleaned up by liquid-liquid partition followed by C18 cartridge. A mean recovery of 80% (75-86%) was found in fortified samples at the range of 0.02 to 1 mg/kg.

A method has been developed for the determination of carbaryl, and the free and conjugated metabolites 5,6-dihydro-5,6-dihydroxycarbaryl and 5-methoxy-6-hydroxy carbaryl in milk, egg, and cow and poultry tissues. This method involves extraction of the analytes with a combination of acetone, acetonitrile and water followed by mild acid hydrolysis reaction to convert the conjugates to their free forms. This procedure also converts 5,6-dihydro-5,6-dihydroxycarbaryl to 5-hydroxycarbaryl. The reaction mixture is partitioned with dichloromethane and acetonitrile/hexane. The acetonitrile phase was analysed in a C18 column HPLC equipped with a

post column hydrolysis system and fluorescent detector. The hydrolysis reaction gave recoveries of 75.5 to 106.4% for all metabolites in all cases. LOD (limit of detection) and LOQ (limit of quantification) for milk, egg, cow liver, cow muscle, cow kidney, cow fat, chicken muscle, chicken liver and chicken fat were 0.005 and 0.020 mg/kg, respectively. The LOQ of carbaryl and 5-methoxy-6-hydroxy carbaryl in chicken liver was 0.10 mg/kg. Average recoveries of fortified samples from the LOQ to 5 mg/Kg, ranged from 72.4 to 107.4% for milk, egg, cow muscle, chicken muscle, chicken fat and chicken liver for all analytes. A modification of this method introduced mainly a high-speed centrifuge for layer separation and filtration of final extracts through 2 or 3 Acrodisk cartridges.

A method has been developed in 1992 for the determination of Carbaryl and 1-naphthol separately in vegetal crops after extraction with dichloromethane, clean-up with florisil column and quantification by HPLC with the basic post-column hydrolysis at 100°C and fluorescence detection. This method was validated in turnips, carrot, wheat, lemon, spinach and strawberry, at levels from 0.003 to 100 mg/kg, with recoveries ranging from 58.8 to 100.4%, and in mustard green, potato and peanut at levels from 5 to 50 mg/kg with recoveries from 75 to 95%. The extraction efficiency of the method was tested with grown-in ¹⁴C-carbaryl residues on lettuce and radish leaves, showing average LSC recoveries ranging from 82 to 104%.

Carbaryl residues can be extracted from soil with a mixture of acetone, water, and phosphoric acid. After filtration, dichloromethane partition and clean using florisil column, carbaryl is quantified as 1-naphthol by HPLC with a post-column hydrolysis / fluorescence detection system. Fortified samples at levels ranging 0.01 to 20 mg/kg had average recovery of 89.4%, and a LOQ of 0.02 mg/kg.

Stability of Residues in Stored Analytical Samples

The percent of radioactivity in extracts of ¹⁴C-carbaryl fortified hen tissues remained constant in egg yolk, fat, kidney, liver and muscle over 18 months of storage at -20 °C.

The stability of incurred residues of carbaryl and conjugated 5,6-dihydro-5,6-dihydro-carbaryl (5,6 DDC) and 5-methoxy-6-hydroxy carbaryl (5,6 MHC) in animal commodities was studied. The compounds were stable in liver (100 to 124 % remained after 173 days), kidney (91.4 to 98% remaining after 196 days) and muscle (80 to 102% remaining after 158 days). 5,6 DDC was also stable in milk and fat (97 to 103% remaining after 215 to 248 days), but only 56 to 79.3% of carbaryl and 5,6 MHC remained in these matrices during the same period.

Another study was conducted in samples fortified with carbaryl and the free 5,6 DDC and 5,6 MHC metabolites. 5,6 MHC was unstable under storage condition in fortified samples of muscle and fat after 2 months (31.0 and 34.7% remaining) and of liver after 5.5 months (57.5% remaining). Carbaryl was stable in fortified samples of muscle and fat (96.1 and 126% remained) after 5 to 6.3 months, but not in liver after 2 months (56.7% remained). 5,6 DDC was stable in all three matrices, with 92.8 to 114% of the residues remaining after 5 to 6.3 months.

Carbaryl was relatively unstable (67% remained) in sugar beet roots fortified at 0.13mg/kg level and stored at -10 °C for 287 days. At level of 10 mg/kg, carbaryl was relatively stable for 12 months (>80% of the initial residue) in barley flour, lettuce peanut, potato, tomato, tomato wet pomace, pure, paste and juice and wheat straw), but not in barley hulls and barley pearled (47%

and 70.9% of the initial residue after 3 months), tomato dry pomace and wheat hay (65 - 75% of the initial residue after 6 months). Carbaryl fortified samples at 0.40 mg/kg, were stable up to 25 months in olive oil and apple (82.1 and 93.2 % remained) and relatively unstable in olive fruit after 6 months of storage at -20°C (75.9% of the residues remained).

In a study with incurred carbaryl at levels from 0.08 to 55 mg/kg, residues were stable (> 80% of the initial residue level) up to 15 months in almonds, soybeans, apples and grapes. Residues dropped to $\leq 60\%$ after 8 months in raisins, after 6 months in dry bean vines and after 10.5 months in dry bean hay.

Residue definition

In plants, carbaryl represents the major residue (55-98% of the total radioactivity, TRR), and no metabolite is present at concentration > 10% TRR.

The Meeting agreed that the residue definition for compliance with MRL and for dietary intake estimation in plant commodities is carbaryl.

Carbaryl accounted for <20% of the total radioactivity found in milk, and the metabolites 5,6-dihydro-5,6-dihydroxy-carbaryl, sulphate conjugates of 1-naphthyl and 5-methoxy-6-hydroxy-carbaryl and accounted for ~82% of the radioactivity. Carbaryl was the major metabolite in muscle (17% TRR), but was present at <10 % TRR in other tissues, which had mainly the metabolites 1-naphthyl sulphate (27 to 30 % TRR in kidney and lung) and 5,6-dihydro-5,6-dihydroxy-carbaryl (31 to 40% TRR in muscle and heart).

The Meeting acknowledge that carbaryl is not the major metabolite in animal products. However, the available methodology to analyse the metabolites 5,6-dihydro-5,6-dihydroxy-carbaryl and 5-methoxy-6-hydroxy-carbaryl, is not trivial, and it is not clear whether the standards for these metabolites can be made available to the laboratories for enforcement. Additionally, storage stability studies have shown that the metabolites have limited stability in some matrices after 1 month of storage. Currently, no information is available to assure that these two metabolites are not of health concern.

Furthermore, the Meeting agreed that, for practice purposes, the residue definition for compliance with MRL and for dietary intake estimation in animal commodities is carbaryl

Carbaryl has a log P_{ow} of 1.85 to 2.36, and is not concentrated in fat of animals dosed orally. The Meeting concluded that carbaryl is not fat soluble.

Results of supervised trials

The Meeting did not receive any information on residues on alfalfa forage, banana, bean forage, blackberries, clover, cotton seed, common bean, cranberry, cowpea (dry), cucumber, dewberries, eggs, hay or fodder of grasses, kiwifruit, melons, milk products, oats, okra, parsnip, peas, pea vines, peanut, peanut fodder, potato, poultry meat, poultry skin, pumpkins, raspberries, rice, husked, strawberry, swede, winter and summer squash and radish. The Meeting agreed to recommend to withdraw the current MRLs for these crops/commodities.

Citrus fruit. Supervised trials on citrus fruits were conducted in the United States (21 trials), Italy (4 trials), and Spain (4 trials). The GAP in USA for citrus is up to 8 applications of 2.42 to 8.4 kg a.i./ha, with a maximum of 22.4 kg a.i./ha per season and 5 days PHI. Additionally, in California, a rate of 5.6-17.9 kg a.i./ha, can be applied once against red scale and up two times against yellow scale (max. 22.4 kg a.i./ha). GAP in Italy recommends 0.071-0.142 kg a.i./hl and 7 days PHI. In Spain, the recommend GAP rate is 0.85 – 1.7 kg a.i./ha or 0.085-0.16 kg a.i./hl and 7 days PHI.

In six trials conducted in grapefruit in Florida and California within maximum GAP, residues were 0.59, 1.9, 2.5, 2.8, 3.5 and 6.8 mg/kg. In 4 trials conducted at the same rates in lemon in Arizona and California, residues were 4.8, 5.0, 5.1 and 5.5 mg/kg. Eleven trials conducted in Florida and California in orange within maximum GAP gave residues of 3.1, 3.7, 4.2 (2), 4.5, 4.6, 5.7, 6.5 (2), 8.1 and 10 mg/kg.

Four trials conducted in orange Italy at maximum GAP, residues in fruit at 7 days PHI were 0.83, 0.93, 2.6 and 3.6 mg/kg. In two declining trials, residues after 29 days represented ~27% of the initial levels. In the other two studies, the ration of residues pulp/residues in whole fruit averaged 0.12 (0.09, 0.10, 0.12 and 0.15). In four trials conducted in Spain at GAP rate, residues in orange fruit were 0.82, 3.2, 3.4 and 4.4 mg/kg at 7 days PHI.

The Meeting agreed that residues from trials conducted according to GAP in orange in USA, Italy and Spain belong to the same population (Mann-Whitney U-test, FAO Manual, 2002) and can be combined as follow: 0.82, 0.83, 0.93, 2.6, 3.1, 3.2, 3.4, 3.6, 3.7, 4.2 (2), 4.4, 4.5, 4.6, 5.7, 6.5 (2), 8.1 and 10 mg/kg. The orange residue population is in the same range as the residues in lemon (4.8, 5.0, 5.1 and 5.5 mg/kg) and grapefruit (0.59, 1.9, 2.5, 2.8, 3.5 and 6.8 mg/kg) and can be combined as a citrus residue population as follow: 0.59, 0.82, 0.83, 0.93, 1.9, 2.5, 2.6, 2.8, 3.1, 3.2, 3.4, 3.5, 3.6, 3.7, 4.2 (2), 4.4, 4.5, 4.6, 4.8, 5.0, 5.1, 5.5, 5.7, 6.5 (2), 6.8, 8.1 and 10 mg/kg.

The Meeting agreed to withdraw the Codex MRL of 7 mg/kg and recommends a maximum residue level of 15 mg/kg for carbaryl in citrus fruit.

Applying the ratio of residues in pulp/whole fruit to the median (4.2 mg/kg) and the highest residue (10 mg/kg) in the citrus residue population, the Meeting recommends an STMR of 0.487 mg/kg and an HR 1.16 mg/kg for carbaryl in citrus fruit, edible portion.

Apple. Supervised trials on apples were conducted in Argentina, Canada, France, Italy, the United Kingdom and the United States. One trial conducted in Argentina according to GAP could not be evaluated as only a summary table was provided.

In three supervised trials conducted in USA within maximum GAP for pome fruit (up to 8 applications of 0.56-3.36 kg a.i./ha, max. of 16.8 kg a.i./ha, and 3 days PHI), residues were 8.8, 9.6 and 10 mg/kg. In four trials conducted in Italy according to GAP (0.06-0.12 kg a.i./hl and 7 days PHI), residues were 0.22, 0.57, 0.67 and 0.68 mg/kg. In one trial conducted in France according to Italian GAP, residues were 0.40 mg/kg. Thirteen trials were conducted in Canada, France, Italy and UK (against French GAP) at higher GAP rates and/or lower PHI and could not be used.

In one trial conducted in South France at higher GAP, 53 apple units were analysed, giving an average residue of 0.43 mg/kg, a standard deviation of 0.14 mg/kg and a highest residue of 0.81

mg/kg. In two French trials (North and South) conducted at higher GAP with 28 apple units analysed in each, average residues were 0.39 and 0.21 mg/kg, standard deviation of 0.29 and 0.16 mg/kg and highest residues of 1.2 and 0.70 mg/kg, respectively. In one trial conducted in Italy at GAP, average residues of 52 apple units was 0.68 mg/kg, with a standard deviation of 0.33 mg/kg and a highest residue of 1.7 mg/kg.

Residues in apples from trials conducted in USA (8.8, 9.6 and 10 mg/kg) represent a distinct residue population from trials conducted in apple in Italy and France (0.22, 0.40, 0.57, 0.67 and 0.68 mg/kg) and cannot be combined.

The Meeting agreed that insufficient number of supervised trials were conducted according to the critical GAP (USA data), and recommends the withdrawal of the MRL of 5 mg/kg (T) for carbaryl in apple.

Pear. Ten trials were conducted in pears in America. One trial conducted in Argentina at lower GAP could not be evaluated as only summary table was provided. Four trials were conducted in Canada at lower GAP and could not be used. In five trials conducted in USA within maximum GAP for pome fruit residues, were 0.98, 2.8, 2.9, 3.5 and 4.0 mg/kg.

The Meeting agreed that insufficient number of supervised trials were conducted according to GAP and recommends the withdrawal of the MRL of 5 mg/kg (T) for carbaryl in pears.

Stone fruits. Ten supervised trials were conducted in the United States in peaches (GAP for stone fruits is up to 4 applications of 2.24 – 3.4 kg a.i./ha and 3 days PHI in all states, except for California where the rate is 3.4-4.5 kg a.i./ha, and 1 day PHI). One trial conducted in Italy (GAP is 0.071-0.118 kg a.i./hl) at higher GAP could not be used.

In seven trials conducted in peaches in Georgia, South Carolina and Pennsylvania according to maximum USA GAP rate, residues in fruit were 0.96, 2.3, 3.0 and 3.6 mg/kg at 3 days PHI. In three trials conducted in California according to California maximum GAP, residues at 1 day PHI were 4.8 (2) and 7.8 mg/kg. In three other trials conducted in California at maximum USA GAP residues were 2.0, 2.6 and 5.5 mg/kg. Trials conducted in California at different rates and in the other USA states yield residues which belong to the same population (Mann-Whitney U-test, FAO Manual, Chapter 6) and can be combined as, in rank order, 0.96, 2.0, 2.3, 2.6, 3.0, 3.6, 4.8 (2), 5.5 and 7.8 mg/kg.

In four trials conducted in plums in Michigan and Oregon according to maximum USA GAP, residues in fruit were 0.37, 1.4, 1.6 and 2.1 mg/kg at 3 days PHI. In four trials conducted in California at maximum GAP for this state (3.4-4.5 kg a.i./ha and 1 day PHI), residues were 0.69, 0.99 and 1.1 (2) mg/kg. These trials gave residues within the same range and can be combined as 0.37, 0.69, 0.99, 1.1 (2), 1.4, 1.6 and 2.1 mg/kg. Two trials conducted in California at maximum USA GAP gave residues of 0.05 and 0.06 mg/kg, which are in a lower range and can not be combined with the previous residue data set.

The Meeting agreed that the residues in peaches and plums comprise a single residue population (Mann-Whitney U-test) and can be combined as a residue population for stone fruits, in rank order, 0.37, 0.69, 0.96, 0.99, 1.1 (2), 1.4, 1.6, 2.0, 2.1, 2.3, 2.6, 3.0, 3.6, 4.8 (2), 5.5 and 7.8 mg/kg.

The Meeting agreed to withdraw the current MRL of 10 mg/kg (T) for plums (including prunes), apricot and nectarine and recommends a maximum residue level of 10 mg/kg, an STMR of 2.05 mg/kg and an HR of 7.8 mg/kg for carbaryl in stone fruits, except cherries.

Cherries. Nine trials were conducted in cherries in USA (same GAP as for peaches and plums). In six trials conducted according to maximum GAP in Colorado, Michigan, New York, Oregon and Washington., residues were 2.4, 3.4, 3.9, 4.7, 6.7 and 16 mg/kg. In two trials conducted in California at maximum GAP for this state or at maximum USA GAP, residues at 1 or 3 days PHI were 2.1, 4.7 and 6.3 mg/kg. The trials conducted in USA gave residues in the same range which can be combined as 2.1, 2.4, 3.4, 3.9, 4.7 (2), 6.3, 6.7 and 16 mg/kg.

The Meeting agreed to withdraw the Codex MRL of 10 mg/kg (T) and recommends a maximum residue level of 20 mg/kg, an STMR of 4.3 mg/kg and an HR of 16 mg/kg for carbaryl in cherries.

Grapes. Seventeen trials were conducted in USA in California, Arizona, New York and Washington. In ten trials conducted in 1994 within maximum GAP rate (5 times 1.12-2.24 kg a.i./ha), residues at 7 days PHI were 2.4 (2), 3.0, 3.3, 6.2, 6.5, 7.2, 7.5, 7.9 and 33 mg/kg. In seven trials conducted in 1988 using 2 applications of the same rate, gave residues of 0.42, 2.4, 3.8, 4.5, 4.9, 5.3 and 6.5 mg/kg.

The trials conducted in 1994 at maximum GAP (5 applications) and in 1988 with 2 applications gave residues in the same range and will be combined as follow, in rank order, 0.42, 2.4 (3), 3.0, 3.3, 3.8, 4.5, 4.9, 5.3, 6.2, 6.5 (2), 7.2, 7.5, 7.9 and 33 mg/kg.

The Meeting recommends a maximum residue level of 40 mg/kg, an STMR of 4.9 mg/kg and an HR of 33 mg/kg for carbaryl in grapes

Olives. Fourteen trials were conducted in olive in Greece, Italy, Spain and USA from 1994 to 1998. In one trial conducted in Greece within maximum GAP rate (0.17 kg a.i./hl), residues were 1.9 mg/kg at 7 days PHI. In three trials conducted in Italy at maximum GAP rate (0.142 kg a.i./hl), residues at 7 days PHI were 1.6, 1.9 and 7.9 mg/kg. In three trials conducted in Spain within maximum GAP rate (2 applications of 0.17 kg a.i./ha), residues in fruit at 7 days PHI were 0.07, 22 and 26 mg/kg, and dropped to <0.05 - 4.0 mg/kg after 14 days.

In three trials conducted in California at maximum GAP rate (up to 2 applications at 8.4 kg a.i./ha), residues in fruit were 3.3, 4.0 and 6.6 mg/kg at 14 days PHI. Four other trials were conducted at a lower rate range (5.48-5.63 kg a.i./ha), and could not be used.

Residues from trials conducted according to GAP were 1.9 mg/kg in Greece, 1.6, 1.9 and 7.9 mg/kg in Italy, 0.07, 22 and 26 mg/kg in Spain, and 3.3, 4.0 and 6.6 mg/kg in USA.

The Meeting agreed that the residue data from trials conducted in USA and in Europe are not distinct and can be combined as, in rank order, 0.07, 1.6, 1.9 (2), 3.3, 4.0, 6.6, 7.9, 22 and 26 mg/kg.

The Meeting agreed to withdraw the Codex MRL of 10 mg/kg (T) and recommends a maximum residue level of 30 mg/kg for carbaryl in olives.

In the 7 trials from Spain, Greece and Italy, stoned fruit/fruit ratio were 1.14, 1.4 (3), 1.7, 1.25 and 1.33 and averaged 1.4. This ratio can be applied to the median residue level (3.65 mg/kg) and the highest residue (26 mg/kg) in the residue data set and the Meeting recommends an STMR of 5.1 mg/kg and an HR of 36.4 mg/kg for carbaryl in olive, edible portion

Cabbage and kale. The Government of Thailand provided data of 4 trials in Chinese cabbage and 3 trials in kale conducted from 1995 to 1997. There is no GAP for carbaryl in cabbage and kale in Thailand, and as only summary tables were provided, it was not possible to evaluate the trials.

The Meeting agreed to withdraw the current MRL of 5 mg/kg (T) for cabbage.

Eggplant. In eight trials conducted in France in eggplant with 2 applications at the maximum GAP rate (1.275 kg a.i./ha), residues at 7 days PHI were 0.06, 0.08, 0.16, <0.2 (4), and 0.49 mg/kg. Two other trials were conducted at higher PHI, and were not used.

The Meeting agreed to recommend a maximum residue level of 1 mg/kg, an STMR of 0.18 mg/kg and an HR of 0.49 mg/kg for carbaryl in eggplant.

Pepper. Five trials were conducted in USA in pepper at maximum GAP rate for pepper and tomato (up to 7 times at 2.24 kg a.i./ha, total of 9 kg a.i./ha) yielding residues at 3 days PHI of 0.33, 0.61, 1.8, 2.0 and 3.8 mg/kg. Four trials were conducted in chilli pepper in Thailand and submitted as summary table by the Government could not be evaluated.

The Meeting agreed to confirm the current MRL of 5 mg/kg and recommends an STMR of 1.8 mg/kg and an HR of 3.8 mg/kg for carbaryl in pepper.

Tomato. In eleven trials conducted in tomato in California and Florida at the maximum GAP rate (up to 7 times at 2.24 kg a.i./ha, total of 9 kg a.i./ha), residues were 0.08, 0.47, 0.52, 0.67, 0.85, 1.1, 1.4, 1.9, 2.2, 2.3 and 2.4 mg/kg. In eight trials conducted in France at maximum GAP rate (1.275 kg a.i./ha), residues at 7 days PHI were 0.06, 0.11, <0.2 (2), 0.21, 0.22, 0.31 and 0.41 mg/kg. The residue population of carbaryl in tomato from trials conducted in USA and France can be combined (Mann-Whitney U-test) as, in rank order, 0.06, 0.08, 0.11, <0.2 (2), 0.21, 0.22, 0.31, 0.41, 0.47, 0.52, 0.67, 0.85, 1.1, 1.4, 1.9, 2.2, 2.3 and 2.4 mg/kg.

The Meeting agreed to confirm the current MRL of 5 mg/kg and recommend an STMR of 0.47 mg/kg and an HR of 2.4 mg/kg for carbaryl in tomato.

Sweet corn. In four trials conducted in USA in 1995 at maximum GAP rate (up to 8 times at 1.12-2.24 kg a.i./ha, min 187 l/ha), residues in ears (kernels and cobs with husks removed) at 2 days PHI were <0.02 (2), 0.02 and 0.05 mg/kg. In two trials conducted at the same rate but using lower water volume (119 l/ha) gave residues of 0.04 (2) mg/kg. This trial, although at higher GAP, can be used to support the data according to GAP.

Two trials were submitted by the Government of Thailand, but as only a summary report was provided, it was not possible to evaluate them.

The Meeting agreed to withdraw the current MRL of 1 mg/kg and recommends a maximum residue level of 0.1 mg/kg, an STMR of 0.02 mg/kg and an HR of 0.05 mg/kg for carbaryl in sweet corn (corn on the cob).

Leafy vegetables. Ten trials were conducted with carbaryl in lettuce and 10 in spinach in 1984 in Canada at maximum GAP rate, but samples were harvested before or after the recommended PHI (5 days for lettuce and 21 days for spinach). Eleven trials conducted in turnip greens at the same conditions in USA (no GAP) were evaluated against the Canadian GAP rate, however the samples were harvested before the recommended 21 days PHI and the trials could not be used.

As no trials according to GAP were submitted in lettuce, spinach and turnip greens, the Meeting agreed to withdraw the current MRL for leafy vegetables.

Soybeans. In nine trials conducted in soybean seeds in USA in 1994 using the maximum GAP rate (4 times 1.68 kg a.i./ha), residues in dry beans were <0.02, 0.03, 0.04, 0.05 (2), 0.09, 0.11, 0.12 and 0.15 mg/kg. Four trials conducted in Thailand were submitted only as summary table by the Government and could not be used.

The Meeting agreed to withdraw the current MRL of 1 mg/kg (T) and recommends a maximum residue level of 0.2 mg/kg, an STMR of 0.05 mg/kg and an HR of 0.15 mg/kg for carbaryl in dry soybeans.

Carrots. Seven trials were conducted in carrots in USA at the maximum GAP rate (2.24 kg a.i./ha, total of 6.72 kg a.i./ha). Residues at 7 days PHI in carrots were <0.02 (4), 0.03, 0.25 and 0.31 mg/kg.

The Meeting agreed to withdraw the current MRL of 2 mg/kg (T) and recommends a maximum residue level of 0.5 mg/kg, an STMR of 0.02 mg/kg and an HR of 0.31 mg/kg for carbaryl in carrots.

Garden beets. Eight trials were conducted in USA in garden beets root within maximum GAP (2.24 kg a.i./ha, total of 6.72 kg a.i./ha) and residues at 7 days PHI were <0.02 (3), 0.02, 0.03 (2), 0.05 and 0.06 mg/kg.

The Meeting recommends a maximum residue level of 0.1 mg/kg, an STMR of 0.025 mg/kg and an HR of 0.06 mg/kg for carbaryl in garden beets.

Sugar beet. Thirteen trials were conducted in sugar beets in USA in 1985 at lower GAP and could not be used.

As no trials according to GAP were submitted, the Meeting agreed to withdraw the current recommendation of 0.2 mg/kg (T) for carbaryl in sugar beet.

Sweet potato. In seven trials conducted in sweet potato in USA at the maximum GAP rate (pre-planting dip at 0.96 kg a.i./hl, followed by up to 8 applications at 0.56-2.24 kg a.i./ha or a total of 9 kg a.i./ha), residues at 7 days PHI were <0.02 (7) mg/kg.

The Meeting recommends a maximum residue level of 0.02* mg/kg, an STMR and an HR of 0.02 mg/kg for carbaryl in sweet potato.

Turnips. In nine trials conducted in turnips using 3 applications at 2.2-2.4 kg a.i./ha, residues in root were <0.02 (5), 0.02, 0.03, 0.10 and 0.89 mg/kg. There is no GAP for turnips in USA, but the trials can be evaluated against the maximum GAP rate recommended in Canada (0.6-2.5 kg a.i./ha, 7 days PHI).

The Meeting recommends a maximum residue level of 1 mg/kg, an STMR of 0.02 mg/kg and an HR of 0.89 mg/kg for carbaryl in turnip root.

Asparagus. In six trials conducted in asparagus in USA in 1994 at maximum GAP rate (3 times at 1.12-2.24 kg a.i./ha), residues at 1 day PHI were 2.0, 2.2, 7.2, 9.0 and 10 (2) mg/kg.

The Meeting agreed to withdraw the current MRL of 10 mg/kg (T) and recommends a maximum residue level of 15 mg/kg, an STMR of 8.1 mg/kg and an HR of 10 mg/kg for carbaryl in asparagus.

Maize. In eight trials conducted in USA in 1995 at maximum GAP rate (4 applications at 1.12-2.24kg a.i./ha), residues in grain were <0.02 mg/kg (8).

The Meeting recommends a maximum residue level of 0.02* mg/kg, an STMR and an HR of 0.02 mg/kg for carbaryl in maize

Barley. In ten trials conducted in barley in Canada in 1986 at maximum GAP rate plants were harvested at 14 days (PHI is 28 days) and the results could not be used.

Twenty trials were conducted in USA, where there is no approved use in barley. Two trials using aerial application matched maximum GAP in Canada (2 x 1.76 kg a.i./ha, 7 to 14 days interval, 28 days PHI) and gave residues of 0.52 and 0.33 mg/kg.

As no sufficient number of trials according to GAP were submitted, the Meeting agreed to withdraw the current MRL of 5 mg/kg (Po, T) for carbaryl in barley.

Rice. In nine trials conducted in rice in USA in 1994 at maximum GAP rate (total of 4.48 kg.ai./ha), residues in grain within 14 days PHI were 2.8, 3.1, 6.0, 7.1, 8.4, 10, 11 (2) and 46 mg/kg.

The Meeting recommends a maximum residue level of 50 mg/kg, an STMR of 8.4 mg/kg and an HR of 46 mg/kg for carbaryl in rice.

Rye. Three trials conducted in rye in USA, where there is no approved use, within Canada GAP (1.1-2.3 kg a.i./ha), had residues in grain at 14 days PHI of 0.36, 0.98 and 2.6 mg/kg, which dropped to 0.32, 0.85 and 2.0 mg/kg after 21 days. In two other trials, residues after 7 days were 9.4 and 6.2 mg/kg.

As insufficient number of supervised trials was conducted according to approved GAP, the Meeting agreed to withdraw the current MRL of 5 mg/kg (Po, T) for carbaryl in rye.

Sorghum. In nine trials conducted in sorghum in USA in 1994 at maximum GAP rate (up to 4 times at 1.12-2.24 kg a.i./ha, total of 6.7 kg a.i./ha), residues in grain after 14 days of the last application ranged from <0.02 to 7.1 mg/kg. The recommended PHI is 21 days.

As no supervised trials was conducted according to approved GAP, the Meeting agreed to withdraw the current MRL of 10 mg/kg (Po, T) for carbaryl in sorghum.

Wheat. Twenty-four trials were conducted in Canada and USA from 1986 to 1996. In twelve trials conducted in Canada at maximum GAP rate (2.3 kg a.i./ha), residues in grain were 0.22, 0.23, 0.26, 0.28, 0.33, 0.49, 1.1, 1.2, 1.3 and 1.6 (3) mg/kg within 14 days PHI. In twelve trials conducted in USA at maximum GAP (1.68 kg a.i./ha), residues in grain at 21 days PHI were <0.02 (7), 0.07, 0.12, 0.19, 0.27 and 1.4 mg/kg.

Residue populations from Canada and the USA were tested (Mann-Whitney U-test) and found to represent similar populations, and furthermore can be combined, in rank order, as <0.02 (7), 0.07, 0.12, 0.19, 0.22, 0.23, 0.26, 0.27, 0.28, 0.33, 0.49, 1.1, 1.2, 1.3, 1.4, and 1.6 (3) mg/kg.

The Meeting agreed to withdraw the current MRL of 5 mg/kg (Po, T) and recommends a maximum residue level of 2 mg/kg, an STMR of 0.245 mg/kg and an HR of 1.6 mg/kg for carbaryl in wheat.

Nuts. Twenty trials were conducted in nuts in USA in 1994 at maximum GAP rate (up to 4 applications at 5.56 kg a.i./ha and 14 days PHI). Residues in almonds nut meat were 0.03, 0.04, 0.07, 0.08 and 0.09 mg/kg.

Residues in pecans were <0.02 (3), 0.02, 0.03 and 0.05 mg/kg. Residues in pistachio nut meals were <0.02 (2), 0.03 and 0.09 mg/kg. Residues in walnuts were 0.02, 0.04, 0.09, 0.44 and 0.77 mg/kg.

The residue population in almonds, pecans, pistachio and walnuts can be combined as, in rank order, <0.02 (5), 0.02 (2), 0.03 (3), 0.04 (2), 0.05, 0.07, 0.08, 0.09 (3), 0.44 and 0.77 mg/kg.

The Meeting agreed to confirm the current MRL of 1 mg/kg (T) and recommend an STMR of 0.035 mg/kg and an HR of 0.77 mg/kg for carbaryl in tree nuts.

The Meeting also agreed to withdraw the current MRL of 10 mg/kg (T) for nuts (whole shell).

Sunflower. In five trials conducted in USA in 1994 in sunflower at maximum GAP (2 applications at 1.12-1.68 kg a.i./ha, 60 days PHI), residues in seeds were <0.02 (2), 0.03, 0.07 and 0.08 mg/kg.

The Meeting recommends a maximum residue level of 0.2 mg/kg, an STMR of 0.03 mg/kg and an HR of 0.08 mg/kg for carbaryl in sunflower seed.

Animal feed commodities

Soybean forage and hay

Eight trials were conducted in soybeans forage in USA at maximum GAP. Residues in forage within 14 days PHI, on a fresh weight basis, were 1.3, 1.4, 1.8, 1.9, 3.6, 3.8, 4.6 and 8.5 mg/kg. . Allowing the standard 35% dry matter content (DM) in soybean forage (FAO Manual, 2002), the media and the highest residues in forage, on a dried basis, are 7.86 mg/kg [2.75/0.35] and 24.3 mg/kg (8.5/0.35), respectively.

The Meeting agreed to withdraw the current MRL of 100 mg/kg (T fresh weight) and recommends a maximum residue level of 30 mg/kg and a STMR of 7.86 for carbaryl in soybean forage green, dried basis.

Residues from 9 trials conducted at maximum GAP in USA in soybean hay, residues within 21 days PHI were <0.02, 2.6, 4.0, 6.3, 6.4 (2), 8.0, 8.4 and 9.6 mg/kg. Allowing a 85% DM, the median and the highest level, on a dried basis, are 7.5 mg/kg (6.4/0.85) and 11.3 mg/kg (9.6/0.85), respectively.

The Meeting recommends a maximum residue level of 15 mg/kg and an STMR of 7.5 mg/kg for carbaryl in soybean hay.

Maize fodder and forage

Six trials were conducted in sweet corn in USA in 1995 at maximum GAP giving residues in forage at 14 days PHI, on a fresh weight base, of 1.8 (2), 3.8, 12, 124 and 163 mg/kg. Eight trials were conducted in field corn in USA at maximum GAP giving residues, on a fresh weight basis, in forage of 1.2, 2.0, 4.1, 7.7, 10, 16 and 24 (2) mg/kg.

The forage residue populations coming from trial conducted in sweet and field corn were found to represent similar populations which can be combined (Mann-Whitney U-test), as , in rank order, 1.2, 1.8 (2), 2.0, 3.8, 4.1, 7.7, 10, 12, 16, 24 (2), 124 and 163 mg/kg. Allowing for 44% dry matter content (DM) in corn forage (average between %DM of sweet corn forage and field corn forage, FAO Manual, 2002), the medium and the highest residues of carbaryl in maize forage, on a dried base, is 20 mg/kg [(7.7+10)/2 * 0.44] and 370 mg/kg (163/0.44), respectively.

The Meeting agreed to withdraw the current MRL of 100 mg/kg (T, fresh weight) and recommends a maximum residue level of 400 mg/kg and an STMR of 20 mg/kg for carbaryl in maize forage, dried basis.

Residues in maize fodder from six trials conducted in sweet corn in USA at maximum GAP were 0.24, 0.62, 1.5 (2), 68 and 184 mg/kg at 48 days PHI, fresh weight. Eight trials conducted in field corn in USA at maximum GAP gave residues in fodder, on a fresh weight basis, of 0.06, 0.14, 0.38, 0.46, 0.70, 0.71, 2.4 and 7.6 mg/kg. The fodder residue populations coming from trials conducted in sweet and field corn were found to represent similar populations which can be combined (Mann-Whitney U-test) as, in rank order, 0.06, 0.14, 0.24, 0.38, 0.46, 0.62, 0.70, 0.71, 1.5 (2), 2.4, 7.6, 68 and 184 mg/kg. Allowing for 83% dry matter content (DM) in corn fodder (stover, FAO Manual, 2002), the median and the highest residues of carbaryl in maize fodder, on a dried base, is 0.85 mg/kg (0.705/0.83) and 221 mg/kg (184/0.83), respectively.

The Meeting recommends a maximum residue level of 250 mg/kg and an STMR of 0.85 mg/kg for carbaryl in maize fodder, dry basis.

Barley forage and straw

Thirty two trials were conducted in barley forage and straw in USA, where there is no approved use for barley. Two trials conducted according to Canadian GAP of aerial application gave residues of <0.2 mg/kg and 0.4 mg/kg in straw.

As no sufficient number of trials were conducted, the Meeting agreed not to recommend a maximum residue level for carbaryl in barley straw and forage

Rice straw

In nine trials conducted in rice straw in USA according to maximum GAP, residues were 7.5, 9.4, 14, 23 (2), 26, 47, 48 and 102 mg/kg. Allowing for 90% DM (FAO Manual, 2002), the medium and the highest residue in rice straw are 25.6 (23/0.9) and 113 mg/kg (102/0.9), respectively.

The Meeting recommends a maximum residue level of 120 mg/kg and an STMR of 25.6 mg/kg for carbaryl in rice straw.

Rye forage and straw

In seven trials conducted in rye forage and straw with 2 applications at 1.68 kg a.i./ha, residues in forage at PHI from 0 to 4 days varied from 4 to 81 mg/kg (3 trials). Residues in rye straw from 5 trials ranged from 0.24 to 35 mg/kg at PHI from 7 to 21 days. There is no approved GAP for rye in USA.

As no supervised trials was conducted according to approved GAP, the Meeting agreed not to recommend a maximum residue level for carbaryl in rye forage and rye straw.

Sorghum forage and fodder

Ten trials were conducted in sorghum forage and silage in USA in 1994 at maximum GAP rate and 14 days PHI. In nine trials conducted in fodder, samples were collected before the recommended 21 days PHI, and residues ranged from 0.04 to 22 mg/kg. Residues in forage were 0.08, 0.41, 0.60, 0.85, 1.0, 2.0, 4.1, 7.3, 12 and 14 mg and in silage varied from 0.38 to 6.2 mg/kg. Allowing for 35% DM (FAO Manual, 2002), the median and the highest residue in sorghum forage are 4.3 mg/kg (1.5/0.35) and 40 mg/kg (14/0.35), respectively, on a dried base.

The Meeting agreed to withdraw the current MRL of 100 mg/kg (T, fresh weight) and recommends a maximum residue level of 50 mg/kg, an STMR of 4.3 mg/kg for carbaryl in sorghum forage, dried basis.

Wheat straw and forage

In five trials conducted in wheat forage, samples were harvested before the recommended PHI of 7 days, and the results could not be used.

Five trials were conducted in wheat straw in USA at maximum GAP, yielding residues of 0.92, 5.2, 8.2, 11 and 22 mg/kg at 21 days PHI. Allowing for 88% DM (FAO Manual, 2002), the median and the highest residue are 9.3 mg/kg (8.2/0.88) and 25 mg/kg (22/0.88), respectively, on a dried base.

The Meeting recommends a maximum residue level of 30 mg/kg and an STMR of 9.3 mg/kg for carbaryl in wheat straw.

Almond hulls

In five trials conducted in almond hulls in USA at maximum GAP rate, residues were 5, 16, 27, 36 and 39 mg/kg aft 14 days PHI. Allowing for 90% DM (FAO Manual, 2002), the median and the highest residue in almond hulls are 30 mg/kg (27/0.9) and 43.3 mg/kg (39/0.9), respectively, on a dried base.

The Meeting recommends a maximum residue level of 50 mg/kg and an STMR of 30 mg/kg for carbaryl in almond hulls.

Fate of residues in processing

Four processing studies were conducted in USA in 1985 and 1994 in citrus fruit, one in grapefruit, one in lemon and two in oranges. The fruits were treated with carbaryl and processed using procedures similar to commercial practices. Residues concentrated in oil in all fruits, with processing factors (PF) of 22.3 in grapefruit, 44 in lemon and 25.8 and 2.4 in orange (average of 23.6 for citrus, n=4). In molasses, the residues concentrated in grapefruit and lemon (PF of 3.2 and 1.2, respectively), but not in orange (0.34 and 0.08, average 0.21). Residues were 10-30% higher in peel (average PF of 1.2 in citrus, n=3), and reduced in juice (average PF of 0.03 for citrus, n=4, and of 0.01 for orange, n=2), wet pulp (average PF of 0.46 in citrus, n=3) and in dried pulp (average PF of 0.24 for citrus, n=4). Washing the fruits removed the residues with a PF of 0.43 (grapefruit), 0.9 (lemon), 0.46 and 0.18 (orange), with an average PF of 0.49 in citrus fruit.

Field-treated apples under various field conditions were processed simulating commercial practice in three studies conducted in USA in 1985 and 1994 and in France in 1997. After washing, residues in apples were reduced with a PF of 0.54 (n=2). Residues concentrated in wet and dry pomace with an average PF of 1.1 (n=2) and 3.1 (n=2), respectively. Residues reduced in juice (PF of 0.38, n=2), and in peeled apple, refined pulp and compote from either peeled or unpeeled apple, with a PF of 0.5.

Four studies were conducted in USA from 1985 to 1994 with grapes treated and processed in a close approximation of commercial practice. In average, residues reduced in juice (PF of 0.65, n=2), but concentrated in wet and dry pomace (PF of 1.4 and 2.0, respectively, n=2), raisins (PF of 1.2, n=6), washed raisins (PF of 1.4, n=3) and raisin waste (PF of 3.0, n=6).

Prunes treated and commercially processed, had the residues reduced after washing and dried (PF of 0.26 and 0.15, respectively).

In one processing study in treated olive conducted in 1994, three samples of washed and cleaned fruits were ground in a Rietz type mill and crushed with a hydraulic press. The oil obtained by centrifugation and filtration had lower residues than the olives, with an average processing factor of 0.82 (n=3).

Two processing studies were conducted in tomato in USA in 1985 and 1994. Tomato were treated at exaggerated rates and processed using comparable procedures, simulating normal commercial practices. Residues were reduced in juice by a PF of 0.5 and did not change in puree, but concentrated in wet and dry pomace and paste, with PF of 2.1, 1.7 and 2.0, respectively (n=2).

In one study conducted in treated sweet corn the cannery waste produced by blending 1/3 of the husks with 1/3 of the cobs. Residues in cannery waste were higher than in sweet corn (kernel plus cob with the husks removed) by an average processing factor of 74 (n=4).

Soybeans treated with carbaryl at 2 times the label rate were processed into hulls, meal, crude oil, refined oil and soapstock. Residues of carbaryl increased in hulls (PF= 1.3), but reduced in meal (PF= 0.03), crude oil (PF = 0.9), refined oil and in soapstock (PF<0.01).

In one study conducted in 1985, potatoes treated with carbaryl were processed into fries, chips and flakes. Residues reduced in washed tubers with a PF of 0.75, in fries with a PF of 0.04, and in chips and flakes with a PF of 0.03. In a second study, conducted in 1994, potatoes treated 3 times with 11.2 kg carbaryl/ha and harvested at 7 days PHI contained 0.03 mg/kg of carbaryl. After being processed, no residues were detected (<0.02 mg/kg) in potato chips, flakes, and dry peel.

In a study conducted in sugar beets treated at 4 times the label rate a roots were processed in a pilot plant representative of actual conditions. Residues in the processing commodities wet pulp, dry pulp, molasses and refined sugar were <0.02 mg/kg. A processing factor for these commodities can be estimated to be <0.09.

In two processing studies conducted in field corn treated with carbaryl, grains were processed to produce fractions from dry and wet milling, using procedures that simulated industrial practices. While in one study conducted in 1985 residues increased in meal and flour produced by dry milling by PFs of 1.3 and 1.7, respectively, in the other conducted in 1994, they were reduced by a factor of <0.05. Residues in grits reduced in both studies by an average PF of <0.4 and in crude oil produced by dry and wet milling it increased by an average PF of 3.3 (n=2). Residues increase in germ by a factor of 1.8 and reduced in starch with PF <0.5 (n=2) and in refined oil (PF<0.4, n=3).

Two studies were conducted in USA in 1985 and 1994 in rice treated and processed in a lab-scale procedure close to commercial practice. Residues of carbaryl concentrated in hulls by a PF of 3.3 and reduced in bran and polished rice by PFs of 0.68 and 0.02, respectively (n=2).

In one study conducted in rye treated with carbaryl, residues in grain concentrated in bran, flour and shorts with processing factors of 1.4, 1.1 and 1.7 and reduced in middlings by a factor of 0.8. No detail of the processing procedure was given in the report.

In one study conducted in treated sorghum, grain samples were dry and wet milled using simulating commercial procedures. Residues in bran increased by a factor of 2.3 (n=2), and reduced in flour by a PF of 0.16 (n=2), in shorts (PF=0.7) and in grits (PF=0.2).

In one study conducted in sweet sorghum, stalks treated at the same rate were crushed in a standard roll mill to produce the crushed stalks (bagasse) and juice, which was heated until 60-70% solid concentration (syrup). Residues of carbaryl increased in bagasse and syrup, with processing factors of 7.8) and 1.6, respectively.

In a processing study conducted in USA, treated wheat grain samples were processed simulating commercial practices. Residues of carbaryl remained almost the same in wheat bran (PF= 1.03) and reduced in low grade flour (PF=0.08), patent flour (PF=0.10) and wheat germ (PF=0.49). The patent flour is made from the finer and whiter flour streams, with lower bran content and higher endosperm content.

One study was conducted in 1995 in USA in peanuts treated with carbaryl and processed by procedures close to commercial practices. Residues in nutmeat were 0.04 mg/kg and were not detected (<0.02mg/kg) in meal and oil (PF<0.5).

Three treated cotton samples were processed in a procedure which duplicate normal commercial practices. Residues concentrated in crude oil (PF of 3.4, n=2) and reduced in hulls, meal and refined oil, with PFs of 0.35, 0.59 and <0.04 (n=3).

In one study conducted in 1994 in USA, three seed samples from a sunflower field plot treated with carbaryl were processed in a procedure which simulates industrial practice. Residues reduced in hulls, meal, crude and refined oil by processing factors of 0.48, <0.06, 0.18 and <0.06 (n=3).

Residues in processed commodities

Residues in processed commodities will be derived by multiplying the residues (maximum residue level, STMR and HR) in the raw commodity estimated from the supervised trials conducted according to GAP and the processing factors (PF) found in the processing studies conducted in the commodity. Estimations will only be derived for commodities of human consumption, for commodities of animal consumption, which can be used to estimate the animal dietary burden, or for commodities with a Codex code.

Based on a processing factor of 0.03 for citrus juice, of 0.24 for dried citrus pulp and the estimations for citrus fruit (maximum residue level of 15 mg/kg and an STMR of 4.2 mg/kg), the Meeting agreed to recommend a maximum residue level of 0.5 mg/kg and an STMR-P of 0.13 mg/kg for carbaryl in citrus juice, and a maximum residue level of 4 mg/kg and an STMR-P of 1.0 mg/kg for citrus pulp, dried.

Based on a processing factor of 2 for grape pomace, dry, of 1.2 for raisins and of 0.65 for grape juice, the estimations for grape (maximum residue level of 40 mg/kg, STMR of 4.9 mg/kg and an HR of 33 mg/kg), the Meeting recommends a maximum residue level of 80 mg/kg and an STMR-P of 9.8 mg/kg for carbaryl in grape pomace, dry; a maximum residue level of 50 mg/kg, an STMR-P of 5.9 mg/kg and an HR of 39.6 mg/kg for carbaryl in raisins; and a maximum residue level of 30 mg/kg and an STMR-P of 3.2 mg/kg for carbaryl in grape juice.

Based on a processing factor of 0.82 from olive to olive oil, and the estimations for olive (maximum residue level of 30 mg/kg and an STMR of 3.65 mg/kg), The Meeting recommends a maximum residue level of 25 mg/kg and an STMR-P of 2.99 mg/kg for carbaryl in olive oil.

Based on a processing factor of 0.5 from tomato to tomato juice and of 2 from tomato to tomato paste and the estimations for tomato (maximum residue level of 5 mg/kg and STMR of 0.47 mg/kg), the Meeting recommends a maximum residue level of 3 mg/kg, and an STMR-P of 0.24 mg/kg for carbaryl in tomato juice and a maximum residue level of 10 mg/kg and an STMR-P of 0.94 for carbaryl in tomato paste.

Based on the processing factor of 74 for sweet corn cannery waste and the estimations for sweet corn (maximum residue level of 0.1 mg/kg and STMR of 0.02 mg/kg), The Meeting estimates a maximum residue level of 7.4 mg/kg and an STMR-P of 1.48 mg/kg for carbaryl in sweet corn cannery waste.

Based on processing factors of 1.3 and 0.9 from soybeans to hulls and crude oil, respectively, and the estimations for soybeans (maximum residue level of 0.2 mg/kg and STMR of 0.05 mg/kg), the Meeting recommends a maximum residue level of 0.3 mg/kg, a STMR-P of 0.065 mg/kg for carbaryl in soybeans hulls, and a maximum residue level of 0.2 mg/kg and a STMR-P of 0.045 mg/kg for carbaryl in soybeans oil, crude. As the PF for soybean meal is low (0.03), it is unlikely that residues of carbaryl will remain in this fraction and no estimations will be performed in soybean meal.

As the estimations for carbaryl in sugar beet were at the LOQ (0.05 mg/kg) and the processing factors for pulp, molasses and sugar were <0.09, the Meeting agreed not proceed on the estimations for processed commodities of sugar beet.

The estimations for carbaryl in field corn were at the LOQ (0.02 mg/kg). Processing factors for grits and refined oil were <0.4, and the results from two studies in meal and flour varied significantly (0.05 and 1.5). Based on a PF of crude oil of 3.3, the Meeting recommends a maximum residue level of 0.1 mg/kg and an STMR-P of 0.066 mg/kg for carbaryl in maize oil, edible.

Based on processing factors of 3.3, 0.68 and 0.02 from rice to hulls, bran and polished rice and the estimations for rice (maximum residue level of 50 mg/kg, STMR of 8.4 mg/kg and HR of 46 mg/kg), the Meeting recommends a maximum residue level of 170 mg/kg and an STMR-P of 27.7 mg/kg for carbaryl in rice hulls; a maximum residue level of 35 mg/kg, an STMR-P of 5.7 mg/kg for carbaryl in rice bran; and a maximum residue level of 1 mg/kg, an STMR-P of 0.168 mg/kg and an HR-P of 0.92 mg/kg for carbaryl in polished rice.

Based on processing factors of 1, 0.09 and 0.49 from wheat to bran, flour and germ and the estimations for wheat (maximum residue level of 2 mg/kg, and STMR of 0.26 mg/kg), the Meeting recommends a maximum residue level of 2 mg/kg and an STMR-P of 0.26 mg/kg for carbaryl in wheat bran; and a maximum residue level of 0.2 mg/kg, and an STMR-P of 0.2 mg/kg for carbaryl in wheat flour; a maximum residue level of 1 mg/kg and an STMR-P of 0.13 mg/kg for carbaryl in wheat germ.

Based on processing factors of 0.18 from sunflower to crude oil and the estimations for sunflower seed (maximum residue level of 0.2 mg/kg and STMR of 0.03 mg/kg), the Meeting recommends a maximum residue level of 0.05 mg/kg and an STMR-P of 0 mg/kg for carbaryl in sunflower seed crude oil. As the PF factor for meal is <0.06, no estimations will be conducted for this processed commodity.

Animal dietary burden

The Meeting estimated the dietary burden of carbaryl in cow on the basis of the diets listed in Appendix IX of the FAO Manual (FAO, 2002) and the MRL and STMR estimated at this Meeting.

Maximum farm dietary burden estimation

Commodity	Group	Residues mg/kg	Basis	% dry matter	Residues, in dry basis, mg/kg	% of diet			Residue contribution, mg/kg		
						Beef	Dairy	Poultry	Beef	Dairy	Poultry
Citrus pulp, dried	AB	1.0	STMR-P	91	1.1	20	20	-	0.22	0.22	-
Almond hulls	AM	50	MRL	90	45	10	10	-	4.5	4.5	-
Rice hulls		25.7	STMR-P	90	28.5	10	10	15	2.85	2.85	4.3
Sweet corn cannery waste		2.22	STPM-P	30	7.4	35	20	-	2.59	1.48	-
Maize forage	AF	400	MRL	100	400	40	50	-	160	250	-
Sorghum forage	AF	50	MRL	100	50	40	50	-	10	25	-
Soybean hay	AL	15	MRL	100	15	30	30	-	4.5	4.5	-
Soybean forage	AL	30	MRL	100	30	30	25	-	9.0	7.5	-
Rice straw	AS	120	MRL	100	120	10	10	-	12	12	-
Maize fodder (stover)	AS	250	MRL	100	250	10	05	-	25	12.5	-
Wheat straw	AS	30	MRL	100	30	10	10	-	3	3	-
Rice	GC	50	MRL	88	56.8	10	10	60	5.7	5.7	34.1
Maize	GC	0.02	MRL	88	0.023	80	40	40	0.018	0.009	0.018
Wheat grain	GC	2	MRL	89	2.24	50	40	80	1.12	0.90	1.8

Soybean seed	VD	0.2	MRL	89	0.22	15	15	20	0.03	0.03	0.04
TOTAL						100	100	100	208.6	279.6	34.3

STMR farm animal dietary burden estimation

Commodity	Group	Residues mg/kg	Basis	% dry matter	Residues, in dry basis, mg/kg	% of diet			Residue contribution, mg/kg		
						Beef	Dairy	Poultry	Beef	Dairy	Poultry
Citrus pulp, dried	AB	1.0	STMR-P	91	1.1	20	20	-	0.22	0.22	
Almond hulls	AM	30	STMR-P	90	33.3	10	10	-	3.33	3.33	
Rice hulls		27.7	STMR-P	90	30.8	10	10	15	3.1	3.1	
Sweet corn cannery waste		2.22	STPM-P	30	7.4	35	20	-	2.59	1.48	
Maize forage	AF	20	STMR	100	20	40	50	-	8.0	10	
Sorghum forage	AF	1.5	STMR	35	4.3	40	50	-	1.7	2.15	
Soybean hay	AL	7.5	STMR	100	7.5	30	30	-	2.25	2.25	
Soybean forage	AL	7.9	STMR	100	7.9	30	20	-	2.4	1.58	
Rice straw	AS	25.6	STMR	100	25.6	10	10	-	2.56	2.56	
Maize fodder (stover)	AS	0.85	STMR	100	0.85	25	15		0.21	0.13	
Wheat straw	AS	9.3	STMR	100	9.3	10	10	-	0.93	0.93	
Rice	GC	8.4	STMR	88	9.3	10	10	60	0.93	0.93	6.6
Maize	GC	0.02	STMR	88	0.23	80	40	40	0.18	0.09	0.09
Wheat grain	GC	0.26	STMR	89	0.29	50	40	80	0.15	0.12	
Soybean seed	VD	0.05	STMR	89	0.056	15	15	20	0.01	0.01	
TOTAL						100	100	100	17.3	17.3	6.7

Animal feeding studies

Dairy cattle were orally dosed daily with carbaryl for a period of 28 days at 114 ppm (Group II), 342 ppm (Group III) and 1140 ppm, changed to 570 ppm at day 5 (Group IV). Cows were milked twice daily and a day's sample consists of a proportional mix of PM milk and the following morning's AM milk. Test animals were terminated within 7 hours after receiving the final dose and samples, of muscle, fat, liver, and kidney were collected for analysis. Milk (days 1, 4, 8, 11, 15, 18, 22, 25 and 28), milk fat (days 22 and 27 of Group IV) and tissue samples were analysed for carbaryl and the metabolites 5,6-dihydro-5,6 dihydroxy carbaryl and 5-methoxy-6-hydroxy carbaryl.

Average residues of carbaryl in milk analysed throughout the study in each group increased with the dose rate, with 0.02, 0.04 and 0.06 mg/kg for the groups II, III and IV, respectively. 5,6-dihydro-5,6 dihydroxy carbaryl was the major residue in all dosing groups, with average residues of 0.15, 0.46 and 1.1 mg/kg in milk from cows from groups II, III and IV, respectively. Average 5-methoxy-6-hydroxy carbaryl residues were 0.11, 0.18 and 0.21 mg/kg.

Carbaryl and 5,6-dihydro-5,6 dihydroxy carbaryl were the main compounds found in kidney and liver and 5,6-dihydro-5,6 dihydroxy carbaryl was the main compound found in muscle. In kidney, average carbaryl concentrations were 0.69, 2.1 and 2.3 mg/kg and in liver 0.49, 0.93 and 1.1 mg/kg, in groups II, III and IV, respectively. 5,6-dihydro-5,6 dihydroxy carbaryl residues in kidney were 0.60, 2.0 and 3.7 mg/kg and in liver 0.21, 0.58 and 1.2 mg/kg. Muscle tissue contained 0.31, 0.97 and 1.9 mg/kg of 5,6-dihydro-5,6 dihydroxy carbaryl, and residues of carbaryl ranged from <0.02 to 0.04 mg/kg. In fat, carbaryl levels ranged from 0.02 to 0.06 mg/kg and of 5,6-dihydro-5,6 dihydroxy carbaryl from 0.06 to 0.18 mg/kg. 5-methoxy-6-hydroxy carbaryl was mostly present in kidney, at concentrations of 0.07, 0.45 and 0.86 mg/kg. In liver and fat, residues ranged from 0.02 to 0.09 mg/kg and it was not detected in muscle.

Animal commodities residue levels

Cattle

As the maximum dietary burden of beef and dairy cattle estimated by the Meeting were 208.6 and 279.6 mg/kg feed, respectively, the highest value (279.6 mg/kg feed) will be used for calculation of the residues. The levels will be derived from the interpolation between the levels found in animals from group II (114 ppm) and group III (342 ppm). For the STMR estimation, the residue levels at 17.3 mg/kg feed (dietary burden for both beef and dairy cattle), will be derived by applying the transfer factor (residue level in milk or tissue/residue level in diet) at the lowest feeding level (114 ppm) to the dietary burden.

Residue levels of carbaryl reached a maximum in milk at day 4 four in cows from the feeding groups III and IV, and the levels dropped to 85 and 24% of the maximum at day 28, respectively. Levels at milk from the lowest feeding group increased up to 24% of the initial value between days 18 to 25. The Meeting agreed that the maximum residue levels in tissues will be derived from the levels found at the maximum dietary burden, using the highest residue level. The STMRs will be derived from the STMR dietary burden and the mean residue levels. For milk, the mean residue at the plateau level from the relevant feeding group will be used to estimate both the maximum residue level and the STMR.

Dose (ppm) (Interpolated) [actual]	Carbaryl concentration (mg/kg)								
	Milk (mean)	Liver		Kidney		Muscle		Fat	
		Highest	Mean	Highest	Mean	Highest	Mean	Highest	Mean
MRL									
(279.6)	(0.034)	(0.907)		(1.90)		(<0.042)		(0.062)	
[114/ 342]	[0.02/ 0.04]	[0.66/ 1.0]		[0.85/ 2.3]		[<0.02/ 0.05]		[0.04/ 0.12]	
STMR									
(17.3)	(0.003)		(0.085)		(0.119)		(<0.003)		(0.003)
[114]	[0.02]		[0.49]		[0.69]		[<0.02]		[0.02]

The Meeting agreed to withdraw the current MRL of 0.1 mg/kg * (T) and recommends a maximum residue level of 0.05 mg/kg and an STMR of 0.003 mg/kg for carbaryl in milks.

The Meeting recommends a maximum residue level of 1 mg/kg, an STMR of 0.085 mg/kg and an HR of 0.907 mg/kg for carbaryl in liver of cattle, goats, pigs and sheep.

The Meeting recommends a maximum residue level of 3 mg/kg, an STMR of 0.119 mg/kg and an HR of 1.9 mg/kg for carbaryl in kidney of cattle, goats, pigs and sheep.

For the purpose of dietary intake calculation, the Meeting also estimates an STMR of 0.003 mg/kg and an HR of 0.062 mg/kg for carbaryl in fat from mammals other than marine mammals.

The Meeting agreed to withdraw the current MRLs of 0.2 mg/kg (T) for cattle meat, goat meat and sheep meat and recommends a maximum residue level of 0.05 mg/kg, an STMR of 0.02 mg/kg and an HR of 0.05 mg/kg for carbaryl in meat (from mammals other than marine mammals).

Poultry

For poultry, the maximum and the STMR estimated dietary burden were 34.4 and 6.4 mg/kg feed, respectively. Metabolism studies on hens conducted at 8.8 and 10.5 mg/kg feed (7 consecutive days orally dosed) showed detectable residue of carbaryl in egg yolks, liver and abdominal fat (0.001 to 0.004 mg/kg ¹⁴ carbaryl eq.). The Meeting agreed that this study is not adequate to estimate maximum residue levels of carbaryl in poultry.

DIETARY RISK ASSESSMENT

Long-term intake

The ADI for carbaryl is 0.008 mg/kg body weight/day. International estimated daily intake (IEDI) was calculated for commodities of human consumption which STMRs were estimated in this evaluation. The results are shown in Annex III.

International Estimated Daily Intakes for the five GEMS/Food regional diets, based on estimated STMRs, ranged from 10 to 60 % of the ADI. The Meeting concluded that the intake of residues of carbaryl resulting from its uses that have been considered by the JMPR is unlikely to present a public health concern.

Short-term intake

The acute RfD for carbaryl is 0.2 mg/kg body weight. The international estimate of short term intake (IESTI) for carbaryl was calculated for food commodities for which maximum residue levels, STMR values and/or HR values were established at this Meeting. The results are shown in Annex IV.

The IESTI for grapes was 420% of the acute RfD for the adult population and 1100% of the acute RfD for the children. The IESTI for apricot, cherries, peaches and plums were 130%, 130%, 170% and 140% of the acute RfD for children, respectively. The information provided to the Meeting precludes an estimate that the dietary acute intake of grapes by children and adults and of apricot, cherries, peaches and plums by children would be below the acute reference dose.

For all the other commodities considered, the % of the acute RfD varied from 8-80%. The Meeting concluded that short-term intake of residues of carbaryl in these commodities, when used in ways that have been considered by the JMPR, is unlikely to present a public health concern.

4.5 CARBOFURAN (096)

TOXICOLOGY

Carbofuran (2,3-dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate) was first evaluated by the 1976 JMPR. It was last evaluated in 1996, when an ADI of 0–0.002 mg/kg bw was allocated on the basis of the NOAEL in a 4-week study in dogs. Establishment of an acute RfD was requested by the Codex Committee on Pesticide Residues, and that was the basis for the present review.

Carbofuran is a carbamate compound that exerts virtually all its effects by inhibiting cholinesterase activity in nervous tissues. Nevertheless, in one study in dogs, carbofuran also caused testicular degeneration.

A study of the reversibility of inhibition of plasma and erythrocyte cholinesterase activity, in which groups of up to nine rats of each sex per dose were given single doses of 0, 0.5 or 1 mg/kg bw of carbofuran, was reviewed. Inhibition of erythrocyte cholinesterase activity was maximal within about 15 min and was rapidly reversible within 6 h in females. Although the activity of cholinesterase was still less than 80% of the level before dosing at 8 h in males at the higher dose, the decrease at that time was only marginal. Furthermore, when compared with the activity in concurrent controls, the activity at the higher dose was not biologically significantly depressed in males after 4 h. The LOAEL was 0.5 mg/kg bw.

Three studies carried out in beagle dogs were considered relevant to establishing an acute RfD. In a 13-week study evaluated by the 1996 JMPR, which was re-evaluated at the present Meeting, the LOAEL was 10 ppm in the diet (equal to 0.43 mg/kg bw per day); a NOAEL was not identified. Significant depression of erythrocyte cholinesterase activity and clinical signs were seen on the first day of dosing at the lowest dose. A supplementary study was carried out over 4 weeks in male dogs, which was evaluated by the 1996 JMPR but not by the present Meeting. The NOAEL for cholinesterase inhibition was 5 ppm, equal to 0.22 mg/kg bw per day. An earlier 1-year feeding study in dogs, evaluated by the 1996 Meeting, was reviewed by the present Meeting. The NOAEL was 10 ppm (stated as being equal to 0.3 mg/kg bw per day in the 1996 JMPR monograph), on the basis of concern about the potential for testicular toxicity at 20 ppm.

After considering the data available to the present Meeting as well as the 1996 evaluations, the Meeting established an acute RfD of 0.009 mg/kg bw on the basis of the NOAEL of 0.22 mg/kg bw per day in the 4-week study in dogs and a safety factor of 25, as the relevant toxic effects of carbofuran are dependent on the C_{\max} (see section 2.2).

An addendum to the toxicological monograph was prepared

RESIDUE AND ANALYTICAL ASPECTS

Carbofuran has been reviewed several times initially in 1976 and more recently in 1997, when a number of commodities were recommended for withdrawals of MRLs. The 1997 JMPR considered desirable data from feeding studies with cows and processing studies on potatoes and sugar cane treated with carbofuran at exaggerated rates. At the 31st Session of the CCPR, the Committee decided to maintain the CXLs for for four years under the periodic review program for rice, maize, sweet corn, soya bean (dry) and soya bean (immature), carrot, cotton seed, eggplant, maize, maize fodder, tomato, wheat grapes, peanut, pepper sunflower seed.

The company submitted residue data for cereals and grains (field corn), rice, oil seeds (cotton seed, rape seed) and sweet corn, GAP information, fate of residue in processing, residues in food in commerce or at consumption and national residue limits. GAP information and residue data were submitted by Thailand for soya bean, rice, and sweet corn and by Poland for horse bean, maize and sugar beet. The Netherlands submitted GAP information and MRLs

Results of supervised trials

Residue definition for carbofuran is sum of carbofuran and 3-OH-carbofuran, expressed as carbofuran. For each trial under GLP, residues were determined for carbofuran and 3-OH-carbofuran separately. For all trials, except for the rice trial in India, LOD is 0.01 mg/kg and LOQ is 0.05 mg/kg for each compound. In India, LOD is 0.05 and LOQ is 0.1 mg/kg for each compound. When residues were estimated (≥ 0.01 and <0.05 mg/kg) for each compound, carbofuran residues were calculated as follow:

Carbofuran	3-OH-carbofuran	Total carbofuran
<0.01	<0.01	<0.05
(0.02)	<0.01	<0.05 (0.03)
(0.02)	(0.02)	<0.05 (0.04)

Horse bean. In one trial conducted in horse bean according to GAP and submitted by the Government of Poland, no residues of carbofuran were detected (<0.06 mg/kg). As only a summary table was provided, it was not possible to evaluate the trial.

Soya bean, dry. In four trials at GAP submitted by the Government of Thailand no residues were detected (no LOQ reported). As the analytical report was not provided, it was not possible to evaluate the trials.

Sweet corn. Six trials were conducted in sweet corn in USA according to maximum GAP for foliar application (0.56 kg a.i./ha, 7 days PHI). No residues of carbofuran (carbofuran + 3-OH-carbofuran) was detected in any sample analyzed (kernels plus the cob with the husks removed) (<0.05 mg/kg). Sixteen trials according to GAP conducted in USA were submitted to the 1997 JMPR and the residues are <0.03 (6), 0.03 (4), 0.04 (4), 0.05 and 0.08 mg/kg. The residues from the 1997 JMPR and from the trials submitted to this Meeting are <0.03 (6), 0.03 (4), 0.04 (4), <0.05 (6), 0.05 and 0.08 mg/kg.

The Meeting confirms the previous recommendation of a maximum residue level of 0.1 mg/kg and an STMR of 0.04 mg/kg and recommends an HR of 0.08 mg/kg for carbofuran in sweet corn (corn-on-the-cob).

Sugar beet. In two trials submitted by the Government of Poland conducted in sugar beet at GAP rate residues of carbofuran were not detected (<0.04 mg/kg) in leaf and root at PHI of 107 to 149 days. As only a summary table was provided, it was not possible to evaluate the trials.

Maize. Three trials were conducted in field corn (maize) in Brazil, state of São Paulo, at the GAP in furrow at-plant application rate of 1.75 kg ai/ha with a granular formulation. For the at-plant use pattern in Brazil, the PHI is 30 days. However, with an at-plant use, crop is not mature at 30 days after application. No residues were detected (<0.02 ppm) in mature grain after 136 to 138 days after treatment, when the plants are at mature stage. These trials were considering at being at GAP and considered for estimations.

The US product label allows growers to use carbofuran as an at-plant and foliar insecticide. Three trials were conducted in the major corn-growing states of Iowa, Nebraska, and Illinois using 1 foliar application at the maximum GAP rate of 1.1 kg a.i./ha and 30 days PHI. No carbofuran residues were detected in corn grain (< 0.05 ppm). In three trials conducted at GAP in maize and submitted by the Poland Government, no residues of carbofuran (<0.04 mg/kg) were detected.. As only a summary table was provided, it was not possible to evaluate these trials.

Trials conducted according to GAP are <0.05 (6) mg/kg total carbofuran. The Meeting agreed that 6 trials are not sufficient to recommend a maximum residue level in maize grain.

Rice. A total of 9 trials were conducted in rice. In Brazil, 3 trials were conducted using ground application of a granular formulation in the state of São Paulo at maximum GAP rate (0.75 to 1 kg a.i./ha). Total residues of carbofuran in grain (carbofuran plus 3-OH-carbofuran, expressed as carbofuran) at 30 days PHI were 0.10 (2) and 0.12 mg/kg.

No residues were detected (<0.05 mg/kg) at 86 and 95 days PHI in two trials conducted in Colombia at maximum GAP (0.9 kg a.i./ha).

In one trial in India, rice plants were treated with 3 broadcast applications at the nursery (10 days before transplant), tillering and booting (25 and 89 days after transplanting, respectively) stages at maximum GAP rate of 2 kg a.i./ha. Plant samples were harvested at 36 days PHI, dried in the field for one day and under the sun for 4-6 hours for 3 days in a clean area. The grain was then separated from the straw by beaten on a wooden plank and analyzed. Carbofuran total residues were 0.16 mg/kg.

In three trials conducted in Korea, plants were treated 2 or 3 times at maximum GAP rate (0.9-1.2 kg a.i./ha) from transplanting to milk-ripe stage. In one trials conducted within 45 days PHI, total residues were 0.17 mg/kg and the two other trials, no residue was detected (<0.02 mg/kg) after 63 days of the last application. Grain samples were air-dried for 15 days at room temperature before analyzed (normal practice is 4 days drying).

In four trials conducted in Thailand at GAP and double GAP rates, no residues were detected at 68 days PHI in rice grain. As the analytical report was not provided, the trials could not be evaluated.

In one trial conducted in Australia according to GAP and evaluated at the 1997 JMPR gave residues of <0.05 mg/kg carbamates (carbofuran + 3-keto-carbofuran + 3-OH-carbofuran).

Trials in rice conducted according to GAP were, in rank order, <0.02 (2), <0.05, 0.10 (2), 0.12, 0.16 and 0.17 mg/kg.

The Meeting agreed to recommend a maximum residue level of 0.3 mg/kg, an STMR of 0.10 mg/kg and an HR of 0.17 mg/kg for carbofuran in rice grain

Cotton seed. Eight trials were conducted in cotton seed in South America. In four trials conducted in Brazil at maximum GAP (1.5-3 kg a.i./ha and 45 days PHI) with hand drilled application of a 50G formulation, residues were <0.02 (4) mg/kg.

In four trials conducted in Colombia using 1 foliar application at maximum GAP rate of 0.7 kg a.i./ha of a SC concentration, residues of total carbofuran at 25-26 days PHI were 0.01, 0.02 and 0.03 (2) mg/kg. These values are estimates, as they are below the LOQ (0.05 mg/kg).

Residues of carbofuran in cotton seed according to GAP are 0.01, <0.02 (4), 0.02 and 0.03 and 0.04 mg/kg.

The Meeting agreed to recommend a maximum residue level of 0.1 mg/kg, an STMR of 0.02 mg/kg and an HR of 0.04 mg/kg for carbofuran in cotton seed

Rape seed. Six trials were conducted in rape seed in Poland in 2000 using one seed treatment at GAP rate of 5.25 g a.i./kg seed. Residues of total carbofuran at 321 to 324 days PHI were <0.05 (6) mg/kg. Seed treatment is the only registered use for oilseed rape in Poland.

The Meeting recommends a maximum residue level of 0.05* mg/kg and an STMR for carbofuran in rape seed

Maize forage and fodder. Twelve trials were conducted in field corn forage and stove (fodder) in Brazil and USA. Residues in forage from trials conducted in Brazil at maximum at-planting GAP rate were <0.05 mg/kg (3) at 81-91 days after treatment in soil with a granular formulation. In fodder, residues were <0.05 mg/kg (3) at 135 to 138 days after treatment.

Residues from trials conducted in USA using maximum GAP for foliar application were 0.11, 0.34 and 0.37 mg/kg in forage and 0.51, 0.84 and 0.30 mg/kg in fodder at 30 days PHI. Trials conducted using soil granular application and foliar application gave residues of different populations, which cannot be combined.

It was not possible to evaluate the two trials conducted in Poland at GAP in maize, as only a summary table was submitted.

The Meeting agreed that only 3 trials conducted at the critical foliar treatment is not sufficient to recommend maximum residue levels for carbofuran in maize forage and fodder.

Rice straw. Nine trials were conducted in rice straw in Brazil, Colombia, India and Korea. In 3 trials conducted in Brazil with soil application at GAP rate of 0.8-1 kg a.i./ha, residues within 30 days PHI were 0.10 (2) and 0.12 mg/kg of total carbofuran. In two trials conducted in Colombia at maximum GAP, no residues were detected (<0.02 mg/kg) at 86-95 days PHI. In both countries, rice straw were sampled from dried stalks or stem with leaves left after the grain had been harvested.

In one trial conducted in India, using 3 applications of the GAP rate (2 kg a.i./ha) residues in straw at 36 days PHI were 0.39 mg/kg. Sampled plants were dried in the field for one day and under the sun for 4-6 hours for 3 days in a clean area. After drying, the grain was separated from the straw by beaten on a wooden plank.

In three trials conducted in Korea at the maximum GAP rate, the straw samples were air-dried for 15 days at room temperature before analyzed. Residues at 45 days PHI were 0.51 mg/kg. Samples harvested at 63 days had residues of <0.01 mg/kg and 0.18 mg/kg.

Trials conducted according to GAP are, in rank order, <0.1 (2), 0.10 (2), 0.12, 0.39 and 0.51 mg/kg.

The Meeting recommends a maximum residue level of 1 mg/kg and an STMR of 0.10 mg/kg for carbofuran in rice straw.

Fate of residues in processing

In the 3 trials conducted in Korea, rice was treated with a granular formulation at 1.2 kga.i./ha and harvested at 48 or 63 days. Grain samples were dried for 15 days at room temperature and submitted to a milling process to obtain hulled rice grain (husked). Total carbofuran residues in dried grain were <0.05 (LOD), 0.18 and <0.05 mg/kg. Residues in hulled grain were (0.02), (0.02) and <0.05 mg/kg. A processing factor of 0.25 from the second trial can be derived. No detailed information on the milling process was provided.

The calculated processing factor from rice to husked rice (0.25) was applied to the recommendations for rice (maximum residue level of 0.3 mg/kg, an STMR of 0.10 mg/kg and an HR of 0.17 mg/kg). The Meeting recommends a maximum residue level of 0.1 m/kg, an STMR-P of 0.025 mg/kg and an HR-P of 0.042 mg/kg for carbofuran in rice, husked.

Rape was treated with at 5.25 g/kg seed as a seed treatment. Samples from 5 trials were collected after 321 to 337 days and composited into one sample for processing into meal (press cake), crude oil and refined oil. The method applied reflects the conditions for the semi-industrial production of rapeseed oil. There were no detectable residues of carbofuran or 3-hydroxy-carbofuran in the seed and in any of the processed samples (<0.05 ppm).

DIETARY RISK ASSESSMENT

Long-term intake

Currently, the ADI for carbofuran is 0.002 mg/kg body weight/day. International estimated daily intake (IEDI) was calculated for commodities of human consumption which STMRs were estimated at the 1997 JMPR and at this Meeting. The results are shown in Anex III.

International Estimated Daily Intakes for the five GEMS/Food regional diets, based on estimated STMRs, ranged from 10 to 30 % of the ADI. The Meeting concluded that the intake of residues of carbofuran resulting from its uses that have been considered by the JMPR is unlikely to present a public health concern.

Short-term intake

The acute RfD for carbofuran was estimated by this Meeting as 0.009mg/kg body weight. The international estimate of short term intake (IESTI) for carbofuran was calculated for commodities for which maximum residue levels, STMR values and/or HR values were established at this Meeting (rice, husked and sweet corn (corn on the cob)). The results are shown in Annex IV.

The calculated IESTI were less than 100% of the acute RfD for children and for the general population. The Meeting concluded that short-term intake of residues of carbofuran, when used in ways that have been considered by the JMPR, is unlikely to present a public health concern.

4.6 CARBOSULFAN (145)

RESIDUE AND ANALYTICAL ASPECTS

Carbosulfan [2,3-dihydro-2,2-dimethylbenzofuran-7-yl (dibutylaminothio)=methylcarbamate] was evaluated for residues by the 1997 JMPR under the Periodic Review Programme. Residues of carbosulfan are defined as carbosulfan. The 1997 JMPR recommended an MRL for oranges (sweet, sour) at 0.1 mg/kg although it concluded that an MRL for citrus fruits should be established. In response to the request of the 31st session of the CCPR (1999) to estimate an MRL for mandarin if it was considered to be more appropriate to recommend MRLs for individual commodities, the 1999 JMPR reviewed the data evaluated by the 1997 JMPR and its recommendations. It agreed to maintain the MRL of 0.1 mg/kg for oranges (sweet, sour) and recommended an MRL of 0.1 mg/kg for mandarin. It concluded that a group MRL for citrus fruits could not be recommended since registered uses of carbosulfan were solely on oranges and mandarin.

At the 33rd CCPR (2001) Spain requested that a general MRL be elaborated for carbofuran in/on citrus fruits and the CCPR requested Spain to submit GAP of carbosulfan on citrus fruits. The Meeting received information on use pattern on citrus fruits in Spain, which allows single application of CS 25% formulation at 0.025-0.0375 kg a.i./hl and 2000 l with a PHI of 90 days.

Carbosulfan was not detected in whole oranges and mandarins harvested 90 ± 23 days after the application in trials conducted in Spain (250 EC formulation was used) which match the GAP.

The results of trials conducted on oranges in Mexico and Brazil following their GAPs (Mexico, LE 26.1%, 250 g ai/ha, 1000 l, 4 applications, PHI of 7 days for Valencia oranges and LE 26.1%, 250 g ai/ha, 1000 l, 3 applications, PHI of 7 days for other oranges; Brazil, 0.93-1.7 g ai/tree, 2 applications, PHI of 7 days for oranges) showed residues of carbosulfan from <0.01 to 0.08 mg/kg and were used to estimate MRLs for oranges (sweet, sour) and mandarins. The Meeting therefore confirmed the decision of the 1999 JMPR that a group MRL for citrus fruits could not be recommended.

4.7 CLETHODIM (187)

RESIDUE AND ANALYTICAL ASPECTS

Clethodim {(±)-2-[(E)-1-[(E)-3-chloroallyloxyimino]propyl]-5-[2-(ethylthio)propyl]-3-hydroxycyclohex-2-enone} was evaluated by the JMPR in 1994, 1997 and 1999. At the 2001 CCPR, the delegation of Germany questioned whether the notionally specific method of analysis employed by the company could actually differentiate residues arising from the use of clethodim from those produced from sethoxydim. This followed concerns expressed by the delegations of France, Germany and The Netherlands at the 2000 CCPR about the availability of an analytical method for regulatory purposes and the rather high and variable limits of determination in several commodities. The 2001 CCPR concluded that the MRLs in development would not be advanced in the absence of a suitable regulatory method and this was reaffirmed by the 2002 CCPR.

The 1999 JMPR recommended that the residue definition for compliance with MRLs and for estimation of dietary intake should be: sum of clethodim and metabolites containing 5-(2-ethylthiopropyl)cyclohexene-3-one and 5-(2-ethylthiopropyl)-5-hydroxycyclohexene-3-one moieties and their sulfoxides and sulfones, expressed as clethodim.

Clethodim and sethoxydim share a common moiety, which accounts for the major part of their structures. Their structures differ in two parts, namely: the oxime oxygen bears an ethyl group in sethoxydim but a 3-chloroallyl group in clethodim; and the imino carbon bears an *n*-propyl group in sethoxydim but an ethyl group in clethodim.

The proton on the 3-hydroxyl of the hydroxycyclohexenone moiety is mobile and keto-enol tautomerisation occurs in both clethodim and sethoxydim. The two tautomers of each compound are indistinguishable.

In addition, (*E*) and (*Z*) isomers occur at the oxime nitrogen of clethodim. The (*E*) form is the less polar and they are readily separated by HPLC. However, the two forms interconvert in aqueous solution, fairly readily at pH 5 and 7 but not measurably at pH 9, and the interconversion may be observable in HPLC chromatograms by the slight tailing between the two peaks. Sethoxydim has no such isomers.

For the purposes of residues analysis, in addition to clethodim (a sulfide) itself, it is also necessary to determine the presence of the sulfoxide and sulfone, and also their 5-hydroxylated counterparts. Sethoxydim also forms the corresponding sulfoxide and sulfone.

Both clethodim and sethoxydim have a single chiral centre, at the 2-carbon of the ethylthiopropyl group. Sulfoxides are also chiral and therefore the (*E*) and (*Z*) isomers of clethodim and sethoxydim sulfoxide should each exist as two diastereomers which, in principle, might be separable by achiral chromatography. The reversed-phase system (a phenyl-hexyl column eluted with a methanol/water gradient containing a constant 0.1% of formic acid) used in the study evaluated (Reed, 2002) appeared unlikely to separate the diastereomers and the chromatograms showed no evidence of it.

Early studies on clethodim residues utilised an analytical method involving treatment with alkaline H₂O₂, to oxidize the sulfide and sulfoxide to the corresponding sulfone, simultaneously oxidatively cleaving the hydroxycyclohexenone ring to form 3-[2-(ethylsulfonyl)propyl]pentanedioic acid. The acid was methylated with anhydrous methanol and HCl for gas chromatography and detection by flame-photometric detection, using the sulfur mode.

3-[2-(ethylsulfonyl)propyl]pentanedioic acid is a photolysis product of clethodim (which is not included in the residue definition) but it also produced from sethoxydim under the same analytical conditions. The method is therefore not specific for the determination of clethodim.

The 1999 JMPR evaluation refers to a specific HPLC method (EPA-RM-26-D-3) having been developed for determination clethodim residues by Lai, 1996. It was a modification of methods developed earlier (EPA-RM-26-D-1 by Lai and Ho, 1990 and EPA-RM-26-D-2 by Lai and Fujie, 1993). Detection is by UV absorption at 266 or 254 nm. The extracted residues are subject to alkaline precipitation, the 5-hydroxyl is methylated with diazomethane and the sulfides and sulfoxides are oxidized to the sulfones with *m*-chloroperbenzoic acid. The description of the method is slightly ambiguous.

The “alkaline precipitation” and oxidation with *m*-chloroperbenzoic acid could be construed as being similar to the process used in the non-specific method, leading to the generation of 3-[2-(ethylsulfonyl)propyl]pentanedioic acid. Hence the method would be no more specific than the original one. The lack of clarity regarding the “alkaline precipitation” presumably gave rise to the concerns about the specificity of the new method, expressed at the 34th meeting of CCPR .

The 1999 JMPR evaluation indicates that the methylated forms of clethodim, 5-hydroxy-clethodim sulfone, sethoxydim and 5-hydroxy-sethoxydim sulfone produce four separated HPLC peaks, not two, suggesting that the common moiety is not produced. However, UV absorption at a single wavelength (or even two) is not a specific detection technique.

A new method was submitted by the company for evaluation by the 2002 JMPR (Reed, 2002), based on detection by LC-MS/MS (triple-sector quadrupole), with electrospray ionization in positive ion mode.

In this method, the alkaline precipitation involves the addition of solid calcium hydroxide to the aqueous methanol extract in the presence of Celite 545, brief swirling and immediate filtration, followed by acidification with HCl. The principle of this process (which is to be completed in <10 min at room temperature) is not described in the study report but the manufacturer confirmed that it is a clean-up, intended to remove relatively strong organic acids

from the extracts, whilst avoiding degradation of clethodim and its metabolites. Oxidation with *m*-chloroperbenzoic acid is intended only to oxidize the sulfides and sulfoxides to their corresponding sulfones. It does not generate 3-[2-(ethylsulfonyl)propyl]pentanedioic acid.

The HPLC chromatograms resulting from this method clearly show the presence of two isomers (*E* and *Z*) of clethodim sulfone, 5-hydroxy-clethodim sulfone and *S*-methylclethodim sulfone (the last is not included in the residue definition). The isomer ratios were evidently not entirely constant, with some interconversion occurring on column, but the two peak areas were summed in each case. The isomers (*E*) and (*Z*) isomers of clethodim sulfone and 5-hydroxy-clethodim sulfone were detectable as four separated peaks.

The analytes were detected by multiple reaction monitoring (MRM) of the transitions *m/z* 392 to 164 for clethodim sulfone, *m/z* 408 to 204 for 5-hydroxy-clethodim sulfone, and *m/z* 378 to 164 for *S*-methylclethodim sulfone. The manufacturer confirmed that the precursor ions for each transition corresponded to the ³⁵Cl isotopic protonated molecule, [M+H]⁺. Sethoxydim and its metabolites cannot produce these precursor ions and would also have different retention times and, presumably, produce much lower sensitivity under the same conditions. The product ions were not rationalised in the analytical method description but the manufacturer noted that the fragmentations produced by the clethodim sulfone and *S*-methylclethodim sulfone followed a pattern similar to that of clethodim, documented by Marek *et al.*, (2000). The common fragment of *m/z* 164 (the most abundant fragment detected by these authors) is postulated to be generated from clethodim via [M - OCH₂CH=CHCl - CH₂CH(CH₃)SCH₂CH₃]. By analogy, the product *m/z* 164 is presumed to be generated from clethodim sulfone via [M - OCH₂CH=CHCl - CH₂CH(CH₃)SO₂CH₂CH₃], and *m/z* 164 is generated from *S*-methylclethodim sulfone via [M - OCH₂CH=CHCl - CH₂CH(CH₃)SO₂CH₃]. Sethoxydim and sethoxydim sulfoxide were reported by Marek *et al.* to undergo a corresponding fragmentation to generate a product ion of *m/z* 178. Sethoxydim sulfone may therefore be expected to produce a product ion at *m/z* 178. The protonated molecule of sethoxydim sulfone cannot generate product ions of the same *m/z* ratio as those of clethodim. The fragmentation of 5-hydroxy-clethodim sulfone is evidently not analogous to that of clethodim.

LC-MS/MS of a single transition has the potential for interference from unrelated compounds, although the risk is not very great with relatively large molecules such as clethodim and its metabolites. Where clethodim and its metabolite sulfones are detected in a single sample by LC-MS/MS, the evidence of identity will be strongly supported if the four peaks are detected. However, if only one of the sulfones is detected in a supposed residue of clethodim, additional specificity could be obtained by monitoring the corresponding transition of the ³⁷Cl isotopic protonated molecule involved. The acquisition of data for the transition(s) *m/z* 394 to 164, 410 to 204 and/or 380 to 164, would permit determination (albeit with only about one-third of the sensitivity) of the ion ratio for molecules containing a single chlorine atom and provide good supporting evidence of the identity of clethodim residues.

Even without this possible refinement, it is clear that the method is highly selective towards, and under most circumstances will provide acceptable specificity for, clethodim.

The accuracy and precision achieved from recovery experiments tomatoes; soybeans; soybean oil; sugar beet roots and tops; beef kidney, liver, fat and muscle; chicken muscle and eggs; and cow's milk was determined in the range 0.01 to 0.5 mg/kg. Average recoveries (n= 5 for every combination) of clethodim, clethodim sulfoxide and 5-hydroxy-clethodim (measured as the sulfones) were in the range 50-117%, with RSDs in the range 3-20%. Low recovery (34-43%) of 5-hydroxy clethodim occurred infrequently. A single, and uncharacteristic, zero recovery of clethodim could have been due to mistake by the analyst. No false positives were detected in

control samples. Given the relative complexity of the method and the nature of the determination procedure, the data appear generally satisfactory.

Limits of quantification (LOQs) ranged from 0.01 mg/kg for tomatoes to 0.1 for soybean oil, with most commodities (soybeans; tops and roots of sugar beet; beef muscle, fat, liver and kidney; cow's milk; and chicken muscle and eggs) at 0.05 mg/kg. Recovery was performed at the LOQ and ten times that concentration. The nature of the detection technique and the LOQs recorded indicate that the method is likely to be sufficient for the determination of compliance with all proposed MRLs, including the values of 0.5 mg/kg(*) (for beans, cotton seed oil, rape seed oil, soya bean oil), 0.2 mg/kg (*) (for mammalian and poultry meat and offals), 0.1 mg/kg(*) (for fodder beet and sunflower seed oil) and 0.05 mg/kg (*) (for eggs and milk).

The 1999 JMPR evaluation referred to an HPLC method for the determination of residues of clethodim, which was described as being specific. Its ability to differentiate between residues of clethodim and sethoxydim was questioned at the 33rd and 34th sessions of the CCPR.

Consideration of the 1999 JMPR evaluation suggests that the method described would be capable distinguishing between the two pesticides but additional specificity (and perhaps sensitivity) is provided by a recent development by the manufacturer.

The new method also employs an HPLC separation but detection is by positive-ion electrospray LC-MS/MS. Validation of the new method with a range of fortified samples showed acceptable recoveries and limits of quantification.

CONCLUSIONS

The LC-MS/MS method is selective towards residues of clethodim and results for clethodim cannot be confused with sethoxydim.

For most purposes the specificity of the method should be sufficient to determine that the measurements relate to clethodim and not to an interfering compound but, if doubt remains, the transitions of the ³⁷Cl isotopic forms of the protonated molecules could also be monitored.

The LC-MS/MS method evidently has adequate sensitivity for control of compliance with proposed MRLs. It would be helpful if the company could identify the reasons for the occasional low recovery of 5-hydroxyclethodim sulfone.

The HPLC-UV absorption method evaluated by the 1999 JMPR appears to provide some specificity. The presence of the (*E*) and (*Z*) isomers of the sulfones in the LC-UV chromatogram would provide some support for the identification. Chromatographic separation from the corresponding metabolites of sethoxydim should avoid interference from that source.

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4.8 DELTAMETHRIN

RESIDUE AND ANALYTICAL ASPECTS

The Meeting received extensive information on deltamethrin [(*S*)- α -cyano-3-phenoxybenzyl (1*R*,3*R*)-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylate] metabolism and environmental fate, methods of residue analysis, freezer storage stability, national registered use patterns, supervised residue trials, farm animal feeding studies, fate of residues in processing and national MRLs.

The 2000 JMPR established an ADI and acute RfD for deltamethrin of 0.01 mg/kg bw/day and 0.05 mg/kg bw, respectively.

Deltamethrin is the [1*R*,*cis*; α -*S*]-isomer of 8 stereoisomeric esters derived from esterification of the dibromo analogue of chrysanthemic acid, 2,2-dimethyl-3-(2,2-dibromovinyl) cyclopropanecarboxylic acid (Br₂CA) with α -cyano-3-phenoxybenzyl alcohol.

The following abbreviations are used for the metabolites discussed below:

α -*R*-deltamethrin = [1*R*-[1 α (*R**),3 α]]- α -cyano-3-phenoxybenzyl 3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylate
trans-deltamethrin = [1*R*-[1 α (*S**),3 β]]- α -cyano-3-phenoxybenzyl 3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylate
*m*PB aldehyde = 3-phenoxybenzaldehyde
*m*PB acid = 3-phenoxybenzoic acid
(*cis*) Br₂CA = (1*R*-*cis*)-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylic acid

Animal metabolism

Radiolabelled deltamethrin preparations separately ¹⁴C-labelled at the benzylic methine, *gem*-dimethyl and cyano positions, were used in the metabolism and environmental studies. The metabolism of laboratory animals was qualitatively the same as for farm animals.

Lactating cows were orally dosed with -*gem*-dimethyl-[¹⁴C]deltamethrin or benzyl-[¹⁴C]deltamethrin at 10 mg/kg bw for 3 consecutive days. The majority of the radioactive residue was excreted unchanged in the faeces with 36-43% eliminated within 24 hours of the last dose. Only 0.4-1.6% of the administered ¹⁴C was secreted in milk. "Total deltamethrin" (deltamethrin, α -*R*- and *trans*-deltamethrin were not individually resolved) was the major identifiable product in milk (0.1-0.14 mg/kg). The radiocarbon content of tissues, reported in deltamethrin equivalents was highest in liver (2.2-3.2 mg/kg), kidney (1.3-2.2 mg/kg), udder (0.4-0.6 mg/kg) and fat (0.28-0.56 mg/kg) and with low levels (<0.2 mg/kg) present in other tissues. Deltamethrins and their hydrolysis products, formed from hydrolysis of the ester, were the main components of the ¹⁴C in liver and kidney (each 23-35%) while "total deltamethrin" was the major component of the ¹⁴C residue in fat (60-90%).

When laying hens were orally dosed with [¹⁴C]-*gem*-dimethyl-deltamethrin or [¹⁴C]-benzyl-deltamethrin for 3 consecutive days at 7.5 mg/hen/day, the majority of the dose (*ca.* 83%) was eliminated in the excreta within 24 hours of the last dose. Radioactive residues in eggs reached a peak at 48 hours after the last dose at 0.2 mg/kg deltamethrin equivalents in albumin and 0.6

mg/kg in yolk. Radioactive residues in tissues of birds slaughtered at 18 hours after the last dose were highest in liver (4.0 mg/kg deltamethrin equivalents) and kidney (6.9 mg/kg) with low levels observed in other tissues. Maximum ^{14}C residues in abdominal fat were 0.66 mg/kg while those in muscle were 0.21 mg/kg, both expressed in deltamethrin equivalents. The major radiolabelled compound identified in eggs, liver and kidney was “total deltamethrin” (deltamethrin, α -*R*- and *trans*-deltamethrin were not individually resolved).

Plant metabolism

The Meeting received information on the fate of deltamethrin after foliar application to cotton, maize, apple and tomato.

Cotton plants were treated with [^{14}C]deltamethrin as a foliar, soil or hydroponic treatment to study root uptake and translocation. Although there was significant root uptake, translocation to other parts of the plant was very limited. Application to single leaves confirmed that translocation is limited. When ^{14}C -deltamethrin labelled at the dibromovinyl, benzyl, and cyano carbons was applied to the leaves of cotton plants grown in a glasshouse or in the field. Conversion of deltamethrin to the *trans*-deltamethrin occurred via photochemical reactions such that after 6 weeks the *trans*:*cis* ratio in leaves was 0.4:1 for glasshouse grown plants. Degradation of deltamethrin was greater under field conditions than in glasshouse experiments.

Cotton plants were grown outdoors and were treated with either ^{14}C -benzyl- or ^{14}C -*gem*-dimethyl-deltamethrin. Deltamethrin and two of its isomers (*trans*- and α -*R*-deltamethrin) were the primary components of the radioactivity detected in leaves (80 – 85% ^{14}C at day 4; 65 – 75% ^{14}C at day 10). Only low levels of radioactivity were detected in cottonseed consistent with limited translocation.

The metabolism of ^{14}C -*gem*-dimethyl- and ^{14}C -benzyl-deltamethrin was also studied in field corn. In forage, foliage and husk at 28 and 42 days after application, 80 – 100% of ^{14}C residues were identified as deltamethrin and its isomers. Minor metabolites were generally present at ≤ 0.01 mg/kg. Grain and cob contained only low levels of radioactivity (≤ 0.06 mg/kg deltamethrin equivalents). A large part of the radioactivity in grain could not be extracted. The metabolism of ^{14}C -*gem*-dimethyl- and ^{14}C -benzyl-deltamethrin was studied in apples. “Total deltamethrins” was the major component of the radioactivity detected at 14 to 42 days after application accounting for 92 – 100% of the ^{14}C . As regards the isomeric composition of the “total deltamethrins” residue, deltamethrin predominated (59-71%) with varying amounts of α -*R*- (19-34%) and *trans*-deltamethrin (5.8-19%) also being present. Several minor components were present at < 0.01 mg/kg deltamethrin equivalents and at $< 10\%$ of the ^{14}C .

The metabolism of deltamethrin was investigated in tomatoes under greenhouse conditions, tomato plants and individual fruit on plants with ^{14}C -*gem*-dimethyl-deltamethrin or ^{14}C -benzyl-deltamethrin foliar spray and by direct application to the fruits. For both methods of application, 79 – 93% of the ^{14}C in fruit was present as “total deltamethrins” (deltamethrin, α -*R*- and *trans*-deltamethrin were not resolved) at 4-28 days after application.

Metabolism studies in tomatoes, apples, corn and cotton demonstrated that deltamethrin and its isomers (*trans*- and α -*R*-deltamethrin) were poorly degraded and that the degradation pattern was similar in all crops. The major identified products of deltamethrin metabolism in plants are analogous to those in mammals but differed in the conjugating moieties involved. The proposed degradation pathway consists of isomerization, hydrolysis, ester cleavage, reduction, oxidation and hydroxylation. Deltamethrin is not systemic, with only limited translocation in plants.

Environmental fate

Soil

The half-lives for deltamethrin degradation under aerobic test conditions was estimated to be 22-25 days. Degradation occurred via ester hydrolysis followed by oxidation and mineralisation to $^{14}\text{CO}_2$.

The half-life for deltamethrin degradation under anaerobic test conditions was estimated to be 32-36 days. Anaerobic degradation occurred via an epimerisation of the pyrethroid moiety followed by ester cleavage, oxidation and mineralisation in the form of $^{14}\text{CO}_2$ and its incorporation into the soil biomass.

The adsorption constants of deltamethrin were determined in four US standard soils ranging from sandy loam to silty clay loam. The adsorption and desorption characteristics of deltamethrin did not vary much between soils and based on the $\log K_{OC}$ values the compound can be considered as being immobile.

In confined rotational crop studies, no significant residues of deltamethrin (<0.01 mg/kg) were found in any crop material. It is concluded that succeeding or rotational crops are unlikely to contain significant residues of deltamethrin.

The degradation of deltamethrin under field conditions was studied at four different locations in Germany. The degradation half-lives for soil ranged from 17 to 29 days.

The dissipation and mobility of deltamethrin and its isomers as well as Br_2CA was studied in corn and cotton fields. The only compounds detected in soil were deltamethrin and α -*R*-deltamethrin, the later only in a few samples and at very low levels. Deltamethrin did not move down the soil profile. The half-life for deltamethrin ranged from 14 to 69 days in the corn field while no significant degradation was observed in the cotton field over the 150 day period studied.

Water-sediment systems

Deltamethrin is stable to hydrolytic degradation at low pH, but degrades with a half-life of 2.5 days at pH 9. Two degradation products were identified, *m*PB aldehyde and traces of Br_2CA , presumably formed from deltamethrin on hydrolysis of the ester. Abiotic hydrolysis is unlikely to contribute significantly to the degradation of deltamethrin residues in aquatic systems unless the pH is high.

During irradiation with artificial light (comparable to that of the average New Jersey, USA sunlight) deltamethrin underwent ester hydrolysis and *cis-trans* isomerization. The major photodegradation products identified were *m*PB acid and *cis*- Br_2CA .

When a deltamethrin solution was inoculated with activated sewage sludge it was not readily biodegraded with 74-84% of the initial concentration remaining after 28 days.

In an anaerobic sediment water study, deltamethrin rapidly became associated with the sediment and was quite persistent (50% decline in 6 months). Significant mineralization occurred (28% in 12 weeks). The major compounds found after 12 weeks of incubation were deltamethrin and its α -*R*-deltamethrin (28 to 53%). The half-life of deltamethrin ranged from 2 to 8 weeks,

depending upon the water/sediment system. The degradation pathways of deltamethrin in water/sediment systems involved ester hydrolysis and isomerization.

In summary, chemical hydrolysis is only expected to occur in waters having high pH values. Indirect photochemical transformation of deltamethrin may occur but is considered to be only a minor route of degradation. Biodegradation in the aquatic environments is expected to be rather slow. Deltamethrin will mainly be distributed to suspended organic material, biota and eventually to sediments.

Analytical methods

Several different analytical methods have been reported for the analysis of deltamethrin (and isomers) in plant material and animal commodities. The basic approach involves extraction by homogenization with an organic solvent mixture incorporating varying proportions of polar and non-polar solvents depending upon the nature of the matrix being extracted and its water content. In general, a primary liquid – liquid partition follows extraction to transfer deltamethrin residues to less polar solvents prior to column clean-up. In all cases, residues are finally determined by gas chromatography with an electron capture detector. In a small number of the methods deltamethrin and its isomers were resolved, however, the majority of the methods (including those utilised in most of the residue trials and the method proposed as a regulatory method) determine “total deltamethrins” (sum of deltamethrin, *α-R*- and *trans*-deltamethrin).

The methods for deltamethrin have been extensively validated with numerous recoveries on a wide range of substrates with LOQs typically in the range 0.01 to 0.05 mg/kg.

Stability of pesticide residues in stored analytical samples

Freezer storage stability was tested for a range of representative substrates. Residues of deltamethrin (and *trans*- and *α-R*-deltamethrin, when measured) were generally stable for the intervals tested:

- hops and beer (5.5 months)
- lettuce (16 months)
- cotton seed products (13 – 38 months)
- grain (9 months)
- soybean seed (9 months)
- cabbage (24 months)
- tomato (24 months)
- poultry tissues and eggs (11 – 13 months)

No significant isomerization (configurational or epimerisation) occurred during frozen storage.

Residue definition

The residue following its use on crops is predominantly deltamethrin and its isomers (*α-R*- and *trans*-deltamethrin). The isomers, when resolved, individually accounted for up to 38 and 20% of the total deltamethrin residue for the *α-R*- and *trans*-deltamethrin respectively. GLC methods are available that can measure the isomers separately, although most of the methods used in the residue trials measured “total deltamethrins” (sum of deltamethrin, *α-R*- and *trans*-deltamethrin).

Based on the actual residue measured, the Meeting recommended that the residue definition for plant and animal commodities for compliance with MRLs and for estimation of dietary intake should be sum of deltamethrin, α -*R*- and *trans*-deltamethrin.

The log K_{ow} of 4.6 (pH 7) and the animal metabolism and feeding studies suggest that deltamethrin should be described as fat-soluble.

The Meeting recommended that deltamethrin be described as fat-soluble

Proposed definition of the residue (for compliance with MRL and for estimation of dietary intake): sum of deltamethrin, α -*R*- and *trans*-deltamethrin ([1*R*-[1 α (*R**),3 α]]- α -cyano-3-phenoxybenzyl 3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylate and [1*R*-[1 α (*S**),3 β]]- α -cyano-3-phenoxybenzyl 3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylate.

The residue is fat-soluble.

Results of supervised trials

Supervised trials were available for the use of deltamethrin on numerous crops: artichokes, apples, black currants, beetroot, Brassica vegetables (broccoli, Brussels sprouts, cauliflower), cacao, carrots, cereal grains, cherries, chicory, coffee, cotton, cucurbits (cucumber, melon, zucchini), egg plant, fodder peas, grapes, hazel nuts, leafy vegetables (kale, lettuce, spinach), leeks, legume vegetables (beans, peas), lupins, mandarins, maize, mushrooms, nectarines, olives, onions, oranges, parsnip, pasture (alfalfa, grass), peaches, peppers, plums, potatoes, pulses, radish, raspberries, rape, sorghum, soybeans, stone fruit, strawberries, sugar beet, sunflower, sweet corn, sweet potato, tea, tomatoes and walnuts.

No relevant GAP was available to evaluate data for black currants, raspberries, lupins, beetroot, sugar beet, parsnip, chicory, sweet potato, artichokes, coffee, cacao and pasture. Only those trials with relevant GAP are discussed in the following sections.

Trial data or relevant GAP were not submitted for several crops with current recommendations for maximum residue levels: artichoke, globe (0.05 mg/kg), banana (0.05 mg/kg), cacao beans (0.05 mg/kg), coffee beans (2 mg/kg P_O), fig (0.01* mg/kg), hops dry (5 mg/kg), kiwifruit (0.05 mg/kg), peanut (0.01* mg/kg), pineapple (0.01* mg/kg) and tree tomato (0.02 mg/kg). The Meeting agreed to withdraw its previous maximum residue level recommendations for these commodities.

Citrus. Deltamethrin is registered in the Italy for use on citrus fruits at 0.75-1.7 g ai/hl with a PHI of 20 days. None of the Italian trials matched GAP for that country. In Spain deltamethrin is registered for use on citrus at 0.75-1.3 g ai/hl with a PHI of 35 days. Trials conducted at \pm 30% of the maximum spray concentration and harvested at 29-32 days were considered to match GAP for Spain by the Meeting. In addition the Italy trials were evaluated against the Spain GAP. The residues resulting from Italy and Spain trials in 2001 meeting those conditions were: mandarin <0.01 (4) mg/kg; oranges <0.01 (3) and 0.01 (2) mg/kg. Residues from the two fruits appear to be from the same population and may be evaluated together. Deltamethrin residues in citrus from 9 trials matching GAP in Spain in rank order (median underlined) were: <0.01 (7) and 0.01 (2) mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in citrus whole fruit of 0.02, 0.01 and 0.01 mg/kg, respectively. The Meeting agreed to withdraw its previous recommendation of 0.05 mg/kg for mandarins and oranges, sweet, sour.

Apples. Data were available from supervised trials on apples in France (GAP: 0.75-1.8 g ai/hl, PHI 7 days), Germany (no GAP), Greece (GAP: 0.88-2.3 g ai/hl; PHI 15 days), Italy (GAP: 0.75-2.5 g ai/hl, PHI 3 days) and Spain (GAP: 0.75-1.3 g ai/hl, PHI 7 days), however with the exception of Spain, the trials did not match GAP of the country they were conducted in. The Meeting decided to evaluate the trials from France and Germany according to the GAP of Belgium and those from Greece and Italy according to the GAP of Portugal.

In Belgium, deltamethrin is registered for application to apples at rates of 3-12 g ai/ha with a spray concentration range of 0.7-1 g ai/hl and a PHI of 7 days. Residues of deltamethrin from seven trials in France at 13 g ai/ha with a PHI of 7 days were 0.02 (4), 0.03 (2) and 0.04 mg/kg. In eighteen trials from Germany at 11 g ai/ha with PHIs of 7 days the residues of deltamethrin were 0.01 (2), 0.02 (3), 0.03 (2), 0.04 (2), 0.05 (4), 0.06 (3), 0.07 and 0.08 mg/kg.

Deltamethrin is registered in Spain for apples (pome fruit) with an application rate 0.75-1.3 g ai/hl and a PHI of 7 days. In six trials that matched GAP for Spain the residues of deltamethrin were of 0.02, 0.03 (2), 0.04 (2) and 0.07 mg/kg.

GAP in Portugal is 0.75 g ai/hl with a 7 day PHI. In three trials from Greece, four from Italy and one from Spain at 0.8 g ai/hl with a PHI of 7 days the residues of deltamethrin were <0.01, 0.02 (3), 0.03 and 0.04 (3) mg/kg, respectively.

The residues from the trials were combined as they appeared to be from the same population. Residues in rank order, median underlined, were: <0.01, 0.01 (2), 0.02 (11), 0.03 (7), 0.04 (8), 0.05 (4), 0.06 (3), 0.07 (2) and 0.08

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in apples of 0.2 mg/kg, 0.03 mg/kg and 0.08 mg/kg, respectively. The Meeting agreed to withdraw its previous recommendation of 0.1 mg/kg for pome fruit.

Stone fruits. Trials on cherries were conducted in France (GAP 1.3 g ai/hl, PHI 7 days) and Germany (no GAP). Two of the France trials matched GAP in that country and had deltamethrin residues of <0.018 and 0.15 mg/kg in whole fruit at seven days after application at 1.3-1.5 g ai/hl.

The Meeting agreed that the two trials were not sufficient for the purposes of estimating a maximum residue level for cherries.

Data were available from supervised trials on peaches and nectarines in France (GAP: 0.75-1.8 g ai/hl, PHI of 7 days), Germany (no GAP), Greece (GAP: 0.88-2.3 g ai/hl, PHI 15 days), Italy (GAP: 0.75-2.2 g ai/hl, PHI 3 days) and Spain (GAP: 0.75-1.3 g ai/hl, PHI 7 days), however, the trials did not match GAP of the country in which they were conducted. The Meeting decided to evaluate the trials from Germany (no GAP) according to the GAP of France and those from Italy according to the GAP of Spain.

Three trials from Germany approximated French GAP with deltamethrin residues of 0.02, 0.03 and 0.03 mg/kg at 7 days after application at 1.3 g ai/hl. A single trial from Italy matched Spain GAP and had a residue of <0.05 mg/kg.

Trials on plums were available from France (GAP 0.75-1.8 g ai/hl, PHI 7 days) and Germany (no GAP). Two of the France trials matched GAP in that country and had deltamethrin residues of 0.005 and 0.009 mg/kg in whole fruit at seven days after application at 1.3 g ai/hl, i.e. within 30% of the France GAP spray concentration. The Meeting decided to evaluate the trials from Germany according to the GAP of France. Two trials from Germany matched the GAP of France with residues of <0.01 and 0.02 mg/kg, the latter being the higher of the residues measured at 7 and 14 days after the last spray.

The Meeting considered that the residues of deltamethrin on peaches, nectarines and plums were similar and that the residues from the trials in the different crops could be used in mutual support of each other. The residues of deltamethrin in peaches, nectarines and plums from trials according to GAP were: 0.005, 0.009, <0.01, 0.02 (2), 0.03 (2) and <0.05 mg/kg.

The Meeting estimated maximum residue levels, STMRs and HRs for peaches, nectarines and plums of 0.05, 0.02 and 0.05 mg/kg, respectively. The Meeting agreed to withdraw its previous recommendation of 0.05 mg/kg for stone fruit and to recommend maximum residue levels of 0.05 mg/kg for peaches, nectarines and plums.

Strawberries. Trials on strawberries from France, Germany (no GAP), Italy, Spain and the UK (no GAP) were made available to the Meeting. The Meeting decided to evaluate the trials from Germany (no GAP) and the UK (no GAP) according to the GAP of France.

In France deltamethrin is registered for use on strawberries at 13 g ai/ha with a PHI of 3 days. In eleven trials from France matching GAP, four under plastic tunnels and one glasshouse, residues of deltamethrin were <0.02 (3), 0.02 (3), 0.03 (3), 0.04 and 0.05 mg/kg. In nine trials from Germany matching the GAP of France, residues of deltamethrin were <0.02 (9) mg/kg. Three trials from the UK matched GAP of France with residues of 0.02, 0.03 and 0.03 mg/kg.

Deltamethrin is registered in Italy for use on strawberries at 0.75-1.3 g ai/hl with a PHI of 3 days. A single trial from Italy matched GAP with residue of <0.01 mg/kg. None of the Spain trials matched GAP of that country, however, the Meeting decided that the Spain trials could be evaluated according to the GAP of Italy. Three Spain trials matched GAP of Italy with residues of 0.03, 0.06 and 0.10 mg/kg.

The residues on strawberries listed above were all from trials carried out at 13 g ai/ha with a 3 day PHI. The Meeting decided that the trials could be considered as a single population for the purposes of estimating a maximum residue level. Residues in rank order, median underlined, were: <0.01, <0.02 (12), 0.02 (4), 0.03 (6), 0.04, 0.05, 0.06 and 0.10 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in strawberries of 0.2 mg/kg, 0.02 mg/kg and 0.1 mg/kg, respectively. The recommendation of a maximum residue level of 0.2 mg/kg replaces the previous recommendation of 0.05 mg/kg for strawberries.

Grapes. Trials on grapes from France (GAP: 7.5-18 g ai/ha, PHI 7 days), Germany (no GAP), Italy (GAP: 0.75-1.7 g ai/hl, PHI 3 days) and Spain (GAP: 7.5-13 g ai/ha, PHI 7 days or 0.75-1.3 g ai/hl, PHI 3 days) were made available to the Meeting. The Meeting decided to evaluate the trials from Germany (no GAP) according to the GAP of France.

In France deltamethrin is registered for use on grapes at 7.5-18 g ai/ha with a PHI of 7 days. In six trials from France matching GAP, residues of deltamethrin in grapes harvested at 7

days or more after the last spray were 0.01, 0.02, 0.03, 0.03, 0.05 and 0.06 mg/kg. In a single trial from Germany matching the GAP of France, residues of deltamethrin were 0.02 mg/kg.

Deltamethrin is registered in Spain for use on grapes at 7.5-13 g ai/ha with a PHI of 7 days. A single trial from Spain matched GAP with residue of 0.07 mg/kg. None of the Italy trials matched GAP of that country. However, the Meeting decided that the Italy trials could be evaluated according to the GAP of Spain. Two Italy trials approximated GAP of Spain with residues of 0.06 and 0.09 mg/kg.

The residues on grapes listed above were all from trials carried out at with the last spray at 17-19 g ai/ha and with a 7 day PHI. The Meeting decided that the trials could be considered as a single population for the purposes of estimating a maximum residue level. Residues in rank order, median underlined, were: 0.01, 0.02 (2), 0.03 (2), 0.05, 0.06 (2), 0.07 and 0.09 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in grapes of 0.2 mg/kg, 0.04 mg/kg and 0.09 mg/kg, respectively. The recommendation of a maximum residue level of 0.2 mg/kg replaces the previous recommendation of 0.05 mg/kg for grapes.

Olives. Trials on olives from France (GAP: 1.3-1.8 g ai/hl, PHI 7 days), Greece (GAP: 1-1.8 g ai/hl, PHI 15 days), Italy (GAP: 1-1.5 g ai/hl, PHI 3 days), Portugal (GAP: 1.3 g ai/hl, PHI 7 days) and Spain (GAP: 5 g ai/ha, PHI 7 days) were made available to the Meeting.

In two trials from France approximating GAP, residues of deltamethrin in olives were 0.22 and 0.54 mg/kg.

One trial from Italy matched GAP from that country with a maximum observed residue of 0.12 mg/kg at 3 or more days after the last spray.

One trial from Portugal matched GAP from that country with a deltamethrin residue of 0.15 mg/kg.

One of the Italy and none of the Spain or Greece trials matched GAP of those countries, however, the Meeting decided that these trials could be evaluated according to the GAP of Portugal. A single trial from Greece, one from Italy and one from Spain approximated the GAP of Portugal (within 30% of the spray concentration) with residues of 0.02, 0.14 and 0.18 mg/kg, respectively.

The Meeting decided that the trials from France, Greece, Italy, Portugal and Spain could be combined for the purposes of estimating a maximum residue level. Residues in rank order, median underlined, were: 0.02, 0.12, 0.14, 0.15, 0.18, 0.22 and 0.54 mg/kg.

The Meeting estimated a maximum residue level for deltamethrin in olives of 1 mg/kg to replace the previous recommendation of 0.1 mg/kg.

Information on residues in the edible portion were also available. Residues in olive pulp for the five trials considered in estimating the maximum residue level for whole fruit were 0.04, 0.18, 0.21, 0.25 and 0.31 mg/kg. The Meeting estimated an STMR value and an HR value for deltamethrin in olive pulp of 0.21 mg/kg and 0.31 mg/kg, respectively.

Onions. Trials on onions from France (GAP: 7.5-13 g ai/ha, PHI 7 days), Germany (no GAP), Greece (GAP: 0.88-1.9 g ai/hl, PHI 7 days), Italy (GAP: 0.75-1.5 g ai/hl, PHI 7 days), Spain (GAP:

0.75-1.3 g ai/hl, PHI 7 days) and the UK (no GAP) were made available to the Meeting. As there is no GAP for onions in Germany, the Meeting decided to evaluate these trials according to the GAP of France.

In five trials from France approximating GAP, residues of deltamethrin in onions were <0.02 (5) mg/kg.

Residue in seven trials from Germany approximating GAP in France were <0.02 (4), and 0.03 (3) mg/kg.

Residues in rank order for trials approximating the GAP of France, median underlined, were: <0.02 (9) and 0.03 (3) mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in onions of 0.05 mg/kg, 0.02 mg/kg and 0.03 mg/kg, respectively.

Leeks. Trials on leeks from France (GAP: 7.5-13 g ai/ha, PHI 7 days), Germany (no GAP), Greece (GAP: 0.88-1.9 g ai/hl, PHI 7 days), Italy (GAP: 0.75-1.5 g ai/hl, PHI 7 days), Spain (GAP: 0.75-1.3 g ai/hl, PHI 7 days) and the UK (no GAP) were made available to the Meeting. As there is no GAP for leeks in Germany or the UK, the Meeting decided to evaluate these trials according to the GAP of France.

In two trials from France approximating GAP, residues of deltamethrin in leeks were 0.04 and 0.09 mg/kg.

Residue in three trials from Germany approximating GAP in France were <0.02, 0.03 and 0.07 mg/kg. Residue in two trials from the UK approximating GAP in France were 0.08 and 0.13 mg/kg.

Residues leeks in rank order for trials approximating the GAP of France, median underlined, were: <0.02, 0.03, 0.04, 0.07, 0.08, 0.09 and 0.13 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in leeks of 0.2 mg/kg, 0.07 mg/kg and 0.13 mg/kg, respectively.

The recommended maximum residue levels of 0.05 and 0.2 mg/kg for onions and leeks, respectively replace the previous recommendation of 0.1 mg/kg for bulb vegetables, except fennel bulb which is now withdrawn.

Brassica vegetables. Deltamethrin is registered in Australia for use on Brussels sprouts at 11-14 g ai/ha or 1.1-1.4 g ai/hl with a PHI of 2 days. In a single trial in Australia approximating GAP deltamethrin residues were <0.05 mg/kg. The Meeting decided that a single trial is inadequate for the purposes of estimating a maximum residue level.

Trials were available from France (no GAP:), Greece (GAP 0.88-1.9 g ai/hl, PHI 7 days), Italy (no GAP) and Spain (GAP: 0.75-1.3 g ai/hl, PHI 7 days) on broccoli and cauliflower. As there is no GAP for broccoli or cauliflower in France and Italy, the Meeting decided to evaluate the trials of France according to the GAP of Belgium and the trials from Italy according to the GAP of Greece.

Residue in two trials from France approximating GAP in Belgium were <0.02 (2) mg/kg. Residues in two trials from Greece approximating GAP from that country were <0.02 (2) mg/kg while residues of deltamethrin in three trials from Italy approximating the GAP of Greece were <0.02 (2) and 0.04 mg/kg.

The residue evaluated according to GAP of Belgium and Greece appeared to be from the same population and could be combined for the purposes of estimating a maximum residue level. Residues broccoli and cauliflower in rank order, median underlined, were: <0.02 (6) and 0.04 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in flowerhead brassicas of 0.1 mg/kg, 0.02 mg/kg and 0.04 mg/kg, respectively. The recommendation for a maximum residue level of 0.1 mg/kg for flowerhead brassicas replaces the previous recommendation of 0.2 mg/kg for Brassica vegetables which is withdrawn.

Cucurbit vegetables. Trials on cucumbers were reported from France (GAP: 7.5-13 g ai/ha, PHI 3 days), Denmark (no GAP), Germany (no GAP), Greece (GAP: 0.88-1.9 g ai/hl, PHI 3 cucumber), Italy (GAP: 0.75-1.5 g ai/hl, PHI 3 days cucumber) and Spain (GAP: 0.75-1.3 g ai/hl, PHI 3 days) and UK (GAP: 1.8 g ai/hl, PHI nil) were made available to the Meeting. As there is no GAP for cucumbers in Germany, the Meeting decided to evaluate the Germany field trials according to the GAP of France and the Denmark and Germany glasshouse trials according the GAP of the UK.

Residue in four field trials from Germany approximating GAP in France deltamethrin residues in cucumber were <0.01 (4) mg/kg. In a single field trial from Italy approximating GAP from that country residues of deltamethrin in cucumber were <0.02 mg/kg. In three glasshouse trials conducted in the UK matching GAP residues of deltamethrin were 0.02 (2) and 0.09 mg/kg. In four glasshouse trials from Germany approximating the GAP of the UK residues of deltamethrin in cucumber were 0.02 (3) and 0.03 mg/kg.

Residues cucumbers from field trials in rank order, median underlined, were: <0.01 (4) and <0.02 mg/kg.

Residues cucumbers from glasshouse trials in rank order, median underlined, were: 0.02 (5), 0.03 and 0.09 mg/kg.

Trials on zucchini were reported from France (GAP: 7.5-13 g ai/ha, PHI 3 days), Greece (GAP: 0.88-1.9 g ai/hl, PHI 7 days), Italy (no GAP) and Spain (GAP: 0.75-1.3 g ai/hl, PHI 3 days) were made available to the Meeting. As there is no GAP for zucchini in Italy, the Meeting decided to evaluate these trials against GAP of Greece.

In two field trials from France approximating GAP for zucchini, residues of deltamethrin were <0.02 (2) mg/kg. The residue in a single trial on zucchini from the Greece approximating GAP from that country was <0.02 mg/kg. In two field trials from Italy approximating the GAP of Greece, residues of deltamethrin in zucchini were <0.02 (2) mg/kg.

Residues zucchini in rank order for field trials approximating GAP, median underlined, were: <0.02 (5) mg/kg.

With the exception of a single trial on gherkins at exaggerated rate, 13 field trials approximating at 1-2 times GAP in France, Greece, Italy and Spain, the residues in cucumbers and zucchini were less than the LOQs of 0.01 and 0.02 mg/kg.

Trials on melon were reported from France (no GAP), Greece (GAP: 0.88-1.9 g ai/hl, PHI 7 days), Italy (no GAP) and Spain (GAP: 0.75-1.3 g ai/hl, PHI 3 days) were made available to the Meeting. As there is no GAP for melon in France, the Meeting decided to evaluate these trials against GAP of Belgium (GAP: 7.5-13 g ai/ha, PHI 3 days). As there is no GAP for melon in Italy, the Meeting decided to evaluate these trials against GAP of Greece.

In six field trials from France matching Belgium GAP, residues of deltamethrin in melon were <0.02 (6) mg/kg. In three trials from Greece and one from Italy that approximated GAP in Greece, residues of deltamethrin in melon were <0.02 (4) mg/kg.

The residues on melons listed above were all from trials carried out at with the last spray at 13 g ai/ha and with residues at 3 or more days after the last spray that were less than the LOQ (0.02 mg/kg).

The Meeting agreed to pool the data to support a cucurbit vegetables MRL, rank order (median underlined): <0.01 (4), <0.02 (16), 0.02 (5), 0.03 and 0.09 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in fruiting vegetables, cucurbits of 0.2, 0.02 and 0.09 mg/kg, respectively. The recommended maximum residue level confirms the previous recommendation. In addition the Meeting recommends withdrawal of the previous recommendation for melons except water melons of 0.01 (*) mg/kg as this commodity would be covered by the fruiting vegetable, cucurbit group maximum residue level.

Mushrooms. Trials on mushrooms from France (no GAP) and Germany (no GAP) were made available to the Meeting. As there is no GAP for mushrooms in France, the Meeting decided to evaluate these trials against GAP of Poland (GAP: 0.75 g ai/hl, PHI 2 days).

In four trials, two from France and two from Germany, matching the GAP of Poland, residues of deltamethrin were <0.02 (3) and 0.03.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in mushrooms of 0.05, 0.02 and 0.03 mg/kg, respectively, the maximum residue level replaces the previous recommendation of 0.01 (*) for mushrooms.

Tomatoes. Trials on tomatoes were reported from Australia (GAP: 8.3-14 g ai/ha or 0.83-1.4 g ai/hl, PHI 3 days), Denmark (no GAP), Finland (no GAP), France (GAP: 5-13 g ai/ha, PHI 3 days), Germany (no GAP), Greece (GAP: 0.88-1.9 g ai/hl, PHI 3 days), Italy (GAP: 0.75-1.5 g ai/hl, PHI 3 days), Mexico (GAP: 13 g ai/ha, PHI 1 day), The Netherlands (GAP: 1.3 g ai/hl, PHI 3 days), New Zealand (GAP: 3-9.9 g ai/ha or 0.74-0.99 g ai/hl, PHI 3 days), South Africa (GAP: no GAP), Spain (GAP: 0.75-1.3 g ai/hl, PHI 3 days) and the UK (GAP: 1.8 g ai/hl, PHI nil) were made available to the Meeting. As there is no GAP for tomatoes in Germany, the Meeting decided to evaluate the Germany field trials according to the GAP of France and the Germany glasshouse trials according to the GAP of The Netherlands.

The trials from Australia, New Zealand and Mexico were reported in summary form and not evaluated further.

Deltamethrin is registered in France for use on tomatoes at 5-13 g ai/ha with harvest permitted 3 days after the final application. Deltamethrin residues in 5 trials from France matching

GAP in rank order were: 0.009, 0.01, 0.016, <0.02 and 0.02 mg/kg and in six from Germany were: <0.01, 0.01, 0.02, 0.03, 0.07, 0.2 mg/kg.

In Greece deltamethrin is registered for use on tomatoes at 0.88-1.9 g ai/hl with harvest permitted 3 days after the final application. In two trials in Greece matching GAP conditions deltamethrin residues were: <0.02 (2) mg/kg. In a further two trials from Italy that approximated GAP in Greece residues were <0.02 (2) mg/kg.

GAP in Italy for deltamethrin use on tomatoes requires a 3 day PHI after application at 0.75-1.5 g ai/hl. Deltamethrin residues in a single tomato trial matching Italy GAP were <0.02 mg/kg.

Residues of deltamethrin in tomatoes from a single trial in Spain that matched GAP from that country were <0.03 mg/kg.

The country or region in which the trials were conducted was considered by the Meeting to be unimportant when considering trials for protected crops (glasshouse). The Meeting decided to evaluate the protected crop trials for tomatoes against the GAP of France as this afforded the largest number of valid residue values for the estimation of a maximum residue level. In eight protected crop trials from Greece, Italy, The Netherlands and Spain, the residues of deltamethrin in tomatoes were <0.01, <0.01, 0.01, 0.01, 0.01, 0.013, 0.014 and 0.03 mg/kg. In a further six trials from Denmark and Germany that approximated the GAP of The Netherlands residues of deltamethrin in tomatoes were 0.03, 0.03, 0.08, 0.1, 0.2 and 0.2 mg/kg.

The Meeting noted that the residues on tomatoes from both the field (0.009, <0.01, 0.01 (2), 0.016, <0.02 (6), 0.02 (2), <0.03, 0.03, 0.07, 0.2 mg/kg) and protected crop (<0.01 (2), 0.01 (3), 0.013, 0.014, 0.03 (3), 0.08, 0.1, 0.2(2) mg/kg) trials appeared to be from the same population and decided that the trials could be pooled for the purposes of estimating a maximum residue level. Residues in rank order, median underlined (n=31), were: 0.009, <0.01 (3), 0.01 (5), 0.013, 0.014, 0.016, <0.02 (6), 0.02 (2), <0.03, 0.03 (4), 0.07, 0.08, 0.1 and 0.2 (3) mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in tomatoes of 0.3 mg/kg, 0.02 mg/kg and 0.2 mg/kg, respectively.

Peppers. In Canada deltamethrin is registered for use on peppers at 13-15 g ai/ha (5-7.5 g ai/hl) with harvest permitted 3 days after the final application. In four trials in Canada matching GAP conditions deltamethrin residues on peppers were: 0.002 (3) and 0.007 mg/kg.

The residues in 2 indoor trials from the UK approximating GAP in that country (1.8 g ai/hl, PHI nil) were: 0.07 and 0.09 mg/kg.

The Meeting agreed to not to combine the peppers data from Canada and the UK as the data appeared to be from two different populations and considered that there were insufficient data on which to estimate a maximum residue level for peppers.

Sweet corn. Field trials on sweet corn were made available to the Meeting from Canada (GAP: 13-15 g ai/ha, PHI 5 days), France (GAP: 20 g ai/ha, PHI 7 days), Germany (no GAP), Italy (no GAP), New Zealand (GAP: 9.9-12 g ai/ha, PHI 7 days), Portugal (no GAP), Spain (no GAP) and the UK (no GAP). None of the trials matched GAP of the particular country they were conducted in. The Meeting decided to evaluate the trials conducted in Germany and France against the GAP of

Belgium. In 10 trials in Germany and France matching GAP conditions for Belgium deltamethrin residues on sweet corn (on the cob) were, median underlined <0.003 (4) and <0.02 (6) mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in sweet corn (corn-on-the-cob) of 0.02*, 0.02 and 0.02 mg/kg, respectively.

Eggplants. In France deltamethrin is registered for use on eggplants at 7.5-13 g ai/ha with harvest permitted 3 days after the final application. In a single trial in France matching GAP conditions deltamethrin residues on eggplants were: <0.01 mg/kg.

The Meeting agreed that one trial was not sufficient to recommend a maximum residue level.

The maximum residue level recommendations for tomatoes and sweet corn replace the previous recommendation of 0.2 mg/kg for fruiting vegetables other than cucurbits (except mushrooms).

Leafy vegetables. Field trials on curly kale were made available to the Meeting from Germany (no GAP) and the UK (no GAP). The Meeting decided to evaluate these trials conducted in Germany and the UK against the GAP of The Netherlands (2.5-10 g ai/ha, 1.3 g ai/hl, PHI 7 days). In seven trials in Germany and one in the UK matching GAP conditions for The Netherlands deltamethrin residues on curly kale were, median underlined 0.07, 0.08, 0.1, 0.11, 0.32, 0.32, 0.34 and 0.39 mg/kg.

In France deltamethrin is registered for use on lettuce at 13 g ai/ha with a 3 day PHI. In trials in France matching GAP, deltamethrin residues in lettuce were: 0.13, 0.18, 0.18, 0.26, 0.29 and 0.41 mg/kg. If the trials conducted in Spain are assessed against GAP of France a further 4 trials matched GAP and had residues of 0.07, 0.12, 0.15 and 0.25 mg/kg. Residues of deltamethrin in lettuce from trials according to GAP were (median underlined): 0.07, 0.12, 0.13, 0.15, 0.18 (2), 0.25, 0.26, 0.29 and 0.41 mg/kg.

In Belgium deltamethrin is registered for use on spinach at 7.5-13 g ai/ha (1.2-3.1 g ai/hl) with a 7 day PHI. In trials in France (2) and Germany (14) matching GAP conditions for Belgium deltamethrin residues in spinach were: 0.03 (2), 0.04, 0.06, 0.08, 0.09 (2), 0.1 (4), 0.14, 0.17, 0.2, 0.5, 1.0 mg/kg.

The range of residues was quite wide but there was overlap of residue levels with the various crops. The Meeting decided to pool the data to support a leafy vegetable MRL, rank order (median underlined, n=34): 0.03 (2), 0.04, 0.06, 0.07 (2), 0.08 (2), 0.09 (2), 0.1 (5), 0.11, 0.12, 0.13, 0.14, 0.15, 0.17, 0.18 (2), 0.2, 0.25, 0.26, 0.29, 0.32 (2), 0.34, 0.39, 0.41, 0.5, 1.0 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in leafy vegetables of 2, 0.125 mg/kg and 1 mg/kg, respectively. The recommendation of 2 mg/kg for leafy vegetables replaces the previous recommendation of 0.5 mg/kg.

Legume vegetables. Field trials on succulent beans were made available to the Meeting from France (GAP: 13 g ai/ha, PHI 7 days), Germany (no GAP), Greece (GAP: 0.88-1.9 g ai/hl, PHI 3 days), Italy (GAP: 0.75-1.3 g ai/hl, PHI 3 days), Portugal (GAP: 1.3 g ai/hl, PHI 2 days) and Spain (GAP: 0.75-1.3 g a/hl, PHI 3 days). The Meeting decided to evaluate the German trials against the GAP of France.

In eight trials conducted in France and approximating GAP in that country the residues of deltamethrin in beans with pods were: <0.005, <0.005, 0.02, 0.03, 0.05 (3) and 0.14 mg/kg.

Eight German trials matched the GAP of France with residues of deltamethrin of <0.01 (6) and 0.01 (2) mg/kg.

Field trials on succulent peas were made available to the Meeting from France (GAP: 13 g ai/ha, PHI 3 days), Germany (no GAP) and the UK (GAP: 6.3-7.5 g ai/ha, PHI 7 days).

Residues of deltamethrin in peas with pods were: <0.01 (2), 0.06 and 0.1 mg/kg for trials conducted in France and Germany and evaluated against the GAP of France.

Field trials on succulent beans, shelled were made available to the Meeting from France (GAP: 13 g ai/ha, PHI 7 days) and Germany (no GAP). None of the trials from France matched GAP. The Meeting decided to evaluate the German trials against the GAP of France. In 4 trials from Germany that approximated the GAP of France the residues of deltamethrin in shelled beans were: <0.01 (3) and 0.01 mg/kg. Field trials on succulent peas, shelled were made available to the Meeting from France (GAP: 13 g ai/ha, PHI 7 days), Germany (no GAP) and the UK (6.3-7.5 g ai/ha, PHI nil). The Meeting decided to evaluate the German and UK trials against the GAP of France. In two trials from France, one from the UK and four from Germany that approximated the GAP of France the residues of deltamethrin in shelled peas were: <0.01 (3) and <0.015 (4) mg/kg.

The residues of deltamethrin in shelled beans and peas are much lower than for the whole pods as expected for a compound that is not readily translocated and the Meeting considered that the residues values from shelled beans and peas (seed) should not be combined with data from whole pods for the purposes of estimating a maximum residue level.

The Meeting agreed to pool the data from beans with pods and peas with pods and estimate a maximum residue level for legume vegetables. Residues, in rank order (median underlined) were: <0.005, <0.005, <0.01 (8), 0.01 (2), 0.02, 0.03, 0.05 (3), 0.06, 0.1 and 0.14 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in legume vegetables of 0.2, 0.01 and 0.14 mg/kg, respectively. The estimated maximum residue level replaces the previous recommendation of 0.1 mg/kg for legume vegetables.

PULSES

Soy beans. Field trials on soy beans were made available to the Meeting from Australia (GAP: 14 g ai/ha, PHI 7 days), France (no GAP), Ivory Coast (no GAP) and Mexico (GAP: 10-13 g ai/ha, PHI 1 day). However, the trials were supplied in the form of summary reports and insufficient detail was presented to allow evaluation of the trials.

Deltamethrin is registered for use on stored grain legumes in Spain with application at 0.5-1 g ai/tonne. The Meeting considered that the location of the trials on stored grain legumes were not relevant in assessing whether or not a trial was conducted according to GAP and that for the purposes of evaluating the data on stored grain legumes a GAP of 1 g ai/tonne would be used.

In two trials from Brazil on stored beans approximating GAP, residues of deltamethrin were 0.2 and 0.26 mg/kg. In four trials from France approximating GAP and involving haricot beans (2), peas and lentils, the residues in the treated grain were 0.45, 0.6, 0.7 and 0.85 mg/kg.

The Meeting agreed that the results for the individual pulses could be combined for the purpose of estimating a maximum residue level. The residue levels for deltamethrin in stored pulses in rank order, median underlined (n=6), were: 0.2, 0.26, 0.45, 0.6, 0.7 and 0.85 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in pulses of 1, 0.5 and 0.85 mg/kg, respectively. The maximum residue level for pulses of 1 mg/kg replaces the previous individual recommendations of 1 mg/kg for beans (dry), field pea (dry) and lentil (dry) which the Meeting agreed to withdraw.

Carrots. Field trials on carrots were made available to the Meeting from France (no GAP), Germany (no GAP), Greece (GAP: 1.5 g ai/hl, PHI 7 days), Italy (GAP: 0.75-1.5 g ai/hl, PHI 3 days), Portugal (no GAP) and the UK (no GAP). None of the trials matched GAP of the particular country they were conducted in. The Meeting decided to evaluate the trials conducted in France, Germany and the UK against the GAP of Belgium (7.5-13 g ai/ha or 1.2-3.1 g ai/hl, PHI 7 days). In 7 trials in Germany, 2 in France and one from the UK matching GAP conditions for Belgium, deltamethrin residues on carrots were, median underlined <0.01 (6), <0.02 (3) and 0.02 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in carrots of 0.02, 0.01 and 0.02 mg/kg, respectively.

Potatoes. Field trials on potatoes were made available to the Meeting from France (GAP: 13 g ai/ha, PHI 3 days), Germany (no GAP), Greece (GAP: 0.88-1.5 g ai/hl, PHI 15 days), Portugal (GAP: 0.75 g ai/hl, PHI 7 days) and Spain (GAP: 0.75-1.3 g ai/hl, PHI 3 days). None of the trials matched GAP of the particular country they were conducted in. The Meeting decided to evaluate the trials conducted in Germany against the GAP of Belgium (7.5 g ai/ha or 2.5 g ai/hl, PHI 7 days). In 4 trials in Germany matching GAP conditions for Belgium deltamethrin residues on potatoes were <0.01 (4) mg/kg.

The Meeting noted that residues in six trials from Greece, Portugal and Spain conducted at two times the Belgium GAP rate were all <0.02 mg/kg and decided that the trials conducted at the higher rate could be used to support the GAP trials for the purposes of estimating a maximum residue level for potatoes. The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in potatoes of 0.01*, 0.01 and 0.01 mg/kg, respectively.

Radish. France GAP permits application of deltamethrin to radish at 5 g ai/ha with harvest 7 days after the final application. The single trial on radish from France did not match GAP from that country. Deltamethrin is not registered for use in Germany. The Meeting decided to evaluate the residue trials from Germany against the GAP of Belgium which is application at 5-13 g ai/ha or at a spray concentration of 1.2-3.1 g ai/hl with harvest 7 days after the last spray. In 8 trials from Germany where conditions approximated GAP in Belgium deltamethrin residues in radish roots were <0.005 (4) and <0.01 (4) mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in radish of 0.01*, 0.01 and 0.01 mg/kg, respectively.

Tree nuts. Deltamethrin is registered in France for use on walnuts with application at 0.75-1.3 g ai/hl and a 14 day PHI. In two trials in France that approximated GAP the deltamethrin residues in nutmeat were all <LOQ (0.02 mg/kg). In other trials with application at spray concentrations of 0.83-1.4 g ai/hl where walnuts were harvested at 0 and 29-30 days later residues were all <0.02 mg/kg.

Trials were available from France (0.75 g ai/hl, PHI 14 days), Italy (no GAP) and Spain (no GAP) on hazelnuts. The Meeting agreed to evaluate all the trials according to the GAP of France. Residues of deltamethrin in nutmeat from five trials conducted at exaggerated rates (1.3-2.5 g ai/hl) were <0.02 mg/kg at 0 and 28-31 days after three applications.

The Meeting agreed that the trials on walnuts and hazelnuts conducted according to GAP and at higher rates could be combined in support of each other to estimate maximum residue levels for hazelnuts and walnuts. The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in hazelnuts and pulses of 0.02*, 0.02 and 0.02 mg/kg, respectively.

Cereals. Field trials on wheat were made available to the Meeting from France (GAP: 6.3-7.5 g ai/ha, PHI 30 days), Germany (no GAP) and the UK (5-6.3 g ai/ha; last application before grain watery ripe GS 71). In a single trial from France that matched GAP, residues of deltamethrin in wheat grain were <0.02 mg/kg. None of the trials for Germany and the UK matched GAP of the particular country they were conducted in. The Meeting decided to evaluate the trials conducted in Germany and the UK against the GAP of France. In two trials in Germany and one in the UK that matched the GAP conditions for France deltamethrin residues in wheat grain were <0.02 (3) mg/kg.

The Meeting decided that four trials are insufficient for the purposes of estimating a maximum residue level for wheat.

Deltamethrin is registered in several countries for use on stored grain, including cereals, at rates ranging from 0.065 g ai/tonne to 1 g ai/tonne. The Meeting considered that the location of the trials on stored grain were not relevant in assessing whether or not a trial was conducted according to GAP and that for the purposes of evaluating the data on stored grains a GAP of 1 g ai/tonne would be used.

Four trials on stored maize approximated GAP, two in France and three in Italy. Residues of deltamethrin in stored maize were 0.34, 0.5, 0.58, 0.7 and 0.74 mg/kg.

Residues of deltamethrin in 3 trials from Belgium and 1 from Brazil on wheat from stored bulk grain in rank order were: 0.21, 0.7, 1.0 and 1.1 mg/kg.

In a single trial on barley from France that matched GAP for stored cereal grain the deltamethrin residue was 0.9 mg/kg.

In three trials on stored sorghum from France, the residues of deltamethrin were 0.45, 0.7 and 0.7 mg/kg.

Residues of deltamethrin in stored rice grain from trials from Brazil were 0.37, 0.55 and 0.80 mg/kg.

The Meeting agreed that the results for the individual cereal grains could be combined for the purpose of estimating a maximum residue level. The residue levels for deltamethrin in stored cereal grains in rank order, median underlined (n=16), were: 0.21, 0.34, 0.37, 0.45, 0.5, 0.55, 0.58, 0.7 (4), 0.74, 0.80, 0.9, 1.0 and 1.1 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in cereal grain of 2, 0.7 and 1.1 mg/kg, respectively. The estimated maximum residue level of 2 mg/kg replaces the previous recommendation of 1 mg/kg for cereal grains.

Cotton seed. In India deltamethrin is registered for use on cotton at 10-13 g ai/ha with harvest permitted 30 days after the final application. None of the India trials matched GAP for India.

Deltamethrin is registered in Mexico for use on cotton with application at 13 g ai/ha and a 1 day PHI. In one trial in Mexico, with 0 days PHI deltamethrin residues in cotton seed were <LOQ (0.01 mg/kg).

Deltamethrin is registered in the USA for use on cotton at 15-34 g ai/ha with harvest permitted 21 days after the final application. No USA trials matched the GAP of the USA.

The Meeting decided that as cotton seed is a major commodity, a single trial from Mexico according to GAP is not sufficient for the purposes of recommending a maximum residue level.

Sunflower seed. Field trials on sunflowers were made available to the Meeting from Canada (GAP: 5 g ai/ha, PHI 70 days), France (GAP: 7.5 g ai/ha, PHI 60 days), Greece (no GAP), Germany (no GAP), Italy (no GAP) and Spain (GAP: 13-18 g ai/ha or 0.75-1.3 g ai/hl, PHI 35 days).

The trials from Canada were supplied as summaries and could not be evaluated. In two trials from France approximating GAP residues of deltamethrin in sunflower seeds were <0.01 and <0.05 mg/kg. The Meeting decided to evaluate the Greece, Germany, Italy and Spain trials against the GAP of France, residues in 2 trials from Germany matching GAP of France were <0.01 (2) mg/kg, and one each from Greece, Italy and Spain were <0.05 (3) mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in sunflower seed of 0.05*, 0.05 and 0.05 mg/kg, respectively.

The Meeting agreed that the previous recommendations for oilseeds and oilseeds except peanuts of 0.1 mg/kg be withdrawn.

Tea. In India deltamethrin is registered for use on tea at 2.5-10 g ai/ha with harvest permitted 3 days after the final application. In six trials in India matching GAP conditions deltamethrin residues in black tea were: 0.77, 2.2, 2.2, 2.3, 2.3 and 3.1 mg/kg.

Deltamethrin residues in green leaf tea from Taiwan in trials approximating GAP for that country (8.8 g ai/ha, PHI 10 days) were 0.75 and 1.5 mg/kg.

The Meeting agreed that the two sets of residue data could be combined for the purposes of estimating a maximum residue level. The residues of deltamethrin in tea in rank order, median underlined were: 0.75, 0.77, 1.5, 2.2, 2.2, 2.3, 2.3 and 3.1 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for deltamethrin in Tea, green, black (black, fermented and dried) of 5, 2.2 and 3.1 mg/kg respectively. The maximum residue level recommendation of 5 mg/kg replaces the previous recommendation of 10 mg/kg for tea, green, black.

Rape forage. Field trials on rape were made available to the Meeting from France (GAP: 6.3 g ai/ha, PHI 28 days for rape) and Germany (no GAP). None of the trials matched GAP of the particular country they were conducted in. The Meeting decided to evaluate the trials conducted in France and Germany against the GAP of The Netherlands (7.5 g ai/ha, PHI nil days). In 2 trials in France and 17 from Germany matching GAP conditions for The Netherlands residues on rape

forage (plants or shoots) were 0.02, 0.037, 0.04, 0.07, 0.09 (2), 0.1 (3), 0.14, 0.16, 0.17, 0.19, 0.24 (2), 0.25 (2), 0.3 and 0.56 mg/kg.

The Meeting estimated an STMR and a high residue value for deltamethrin in rape forage of 0.14 and 0.56 mg/kg, respectively, both on a fresh weight basis.

Alfalfa. Field trials on alfalfa were made available to the Meeting from France (GAP: 6.3 g ai/ha, PHI 21 days) and New Zealand (GAP: 6.2 g ai/ha, PHI 21 days). None of the trials matched GAP of the particular country they were conducted in. The Meeting decided to evaluate the trials conducted in the south of France and against the GAP of Italy (15 g ai/ha, PHI 15 days). In 4 trials in France approximating GAP conditions for Italy residues on alfalfa forage were 0.07, 0.1, 0.11 and 0.16 mg/kg.

The Meeting considered the number of trials was insufficient to permit a maximum residue level to be estimated for deltamethrin on an important crop such as alfalfa forage and agreed to withdraw its previous recommendation of 0.5 mg/kg (dry) for legume animal feeds.

Wheat straw and fodder. In two trials in Germany and one in the UK that matched the GAP conditions for France deltamethrin residues in residues in wheat straw were 0.09, 0.12, 0.39 and 0.41 mg/kg. The Meeting decided that four trials was not sufficient to estimate a maximum residue level for straw and fodder (dry) of cereal grain and agreed to withdraw its current recommendation of 0.5 mg/kg.

Processing

The meeting received information on the fate of incurred residues of deltamethrin residues during the processing of apples, plums, tomatoes, olives, rice, maize, wheat, sorghum and rape seed (canola). The field incurred residues of deltamethrin in the rape seed used for processing were too low to allow meaningful processing factors to be derived for rape seed. Processing factors were calculated for processed commodities derived from these raw agricultural commodities using total deltamethrin residues. When residues in the processed commodity did not exceed the LOQ the processing factor was calculated from the LOQ and was prefixed with a 'less than' symbol (<).

The deltamethrin processing factor for apples to wet pomace and to juice were 5.7 and <0.09, respectively. These factors applied to the STMR (0.03 mg/kg) and MRL (0.2 mg/kg) for apples provide the STMR-P and highest residue for wet apple pomace (0.17 and 1.1 mg/kg) and applied to the apple STMR provide the STMR-P value for apple juice (0.0027 mg/kg).

The mean processing factors (“total deltamethrins”) for olives to crude oil and refined oil were 1.5 and 1.6, respectively. These factors applied to the STMR for olives (0.21 mg/kg) provided the STMR-Ps for crude oil (0.315 mg/kg) and refined oil (0.336 mg/kg).

The processing factors for tomatoes to purée and paste were both <0.1. These factors applied to the STMR (<0.02 mg/kg) for tomatoes provided the STMR-Ps for tomato purée and tomato paste of 0.002 mg/kg.

The processing factors for rice grain to hulls (4.5), mill by-products (0.21), brown rice (0.15), bran (1.5) and polished rice (<0.06) when applied to the STMR for cereal grain (0.7 mg/kg), provide STMR-Ps for hulls (3.15 mg/kg), mill by-products (0.147 mg/kg), brown rice (0.105 mg/kg), bran (1.05 mg/kg) and polished rice (0.042 mg/kg).

The processing factors for dry milling of maize to germ and oil were higher than for wet milling. The Meeting decided to use the processing factors derived from the dry milling of maize to germ (0.32) and oil (18), applied to the STMR for cereal grain, to provide STMR-Ps for maize germ (0.224 mg/kg) and oil (12.6 mg/kg).

The mean processing factors for wheat to bran (3.3), flour (0.31), middlings (0.7), shorts (0.79), germ (1.2), wholemeal (0.91), white bread (0.14), wholemeal bread (0.42), flat bread (0.5), steamed bread (0.14), yellow alkaline noodles (0.17) and white noodles (0.13) when applied to the STMR for cereal grain, provide STMR-Ps for bran (2.31 mg/kg), flour (0.217 mg/kg), middlings (0.49 mg/kg), shorts (0.55 mg/kg), germ (0.84 mg/kg), wholemeal (0.637 mg/kg), white bread (0.098 mg/kg), wholemeal bread (0.294 mg/kg), flat bread (0.35 mg/kg), steamed bread (0.098 mg/kg), yellow alkaline noodles (0.119 mg/kg) and white noodles (0.091 mg/kg).

The Meeting recommended maximum residue levels of 5 mg/kg for wheat bran, 0.3 mg/kg for wheat flour and 2 mg/kg for wholemeal flour. In recommending a maximum residue level of 2 mg/kg for wholemeal flour the Meeting noted that deltamethrin residues do not decline significantly during storage and does not degrade during milling of grain to wholemeal flour, therefore the recommendation is at the same level as for cereal grain. The recommendation of 5 mg/kg for wheat bran confirms the previous recommendation while those for wheat flour (0.3 mg/kg) and wholemeal flour (2 mg/kg) replace the previous recommendations of 0.2 and 1 mg/kg, respectively.

The processing factors for sorghum grain to flour (0.33) and starch (0.04) when applied to the STMR for cereal grain, provide STMR-Ps for flour (0.231 mg/kg) and starch (0.028 mg/kg).

Farm animal dietary burden

The Meeting estimated the farm animal dietary burden of deltamethrin residues using the diets in Appendix IX of the FAO Manual. The calculation from the MRLs provides the feed levels suitable for animal commodity MRL estimation, while the calculation from feed STMRs is suitable for estimation of animal commodity STMRs. DM is dry matter. The % DM is taken as 100% where MRLs and STMRs are already expressed on a dry weight.

Commodity	MRL (or HR)	Group (or)	% DM	MRL + DM	Choose diets, %			Residue contribution, mg/kg		
					Beef	Dairy	Poultry	Beef	Dairy	Poultry
Apple pomace wet	0.17 (ST-P)	AB	40	0.425			20			0.085
Carrot culls	0.02	VR	12	0.167			10			0.0167
Barley grain	2	GC	88	2.27						
Corn grain	2	GC	88	2.27			10			0.227
Corn aspirated grain fractions	21.7	CF	85	25.5			20	20		5.1 5.1
Corn milled by-products	0.539	CF	85	0.63						
Millet grain	1	GC	88	1.14						
Oats grain	2	GC	89	2.24						
Pea field	1	VD	90	1.11						
Rape forage	0.56	AM	30	1.87			20	30		0.374 0.561
Lupin	1	VD	88	1.14						
Potato culls	0.01	VR	20	0.05						
Rice grain	2	GC	88	2.27						
Rice hulls	3.15 (ST-P)	CM	90	3.5			10	10	15	0.35 0.35 0.525
Rice bran	1.05 (ST-P)	CM	90	1.17						

Commodity		Group	% DM	Choose diets, %			Residue contribution, mg/kg			
				Beef	Dairy	Poultry	Beef	Dairy	Poultry	
Rye grain	2	GC	88	2.27						
Sorghum	2	GC	86	2.33	40	10	35	0.932	0.233	0.8155
Soy bean	1	VD	89	1.12						
Wheat grain	2	GC	89	2.24						
Wheat milled by products	2.31	CF	88	2.625			50			1.31
TOTAL					100	100	100	7.0	6.3	2.65
Commodity	STMR			STMR + DM						
Apple pomace wet	0.17	AB	40	0.425		20				0.085
Carrot culls	0.01	VR	12	0.08						
Barley grain	0.7	GC	88	0.80						
Corn grain	0.7	GC	88	0.80	10	10		0.08	0.08	
Corn aspirated grain fractions	21.7	CF	85	25.5	20	20		5.1	5.1	
Corn milled by products	0.539	CF	85	0.63						
Millet grain	0.5	GC	88	0.57						
Oats grain	0.7	GC	89	0.79						
Pea field	0.5	VD	90	0.56						
Rape forage	0.14	AM	30	0.47	20	30		0.094	0.141	
Lupin	0.5	VD	88	0.57						
Potato culls	0.01	VR	20	0.05						
Rice grain	0.7	GC	88	0.80						
Rice hulls	3.15	CM	90	3.5	10	10	15	0.35	0.35	0.525
Rice bran	1.05	CM	90	1.2						
Rye grain	0.7	GC	88	0.80						
Sorghum	0.7	GC	86	0.81	40	10	35	0.324	0.081	0.2835
Soy bean	0.5	VD	89	0.56						
Wheat grain	0.7	GC	89	0.79						
Wheat milled by products	2.31	CF	88	2.6			50			1.3
TOTAL					100	100	100	5.9	5.8	2.1

Maize aspirated grain fractions PF for impurities = 31, STMR = 31×0.7 = 21.7 mg/kg.

Corn milled by-products used de-germed maize (dry-milled) PF = 0.77, STMR-P 0.77×0.7 = 0.539 mg/kg.

The deltamethrin dietary burdens for animal commodity MRL and STMR estimation (residue levels in animal feeds expressed on dry weight) are: beef cattle 7.0 and 5.9 ppm, dairy cattle 6.3 and 5.8 ppm and poultry 2.7 and 2.1 ppm.

Farm animal feeding studies

The Meeting received information on the residue levels arising in animal tissues and milk when dairy cows were dosed with deltamethrin for 28 days at the equivalent of 2 and 10 ppm in the diet. Residues in milk reached a plateau by day 4. Deltamethrin residues in the fat were higher than in other tissues. Transfer factors (residue level in tissue ÷ residue level in feed) for each tissue and milk for the two dosing levels (2 and 10 ppm respectively, single animals) were: fat, 0.023, 0.027; muscle, <0.015, <0.003; kidney, residues not reported due to analytical problems; liver, <0.015, <0.003; milk 28 days, 0.008, 0.0035.

In an additional study lactating dairy cows were administered a 1:1 mixture of deltamethrin and tralomethrin for 28 days at the equivalent of 2, 6 and 20 ppm in the diet and the residue levels

arising in animal tissues and milk reported. Tralomethrin is rapidly converted to deltamethrin and the study can be used to provide information on likely residues on exposure to deltamethrin at 2, 6 and 20 ppm in the feed. As with the study above, residues in the fat were higher than in other tissues. Transfer factors (residue level in tissue ÷ residue level in feed) for each tissue and milk for the three dosing levels (2, 6 and 20 ppm respectively) were: fat, 0.006, 0.003, 0.001, mean 0.003; muscle, <0.005, <0.002, <0.0005, mean <0.0025; kidney, <0.005, <0.002, <0.0005, mean <0.0025; liver, <0.005, <0.002, <0.0005, mean <0.0025; milk 28 days, <0.005, <0.002, <0.0005, mean <0.0025, milk fat 28 days, 0.02, 0.005, 0.001, mean 0.009.

The Meeting received information on the residue levels arising in animal tissues when pigs were fed deltamethrin in the diet for 130-141 days at 0.67 ppm. Residues in the fat were higher than in other tissues. Transfer factors (residue level in tissue ÷ residue level in feed) for each tissue (fat, muscle, liver and kidney) were all <0.04.

The Meeting received information on the residue levels arising in tissues and eggs when laying hens and chickens were fed deltamethrin in the diet for up to 70 days in the case of chickens and for 20 weeks in the case of laying hens. Residues were below the LOQ of the analytical methods for tissues and eggs.

The Meeting also received information on the residue levels arising in tissues and eggs when laying hens were dosed with a 1:1 mixture of deltamethrin and tralomethrin for 28 days at the equivalent of 2, 6 and 20 ppm in the diet. At the 2 ppm feeding level the residues were below the LOQ of the analytical methods. Residues in fat were substantially higher than residues in other tissues and eggs. Residue levels in muscle and liver were below the LOQ of the analytical methods for all the dosing groups. Transfer factors based on highest residues for fat were <0.05, 0.04 and 0.03 respectively for the 2, 6 and 20 ppm feeding levels (<0.05, 0.02, 0.02 if means are used). Transfer factors (based on highest and mean residue) for muscle and liver were <0.01, <0.003 and <0.001 respectively for the 2, 6 and 20 ppm feeding levels. Residues in eggs reached a plateau by day 10 in the highest dose group. Residues in eggs were generally below the LOQ (0.01 mg/kg) for the other dose groups. The transfer factors (based on highest and mean residue) for eggs were <0.0075, <0.003 (at 7 days) and 0.002 (at 21 days) respectively for the 2, 6 and 20 ppm feeding levels.

Farm animal direct treatment

No studies were received on the residues of deltamethrin arising from direct animal treatment. The Meeting noted that JECFA has evaluated deltamethrin residues arising from direct animal treatment at its 52nd Meeting in 1999 and recommended maximum residue limits for cattle, sheep and chickens of 30 µg/kg for muscle, milk and eggs, 50 µg/kg for liver and kidney and 500 µg/kg for fat. The muscle maximum residue limit also applies to salmon. The marker residue that applied to the residue limits was deltamethrin. The 52nd JECFA noted that no residues were detected in muscle, milk and eggs of treated animals/hens in residue depletion studies.

Animal commodity maximum residue levels

The Meeting decided to utilise the published feeding with dairy cattle where significantly higher residues (in-line with the lactating cow metabolism study on deltamethrin and feeding studies with related pyrethroids) rather than the tralomethrin/deltamethrin feeding study to estimate maximum residue levels for mammalian commodities. The maximum dietary burden for beef and dairy cattle is 7.0 mg/kg, so the levels of residues in tissues and milk can be obtained by interpolation between the high residues obtained in tissues at the 2 and 10 ppm feeding levels. Maximum residues

expected in tissues are: fat 0.19 mg/kg, muscle <0.03 mg/kg, liver <0.03 mg/kg and the mean residue for milk 0.018 mg/kg.

The Meeting estimated maximum residue levels for meat (from mammals other than marine mammals) 0.5 mg/kg (fat); kidney of cattle, goats, pigs and sheep 0.03 (*) mg/kg; liver of cattle, goats, pigs and sheep 0.03 (*) mg/kg and milks 0.05 mg/kg. The recommendation of 0.5 mg/kg (fat) for meat (from mammals other than marine mammals) replaces the previous recommendation at the same level that also incorporated direct animal uses while the recommended levels for kidney and liver of cattle, goats, pigs and sheep at 0.03* mg/kg replace the previous recommendation of 0.05 mg/kg for edible offal (mammalian).

The STMR dietary burden for beef and dairy cattle is 5.9 mg/kg (mean of 5.9 and 5.8 mg/kg). The Meeting interpolated STMR values from the high residues in each feeding level. The high residue in each feeding level was used to interpolate STMR values as for deltamethrin only a single animal was slaughtered at 24 hours after the last dose. The additional animals slaughtered at 4 and 9 days after the last dose also had significant residues in fat and provided confidence in the procedure used. The estimated STMRs were: meat (from mammals other than marine mammals) <0.03 mg/kg, fat (from mammals other than marine mammals) 0.16 mg/kg, kidney of cattle, goats, pigs and sheep <0.03 mg/kg, liver of cattle, goats, pigs and sheep <0.03 mg/kg and milks 0.017 mg/kg.

The highest individual tissue residue from the relevant feeding group was used in conjunction with the highest residue dietary burden to calculate the likely highest animal commodity residue level. As only a single animal is available per feeding group, these tissue residues from the animals in the relevant feeding groups were used in conjunction with the STMR dietary burden to estimate the animal commodity STMR values. For milk the mean milk residue at the plateau level from the relevant feeding group was used to estimate both the maximum residue level and the STMR.

Dietary burden (mg/kg) ¹ Feeding level [ppm] ²		Deltamethrin residues, mg/kg ³								
		Milk Mean	Fat high	mean	Muscle High	mean	Liver high	mean	Kidney High	mean
MRL beef	(7.0) [10]		(0.186) 0.27		(<0.03) <0.03		(<0.03) <0.03		(<0.03) ⁴	
MRL dairy	(6.3) [10]	(0.018) 0.026								
STMR beef	(5.9) [10]		(0.155) 0.27		(<0.03) <0.03		(<0.03) <0.03		(<0.03) ⁴	
STMR dairy	(5.8) [10]	(0.017) 0.026								

¹ Values in parentheses are the estimated dietary burdens

² Values in square brackets are the actual feeding levels in the transfer study

³ Residue values in parentheses in italics are interpolated from the dietary burden, feeding levels in the transfer study and the residues found in the transfer study. High is the highest individual animal tissue residue in the relevant feeding group. Mean is mean animal tissue (or milk) residue in the relevant feeding group.

⁴ The lactating goat metabolism study suggests residues in kidney will be below the limit of analytical quantitation.

The maximum dietary burden for poultry is 2.7 mg/kg. The levels of residues in tissues and eggs can be obtained from interpolation between the 2 and 6 ppm feeding levels. Maximum residues expected are: muscle <0.02 mg/kg, fat 0.09 mg/kg, liver <0.02 mg/kg, eggs <0.02 mg/kg.

The Meeting estimated maximum residue levels for poultry meat 0.1 mg/kg (fat); poultry offal 0.02* and eggs 0.02 (*) mg/kg to replace previous recommendations of 0.01* for poultry meat and poultry edible offal and 0.01* mg/kg for eggs.

As no residues are observed at the maximum feeding level for poultry, the STMRs for poultry edible offal and eggs are the same as the maximum residue levels. The STMR for poultry meat (fat) is 0.038 mg/kg based on a median residue of 0.11 mg/kg for fat at a feeding level of 6 ppm and a dietary burden of 2.1 ppm.

DIETARY RISK ASSESSMENT

Deltamethrin was evaluated by the 52nd JECFA for residues in animal commodities arising from direct animal treatment. In the case of animal commodities, the maximum residue limit recommendations of the 52nd JECFA for cattle, sheep and chicken were the same or higher than those recommended above. The residue definition (marker residue) chosen by JECFA was deltamethrin.

As the major proportion of the consumption for animal commodities comes from cattle, sheep and chickens, the Meeting decided to translate the MRL recommendations of JECFA to the recommendations above and use them in the short and long-term dietary intake calculations below. For example, the JECFA recommendations for fat, liver, kidney, muscle and milk of cattle and sheep are translated to MRL/HR inputs in the dietary intake calculations for meat (from mammals other than marine mammals), liver and kidney of cattle, goats, pigs and sheep and milks. Similarly the JECFA recommendations for chicken fat, muscle, liver, kidney and eggs translate to poultry meat, poultry edible offal and eggs.

Chronic intake

The evaluation of deltamethrin has resulted in recommendations for MRLs and STMRs for raw and processed commodities. Consumption data were available for 50 food commodities and were used in the dietary intake calculation. The results are shown in Annex 3.

The International Estimated Daily Intakes for the 5 GEMS/Food regional diets, based on estimated STMRs were in the range 20-30% of the ADI of 0-0.01 mg/kg bw (Annex 3). The Meeting concluded that the long-term intake of residues of deltamethrin from uses that have been considered by the JMPR is unlikely to present a public health concern.

Short-term intake

The international estimated short-term intake (IESTI) for deltamethrin was calculated for the food commodities (and their processing fractions) for which maximum residue levels and HRs were estimated and for which consumption data were available. Where group MRLs were recommended and the IESTI calculation involved a variability factor (e.g. citrus fruits, leafy vegetables) the IESTI was calculated for both the commodities with the highest consumption figure and with the largest unit weight to ensure the IESTI calculation covered the highest intake. Where group MRLs were recommended and the IESTI calculation was for case 1 or 3 (no variability factor) the IESTI was calculated only for the commodity with the highest consumption figure as this covers the highest intake situation for a commodity in that group. The results are shown in Annex 4.

The IESTI varied from 0-58 % of the acute RfD (0.05 mg/kg bw) for the general population. The IESTI varied from 0-130% of the acute RfD for children. The short-term intake for the leafy vegetables, for which the calculation was made, was 115-130% of the acute RfD for children.

The Meeting concluded that the short-term intake of residues of deltamethrin from uses that have been considered by the JMPR, with the exception of leafy vegetables, is unlikely to present a public health concern.

4.9 DIFLUBENZURON (130)

RESIDUE AND ANALYTICAL ASPECTS

Diflubenzuron [1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl)urea] is included in the CCPR periodic review programme. This insecticide was originally evaluated by the JMPR in 1981 and re-evaluated for residues several times up to 1988. At the 28th Session of the CCPR in 1996 (ALINORM 97/24) diflubenzuron was scheduled for the JMPR in 1999 as a priority compound under the Periodic Review Program. However, the manufacturer asked for a postponement and therefore the periodic review of diflubenzuron was re-scheduled for the JMPR in 2002.

The primary manufacturer supplied information on identity, metabolism and environmental fate, residue analysis, use pattern, residues resulting from supervised trials on crops (almonds, apples, berries, blackcurrants, Brussels sprouts, Chilli peppers, cotton, gooseberries, grapefruits, head cabbages, lemons, limes, mandarins, mushrooms, oranges, peaches, pears, peas, pecans, plums, range grass, rice, soybeans, sweet peppers, tomatoes, walnuts), fate of residues during storage or in processing, residues in animal commodities (meat, milk, eggs) resulting from direct animal treatment or feeding, and national MRLs. In addition, GAP information and National MRLs were supplied by The Netherlands, Germany and Australia.

Animal metabolism

The Meeting received information on the fate of orally dosed diflubenzuron in lactating cows, male sheep, lactating goats, laying hens, and pigs and on dermally applied diflubenzuron on cattle. Studies on laboratory animal metabolism (rat, mouse, rabbit, cat) were evaluated by the WHO panel of the 2001 JMPR. All studies were performed using ¹⁴C-diflubenzuron, equally labelled in both phenyl moieties.

The studies indicated that diflubenzuron is metabolised via two routes. Hydroxylation of the phenyl groups, which leaves the basic structure of diflubenzuron intact, yields the metabolites 2,6-difluoro-3-hydroxydiflubenzuron (3-OH(F)-DFB), 4-chloro-3-hydroxydiflubenzuron (3-OH-DFB), 4-chloro-2-hydroxydiflubenzuron (2-OH-DFB) and their conjugates. On the other hand, cleavage between the carbonyl and amide groups yields 2,6-difluorobenzoic acid (DFBA), 2,6-difluorobenzamide (DFBAM) and p-chlorophenylurea (CPU).

Lactating cows and goats excreted 73-86% of the ¹⁴C administered in the faeces and 4-15% in the urine. Into the milk 0.07-0.2% was secreted. In muscle and fat, no radioactive residues could be detected. In liver, 0.4-0.8% of the administered dose was found and in kidney 0.01-0.02%. Radioactivity in liver could be attributed to the following components: parent (3.5-7.0% TRR; both cow and goat), DFBA (13-20% in cow), DFBAM (1-5% in goat), CPU (0.2% in cow, 11-16% in goat), p-chloroaniline (PCA; 1.4% in cow, maybe also in goat at low amounts). The nature of the residue in kidney was not investigated.

In both cow studies, 61%-82% TRR could be extracted from the milk with acidified ethyl acetate. Concerning the nature of the residue in milk, conflicting data were reported. In the first cow study, it is stated that the radioactivity present in milk was not due to the parent itself, but to non-specified metabolites. However, in the second cow study, a significant amount of parent compound (43% TRR) was found in milk and metabolites were identified as well: DFBAM (13% TRR), 3-OH(F)-DFB (12% TRR) and 2,6-difluorohippuric acid (DFHA; 2% TRR). In the goat study, 87% TRR could be extracted from milk with 10% ammonia. HPLC analysis of milk extracts from goat showed, that the residue in milk consisted of about 8 components. None of these components was parent, CPU, PCA or p-chloroacetanilide (PCAA). About 20% of the metabolites was characterised as sulphate- or glucuronide conjugates.

¹⁴C-Diflubenzuron was not degraded to any significant extent when incubated *in vitro* with digestive tract fluids of cattle or sheep.

Pigs rapidly excreted 70-80% of the radioactive oral dose in the faeces, and 5-10% in the urine. Six hours after the last dose, radioactive residues in muscle and fat were below the LOQ, in liver and kidney low levels of radioactivity were detectable. Diflubenzuron itself could not be detected in liver and kidney. The main metabolites in liver and kidney were found to be DFBA (30 and 55%, respectively) and DFHA (20 and 10%, respectively).

Laying hens showed rapid elimination of radioactivity in excreta: 40-65% of the administered dose in the first 8 hours after administration. In total, 80-90% of the administered dose was recovered in the excreta. About 4% was recovered from the tissues. Of the relevant tissues, the highest residue levels were present in fat and (partially formed) eggs, followed by liver and kidney while only minor amounts were found in muscle. In chicken eggs, 0.30-0.79% of the dose is excreted.

In chicken fat, 99% of the radioactive residue could be attributed to parent compound. In muscle, 63-76% was parent, about 13-22% CPU, and about 8% DFBA. In liver, 19-49% was parent, 20-50% CPU, about 7% DFBA, 1-3% PCA and about 3% PCAA. In kidney, 12-24% was parent, 23-40% CPU, and about 4% was PCA. In eggs, 69-80% of the radioactive residue was found to be parent, 11% CPU, and 4% DFBA. Traces of PCAA were found in one dose group. Almost all residue was present in egg yolk, negligible amounts were in the egg white.

Studies with a stanchioned, catheterised cow indicated that diflubenzuron applied as WP is not absorbed through the skin to any significant extent after dermal application. During a 3 day period after application, no detectable residues were excreted in the urine. After 3 days, 68% of the radioactivity applied was recovered by clipping and extracting the treated hair and thoroughly washing the exposed skin with acetone. TLC of these fractions showed that DFB was the only radioactive compound found. Residues in tissues were not investigated.

Metabolism of diflubenzuron in laboratory animals was qualitatively comparable to that in farm animals.

Plant metabolism

The Meeting received information on the fate of diflubenzuron after spotwise treatment of leaves from maize, soybean, cabbage, apple, cotton and rice, after application to fruits of apple and orange, after application to pods of soybean, after soil application to cotton, after surface water treatment to rice and wheat, after compost and/or casing treatment to mushrooms. Further,

information was received on the fate of diflubenzuron after incubation on bean leaf disks and after injections into the stem and leaves of lima bean, and on CPU and DFBA uptake by root/stems from nutrient solutions. The studies were conducted with diflubenzuron labelled in both rings with ^{14}C , or labelled with ^{14}C (chloroaniline ring) and ^3H (difluorobenzoyl ring) in the same molecule or with a mixture of ^{14}C -diflubenzuron labelled at the chloroaniline and the difluorobenzoyl moiety.

After spotwise treatment of leaves from apple, maize, soybean, cabbage, >90% of the recovered radioactivity was found to be parent compound. The residue did not translocate. Spotwise treatment of apples and oranges (the fruit) gave the same result. Spot wise treatment of developing pods of soybean plants showed >99% of the recovered radioactivity in the treated pods and less than 0.2% in the untreated parts (vines, untreated pods). On the treated pods, >99% of the recovered radioactivity was found in the hulls and less than 0.2% was found in the seeds. In the immature pods and mature hulls 90%-104% TRR was identified as parent compound.

Miniature citrus trees (in a greenhouse) were sprayed with radiolabelled diflubenzuron. Two simulated rain events removed 57%-87% TRR. When treated citrus leaves were soaked in tap water for 24 hours, essentially quantitative removal of radioactivity was observed (96% TRR).

In soybean plants treated twice at mid to full bloom (foliar treatment), diflubenzuron residues were found in foliage from 0-8 weeks. At maturity (after 12 weeks) residues were found in trash, leaves, pods, hulls, but not in seeds. It was found that 57%-100% TRR was extractable and this was observed to be unchanged diflubenzuron.

Agar cylinders containing ^{14}C -diflubenzuron were placed on dwarf bean leaf disks for 24 hours, of which 16 hours under illumination and 8 hours in the dark. No blackening of the X-ray film was observed outside the spots where the agar cylinders had been, nor on the places where the epidermis + cuticula were removed. This indicates, that ^{14}C -diflubenzuron does not penetrate the leaf disks.

LSC analysis of bean plants following stem injection of diflubenzuron, revealed that 84% of the applied radioactivity remained in the stems, the leaves contained 9% and the roots 0.2%. In the stems 89% - 88% TRR consisted of parent, up to 12 days after application. In the leaves (6 days after exposure), the organosoluble fraction consisted of parent (1.3% TRR), 2-OH-DFB (2.4%), 3-OH-DFB (8.9%), DFBAM (0.8%), CPU (0.7%), DFBA (0.6%) and 2 unknowns (1.7% and 0.2%). PCA was not detected.

In a greenhouse, leaves of cotton plants were sprayed with radiolabelled diflubenzuron. Of the applied radioactivity 100% was recovered in the treated leaves, 0.18%-0.37% in the bolls and squares, <0.01%-0.08% in stems, roots and new growth. When bolls and squares were subdivided in burr, seed and cotton fiber, the radioactivity was mainly present in the burr. In cotton seed extracts no radioactivity was found. The ^{14}C in the leaf and stem extracts was identified as diflubenzuron.

Cotton plants (41 days old) were transplanted in diflubenzuron-treated soil and 89 days after soil treatment 51% of the applied radioactivity was present in the soil; 3.5% in the plants and 46% was missing (probably degraded to $^{14}\text{CO}_2$). After 89 days radioactive residue was found in leaves (67%), roots (24%), stems (4.5%), and bolls plus squares (2.8%).

The ^{14}C in the 89 day soil extract was characterised as parent (13% TRR), CPU (10% TRR), DFBA (3%-4% TRR). The extractable ^{14}C from leaf samples was identified as CPU (21%

TRR). The extractable ^{14}C from root samples was characterised as parent (major part) and DFBA (minor part).

In the field, separate leaves of cotton plants were treated with radiolabelled diflubenzuron. After 14 days, 87% of the applied radioactivity could be washed off by organic solvents. After 21 days and following a rainfall, 70% of the applied diflubenzuron was washed off. After 28 days exposure to summer sunlight (protection against rainfall; crop oil suspension), 38% was lost as a result of volatilization. In extracts from cotton leaves, only the parent compound was found, no degradation products were observed.

Rice and wheat plants (in a greenhouse) were treated with radiolabelled diflubenzuron (^{14}C and ^3H) added to the irrigation water. Of the total recovered radioactivity 88%-94% (both ^3H , ^{14}C) was found in the soil, 1.3% (^{14}C) and 10% (^3H) was found in the roots and 6.2%-10% (^{14}C) and 1.8%-6.3% (^3H) was found in the shoots. The ^3H residues were not characterized (DFB-DFBA route). In the soil parent was present at 25% TRR up to 2 weeks after application and at 1.4%-9.9% up to 18 weeks after application. CPU was found in the soil at 0%-53% TRR. In the rice leaves 0%-16% TRR was identified as parent compound; CPU was found at 0%-72%. In the wheat leaves, parent compound was not detected; CPU was found at 39% TRR). In wheat grain, neither parent nor CPU was found.

Rice plants (in a greenhouse) received a foliar spray of radiolabelled diflubenzuron (1:1 mixture of ^{14}C ring labels). Only a very small amount of the applied radiolabel moved from the foliage to the grain. In rice grain 26%-32% TRR was extractable; CPU was identified as the major metabolite (17%-22% TRR); minor residues were parent (0.2%-0.3%), CPU conjugates (0.9%), DFBA conjugates (3.0%), PCA (0.3%) and unknown compounds (5.0%-9.4%). The non-extractable residues in rice grain were characterized as ^{14}C incorporated into glucose units of starch (30% TRR), into protein (12%) or as bound or lignin related residues (24%). Hydrolytic treatments released 5.0%-35% TRR from the non-extractable residues: no residues of diflubenzuron or its primary metabolites could be detected in the hydrolysates.

In rice straw 71%-81% TRR was extractable; parent (36%-42% TRR) and CPU (26%-29%) were the major residues; minor metabolites were CPU conjugates (2.5%), DFBA conjugates (2.1%), PCA (0.2%) and unknown compounds (5.8%-8.6%). The non-extractable residues in rice straw could be released by acid/base hydrolysis (15% TRR), resulting in CPU as the major metabolite (10%) and DFBA (2.2%), PCA (0.4%) and unknown compounds (2.2%) as minor metabolites.

The compost and casing layer of mushrooms were subsequently treated (indoors) with radiolabelled diflubenzuron. The main metabolites in the growth medium were CPU (25%-38% TRR) and DFBA (10%-33% TRR). PCA was present in amounts <1% TRR. Diflubenzuron applied to the casing is metabolized more rapidly than diflubenzuron applied to the compost.

The amount of parent compound was highest in the first flush of mushrooms (8.2%-17% TRR; 19 days after last treatment) and decreased to levels at or below the LOQ at subsequent flushes. The main metabolites in mushrooms in one study were CPU (54%-82% TRR) and DFBA (25%-43% TRR). PCA was present in amounts <1% TRR at day 32. Distillation of mushroom extracts indicated that 40%-70% TRR was possibly tritiated water. In another study, the main part of the residue in the mushrooms (compost and casing treatment) consisted of DFBA (81%-88% TRR).

CPU uptake from nutrient solutions was tested on tomato and broad bean plants. CPU was rapidly taken up by the roots and transported via the xylem to the leaves. CPU accumulated in the leaves and was metabolized to PCA at very slow rates.

DFBA uptake from nutrient solutions was tested on tomato plants. DFBA was decarboxylated rapidly under the influence of tomato roots and the xylem sap contained very little DFBA.

The Meeting concluded that the metabolism and degradation of diflubenzuron on crops is adequately understood. The compound does not penetrate into plant tissue and residues are only present on those parts directly exposed during the application. After application to aerial parts of plants, diflubenzuron is not metabolized to any practical extent. Diflubenzuron can be partly washed off by rainfall or can be volatilised by sunshine.

When applied to bare soil, diflubenzuron is partly degraded to CO₂. When plants are growing in the same soil, a larger part of diflubenzuron is degraded to CO₂ and low amounts of residues are found in the plant. Parent and the soil metabolites CPU and DFBA can be taken up by the roots: parent and DFBA remain in the roots, CPU is translocated to the leaves. Therefore, in rice and mushroom, CPU and DFBA are part of the residue.

All metabolites found in plants were also characterized in animal metabolism studies.

Environmental fate

Soil

Soil biodegradation. At the end of a laboratory study performed in a sandy loam soil at 24 °C for 21 days, unextracted radiolabel increased to 37% of the applied amount of ¹⁴C-diflubenzuron while CO₂ formation increased to 26%. Four metabolites were identified. Except for CPU, all of them were found in amounts of <10% of the applied diflubenzuron. The amount of CPU increased to a maximum of 31% of the applied diflubenzuron after 7 days and decreased thereafter to 25% at day 21. From this study the half-life of diflubenzuron was calculated to be 50 hours at 24 °C, while the half-life of CPU in soil was calculated to be 43 days at 24 °C.

In a laboratory study in a loam and a sand soil, the biodegradation of DFBA was investigated. Soil bound residues at the end of the study after 32 days amounted to 37% and 33% of applied radioactivity in loam and sand, respectively, while CO₂ production increased to 28% and 52%, respectively. In loam, DFBA content in the extracts decreased from 98% on day 0 to 27% on day 32. From this a half-life of about 12 days was calculated. In sand, DFBA decreased from 96% on day 0 to 2% on day 32 from which a half-life of about 9 days was calculated.

Field dissipation half lives of 78 (application on citrus trees) and 11 (application of bare soil) days were obtained for diflubenzuron. Since DFBA and CPU were formed in very small amounts it was not possible to determine half-lives for these metabolites. Metabolites DFBA and CPU were found only in the upper 15 cm soil layer, with a maximum concentration of 0.04 mg/kg dry weight soil.

Two studies concerned with the photodegradation of diflubenzuron on soil layers were submitted. From one of the study, a half-life for photolysis of 68 days could be estimated.

Mobility of diflubenzuron in soils is very low. In laboratory batch adsorption experiments with eight different soils and sediments with organic matter (OM) contents of 0.56% to 4.8%, K_{om} s between 1920 and 12727 L/kg were obtained. There was no relationship between adsorption and clay content. Metabolite DFBA is very mobile: the sorption of this metabolite in three different soils was too low to calculate a reliable adsorption coefficient. Metabolite CPU is slightly mobile: K_{om} s between 123 and 171 L/kg were obtained in three different soil types (0.7% to 4.3% OM). K_{om} s for CPU obtained in a column leaching experiment were higher: values of ≥ 1548 and 276 L/kg were determined in sand and loam with 4.6% and 3.6% OM, respectively.

In a confined rotational crop study sandy loam soil was treated with a suspension of radiolabelled diflubenzuron (^{14}C and ^3H label). After an ageing period of 10 weeks, soybean and maize seedlings and potato tubers were planted in the soil. At harvest, 22-26 weeks after treatment, there were no extractable residues in the leaves, soybean seeds, maize cobs and potato tubers. A low level of unextracted radiolabel was found in soybean leaves and seeds. In the maize leaves and cobs and in the potato leaves and tubers the total unextracted radiolabel was < 0.005 mg/kg. In the plant extracts, traces of CPU, possibly parent and 2 unidentified metabolites were found.

In a field rotational crop study the bare soil was sprayed with radiolabelled diflubenzuron (^{14}C in both rings). Wheat, onion and cabbage were planted 2 months after the last treatment and were collected 5.5 months after the last treatment. Radioactivity in plant tissue was below the level of 0.01 mg/kg diflubenzuron eq.

In another field rotational crop study radiolabelled diflubenzuron (^{14}C in both rings) was sprayed onto field grown cotton. After harvest of the cotton, 90% of the cotton plant material was distributed over the surface area of the treated plots, and cultivated into the top 10 cm of soil. Wheat seed and collard seedlings were planted after 3 weeks, radish and pinto bean seeds were planted after 6 months. At harvest, radioactive residues were generally low in the rotational crops, especially in the edible portions.

Post-harvest residues of diflubenzuron in soil were located in the top 10 cm of the soil and were persistent during the subsequent winter and spring months, but declined slightly with the onset of high summer temperatures. In soil collected in spring the extractable residue was characterized as diflubenzuron (81% TRR), CPU (1.7%) and two unknowns (each $< 2\%$). In soil collected in the following autumn all extractable residue was identified as DFB.

The Meeting concluded that rotational crops take up very low amounts of residues. The Meeting observed that the persistence of diflubenzuron in soil in field studies is longer than as deduced from laboratory experiments (laboratory half life 2-3 days at 20 °C).

Water-sediment systems

In a 63 day study at 22 °C in the dark at pH 5, 7, 9, and 12 in sterile solutions, double labelled diflubenzuron hydrolyzed faster at higher pH. At pH 5, about 80% was remaining after 63 days, at pH 7 about 70%, and at pH 9 about 35%. At pH 12, 8% was remaining after 28 days. DFBA and CPU were identified as degradation products.

The photodegradation of ^{14}C -phenyl-labelled diflubenzuron was determined in a solution containing 1% acetonitrile irradiated for 15 days. After 15 days 85 % of the radioactivity was recovered, 78% of which was diflubenzuron. Metabolites DFBA, DFBAM and CPU were found in amounts of 4, 1 and 8% of the recovered radioactivity. PCA was not found.

Diflubenzuron is rapidly degraded in aerobic water/sediment systems. In a 45 day study with a sandy loam and a silty loam system, the half-life of diflubenzuron in the water phase was 2 and 1 days at 20 °C, respectively. The half-lives for the whole system were 25 and 10 days for sandy loam and silty loam, respectively. Metabolites DFBA and CPU were the major degradation products. In another study with a river and pond sediment, half-lives for diflubenzuron in the system were 5.4 and 3.7 days at 20 °C, respectively. Metabolites DFBA and CPU were formed in maximum amounts of 17% and 48% in the system. Indicative half-lives of CPU for the water phase were 18 and 32 days for river and pond, respectively, half-lives for the system are 27 and 53 days. The amount of sediment bound residues in the respective systems was 44% and 37% after 104 days, mineralization as CO₂ was 33% and 38% after 104 days in river and pond, respectively.

In an anaerobic system, the half-life of diflubenzuron in the water phase was 18 days at 20 °C, the half-life for the whole system is 34 days. DFBA and CPU were formed in the water phase in amounts of 39% and 26%, respectively, after 90 days.

In studies in ditch water, half-lives of 9 and 22 days were found at 25 and 24 °C. Metabolites DFBA and CPU were formed in maximum amounts of 34% and 42%.

Analytical methods

The Meeting received numerous analytical methods used in supervised residue trials or in studies on storage stability, environmental fate, processing, animal feeding or direct animal treatment. Most analytical methods are single methods for determinations of either diflubenzuron, DFBA, CPU, PCA or PCAA in only a few matrices. The sample clean-up is in most cases very laborious and has to be adapted for each matrix. In addition, the methods need modifications when the samples are aged due to the increase in matrix interferences thereby resulting in decreasing recoveries.

HPLC methods for diflubenzuron, CPU or PCAA consist of extraction, clean-up and direct determination by HPLC-UV, HPLC-MS or LC-MS-MS.

GC methods for diflubenzuron, CPU or PCA consist of hydrolysis of PCA conjugates, extraction, clean-up, hydrolysis of diflubenzuron, followed by derivatization with heptafluorobutyric acid anhydride and determination by GC-ECD or GC-MS. At the hydrolysis of diflubenzuron both CPU and PCA are formed, but both compounds are derivatised to the same product. Any CPU and PCA present in the sample, will be determined as diflubenzuron if not separated prior to the hydrolysis step. PCA methods: when hydrolysis conditions for PCA are strong enough, any diflubenzuron or CPU present in the sample will be determined as PCA, if not separated prior to hydrolysis.

GC methods for DFBA consist of extraction (hydrolysis conditions), followed by clean-up and derivatisation with pentafluorobenzylbromide (PFBBBr) or with diazomethane and determination by GC-ECD or GC-MS. When hydrolysis conditions for DFBA are strong enough, any diflubenzuron present in the sample will be determined as DFBA, if not separated prior to hydrolysis.

Since no hydrolysis is included, the proposed analytical methods in plants underestimate the amount of CPU present in the sample, as only the free CPU is determined and not the soluble/bound conjugates.

Enforcement methods (GC methods) were submitted for the single and separate determination of diflubenzuron (LAI 3-86-6), CPU (LAI 3-86-9) or PCA (PTRL 625W) in rice grain.

Reported LOQs for plant commodities generally range from 0.01-0.05 mg/kg, with exceptions going up to 0.1 mg/kg. However, because of high residue levels in control samples/matrix interferences actual LOQs can be as high as 0.6 mg/kg. Reported LOQs for animal commodities range from 0.04-0.1 mg/kg. Recoveries in both plant and animal analytical methods were not always adequate and therefore results from trials with poor recoveries were excluded from evaluation.

Stability of pesticide residues in stored analytical samples

The Meeting received data on the stability of residues in plant products (grapefruits, lemons, limes, oranges, apples, pears, tomatoes, peppers, mushrooms, lettuce, turnip roots, wheat grain, wheat hay, rice commodities) and animal products (chicken manure, chicken muscle, chicken liver, chicken egg white, chicken egg yolk, cow's milk, goat liver, goat milk) stored frozen.

Storage results for citrus fruits are conflicting. In the first study diflubenzuron residues in oranges and grapefruits decreased to 37%-71% when stored for 19 weeks at -20 °C. However, in 3 additional studies diflubenzuron was found to be stable in lemons, oranges, and limes when stored for 4 - 6 months at -10 °C.

Diflubenzuron residues in apples were stable for the time tested (1.5 months at -20 °C, and 7 weeks at -10 °C). In pears stored frozen for up to 12 months, diflubenzuron and CPU were stable for 3 months and PCA declined. Diflubenzuron storage was not investigated for longer storage times, CPU levels decreased to 32% after 6 months storage and PCA levels decreased to 47% after 1 month of storage.

Diflubenzuron residues in tomatoes were stable for the time tested (10 months) at -20 °C. In peppers stored frozen for up to 12 months, diflubenzuron and CPU were stable for 12 months and PCA was not stable. CPU levels decreased to a plateau level of 72%-75% after 3-12 months storage and PCA levels decreased to 59% after 1 month of storage.

In mushrooms stored frozen for up to 19 months, diflubenzuron was stable for 12 months, CPU was stable for 19 months, and PCA was not stable. Diflubenzuron levels decreased to 68% after 18 months of storage, PCA levels decreased to 14% after 1 month of storage.

In lettuce, turnip roots, wheat (grain, hay), rice (grain, bran, straw, hulls) stored frozen for up to 12 months, storage stability data for diflubenzuron and CPU were considered not validated beyond a 1 month time period, because of analytical problems. In this 1 month, diflubenzuron and CPU were stable. PCA levels were reduced within one month to 43% (lettuce), 78% (turnip roots), 68% (wheat grain), 69% (wheat hay), 40% (rice grain), 52% (rice bran), 67% (rice straw) or 65% (rice hulls).

In egg whites and cow's milk diflubenzuron was stable for 1 year at -20 °C. In another study goat milk and goat liver were fortified with a mixture of diflubenzuron, CPU, PCA and PCAA and were stored for 22 months at -10 °C. The analytical results showed a high variability (RSD>20%) and storage stability results from this study are considered not accurate.

Chicken liver, chicken thigh muscle, and egg yolk fortified with a mixture of diflubenzuron, CPU, PCAA and PCA, were stored frozen at -20, -80 and -195 °C. At all temperatures, diflubenzuron was stable for 10-15 months in egg yolk, chicken liver and chicken muscle. For CPU the best results were obtained at -80 °C or lower: in egg yolk, chicken liver and chicken muscle CPU was stable for 12 months. The storage results for PCA and PCAA are variable and both metabolites are considered not stable: low PCA levels tend to go together with high PCAA levels, perhaps from transformation of PCA in PCAA.

Residue definition

In farm animals, diflubenzuron was rapidly excreted. In ruminant and pig muscle and fat, radioactive residues were very low and could not be characterized. In chicken muscle, about 70% of the residue was parent, in chicken fat 99%. Liver of all farm animals except pig contained parent compound as one of the main residues. Kidney of ruminants was not investigated, chicken kidney contained parent as one of the main residues. The nature of the residue in milk is unclear; in one study 43% of the TRR was found to be parent, in two other studies parent was not detected. No major metabolite was identified in milk. In chicken eggs, a large part of the residue was parent, and almost all residue was present in the egg yolk.

The Meeting agreed that parent is a suitable marker molecule for enforcement in animal commodities and is also the compound of interest for dietary risk assessment.

The log K_{ow} of diflubenzuron is 3.89. Taking into account results from trials on direct animal treatment and farm animal feeding studies, the Meeting decided that diflubenzuron should be classified as fat-soluble.

In plants, diflubenzuron is a surface residue when applied to the aerial parts of the plant. The compound does not degrade nor translocate and can easily be washed off. Therefore in general diflubenzuron *per se* is the residue of interest both for enforcement and for dietary risk assessment.

However, in soil and water diflubenzuron is degraded to DFBA and CPU, which can be taken up by the plants. Thus in crops which grow on the treated soil (mushroom) or in flooded area (rice) these metabolites are present in larger quantities than the parent. Metabolism studies showed that the residue in rice grain consists mainly of CPU, and in rice straw of both CPU and diflubenzuron. In mushrooms DFBA and CPU are the main metabolites, and parent is mainly detected in the first flush.

Metabolism studies in rice and the USA supervised residue field trials available to this Meeting show that at the currently registered USA maximum dose rates, CPU levels are below the reported LOQ of 0.001 mg/kg in rice grain. In mushrooms, DFBA is the main residue, although the amount varies widely among studies. In view of the fact that DFBA is not a residue of particular toxicological concern and that the intake of mushrooms is quite low all around the world, and further that analytical methods for diflubenzuron, DFBA and CPU are quite laborious, the Meeting decided that the definition of the residue (for compliance with MRLs and for dietary intake) is diflubenzuron, both for plant and animal commodities. The residue is fat-soluble.

Results of supervised residue trials

Trials were available for citrus fruits (grapefruit, lemon, lime, mandarin, orange), pome fruits (apple, pear), stone fruits (peach, plum), berries (blackcurrants, gooseberries), brassica vegetables (Brussels sprouts, head cabbages), fruiting vegetables (sweet peppers, chilli peppers, tomatoes,

mushrooms), pulses (peas, soybeans), rice, tree nuts (walnuts, almonds, pecans), cotton, and range grass.

Citrus fruits. Residue trials on citrus fruits were conducted in the USA (1985, 1988/1989, 1996), Spain (1995) and Italy (1996, 1997; no GAP). USA trials on grapefruits and oranges from 1988/89 could not be evaluated because of low storage stability results (37%-71% for diflubenzuron at 0.2-1.0 mg/kg). Italian trials on orange and lemon from 1997 could not be evaluated because of concurrent method recoveries as low as 46%.

Orange. Four USA trials (1985) with oranges were available. USA critical GAP is 3 times 0.35 kg ai/ha (interval 90 days) with a maximum spray concentration of 0.75 kg ai/hl (spray by aeroplane) or 0.075 kg ai/hl (spray). PHI is 21 days. One trial from 1985 was according to critical GAP, yielding a residue of 0.18 mg/kg.

Two Spanish trials (1995) with oranges were available. Spanish critical GAP is 0.015 kg ai/hL with a PHI of 30 days. Both trials complied with this GAP, yielding residues of 0.27 and 0.28 mg/kg.

Three Italian trials (1996) were available. Italy has no GAP for citrus, so the trials were evaluated according to the Spanish GAP. All 1996 trials were at GAP, yielding residues of 0.18, 0.27, 0.45 mg/kg.

Mandarin. Two Spanish trials (1995) with mandarins were at GAP, yielding residues of 0.18, 0.33 mg/kg.

Lemon. Two USA trials (1996) with lemon were available. The USA has no GAP on lemons. Three Italian trials (1996) were available. Italy has no GAP for citrus, so the trials were evaluated according to the Spanish GAP. All 1996 trials were at GAP, yielding residues of 0.18, 0.24, 0.26 mg/kg.

Lime. Two USA trials (1996) with lime were available. The USA has no GAP on lime.

Because residue results for single and double applications and residue results for different citrus fruits from USA, Italy and Spain are similar, residues were combined (STMR underlined): 0.18 (4), 0.24, 0.26, 0.27 (2), 0.28, 0.33, 0.45 mg/kg (lemon, mandarin, orange). Data on the residue in the edible portion were not available.

The Meeting agreed to maintain the current recommendation of 1 mg/kg for citrus fruit and estimated an STMR of 0.26 mg/kg for citrus whole fruit.

Pome fruit. Residue trials on apples and pears were conducted in The Netherlands (1974, 1975, 1976, 1979), Germany (1975, 1976, 1978, 1979, 1993), UK (1975, 1977, 1978, 1982), Poland, (1994), France (1974, 1975, 1976, 1979), Italy (1974, 1975, 1976, 1982, 1985, 1987), Spain (1975, 1976; no GAP), Japan (1976; no GAP), South Africa (1976/1977, 1977; no GAP), Canada (1983, 1984, 1997; no GAP) and the USA (1983, 1984, 1986, 1996, 1997; no GAP). South Africa, Canada and the USA have no registered use for diflubenzuron and the trials could not be evaluated against another GAP. Results from the 1976 German trials, the 1974 and 1976 Italian trials and the 1976 Spanish trials could not be used because of high values in control samples. Because residue results

from 1974-1985 trials below 0.6 mg/kg are considered as not valid (matrix interferences), these results are expressed as <0.6 mg/kg.

Apples. Diflubenzuron is registered in The Netherlands for use on apples and pears as SC480 and WP250 formulation at 1-2 applications with a spray concentration of 0.01-0.02 kg ai/hL and a PHI of 14 days. Of the trials conducted in The Netherlands, Germany, UK, Poland and Northern France, 8 trials on apples (Netherlands 1974, 1976, Germany 1975) were conducted at the Dutch critical GAP, yielding residues of 0.14, 0.17, 0.27, 0.31, 0.38, 0.40, 0.67, 0.89 mg/kg. Adjusted for matrix interference the residues are: <0.6 (6), 0.67, 0.89 mg/kg. .

Diflubenzuron is registered in Germany for use on apples and pears with WG 800 formulations at 1-4 applications at 0.18-0.30 kg ai/ha with normal spray at 0.012-0.02 kg ai/hL or low volume spray at 0.06-0.10 kg ai/hL with 14-21 day intervals and a PHI of 28 days. Of the trials conducted in Germany, The Netherlands, UK, Poland and Northern France, 1 trial on apples (Germany 1979) was conducted at the critical German GAP yielding a residue of 0.73 mg/kg.

Diflubenzuron is registered in the UK for use on apples and pears. Of the trials conducted in the UK, Germany, The Netherlands, Poland and Northern France, no trials were conducted at the UK critical GAP.

Diflubenzuron is registered in Poland for use on apples and pears with WP 250 formulations at 0.10-0.30 kg ai/ha with a PHI of 14 days at 0.0075-0.06 kg ai/hL. Of the trials conducted in Poland, UK Germany, The Netherlands and Northern France, 1 trial was conducted at the Polish critical GAP: yielding a residue of 1.0 mg/kg for the application on apples (Germany 1979).

Diflubenzuron is registered in France for use on apples, pears, nashi pears and quinces with SC 150 and WP 250 formulations with a PHI of 15 days at 0.01 kg ai/hL. Of the trials conducted in France, Poland, UK, Germany, The Netherlands, Italy and Spain, residues complying with French critical GAP are: 0.043, 0.15, 0.19, 0.21, 0.22 (2), 0.23, 0.34 (2), 0.37, 0.38, 0.42, 0.66, 0.80 mg/kg for apples (France 1979, The Netherlands 1974, 1979, Poland 1994, Italy 1982, 1985, 1987). Residues adjusted for matrix interferences (1974-1985 trials) are: 0.043, 0.21, 0.34, <0.6 (9), 0.66, 0.80 mg/kg on apples.

Diflubenzuron is registered in Italy for use on apples and pears with WP 050 and WP 250 formulations with a PHI of 45 days at 0.01-0.02 kg ai/hL or 2 applications with a combination formulation with a PHI of 45 days at 0.006-0.012 kg ai/hL at an interval of 21 days. Of the trials conducted in Italy, Southern France and Spain, residues complying with Italian critical GAP are: 0.12, 0.28, 0.31, 0.42, 0.43, 0.47, 0.49, 0.57, 0.76, 0.92, 3.6 mg/kg on apples (Italy 1975, Southern France 1975, 1976, 1979, Spain 1975). Residues adjusted for matrix interferences are: <0.6 (8), 0.76, 0.92, 3.6 mg/kg for the applications on apples.

Diflubenzuron is registered in Spain for use on fruits with WP 250 formulations with a PHI of 30 days at 0.01-0.015 kg ai/hL. Of the apple trials conducted in Spain, Italy and Southern France, residues complying with Spanish critical GAP are: 0.15^F, 0.21^F, 0.28^I, 0.34^F, 0.43^I, 0.49^I, 0.60, 0.65^F, 0.92^I, 3.6^I mg/kg (Italy 1985, 1987, Southern France 1976, 1979). Results indicated with F or I were derived from trials where the same or a higher value was already selected for French or Italian GAP. Because only one residue per trial may be selected, the residues derived from the same trial (superscript F or I) were not considered for MRL estimation. Adjusted results are: 0.60 mg/kg for apples.

Diflubenzuron is not registered in Japan for use on pome fruit, but the residue trials can be evaluated against the GAP for China. Diflubenzuron is registered in China for use on apples with WP 250 formulations at 0.012-0.025 kg ai/hL. Of the trials conducted in Japan, residues complying with Chinese critical GAP are: 0.042, 0.11, 0.23, 0.40 mg/kg for applications on apples (Japan 1976). Because results below 0.05 mg/kg are considered not valid (matrix interferences), these results are expressed as <0.05 mg/kg. Corrected results are: <0.05, 0.11, 0.23, 0.40 mg/kg for applications on apples.

Pears. Diflubenzuron is registered in The Netherlands for use on apples and pears as SC480 and WP250 formulation at 1-2 applications with a spray concentration of 0.01-0.02 kg ai/hL and a PHI of 14 days. Of the pear trials conducted in The Netherlands, Germany, UK, Poland and Northern France, 2 trials were conducted at the Dutch critical GAP, yielding residues of 0.083, 0.11 mg/kg (UK 1982). Adjusted for matrix interferences the residues are: <0.6 (2) mg/kg.

Diflubenzuron is registered in France for use on apples, pears, nashi pears and quinces with SC 150 and WP 250 formulations with a PHI of 15 days at 0.01 kg ai/hL. Of the pear trials conducted in France, Poland, UK, Germany, The Netherlands, Italy and Spain, residues complying with French critical GAP are: 0.10, 0.12, 0.14, 0.33 mg/kg for pears (France 1979, Italy 1982, 1985). Adjusted for matrix interferences the residues are: <0.6 (4) mg/kg.

Diflubenzuron is registered in Spain for use on fruits with WP 250 formulations with a PHI of 30 days at 0.01-0.015 kg ai/hL. Of the pear trials conducted in Spain, Italy and Southern France, residues complying with Spanish critical GAP are: 0.29^F, 0.40 mg/kg (Italy 1985, Southern France 1979). The result indicated with F was derived from a trial where the same or a higher value was already selected for French GAP. Because only one residue per trial may be selected, this residue was not considered for MRL estimation. Adjusted for matrix interferences the remaining residue is: <0.6 mg/kg.

In conclusion, 40 trials on apples were selected yielding residues of 0.043, <0.05, 0.11, 0.21, 0.23, 0.34, 0.40, <0.6 (23), 0.60, 0.66, 0.67, 0.73, 0.76, 0.80, 0.89, 0.92, 1.0, 3.6 mg/kg and 7 trials on pears yielding residues of <0.6 (7) mg/kg. Because all selected data points are in the same range, the Meeting decided to combine residue results from all selected trials, both from apples and pears (STMR underlined): 0.043, <0.05, 0.11, 0.21, 0.23, 0.34, 0.40, <0.6 (30), 0.60, 0.66, 0.67, 0.73, 0.76, 0.80, 0.89, 0.92, 1.0, 3.6 mg/kg.

The Meeting agreed to withdraw the previous maximum residue level recommendation for apples and pears (1 mg/kg) and estimated a maximum residue level of 5 mg/kg, and an STMR of 0.6 mg/kg for pome fruit.

Stone fruit. Residue trials on peaches and plums were conducted in the USA (1997, 1998). There is no registered use in the USA.

The Meeting agreed to withdraw the previous maximum residue level recommendation of 1 mg/kg for plums (including prunes).

Berries and other small fruits. Residue trials on blackcurrants (1) and gooseberries (1) were conducted in the UK (1978). Diflubenzuron is not registered in the UK on gooseberries, but it is for

use on blackcurrants. Of the trials conducted in the UK (1978), no trial was conducted at the UK critical GAP.

The Meeting agreed not to establish an MRL for blackcurrants and gooseberries.

Brassica (cole or cabbage) vegetables, head cabbages, flowerhead cabbages. Residue trials on Brussels sprouts were conducted in The Netherlands (1976) and the UK (1977, 1978). Diflubenzuron is not registered for use on Brussels sprouts in The Netherlands, but these trials could be evaluated against UK GAP. Diflubenzuron is registered in the UK for use on Brussels sprouts with SC 480 or WP 250 formulations with 2 applications at 0.1 kg ai/ha with 0.01-0.02 kg ai/hL with a PHI of 14 days. Of the trials conducted in The Netherlands and the UK, none of the trials was conducted at the critical UK GAP.

The Meeting agreed to withdraw the previous maximum residue level recommendation of 1 mg/kg for Brussels sprouts.

Residue trials on cabbage were conducted in The Netherlands (1974), the UK (1978), Germany (1975) and Brazil (1986). There is no registered use on cabbage in Brazil and Brazilian trials could not be evaluated against a GAP from another country. Diflubenzuron is not registered for use on cabbage in The Netherlands and Germany, but these trials could be evaluated against UK GAP.

Diflubenzuron is registered in the UK for use on cabbage with SC 480 or WP 250 formulations with 2 applications at 0.1 kg ai/ha with 0.01-0.02 kg ai/hL with a PHI of 14 days. Of the trials conducted in The Netherlands, Germany and the UK, residues complying with UK critical GAP are: 0.058 mg/kg for the double application on cabbage (UK 1978).

Because one trial is insufficient for the estimation of a maximum residue level, the Meeting agreed to withdraw the previous recommendation for head cabbage of 1 mg/kg.

Fruiting vegetables, other than cucurbits. Residue trials on sweet peppers and chili peppers were conducted in the USA (1997). There is no registered use in the USA, and trials could not be evaluated against another GAP.

Residue trials on tomatoes were conducted in the UK (1977, 1978) and Brazil (1989, 1991). There is no registered use in the UK, but the UK trials could be evaluated against GAP from Poland (glasshouse use): 0.2 kg ai/ha, 0.01 kg ai/hL, PHI 7 days. Assuming the UK trials were performed in a glasshouse, all were according to GAP, yielding residues of 0.075, 0.74, 0.92 mg/kg.

Diflubenzuron is registered in Brazil for use on tomatoes, but because no printed label or registration certificate is available, the trials may not be evaluated against this GAP. The trials can however be evaluated against the critical GAP for Ecuador (WP 250 formulation, at 0.12 kg ai/ha with a PHI of 14 days) or the GAP for Uruguay (WP 250 or SC 480 formulation, at 0.12 kg ai/ha with a PHI of 15 days). Of the trials conducted in Brazil, residues complying with Ecuadorian critical GAP are: 0.066 mg/kg for the single application on tomatoes (Brazil 1989).

Because results below 0.2 mg/kg are considered not valid (matrix interferences), these results are expressed as <0.2 mg/kg. Adjusted results are: <0.2 (2), 0.74, 0.92 mg/kg for applications on tomatoes.

Because four trials are insufficient for the estimation of a maximum residue level on tomatoes, the Meeting agreed to withdraw the previous recommendation (1 mg/kg).

Residue trials on mushrooms were conducted in the Netherlands (1975, 1976, 1977), Australia (1992) and in the USA (1996, 1997).

Diflubenzuron is registered in The Netherlands for use on mushrooms as a single compost or casing treatment at 10 kg ai/ha or 0.06-0.10 kg ai/hL. Of the trials conducted in The Netherlands, residues complying with Dutch critical GAP are: 0.042 - 0.062 mg/kg (Netherlands 1977). Because residue results below 0.5 mg/kg DFB are considered not valid (matrix interferences, recoveries), these results are expressed as <0.5 mg/kg resulting in <0.5 (2) mg/kg diflubenzuron for casing application.

Diflubenzuron is registered in Australia for use on mushrooms as a casing treatment at 5 g ai/bale or a single compost treatment at 10 g ai/tonne or a casing drench treatment at 10 kg ai/ha with WP250 formulations. The critical GAP is the casing treatment. Of the trials conducted in Australia, 1 of the trials was conducted at the critical Australian GAP: 1x 7.5 kg ai/ha at casing. The residue was: 0.021 mg/kg (Australia 1992).

Diflubenzuron is registered in the USA for use on mushrooms as a compost treatment at 29-49 kg ai/ha and/or as a casing treatment at 10 kg ai/ha at 0.063 kg ai/hL with SC 480 or WP250 formulations. The critical GAP is either the compost treatment or the casing treatment or a combination of both. Residues complying with the USA critical GAP are: <0.01 (5), 0.01, 0.02 (2) mg/kg for the single compost application and 0.05, 0.06, 0.07, 0.09, 0.11, 0.14, 0.21 mg/kg for the single casing application and 0.04 (2), 0.05, 0.08, 0.10 (2) mg/kg for the combined compost plus casing application (USA 1996, 1997). From the four flushes per trial the highest residue was selected. The Meeting observed that the single casing treatment and the combined compost plus casing treatment resulted in higher diflubenzuron residues than the single compost treatment. Results from the single compost treatment are therefore not used for MRL estimation. The Meeting decided to combine the other data. The selected residues from 13 trials according to USA critical GAP are: 0.04, 0.04, 0.05, 0.05, 0.06, 0.07, 0.08, 0.09, 0.10, 0.10, 0.11, 0.14, 0.21 mg/kg.

The Meeting decided to combine all casing and combined compost plus casing trials from The Netherlands, Australia and the USA (STMR underlined). Because the LOQ of the method in the Dutch trials (>0.5 mg/kg) is too high, the values from the Dutch trials (<0.5 (2)) were not used. Residues resulting from single casing or a combined compost plus casing treatment resulted in: 0.021, 0.04 (2), 0.05 (2), 0.06, 0.07, 0.08, 0.09, 0.10 (2), 0.11, 0.14, 0.21 mg/kg.

The Meeting decided to withdraw the current recommendation for mushrooms of 0.1 mg/kg and estimated a maximum residue level of 0.3 mg/kg and an STMR of 0.075 mg/kg.

Pulses

Two residue trials on peas were conducted in the UK (1978). There is no registered use in the UK on peas. There is GAP on vegetables in Ireland but the trials did not match. The Meeting decided not to recommend an MRL for peas.

Four residue trials on soybeans were conducted in the USA (1996). Diflubenzuron is registered in the USA for use on soybeans with OF 240 or SC 240 formulations with 1-2 applications with an interval of 30 days at 0.035-0.070 kg ai/ha with a PHI of 21 days with low volume spray at 0.011-0.083 kg ai/hL or low volume spray by aeroplane at 0.075-0.25 kg ai/hL. Of the trials conducted in USA (1996), 2 trials were conducted at the critical USA GAP. Diflubenzuron residues were <0.05 (2) mg/kg in dry soybeans.

Because two trials are insufficient for the estimation of a maximum residue level on soybeans, the Meeting agreed to withdraw the previous recommendation of 0.1 mg/kg.

Cereal grains. Diflubenzuron is registered in the USA for use on rice with an SC 240 formulation by 1-2 low volume spray applications by aeroplane with an interval of 5-7 days with 0.14-0.28 kg ai/ha with 0.30-0.60 kg ai/hL and a PHI of 80 days. Residue trials on rice were conducted in the USA (1995, 1996, 1998). Storage stability of diflubenzuron and CPU in rice samples was not validated beyond a 1 month time period, because of analytical problems. In this 1 month, diflubenzuron and CPU were stable. In 6 of the 21 trials, the time that samples were stored before diflubenzuron analysis (162-388 days) exceeded the validated storage stability time by a large margin, and therefore these trials are not used for MRL estimation. In the remaining 15 trials storage time was more appropriate (9-76 days before diflubenzuron analysis) and these trials were evaluated. Eight trials were according to USA GAP, except that the applications were not done by aeroplane. Residues in rice grain were <0.01 (8) mg/kg. Another four trials were according to GAP, yielding residues in rice grain of <0.01 (4) mg/kg.

The Meeting estimated a maximum residue level of 0.01* mg/kg in rice grain, and an STMR of 0.01 mg/kg.

Tree nuts. Residue trials on walnuts, almonds and pecans were conducted in France (1999) and the USA (1988, 1998, 1999). There is no registered GAP in the USA on tree nuts and the trials could not be evaluated against another GAP.

Diflubenzuron is registered in France for use on tree nuts with SC 150 formulations with 0.01 kg ai/hL with a PHI of 28 days. Residues at GAP were <0.05 (2) mg/kg in walnut meat (France 1999).

Two trials are insufficient for the estimation of a maximum residue level for nutmeat of walnuts, almonds or pecans.

Oilseeds. Residue trials on cotton were conducted in the USA (1993, 1995). The critical USA GAP is 6 times 0.14 kg ai/ha (interval 5-14 days) with a PHI of 14 days with either (ultra) low volume spray or low volume spray by aeroplane. None of the trials were at critical GAP. Therefore the Meeting agreed to withdraw the previous maximum residue level recommendation for cotton (0.2 mg/kg).

Legume animal feed. Four residue trials on soybeans were conducted in the USA (1996). Diflubenzuron is registered in the USA for use on soybeans with OF 240 or SC 240 formulations with 1-2 applications with an interval of 30 days at 0.035-0.070 kg ai/ha with a PHI of 21 days with low volume spray at 0.011-0.083 kg ai/hL or low volume spray by aeroplane at 0.075-0.25 kg

ai/hL. Residues at the critical USA GAP were 0.06-0.10 mg/kg in soybean forage (after 1 treatment) and 0.42-0.70 mg/kg in soybean hay (after 1 treatment). Because residue results below 1.0 mg/kg in soybean forage and below 3 mg/kg DFB in soybean hay are considered not valid (matrix interferences), these results are expressed as <1.0 mg/kg, or <3.0 mg/kg resulting in <1 (2) mg/kg for soybean forage and <3 (2) mg/kg in soybean hay.

Two trials are insufficient for the estimation of a maximum residue level on soybean forage and hay.

Straw, fodder and forage of cereal grains and grasses. Residue trials on rice were conducted in the USA (1995, 1996, 1998). Diflubenzuron is registered in the USA for use on rice with an SC 240 formulation by 1-2 low volume spray applications by aeroplane with an interval of 5-7 days with 0.14-0.28 kg ai/ha with 0.30-0.60 kg ai/hL and a PHI of 80 days. Nine trials were according to USA GAP, except that the applications were not done by aeroplane. Residues in rice straw were <0.01, 0.01, 0.02, 0.06 (2), 0.14, 0.25, 0.40, 0.48 mg/kg. Another six trials were according to GAP, yielding residues in rice straw of <0.01 (4), 0.02, 0.15 mg/kg. The Meeting decided to combine the datasets resulting in <0.01 (5), 0.01, 0.02 (2), 0.06 (2), 0.14, 0.15, 0.25, 0.40, 0.48 mg/kg.

The Meeting decided to recommend a maximum residue level of 0.7 mg/kg in rice straw, and an STMR of 0.02 mg/kg.

Residue trials on cotton were conducted in the USA (1993, 1995). None of the trials were at critical GAP.

Residue trials on range grass were conducted in the USA (1991, 1992). Diflubenzuron is registered in the USA for use on pasture/rangeland with a critical GAP of 0.018 kg ai/ha with an unknown PHI with either low volume spray or low volume spray by aeroplane. Two trials with ultra low volume spray applications by aeroplane were not used, because samples from 0.035 kg ai/ha and 0.018 kg ai/ha applications are probably mislabelled. Diflubenzuron residues complying with USA GAP from low volume spray applications were: 0.65, 1.5, 1.8, 2.0 (2), 2.3, 2.7, 3.4 mg/kg for fresh grass. Diflubenzuron residues from ultra low volume spray applications by aeroplane were: 0.37, 0.60, 0.70, 0.84, 0.88, 0.92, 2.2, 2.6 mg/kg in fresh grass and 0.28, 0.61, 0.86, 1.1, 1.2, 2.1, 2.2, 2.7 for dry grass. Results from fresh grass below 0.7 mg/kg are considered not valid (matrix interferences) and these results are expressed as <0.7 mg/kg.

The Meeting observed that residues from ultra low volume spray by aeroplane were comparable to those from low volume spray treatment, and The Meeting decided to combine both treatments. Corrected residues on fresh grass complying to USA GAP were (STMR underlined): <0.7 (3), 0.70, 0.84, 0.88, 0.92, 1.5, 1.8, 2.0 (2), 2.2, 2.3, 2.6, 2.7, 3.4 mg/kg. Diflubenzuron residues on dry grass complying to USA GAP were: 0.28, 0.61, 0.86, 1.1, 1.2, 2.1, 2.2, 2.7 mg/kg. Diflubenzuron residues in dry and fresh grass are valid in the range 1.0-4.0 mg/kg.

The Meeting estimated a highest residue level of 5 mg/kg (fresh weight) and an STMR of 1.65 mg/kg in fresh grass.

Fate of residues in storage and during processing

Fate of residues in storage

The Meeting received information on the fate of residues during storage of wheat grain. The wheat grain was spray treated post-harvest with a single 2 or 4 g ai/tonne. Diflubenzuron levels remained stable for 9 months at 1.4-1.8 mg/kg for 2 g ai/tonne and 3.2-4.4 mg/kg DFB for 4 g ai/tonne.

Fate of residues during processing

The Meeting received information on the fate of incurred residues of diflubenzuron during the processing of oranges, apples, pears, plums, mushrooms, rice, wheat and soybean.

Oranges containing 0.66 mg/kg diflubenzuron eq radiolabelled residues were subjected to small scale processing into orange oil. In the oranges 95% TRR was parent while 5% TRR was unextracted radiolabel. In the orange oil only parent was found. Total diflubenzuron residues were concentrated in the citrus oil, the calculated processing factor for the parent compound is 68. When corrected for weight fractions, the % transference is 9.8%.

Apples, grown in the USA in 1983 and treated with diflubenzuron, were subjected to industrial processing into canned apple sauce, wet and dry pomace, pasteurised apple juice and apple butter. Diflubenzuron was concentrated in wet and dry apple pomace, the calculated processing factors were 3.6, 4.6, 4.7(2), 5.2, 5.6, 5.9, 6.1 (average 5.0) for wet apple pomace and 9.3, 12 (2), 13, 14 (2), 16, 17, (average 13) for dry apple pomace. Diflubenzuron was diluted in canned apple sauce and pasteurized apple juice: residues were below the LOQ (0.05 mg/kg) and therefore their processing factors were in each trial calculated to be identical: <0.058, <0.062, <0.078, <0.098, <0.14, <0.15, <0.16, <0.28 (average <0.12). The LOQ for apple butter was too high (0.5 mg/kg) to draw conclusions on dilution or concentration of residues.

In another trial, apples, grown in Germany (1993) and treated with diflubenzuron, were subjected to household processing into raw apple juice and wet apple pomace. Diflubenzuron was concentrated in wet apple pomace, the calculated processing factors were 2.1, 1.3, 2.4, 1.1 (average 1.7). Diflubenzuron was diluted in raw apple juice, the calculated processing factors were 0.14, 0.086, 0.15, 0.061 (average 0.11). The % transference was 3.0%-7.5% for apple juice and 55%-120% for wet apple pomace. In this study there were residue losses, because the sum of % transference in apple juice and apple pomace is in some cases lower than 80%.

The Meeting decided not to combine the processing factors from the USA and German trials and to use the average processing factor of 5.0 for wet apple pomace in the calculation of the dietary burden for livestock. From this processing factor and the STMR for apples (0.6 mg/kg) the Meeting estimated an STMR_p for wet apple pomace of 3 mg/kg. From the average processing factor of <0.12 for pasteurized apple juice and the STMR for apples (0.6 mg/kg) the Meeting estimated an STMR_p of 0.072 for apple juice.

Pears, grown in the USA (1983), were subjected to industrial processing into canned pears. Diflubenzuron was diluted in canned pears: residues were below the LOQ (0.05 mg/kg) and accurate processing factors could not be calculated.

Plums, grown in the USA (1998), were dried for 18 hours. Diflubenzuron was not concentrated during processing to prunes: the processing factor for diflubenzuron for the preparation of prunes is 1. When corrected for weight fractions, the % transference is 32%; it is unclear where the remaining residues went. Because of low recoveries, results are considered not valid.

Mushrooms treated with ^{14}C -DFB in compost or casing were harvested in 3 flushes. The combined flushes were canned. During canning more than 70% of the radioactivity present in the mushrooms moved into the canning liquid. The main part of the residue in the canning liquid consisted of DFBA (>100%); the residue in canned mushrooms consisted of parent (1.8%-14%), DFBA (46%-72%) and unextracted radiolabel (20%-39%). Processing factors for canned mushrooms were 0.43 and 2.5 for diflubenzuron for casing and compost treatment, respectively.

Mature pods from soybean plants were harvested 62 days after treatment with ^{14}C -DFB. Mature pods were separated in seeds and hulls and oil was extracted on laboratory scale. On the treated pods, >99% of the recovered radioactivity was found in the hulls and less than 0.2% was found in the seeds. In the soybean oil ^{14}C residues were near the LOQ (0.01 mg/kg oil) and there was no significant difference between oil from treated or from untreated pods: 0.014 and <0.01-0.012 mg/kg, respectively. From this study, The Meeting concluded that diflubenzuron does not accumulate in soybean oil.

In four trials (1995, 1996, USA), rice was harvested 82-115 days after a single spray or a single spray by aeroplane with diflubenzuron at 2.2 kg ai/ha (8x exaggerated dose for USA). Rice grain was processed into polished rice, hulls and bran. Diflubenzuron, CPU and PCA were analyzed. In one trial only, residue was detected in the rice grain itself. From this trial, the calculated processing factors for diflubenzuron were: hulls 0.39, bran 0.14, polished rice <0.018. When corrected for weight fractions, the % transference is hulls 0.08%, bran 0.03% and polished rice <0.01%. Storage stability of diflubenzuron and CPU was not validated beyond a 1 month time period, because of analytical problems. In the rice processing trial described above, diflubenzuron was measured after 351-388 days, and CPU after 499-542 days. Since the storage time of the samples exceeded the validated storage stability time by a large margin, the results of this processing trial are considered unreliable.

Wheat grain, treated post-harvest with 2 g ai/tonne, was stored for 4 months at ambient temperatures. Wheat grain was processed into sieved wheat and bran. The sieved wheat was further processed into Buehler flour, first reduction flour, wholemeal flour, white bread and whole meal bread. Diflubenzuron was concentrated in bran: processing factors 1.9, 2.3(2). Diflubenzuron was diluted in flour and bread: processing factors 0.32, 0.34, 0.35 in first reduction flour, 0.15, 0.17, 0.18 in Buehler flour, 0.20, 0.22, 0.23 in white bread, 0.62, 0.72, 0.74 in whole meal flour and 0.40, 0.47, 0.49 in whole meal bread. Transferences could not be calculated.

Farm animal dietary burden

The Meeting estimated the dietary burden of diflubenzuron residues in farm animals from the diets listed in Appendix IX of the FAO Manual (FAO, 2002). Calculation from the HR values provides the concentrations in feed suitable for estimating MRLs for animal commodities, while calculation from the STMR values for feed is suitable for estimating STMR values for animal commodities. In the case of processed commodities, the STMR-P value is used for both intake calculations.

Maximum farm animal dietary burden estimation

Commodity	Residue, mg/kg	Basis	% D M	Residue mg/kg dw	Group	Feed allocation to total diets (%)				Residue contribution of feeds (mg/kg)			
						Beef cattle	Dairy cows	Poultry	Swine	Beef cattle	Dairy cows	Poultry	Swine
Apple, wet pomace	3	STMR _p	40	7.5	AB	40	20			3	1.5		

Commodity	Residue, mg/kg	Basis	% D M	Residue	Group	Feed allocation to total diets (%)				Residue contribution of feeds (mg/kg)			
Grass, forage	5	MRL	25	20	AF	60	60			12.00	12.00		
Rice, grain	0.01	MRL	88	0.01	GC		10	60	65		0.001	0.01	0.01
Rice, straw	0.7		90	0.78	AS		10				0.078		
TOTAL						100%	100%	60%	65%	15.0	13.58	0.01	0.01

Mean farm animal dietary burden estimation

Commodity	Residue, mg/kg	Basis	% D M	Residue mg/kg dw	Group	Feed allocation to total diets (%)				Residue contribution of feeds (mg/kg)			
						Beef cattle	Dairy cows	Poultry	Swine	Beef cattle	Dairy cows	Poultry	Swine
	For dietary intake												
Apple, wet pomace	3	STM Rp	40	7.5	AB	40	20			3.0	1.5		
Grass, forage	1.65	STM R	25	6.6	AF	60	60			3.96	3.96		
Rice, grain	0.01	STM R	88	0.01	GC		10	60	65		0.001	0.01	0.01
Rice, straw	0.02	STM R	90	0.02	AS		10				0.002		
TOTAL						100%	100%	60%	65%	6.96	5.46	0.01	0.01

Direct treatment of farm animals

Four studies on direct animal treatments are available for sheep. In all studies, only parent compound was analyzed.

In the first trial male Merino sheep were treated within 24 hours after shearing with a dose corresponding to 1.5-2x the standard dose for pour-on application in Australia. The liver, kidney and muscle tissues had levels below the LOQ (<0.02 mg/kg) at all post-treatment days, except 1 liver sample at day 1 after treatment (0.02 mg/kg). Residues were found at random in fat day 1 to day 21 post-treatment (<0.02-0.05 mg/kg), with the greatest persistence being in the peri-renal and lumbar fat. Diflubenzuron residues were at levels below the LOQ (<0.02 mg/kg) after 21 days for the peri-renal fat and after 42 days (= withdrawal period on the label) for the pre-femoral fat and lumbar fat. After 14 days, one animal gave anomalous high residues in fat (0.23-0.50 mg/kg) when compared to the rest of the animals in that group (0.03 mg/kg maximum). Low residues were also found in the liver (0.03 mg/kg) and muscle (0.02 mg/kg) of this animal.

In a trial that matched Australian label instructions for pour-on application, 5 month old Merino lambs were treated. Only fat was analyzed. Residues were found randomly in fat samples from 1-42 days post-treatment (<0.02-0.13 mg/kg). After 42 days (= withdrawal period on the label) residues were found in one pre-femoral fat sample (0.04 mg/kg) and one lumbar fat sample (0.04 mg/kg) from different animals.

In a trial that matched Australian label instructions for plunge dip, ewes plunged and swum for 3 min in solution until total saturation of the fleece was obtained. Animals were slaughtered at 15 hours and 7 days post dipping (there is no waiting period on the label). No residues were found in liver and kidney (<0.03 mg/kg). Other tissues were not analysed.

In the UK, sheep were treated with diflubenzuron by pour-on application. There is no label in the UK, therefore the trial was evaluated against the Australian label. The instructions on the label were not entirely matched as sheep were shorn 7 days before treatment and the Australian label states that the product should be used on sheep with 6 weeks – 6 months wool growth. Fat contained the highest concentration of residues (max. 0.28 mg/kg) 3 days after treatment, followed by muscle (max. 0.17 mg/kg). Residues in fat and muscle declined below the LOQ (0.05 mg/kg) 10 days after treatment. Residues in liver and kidney were below the LOQ (0.05 mg/kg) at all time points.

Based on all trials above, and taking into consideration the waiting periods on the labels, the Meeting estimated a maximum residue level of 0.05 mg/kg for diflubenzuron residues in sheep meat (fat) and 0.05 mg/kg sheep offal.

The STMR concept is designed for use in supervised field trials on crops to obtain the typical residue value when a pesticide is used according to maximum GAP. The method is not directly applicable to a trial of single direct treatment of animals. However, the Meeting agreed that a typical residue value for a pesticide used directly on animals (at maximum label conditions) would be useful in estimating long-term dietary intake. The Meeting estimated a typical concentration of diflubenzuron residues (from direct use at maximum label conditions) of 0.05 mg/kg in sheep meat and sheep offal.

Farm animal feeding studies

Animal feeding studies are available for beef cattle, dairy cows, sheep and chickens. In all animal feeding studies, only parent compound was analyzed.

One dairy cow was fed 1 mg/kg bw diflubenzuron per day for 119 days. Assuming a bodyweight of 550 kg and a dry feed intake of 20 kg/day, the daily intake is estimated at 28 mg/kg diflubenzuron in feed. In omental fat a residue of 0.10 mg/kg was measured. In all other samples (renal fat, diaphragmatic fat, subcutaneous fat, muscle, kidney, liver) the residue level was below the reported LOQ (0.1 mg/kg). Another dairy cow was fed with increasing levels from 1-8 mg/kg bw diflubenzuron per day for 2 week periods and after 56 days the rate was increased to 16 mg/kg bw diflubenzuron per day for 94 days. Assuming a bodyweight of 550 kg and a dry feed intake of 20 kg/day, the daily intake is estimated at 28-220 mg/kg diflubenzuron in feed for the first 55 days and 440 mg/kg diflubenzuron in feed for the remaining days. In milk no residue was found during the 1-8 mg/kg bw feeding period, but 0.02 mg/kg DFB was found during the 16 mg/kg bw feeding period (LOQ 0.02 mg/kg). In fat a residue of 0.25 mg/kg was found, and in liver a residue of 0.13 mg/kg. In all other samples (muscle, kidney) the residue was below the LOQ (0.1 mg/kg).

One Holstein bull calf was fed 2.8 mg/kg bw diflubenzuron per day from 3 days of age until slaughter at 146 days of age. Three Holstein bull calves were fed 2.8 mg/kg bw diflubenzuron per day from 3-208 days of age and thereafter with 1.0 mg/kg bw diflubenzuron per day until slaughter (at 349, 569, 571 days). Because of increasing weights and unknown feed intakes, the daily feed intake cannot be calculated but is certainly not constant. The first bull calf had 0.08 mg/kg diflubenzuron in the renal fat, 0.04 mg/kg in the omental and subcutaneous fat, 0.02 mg/kg in the liver and kidney and <0.02 mg/kg in muscle. In the tissues from the other three calves analysed, diflubenzuron was not found (reported LOQ 0.02 mg/kg).

Three bulls and three cows were fed 0.2 mg/kg bw diflubenzuron per day for 28 days

(feed-through application). Taking the mean body weight of 319 kg and assuming a feed intake of 15 kg for beef cattle, the daily intake is 4.3 mg/kg diflubenzuron in feed. In one liver a residue of 0.06 mg/kg was measured. In all other samples (muscle, liver, fat and kidney) the residue level was below the LOQ (0.05 mg/kg). In the milk of six lactating cows fed at the same dose rate (feed-through application) no residues were found 3, 7, 14, 21 and 28 days after treatment (LOQ = 0.01 mg/kg).

In sheep fed with 100 mg/kg diflubenzuron in feed for 1-9 months, a maximum residue level of 1.7 mg/kg in fat, 0.58 mg/kg in liver, 0.33 mg/kg in kidney and 0.26 mg/kg in muscle was observed during the treatment period. After treatment had stopped, the residue level decreased to levels below 0.05 mg/kg (reported LOQ) in one week for muscle and in four weeks for liver and kidney. However, in fat a residue of 0.20 mg/kg was still present four weeks after treatment. In the treatment period, a maximum residue level of 0.44 mg/kg was found in milk.

Chickens (8 white, 8 brown) were fed diflubenzuron at a level of 10 mg/kg feed for 15 weeks. At all dosage levels, white eggs contained more residue than brown eggs: the mean residue was 0.38 mg/kg for brown eggs and 0.53 mg/kg for white eggs. The same was observed in the tissues: the mean residue level in white chicken liver was 0.45 mg/kg while it was 0.12 mg/kg in brown chicken liver and the mean residue level in white chicken fat was 1.8 mg/kg while it was 1.2 mg/kg DFB in brown chicken fat. In muscle, residue levels were below the reported LOQ (0.1 mg/kg).

Chickens were fed 2.5 or 250 mg/kg diflubenzuron in the feed for 98 days. The higher dosage resulted in tissue residue levels that were 7 times higher than that of the lower dosage. At the low dosage, the highest residue in fat was 6.3 mg/kg, in breast muscle + skin 0.31 mg/kg, leg muscle 0.41 mg/kg and liver 0.70 mg/kg. At the high dosage, the highest residue in fat was 56 mg/kg DFB, breast muscle + skin 2.9 mg/kg, leg muscle 2.8 mg/kg and liver 3.5 mg/kg.

Chickens were fed diflubenzuron at a level of 10 mg/kg feed for 28 days (feed-through application). White eggs contained more residue than brown eggs: the residue was 0.48-0.65 mg/kg for white eggs and 0.29-0.35 mg/kg for brown eggs. The same was observed in the tissues: the residue level in white chickens was 2.3-0.47-0.17-0.14 mg/kg, while it was 1.4-0.13-0.060-0.065 mg/kg in brown chickens for fat, liver, kidney and muscle, respectively.

Animal commodity maximum residue levels

As the maximum dietary burdens of beef and dairy cattle were 15.0 and 13.6 mg/kg, respectively, the concentrations of residues in tissues and milk were taken from the first dairy cow feeding study. This is an old feeding study which was not conducted according to current standards but which can be used because of the low animal dietary burden. When fed with increasing levels of about 28-220 mg/kg diflubenzuron in feed for two week periods, no residue was found in milk (<0.02 mg/kg). After feeding a cow 28 mg/kg diflubenzuron in feed for 119 days, no residues were found in muscle, kidney and liver (<0.1 mg/kg). In fat a residue of 0.1 mg/kg was measured.

Since the estimated dietary burden is lower than the feeding level in the study where no residue was found in milk, muscle, liver and kidney, and a residue at the LOQ was found in fat, the Meeting estimated a maximum residue level of 0.02* mg/kg in milk and a maximum residue level of 0.1* mg/kg in edible offal. For meat (fat) a maximum residue level of 0.1 mg/kg was estimated.

From the direct animal treatment studies the Meeting estimated a maximum residue level of 0.05 mg/kg for diflubenzuron residues in sheep meat (fat) and 0.05 mg/kg sheep offal. The

highest value from either direct treatment or animal feeding is observed for estimation of maximum residue levels.

In conclusion, the Meeting replaced the previous maximum residue level recommendations for milks (0.05* mg/kg), meat (from mammals other than marine mammals; 0.05* mg/kg) and edible offal (mammalian; 0.05* mg/kg) by recommendations for milks of 0.02* (F) mg/kg, meat (fat) of 0.1 mg/kg and edible offal of 0.1* mg/kg. The Meeting estimated STMRs for milks of 0.02 mg/kg, and for meat and edible offal of 0.1 mg/kg.

As the maximum dietary burden for poultry is only 0.01 mg/kg feed, residues in meat and eggs are not to be expected. Since the residue is now defined as fat-soluble, the Meeting replaced the previous maximum residue level recommendation for poultry meat (0.05* mg/kg) by a recommendation for poultry meat of 0.05* (fat) mg/kg. The Meeting agreed to maintain the current recommendation of 0.05* mg/kg for eggs. The Meeting estimated STMRs for poultry meat and eggs of 0.05 mg/kg.

FURTHER WORK OR INFORMATION

Desirable

1. A ruminant feeding study according to modern standards.
2. A storage stability study in rice samples, going on for as long as 400 days for diflubenzuron analysis and 500 days for CPU analysis.

DIETARY RISK ASSESSMENT

Chronic intake

The International Estimated Daily Intakes of diflubenzuron, based on the STMRs estimated for 9 commodities, for the five GEMS/Food regional diets were 1-6% of the ADI (Annex 3). The Meeting concluded that the long-term intake of residues of diflubenzuron resulting from its uses that have been considered by JMPR is unlikely to present a public health concern.

Short-term intake

The WHO panel of JMPR 2001 decided that an acute RfD is unnecessary and therefore the Meeting concluded that the short-term intake of diflubenzuron residues is unlikely to present a public health concern.

4.10 ESFENVALERATE (204)

TOXICOLOGY

Esfenvalerate [(S)- α -cyano-3-phenoxybenzyl (S)-2-(4-chlorophenyl)-3-methylbutyrate], a synthetic pyrethroid insecticide, is one of the four isomers ([2S, α S], [2S, α R], [2R, α S] and [2R, α R]) found in fenvalerate in approximately equal proportions. Esfenvalerate ([2S, α S]) is the biologically active component of fenvalerate. As for all the synthetic pyrethroids, the insecticidal action of esfenvalerate is due to its interaction with sodium ion channels in the axons of the target species. Fenvalerate was evaluated toxicologically by the Joint Meeting in 1979, 1981, 1982, 1984 and 1986. An ADI of 0–0.02 mg/kg bw was established in 1986.

Studies of metabolism have been conducted in rats, mice and dogs with ^{14}C -labelled esfenvalerate and fenvalerate. Excretion of both compounds was very rapid in rats and mice, 78–95% of the administered label being excreted within 1 day after oral administration. The concentrations of residues in tissues were generally very low; more persistent fenvalerate residues were found in mice than in other species. The metabolism of esfenvalerate in rodents was similar to that of fenvalerate. In dogs given labelled fenvalerate orally, less total radioactivity was recovered than in mice or rats, but the half-life was similar to that in rodents. The pattern of hydroxylation was different in rats and dogs, and the glycine conjugate, 3-phenoxybenzylglycine, was the major conjugate of the alcohol moiety in dogs, whereas it was a minor one in rats. Dogs also had a higher proportion of glucuronides of the acid moiety and its hydroxy derivatives. There was no evidence of accumulation of esfenvalerate or fenvalerate in fetal tissue or amniotic fluid of rats. No major sex differences were found in the metabolism of esfenvalerate or fenvalerate.

Esfenvalerate is a type II pyrethroid, a class that induces a typical syndrome characterized by choreoathetosis (coarse tremors progressing to sinuous writhing), sedation, salivation, dyspnoea and/or clonic seizures; sometimes, body tremors and prostration are seen. Such toxic signs have been observed in various species tested with esfenvalerate and are characteristic of a strong excitatory action on the nervous system, resulting from a specific interaction between esfenvalerate and the sodium channels of the nerve membranes. Series of nerve impulses are induced as a result of a change in the permeability of the membranes to sodium (repetitive effect). While the nerve endings of sensory organs are particularly sensitive to this effect, other parts of the nervous system are also affected.

The oral LD_{50} value of esfenvalerate in corn oil in rats was about 90 mg/kg bw, whereas the value in mice when administered in methyl cellulose was 320 mg/kg bw, but no investigation has been conducted to determine whether this is a true species difference or was due to differences in the vehicles used. Other pyrethroids, including fenvalerate, were less toxic when administered in an aqueous vehicle, than in an oily or lipophilic vehicle. The dermal LD_{50} was > 5000 mg/kg bw in rats and > 2000 mg/kg bw in rabbits. After inhalation, the 4-h LC_{50} value for rats was 480 mg/m³ in males and 570 mg/m³ in females.

Esfenvalerate was not irritating to the skin and was minimally irritating to the unwashed eyes of rabbits. It was judged to be a skin sensitizer in guinea-pigs in the Magnusson and Kligman maximization test but not in the Buehler test. WHO has classified esfenvalerate as 'moderately hazardous'.

Studies with repeated oral administration to mice, rats and dogs and dermal application to rats showed that the main effects of esfenvalerate are on clinical signs. These include hypersensitivity, agitation, impaired locomotor activity and reduction in body-weight gain. In the short-term studies with esfenvalerate in the diet, the NOAEL was 10 mg/kg bw per day in mice treated for 13 weeks, 6.2 mg/kg bw per day in rats treated for 13 weeks and 5 mg/kg bw per day in dogs treated for 12 months. In a 21-day study in rats treated cutaneously with esfenvalerate, the NOAEL was 25 mg/kg bw per day.

In the only long-term study with esfenvalerate, no evidence of carcinogenicity was found in mice; however, the single treated group that was suitable for evaluation received a concentration of 35 ppm in the diet, equal to 4.3 mg/kg bw per day, which was well below the maximum tolerated dose. The next highest concentration, 150 ppm, resulted in excessive self-mutilation and reduced survival, so that the results could not be used.

The Meeting was aware of five long-term studies of toxicity with fenvalerate, two in mice and three in rats. There was no evidence of carcinogenicity in mice. In the experiments in rats, increased incidences of certain neoplasms were observed in some groups: mammary tumours in one experiment without a dose–response relationship, and no increase in the incidence of this tumour type in another experiment with the same strain of rat and a higher dose; spindle-cell sarcomas (probably various types and at a low incidence even when combined) in males but not in females; and Leydig-cell adenomas in a strain of rats in which they are particularly common and occur at variable incidence. Increased incidences of these benign Leydig-cell tumours, which are rare in man, were not observed in the other experiments in rats or in mice and were consequently considered to be of little relevance, if any, to an evaluation of effects on human health. The unusual, but low, combined incidence of various sarcomas of the subcutis in males in one of the experiments in rats could not be entirely dismissed. These tumours were not, however, observed in females in the same experiment or in a different strain of rat in another experiment in which a 50% higher dose was used. In spite of these three examples of elevated tumour incidences with fenvalerate, the weight of evidence led the Meeting to the conclusion that esfenvalerate is not carcinogenic in rodents.

The NOAEL for the toxicity of fenvalerate in long-term studies in rats was 150 ppm, equivalent to 7.5 mg/kg bw per day, on the basis of a reduction of body-weight gain in males, giant-cell infiltration of lymph nodes and adrenals and reticuloendothelial-cell proliferation in the lymph nodes at 500 ppm, equivalent to 25 mg/kg bw per day. The NOAEL for the toxicity of esfenvalerate in long-term studies in mice was 35 ppm, equal to 4.3 mg/kg bw per day, on the basis of dermal damage and extramedullary haematopoiesis in the spleen at 150 ppm, equal to 18 mg/kg bw per day, in the same study.

Esfenvalerate was tested for genotoxicity in an adequate range of assays, both in vitro and in vivo. It showed no evidence of genotoxicity.

The Meeting concluded that esfenvalerate, which has been tested in mice and rats as a component of fenvalerate, is unlikely to pose a carcinogenic risk to humans.

In a three-generation study of reproductive toxicity in rats, the NOAEL for systemic toxicity was 75 ppm, equal to 4.2 mg/kg bw per day, on the basis of a reduction in body-weight gain in males and females at 100 ppm, equal to 5.6 mg/kg bw per day, during the pre-mating period. Treatment-related dermal lesions were found in adults fed powdered diets containing 75 or 100 ppm of esfenvalerate. No NOAEL was identified for the adults in this study, but the NOAEL for toxicity in offspring was 75 ppm, equal to 4.2 mg/kg bw per day, on the basis of reductions in litter size and pup body weight at 100 ppm. The NOAEL for reproductive toxicity was 100 ppm, equal to 5.6 mg/kg bw per day, the highest dose tested. A second study was conducted to identify the NOAEL for adults when cutaneous exposure was avoided by administering esfenvalerate in pelleted diets. There were no dermal lesions. The NOAEL for adults was 40 ppm, equal to 2.4 mg/kg bw per day, on the basis of reduced body weight and food consumption at 100 ppm in both the parental rats and their offspring.

In a study of developmental toxicity in rats, the NOAEL for maternal toxicity was 3 mg/kg bw per day on the basis of significant maternal toxicity (abnormal gait, hind-limb spasms, diarrhoea and tremors) at 4 mg/kg bw per day, and the NOAEL for developmental toxicity was 20 mg/kg bw per day, the highest dose tested.

In a study of developmental toxicity in rabbits, the NOAEL for maternal toxicity was 2 mg/kg bw per day on the basis of significant maternal toxicity (erratic jerking and extension of

the limbs, followed by excessive grooming and rapid side-to-side head movements) at 3 mg/kg bw per day. The NOAEL for developmental toxicity was 20 mg/kg bw per day, the highest dose tested.

The results of acute and 90-day studies of neurotoxicity in rats showed that esfenvalerate does not induce neuropathological changes. The NOAEL for neurotoxicity in a study in rats given a single dose was 1.75 mg/kg bw, as tremors were induced at 1.90 mg/kg bw. The NOAEL for systemic toxicity and neurotoxicity in a 90-day study in rats was 40 ppm, equal to 3 mg/kg bw per day, on the basis of decreased motor activity and reduced body-weight gain at 120 ppm, equal to 8.9 mg/kg bw per day.

The Meeting concluded that the existing database was adequate to characterize the potential hazard of esfenvalerate to fetuses, infants and children.

An ADI of 0–0.02 mg/kg bw was established for esfenvalerate on the basis of the NOAEL of 2 mg/kg bw per day for maternal toxicity in the study of developmental toxicity in rabbits, which was supported by the NOAEL of 2.4 mg/kg bw per day in the multigeneration study of reproductive toxicity in rats and a safety factor of 100.

The Meeting established an acute RfD of 0.02 mg/kg bw on the basis of the NOAEL of 1.75 mg/kg bw in the study of acute neurotoxicity in rats and a safety factor of 100.

A toxicological monograph was prepared.

TOXICOLOGICAL EVALUATION

Levels relevant to risk assessment

Species	Study	Effect	NOAEL	LOAEL
Mouse	18-month study of toxicity and carcinogenicity ^a	Toxicity	35 ppm, equal to 4.3 mg/kg bw per day	150 ppm, equal to 18 mg/kg bw per day
		Carcinogenicity	35 ppm, equal to 4.3 mg/kg bw per day ^c	–
Rat	104–119-week study of toxicity and carcinogenicity with fenvalerate ^a	Toxicity	150 ppm, equivalent to 7.5 mg/kg bw per day	500 ppm, equivalent to 25 mg/kg bw per day
		Carcinogenicity	1500 ppm, equivalent to 75 mg/kg bw per day ^d	–
	Three-generation study of reproductive toxicity ^a	Parental toxicity	40 ppm, equal to 2.4 mg/kg bw per day	100 ppm, equal to 4.7 mg/kg bw per day
		Pup toxicity	75 ppm, equal to 4.2 mg/kg bw per day	100 ppm, equal to 5.6 mg/kg bw per day
	Developmental toxicity ^b	Maternal toxicity	3 mg/kg bw per day	4 mg/kg bw per day
		Pup toxicity	20 mg/kg bw per day ^d	–
Acute neurotoxicity ^b	Neurotoxicity	1.75 mg/kg bw	1.90 mg/kg	
13-week study of neurotoxicity ^a	Neurotoxicity	40 ppm, equal to 3 mg/kg bw per day	120 ppm, equal to 8.9 mg/kg bw per day	
Rabbit	Developmental toxicity ^b	Maternal toxicity	2 mg/kg bw per day	3 mg/kg bw per day
		Kit toxicity	20 mg/kg bw per day ^d	–
Dog	1-year study of toxicity ^a	Toxicity	200 ppm, equivalent to 5 mg/kg bw per day ^d	–

Esfenvalerate was tested, except where indicated.

^aDietary administration

^bGavage

^cOnly dose suitable for evaluation

^dHighest dose tested

Estimate of acceptable daily intake for humans

0–0.02 mg/kg bw

Estimate of acute reference dose

0.02 mg/kg bw

Studies that would provide information useful for continued evaluation of the compound

Further observations in humans

*List of end-points relevant for setting guidance values for dietary and non-dietary exposure**Absorption, distribution, excretion and metabolism*

Rate and extent of absorption of an oral dose	78–95% excretion within 24 h, indicating extensive absorption
Dermal absorption	No study of direct dermal absorption available
Distribution	Distributed throughout the body. Generally very low concentrations of residues in tissues. Most extensive distribution to fat, skin, hair and stomach
Potential for accumulation	Low, due to rapid excretion
Rate and extent of excretion	78–95% excretion within 24 h
Metabolism in animals	Extensive
Toxicologically significant compounds (animals, plants and environment)	Parent

Acute toxicity

Rat: LD ₅₀ , oral	90 mg/kg bw
Rat: LD ₅₀ , dermal	> 5000 mg/kg bw
Rat: LC ₅₀ , inhalation	480 mg/m ³ (4 h)
Mouse: LD ₅₀ , oral	250 mg/kg bw
Rabbit: LD ₅₀ , dermal	> 2000 mg/kg bw
Rabbit: Skin irritation	Not irritating
Rabbit: Eye irritation	Mildly irritating
Guinea-pig: Skin sensitization	Sensitizing in Magnusson & Kligman test Not sensitizing in Buehler test

Short-term studies of toxicity

Target/critical effect	Clinical signs of neurotoxicity and decreased body-weight gain
Lowest relevant oral NOAEL	125 ppm, equivalent to 6.2 mg/kg bw per day (90 days, rat)
Lowest relevant dermal NOAEL	1000 mg/kg bw per day (21 days, rabbit)
Lowest relevant inhalation NOAEL	No data available

Genotoxicity

Not genotoxic

Long-term studies of toxicity and carcinogenicity

Target/critical effect	Decreased body-weight gain
Lowest relevant NOAEL	35 ppm, equal to 4.3 mg/kg bw per day (18 months, mouse)

Carcinogenicity

Not carcinogenic

Reproductive toxicity

Target/critical effect for reproductive toxicity	Reduced parental and offspring body weight.
Lowest relevant NOAEL for reproductive toxicity	40 ppm, equal to 2.4 mg/kg bw per day
Target/critical effect for developmental toxicity	Maternal: clinical signs of toxicity Developmental: none
Lowest relevant NOAEL for developmental toxicity	Maternal: 2 mg/kg bw per day Developmental: 20 mg/kg bw per day, highest dose tested

Neurotoxicity

Target/critical effect for acute neurotoxicity	Tremors
Lowest relevant NOAEL for acute neurotoxicity	1.8 mg/kg bw
Target/critical effect for 90-day neurotoxicity	Decreased motor activity
Lowest relevant NOAEL for 90-day neurotoxicity	3.0 mg/kg/day

Medical data

Transient paraesthesia

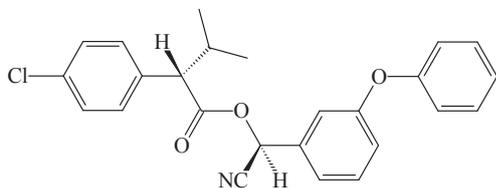
<i>Summary</i>	<i>Value</i>	<i>Study</i>	<i>Safety factor</i>
ADI	0–0.02 mg/kg bw	Maternal toxicity in a study of developmental toxicity in rabbits	100
Acute RfD	0.02 mg/kg bw	Rat, acute neurotoxicity	100

RESIDUE AND ANALYTICAL ASPECTS

Residue and analytical aspects of esfenvalerate were considered for the first time by the present Meeting.

It should be noted that fenvalerate (119) was first considered in 1979. Advice has been received that fenvalerate will be supported by the data submitter during the review process for esfenvalerate and possibly post-review (Annex 1 of CCPR Report 2002, ALINORM 03/24). The Meeting was informed that fenvalerate registrations are withdrawn in some European countries but will continue in other countries including Japan and USA.

Esfenvalerate is a broad-spectrum pyrethroid insecticide with uses on many crops.



Relation between fenvalerate and technical esfenvalerate - typical isomer compositions

	S,S-isomer	R,S-isomer	S,R-isomer	R,R-isomer
Fenvalerate	23%	27%	27%	23%
technical esfenvalerate	84%	8%	7%	1%

The Meeting received information on esfenvalerate metabolism and environmental fate, methods of residue analysis, freezer storage stability, national registered use patterns, supervised residue trials and national MRLs. Information on fenvalerate was also supplied on these topics in support of esfenvalerate.

Animal metabolism

The Meeting received metabolism studies for esfenvalerate and fenvalerate on rats and mice, and for fenvalerate on dairy cows and laying hens.

The following compounds were identified as metabolites of esfenvalerate in rats or mice, appearing in the excreta in amounts exceeding 5% of the dosed parent compound: 4'-OH-esfenvalerate; 2-(4-chlorophenyl)isovaleric acid (CPIA); 2-(4-chlorophenyl)-2-hydroxy-3-hydroxymethyl butanoic acid (2,3-OH-CPIA); 3-(4'-hydroxyphenoxy)benzoic acid (free + conjugated); 3-phenoxybenzoic acid (free + conjugated).

In a dairy cow metabolism study with [¹⁴C]fenvalerate the residue rapidly reached a plateau in milk (by day 3). Approximately 90% of the ¹⁴C in the milk was accounted for by fenvalerate itself and almost all of the ¹⁴C in the milk was present in the fat. A comparison of the ¹⁴C measurement on fat tissues and fat of milk with a fenvalerate measurement by GLC showed that most of the ¹⁴C was present as fenvalerate itself. Carboxylic metabolites of fenvalerate and their conjugates were identified in the liver and kidney.

Fenvalerate was identified as the major component of the residue in fat comprising 81-85% of the radiolabel in fat from laying hens dosed with labelled fenvalerate. Fenvalerate residues were identified in the egg yolks.

Fenvalerate, and esfenvalerate as a component of fenvalerate, should be defined as a fat-soluble residue.

Plant metabolism

The Meeting received plant metabolism studies for esfenvalerate on cabbages and for fenvalerate on apple trees, cabbages, kidney bean, lettuce, soybean, tomato and wheat.

In a comparative study on cabbages it was found that the nature and amounts of transformation products formed from fenvalerate and esfenvalerate were very similar. Most of the applied radiolabel remained on the treated leaves with little translocation to other parts of the plant. No α S/ α R epimerisation was observed for residues in cabbage treated with esfenvalerate. After 24 and 48 days the parent compound (fenvalerate or esfenvalerate) was still the major identified component of the remaining residue. The main identified metabolite was free and conjugated CPIA. Dec-fen (3-(4-chlorophenyl)-4-methyl-2-(3-phenoxyphenyl) pentanenitrile), a photolysis product, was identified as a minor component of the residue.

In the fenvalerate metabolism studies, fenvalerate was a surface residue and solvent extractable. Parent fenvalerate constituted the main identified component of the residue. A number of metabolites were identified including the photoproduct Dec-fen, which is unlikely to be an animal metabolite. Dec-fen constituted 5-10% of the residue on crop foliage.

Environmental fate

Soil

The Meeting received information on the behaviour and fate of esfenvalerate during soil and solution photolysis, aerobic soil metabolism and field dissipation. Information was also provided on the soil adsorption properties of esfenvalerate and on the behaviour and fate of fenvalerate during soil photolysis, aerobic and anaerobic soil metabolism, column leaching of aged residues, field dissipation and crop rotation.

Esfenvalerate is susceptible to soil surface photolysis (half-life 3-4 days). A study of photoisomerization of esfenvalerate in solution predicted that epimerization induced by sunlight will be generally minor.

Aerobic soil metabolism of fenvalerate and esfenvalerate occurred at much the same rates and their behaviour in the soil was generally comparable. The configuration of esfenvalerate was not converted to any other configuration, i.e. epimerization was not apparent. Esfenvalerate was the major part of the environmental residue. The behaviour of fenvalerate under aerobic and anaerobic conditions was similar.

Adsorption-desorption and leaching studies indicate that esfenvalerate will be highly immobile in soils. In field dissipation, the residues of esfenvalerate did not move down the soil profile and dissipated with half-lives of approximately 60-130 days.

In fenvalerate crop rotation studies, little of the residue carried over to the succeeding crop and none of the residue was fenvalerate itself. Part of the carry-over residue was identified as a conjugate of CPIA.

Water-sediment systems

The Meeting received information on the behaviour of esfenvalerate and fenvalerate during aqueous sterile hydrolysis and the fate of esfenvalerate in water-sediment systems.

Hydrolysis rates at pH 5 and 7 were too small to be measurable in 28 days. At pH 9 the half-lives were quite similar - 80 and 64 days for fenvalerate and esfenvalerate respectively.

Epimerization of esfenvalerate occurred at pH 7 and pH 9 at the α -position. Epimerization was faster than hydrolysis. At pH 9 from day 2 through the rest of the experiment the level of [2S, α R] was slightly higher than or equal to the esfenvalerate level. At pH 7 the epimerization rate was slower but substantial. After 14 days at pH 7 the ratio of esfenvalerate to [2S, α R] epimer was 2.5.

CPIA was the most prevalent metabolite in water-sediment systems and became the major part of the residue to occur in the water phase.

Analytical methods

Samples in the field trials were analysed for esfenvalerate by solvent extraction, cleanup by solvent partition and column chromatography followed by GC-ECD measurement. Validation with an LOQ of 0.01 mg/kg was achieved for numerous commodities.

The RS,SR pair elutes before the SS,RR pair on GC analysis, so significant racemization of esfenvalerate to fenvalerate would be apparent as a changed peak ratio.

Stability of pesticide residues in stored analytical samples

The Meeting received information on the stability of esfenvalerate residue samples during storage of analytical samples at freezer temperatures. Test data were provided on the following substrates: almonds, beef, blackberries, cabbage, corn silage, eggs, green beans, lettuce, milk, peach, soil, soybeans, sugar beets, tomatoes, watermelon, wheat grain and wheat straw.

Esfenvalerate residues were stable in storage at -10°C for the 2-3 years of the tests. No significant racemization of esfenvalerate was observed during storage. The RS,SR pair elutes before the SS,RR pair in the GC analysis, but was not observed in the stored samples.

Residue definition

Fenvalerate was introduced as a pesticide before esfenvalerate and residue limits for fenvalerate were usually defined as the sum of the fenvalerate isomers. In national systems esfenvalerate residues then conveniently fitted into the fenvalerate residue definition.

The residue definition for esfenvalerate should consist of the SS isomer only. However, separation of the SS and RR isomers would be analytically expensive and generally would serve little purpose because the level of RR isomer in esfenvalerate is typically only about 1%.

The hydrolysis studies suggest that epimerization of esfenvalerate is possible and that some of the SS isomer could be converted to SR isomer and appear as such as residues. In crop and animal residue situations epimerization probably is insignificant (<10%) and the SR isomer (initially a 7% component of technical esfenvalerate) remains a minor component of the residue. The RS,SR pair elutes before the SS,RR pair in the GC analysis and, if the SR isomer is included, the RS should also be included because they are not separated in routine analytical methods.

It should be noted that most of the residue data for esfenvalerate are recorded as the sum of all isomers. A residue of SS+RR isomers would generally be about 15% less than the sum of all isomers, but in practice 15% makes little difference in comparison with inherent residue variability.

The FAO Manual (page 51) states that preferably no compound, metabolite or analyte should appear in more than one residue definition. It follows that, while a fenvalerate CXL is

maintained for the relevant commodity, the residues of esfenvalerate may be accommodated into the fenvalerate residue definition.

At least while fenvalerate MRLs are maintained, the residue definition for esfenvalerate as "fenvalerate, sum of all isomers" might be a practical solution.

The Meeting agreed that the residue definition for esfenvalerate would be the sum of fenvalerate isomers.

Definition of esfenvalerate residue (for compliance with MRL and for estimation of dietary intake): sum of fenvalerate isomers.

The residue definition is worded to emphasise that all fenvalerate isomers are included, but the intention is that the residue definition is identical to that for fenvalerate.

The definition applies to plant and animal commodities. The residue is classed as fat-soluble.

Results of supervised trials

Supervised trials were available for the use of esfenvalerate on tomatoes, soybeans, wheat, cotton seed and rapeseed.

Supervised residue trials for fenvalerate were also provided but were not used because the fenvalerate application rate did not match the esfenvalerate GAP application rate.

Tomato. Italian GAP permits the use of esfenvalerate on tomatoes at a spray concentration of 0.003 kg ai/hl with harvest 7 days later. In two French trials in line with Italian GAP the residues were 0.01 and 0.02 mg/kg.

Spanish GAP allows the use of esfenvalerate on tomatoes at a rate of 0.015 kg ai/ha and harvest 3 days later. Residues from 8 Italian and 8 Spanish trials with conditions matching Spanish GAP were: <0.01, 0.01 (2), 0.02 (10), 0.03 (2) and 0.04 mg/kg.

In USA esfenvalerate may be used on tomatoes at 0.056 kg ai/ha with harvest permitted 1 day later. In four US trials with conditions matching US GAP the esfenvalerate residues were: 0.04, 0.12, 0.14 and 0.28 mg/kg.

The data populations from European and US trials appear to be different and should not be combined. The number of tomato trials (4) from the higher population was insufficient to make a recommendation so the recommendations are based on the European trials. There are 18 trials with highest and median values of 0.04 and 0.02 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for esfenvalerate in tomatoes of 0.1, 0.02 and 0.04 mg/kg, respectively.

Esfenvalerate residues complying with the estimated maximum residue level of 0.1 mg/kg would not exceed the current fenvalerate MRL of 1 mg/kg for tomatoes.

Soybeans. In the USA esfenvalerate may be used on soybeans at 0.056 kg ai/ha and with harvest 21 days after the final application. In 3 US trials with the GAP application rate and PHIs of 21 and 28 days the esfenvalerate residues were: <0.01, 0.02 and 0.04 mg/kg

The number of trials was insufficient for an MRL recommendation.

Esfenvalerate residues from these trials in line with US GAP did not exceed the current fenvalerate MRL of 0.1 mg/kg for soya bean.

Wheat. In France esfenvalerate is registered for use on cereals at 0.0075 kg ai/ha. No PHI is specified. In four French trials on wheat with application rate 0.0075 kg ai/ha and PHI 42-62 days the residues in wheat grain were all below LOQ (0.01 mg/kg).

Esfenvalerate may be used on wheat in Spain with 2 applications at 0.015 kg ai/ha and harvest 28 days after the second application. In 2 Spanish trials, 4 Italian trials and 2 French trials with conditions matching Spanish GAP esfenvalerate residue levels were: <0.01 (5), 0.02 (2) and 0.03 mg/kg. Harvest of two Italian trials was 21 days after treatment, which was considered sufficiently close to the prescribed 28 days to be valid.

Residues in wheat from a trial matching UK GAP (3 applications of 0.005 kg ai/ha and 20 days PHI), except that there was only 1 application instead of 3, were <0.05 mg/kg. The trial data were not used because the LOQ (0.05 mg/kg) was substantially higher than the LOQ (0.01 mg/kg) for the other trials.

In summary, residues in the 12 trials matching GAP were: <0.01 (9), 0.02 (2) and 0.03 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for esfenvalerate in wheat of 0.05, 0.01 and 0.03 mg/kg, respectively.

Esfenvalerate residues complying with the estimated maximum residue level of 0.05 mg/kg would not exceed the current fenvalerate MRL of 2 mg/kg for cereal grains.

Cotton seed. Esfenvalerate is registered for use on cotton in Spain at 0.03 kg ai/ha with a 30 day PHI. In four Greek trials with conditions matching Spanish GAP the residues on cotton seed were: <0.01 (2), 0.01 and 0.04 mg/kg. In four Spanish trials also with conditions matching Spanish GAP the residues in cotton seed were: <0.01 (4) mg/kg.

In USA esfenvalerate is registered for use on cotton at 0.056 kg ai/ha with a 21 days PHI. Esfenvalerate residues on cotton seed were <0.01 and 0.01 mg/kg in two US trials where the application rate was 0.050 kg ai/ha and the intervals to harvest were 30 and 21 days.

The residue data from US and Europe appear to be from the same population. In summary the residues from the 10 cotton seed trials are, in rank order, median underlined: <u>0.01 (7), 0.01 (2), 0.04 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for esfenvalerate in cotton seed of 0.05, 0.01 and 0.04 mg/kg, respectively.

Esfenvalerate residues complying with the estimated maximum residue level of 0.05 mg/kg would not exceed the current fenvalerate MRL of 0.2 mg/kg for cotton seed.

Rapeseed. Esfenvalerate may be used on rapeseed in Germany with one application at 0.013 kg ai/ha with a 56 days PHI. Residues in rapeseed were below LOQ (0.01 mg/kg) in rapeseed from 6 trials in Germany (1-3 applications of 0.013 kg ai/ha and 43-56 days PHI) 2 trials in France (2 applications of 0.015 kg ai/ha, 41-42 days PHI) and 2 Italian trials (2 applications of 0.013 kg ai/ha and 42 days PHI).

Although all residues were below LOQ there was no evidence that the residue levels were essentially zero; STMR and HR were therefore recommended at the LOQ..

The Meeting estimated a maximum residue level, an STMR value and an HR value for esfenvalerate in rapeseed of 0.01*, 0.01 and 0.01 mg/kg, respectively.

Wheat straw and forage. The twelve trials that produced wheat data also produced wheat straw data. Two additional trials from Spain produced straw data within GAP. The esfenvalerate residues in the 14 trials in rank order, median underlined, are: 0.19, 0.24, 0.32, 0.32, 0.33, 0.39, 0.42, 0.52, 0.56, 0.64, 0.76, 0.79, 0.91 and 0.98.

The Meeting estimated a maximum residue level and an STMR value for esfenvalerate in wheat straw and fodder of 2 and 0.47 mg/kg, respectively.

Soybean hay. Residue data were provided for soybean hay and whole soybean plant from the 3 US soybean trials already considered. The number of trials was insufficient for an MRL recommendation.

Rapeseed whole plant. Rapeseed whole plant residue data were provided from the German trials already considered for rapeseed. If the permitted interval between treatment and cutting for forage is the same as for rapeseed harvest (56 days) the conditions of the trials do not match GAP and the trials cannot be evaluated.

Processing

The Meeting received processing information for residues of fenvalerate in tomatoes, soybeans and cotton seed and decided that the information could be used in support of esfenvalerate.

The cotton seed and soybean data were of limited value because of 'non-detect' values and some inconsistency. In one cotton seed study the crop was harvested only 1 day after treatment so the residues may not have been representative of 21-30-day old residues as required by current GAP.

The processing factor for tomatoes to paste was 0.46 and for tomatoes to puree 0.51. The Meeting applied the processing factors to the tomato STMR (0.02) to produce STMR-Ps of 0.01 mg/kg for tomato paste and tomato puree.

Farm animal dietary burden

The Meeting estimated the farm animal dietary burdens for esfenvalerate.

Maximum farm animal dietary burden estimation

						Choose diets, %			Residue contribution, mg/kg		
Commodity	group	residue mg/kg	basis	% dry matter	residue, on dry wt mg/kg	Beef cattle	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Cotton seed	SO	0.05	MRL	88	0.056	25			0.014		
Wheat straw and fodder	AS	2	MRL	88	2.3	25	60		0.57	1.4	
Wheat	GC	0.05	MRL	89	0.056	50	40	80	0.028	0.023	0.045
					TOTAL	100	100	80			
						Maximum dietary burden			0.61	1.6	0.045

STMR farm animal dietary burden estimation

						Choose diets, %			Residue contribution, mg/kg		
Commodity	group	residue mg/kg	basis	% dry matter	residue, on dry wt mg/kg	Beef cattle	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Cotton seed	SO	0.01	MRL	88	0.011	25			0.003		
Wheat straw and fodder	AS	0.47	STMR	88	0.53	25	60		0.13	0.32	
Wheat	GC	0.01	STMR	89	0.011	50	40	80	0.006	0.005	0.009
					TOTAL	100	100	80			
						STMR dietary burden			0.14	0.32	0.009

The esfenvalerate dietary burdens for animal commodity MRL and STMR estimation (residue levels in animal feeds expressed on dry weight) are: beef cattle 0.61 and 0.14 mg/kg, dairy cattle 1.6 and 0.32 mg/kg and poultry 0.045 and 0.009 mg/kg.

Farm animal feeding studies

The dairy cow feeding study with [¹⁴C]fenvalerate was designed to provide residue transfer information as well as metabolism information. The level of fenvalerate in the animal diet was 79 ppm. Approximate levels of ¹⁴C and % as fenvalerate were: fat 1-3 mg/kg (90%+), milk 0.47 mg/kg (90%+), muscle 0.25 mg/kg (90%), liver 2 mg/kg (<1%) and kidney 1.4 mg/kg (17%).

White Leghorn laying hens were dosed with [¹⁴C]fenvalerate at the equivalent of 158 ppm in the feed in a metabolism study that also provided information on residue levels in tissues and

eggs. Approximate levels of ^{14}C and % as fenvalerate were: fat 0.5 mg/kg (81-85%), egg yolk 1-1.3 mg/kg (52-70%), liver 1-2.4 mg/kg (insignificant %), muscle <0.2 mg/kg, egg whites <0.2 mg/kg.

Animal commodity maximum residue levels

The feeding levels in the fenvalerate metabolism studies (cow 79 ppm and hen 158 ppm) were so much higher than the maximum dietary burdens for esfenvalerate (cow 1.6 mg/kg and hen 0.045 mg/kg) that it is not reasonable to make calculations. It is reasonable to conclude that the residues will be 'much less' than in the feeding studies and probably mostly below LOQ.

The Meeting noted that the residues of esfenvalerate in mammalian products arising from the farm animal diet would not exceed the MRLs already established for fenvalerate for:

- meat (from mammals other than marine mammals) 1 mg/kg (fat); and
- edible offal (mammalian) 0.02 mg/kg; and
- milks 0.1 mg/kg F..

The Meeting estimated maximum residue levels of 0.01* mg/kg for poultry meat (fat), poultry offal and eggs. In the absence of more definitive information the Meeting decided to estimate STMR and HR values at the LOQ for poultry meat, poultry edible offal, poultry fat and eggs.

DIETARY RISK ASSESSMENT

Long-term intake

The Meeting decided to treat esfenvalerate and fenvalerate together for the purposes of dietary risk assessment because the residues consist of the same components but in different proportions.

Fenvalerate has not been recently evaluated so STMRs and HRs are not available. The TMDIs for fenvalerate for the five GEMS/Food regional diets were in the range 50-70% of the ADI, 0.02 mg/kg bw/day (Annex 3).

Esfenvalerate IEDIs for the five GEMS/Food regional diets for the crop and farm animal commodities where STMRs are available were <1% of the ADI, 0.02 mg/kg bw/day (Annex 3).

When esfenvalerate IEDIs were added to the fenvalerate TMDIs the estimated intakes for the five GEMS/Food regional diets were in the range 50-70% of the ADI (Annex 3).

The Meeting concluded that the long-term intake of residues of esfenvalerate resulting from its uses that have been considered by JMPR is unlikely to present a public health concern.

Short-term intake

The International Estimated Short term Intake (IESTI) for esfenvalerate was calculated for 6 food commodities [(and their processed fractions)] for which maximum residue levels were estimated and for which consumption data were available. The results are shown in Annex 4.

The IESTI represented 0 - 3% of the acute RfD for the general population and 0 - 10% of the acute RfD for children. The Meeting concluded that the short-term intake of residues of esfenvalerate, resulting from its uses that have been considered by the JMPR, is unlikely to present a public health concern.

4.11 ETHEPHON (106)

TOXICOLOGY

Ethephon (2-chloroethylphosphonic acid) was evaluated by the Joint Meeting in 1977, 1978, 1993, 1995 and 1997. An ADI of 0–0.05 mg/kg bw was allocated in 1993 on the basis of a NOAEL of 0.5 mg/kg bw per day in a 16-day study in humans treated orally and a safety factor of 10. This ADI was maintained by the 1995 JMPR. The 1995 Meeting recommended re-evaluation of ethephon in 1997 to take into account the results of a study that was under way of the effects of the compound on rat plasma and erythrocyte cholinesterase activity *in vitro*. The 1997 Meeting was informed that ethephon had not inhibited cholinesterase activity in this study and that further research was being undertaken. The Meeting recommended that a re-evaluation be scheduled when those data became available.

The results of studies of acute and short-term neurotoxicity in rats, including evaluation of the time-course of the effects of ethephon on cholinesterase activity and a study of the potential of ethephon to inhibit cholinesterase activity *in vitro*, were available for consideration by the present Meeting. In addition, the results of a Magnusson and Kligman skin sensitization test in guinea-pigs were available, in which ethephon did not induce delayed contact hypersensitivity.

Ethephon is a dibasic phosphonic acid and hence does not behave like a typical organophosphorus compound towards cholinesterase enzymes. However, the phosphonic acid dianion form can phosphorylate serine residues in the active site of cholinesterases. Plasma cholinesterase is more susceptible than acetylcholinesterase to the effects of ethephon.

The oral LD₅₀ in rats was > 2000 mg/kg bw. WHO has classified ethephon as 'unlikely to present an acute hazard in normal use'.

In preliminary studies, peak effects were observed in rats 5–6 h after a single oral dose. There was no effect on acetylcholinesterase activity. In a study of acute neurotoxicity, rats were given ethephon by gavage at a single dose of 250, 500, 1000 or 2000 mg/kg bw. Cholinesterase activity was not determined. One or two animals at the two higher doses died, and abnormal clinical signs and some changes in a battery of functional tests were observed at these doses on the day of treatment, which persisted for a few days in one or two animals. Pinpoint pupils were seen at 500, 1000 and 2000 mg/kg bw, although not in all animals at the lower doses, and this effect persisted for several days in a few animals. Pinpoint pupils occurred predominantly in moribund animals. The NOAEL was 250 mg/kg bw on the basis of an increased incidence of miosis.

After preliminary studies to establish a suitable dose range, a 90-day study of neurotoxicity was performed in rats in which ethephon was administered by gavage at a dose of 75, 150 or 400 mg/kg bw per day. The highest dose was reduced to 300 mg/kg bw per day at week 10–11 because of excessive mortality. These were the only deaths that occurred. Abnormal clinical signs were observed at the highest dose. Erythrocyte cholinesterase activity was significantly inhibited by

> 20% at the higher doses. Brain cholinesterase activity was inhibited by < 10% at the highest dose. The NOAEL was 75 mg/kg bw per day on the basis of > 20% inhibition of erythrocyte cholinesterase activity at 150 mg/kg bw per day.

In studies previously evaluated by the JMPR, the short-term effects of ethephon were evaluated in volunteers. In three studies, no inhibition of erythrocyte cholinesterase activity was observed at doses up to 1.5 mg/kg bw per day for 28 days, while plasma cholinesterase activity was inhibited. Symptoms consistent with inhibition of acetylcholinesterase activity were reported at the highest dose (1.5 mg/kg bw per day for men, 2.2 mg/kg bw per day for women), including effects on the gastrointestinal tract and urinary urgency. On the basis of these symptoms, the overall NOAEL was 0.5 mg/kg bw per day for the effects of ethephon in humans exposed for at least 2 weeks.

After considering the previous evaluation of ethephon, the new data submitted and recent publications in the open literature, the Meeting established an acute RfD of 0.05 mg/kg bw on the basis of the NOAEL of 0.5 mg/kg bw in studies in humans given repeated doses and a 10-fold safety factor.

An addendum to the toxicological monograph was prepared.

DIETARY RISK ASSESSMENT

Short-term intake

The international estimated short-term intake (IESTI) for ethephon was calculated for the commodities for which MRLs have been recommended, STMR and highest residue levels have been estimated and data on consumption of large portion sizes and unit weights were available. The results are shown in Annex 4.

Short-term intake represented 4–90% of the acute RfD for the general population. The IESTI represented 7–200% of the acute RfD for children; the short-term intake of cantaloupe, peppers, pineapple and tomato exceeded the acute RfD.

4.12 FENAMIPHOS (085)

TOXICOLOGY

Fenamiphos (ethyl 4-methylthio-*m*-tolyl isopropylphosphoramidate) was first evaluated toxicologically by the 1974 JMPR, which allocated an ADI of 0–0.0006 mg/kg bw on the basis of the results of a 2-year study in dogs in which inhibition of plasma cholinesterase activity was observed. In 1985, after a review of additional data, a temporary ADI of 0–0.0003 mg/kg bw was allocated. The ADI was made temporary because of concern about the finding of fetotoxicity in rabbits, for which a LOAEL of 0.1 mg/kg bw per day was identified. The 1985 JMPR requested submission of the results of an on-going study of carcinogenicity in rats, more data from a study of teratogenicity in rats and the results of a new study of teratogenicity in rabbits. These data were evaluated by the 1987 JMPR, which allocated an ADI of 0–0.0005 mg/kg bw. Fenamiphos was toxic to the dams, but it was not embryotoxic or teratogenic in these studies. The 1997 JMPR re-evaluated fenamiphos and established an ADI of 0–0.0008 mg/kg bw on the basis of the results of a new 1-year study of toxicity in dogs and a 100-fold safety factor. The NOAEL in this study was for

inhibition of brain acetylcholinesterase activity and anaemia at the next highest dose. The Meeting established an acute reference dose (RfD) at the same level as the ADI, on the basis of data from a study of neurotoxicity in rats given single doses. As dogs were found to be more sensitive to fenamiphos than rats, however, the Meeting also requested a study in dogs given single doses to aid in establishment of an acute RfD.

Fenamiphos is an organophosphorus compound, and virtually all its toxicological effects are due to inhibition of acetylcholinesterase activity.

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In response to the request from the 1997 JMPR, a study was performed which was divided into three trials. During the first, two males and two females received fenamiphos at a dose of 0.063, 0.12, 0.25 or 0.5 mg/kg bw, with wash-out periods in between dosing. In the second trial, a dose of 0.5 or 2 mg/kg bw was used, and in the third, 1 mg/kg bw. Plasma, erythrocyte, and, at sacrifice, brain cholinesterase activities were measured. For plasma and erythrocyte activity, the activity before treatment was used as the control, whereas brain cholinesterase activity was compared with that of dogs in other studies. Clinical signs of cholinergic toxicity were seen at doses of 0.5 mg/kg bw and above, while plasma cholinesterase activity was significantly inhibited at 0.12 mg/kg bw and above and also transiently at the lowest dose. Erythrocyte cholinesterase activity was inhibited at 0.5 mg/kg bw and above, most inhibition occurring 60–90 min after dosing. The data on brain cholinesterase activity could not be interpreted because the controls had considerably less activity than the test animals, with the exception of those given fenamiphos at 1 mg/kg bw and killed after 24 h; moreover, there was no evidence of dose-related inhibition in the treated animals. Accordingly, the NOAEL was 0.25 mg/kg bw on the basis of inhibition of erythrocyte cholinesterase activity at 0.5 mg/kg bw. The Meeting concluded that data on inhibition of brain cholinesterase activity were not critical to the evaluation because there was evidence from a study of absorption, distribution, metabolism and excretion, evaluated by the 1997 JMPR, that fenamiphos has minimal ability to cross the blood–brain barrier.

The Meeting established an acute RfD of 0.003 mg/kg bw on the basis of the NOAEL of 0.25 mg/kg bw in the single-dose study in dogs reviewed at the present Meeting and a safety factor of 100. This acute RfD was supported by the NOAEL of 0.37 mg/kg bw (on the basis of clinical signs) in a study of neurotoxicity study in rats given single oral doses, which was evaluated by the 1997 JMPR.

An addendum to the toxicological monograph was prepared.

DIETARY RISK ASSESSMENT

Short-term intake

The international estimated short-term intake (IESTI) for fenamiphos was calculated for the commodities for which MRLs have been recommended, STMR and highest residue levels have been estimated, and data on consumption of large portion sizes and unit weights were available. The results are shown in Annex 4.

The IESTI represented 1–220% of the acute RfD for the general population; the short-term intake of peppers, pineapple and tomato exceeded the acute RfD. The IESTI represented 2–600% of the acute RfD for children; the short-term intake of carrot, grapes, peppers, pineapple, tomato and watermelon exceeded the acute RfD.

4.13 FLUTOLANIL (205)

TOXICOLOGY

Flutolanil (α, α, α -tri-fluoro-3'-isopropoxy-*o*-toluanilide) is a systemic benzanilide fungicide. It specifically inhibits the succinate dehydrogenase complex (EC 1.3.99.1, complex II) of Basidiomycetes but not those of fungi of other classes. Succinate dehydrogenase is an iron-sulfur protein that is an integral part of the inner mitochondrial membrane and a key element in the electron transport chain of mammals. Flutolanil has not been evaluated previously by JMPR.

The available studies on the toxicity of flutolanil were performed between 1977 and 1990. Although a number of the studies were performed before adoption of good laboratory practice, the overall quality of the database and standard of reporting were considered to be adequate.

Two studies of absorption and metabolism in rats were evaluated, in which different vehicles were used. [aniline ring- U - ^{14}C]Flutolanil was rapidly absorbed, peak concentrations of radioactivity being achieved in blood and tissue 2 h after dosing. The highest concentrations of radioactivity at 2 h were found in liver and kidney, which were 3.5- and 2.5-fold higher than those in whole blood, respectively. The extent of absorption of an oral dose, as estimated from urinary excretion, varied with dose and with whether single or repeated doses were given. The greatest absorption of an oral dose of 20 mg/kg bw was about 70%. The absorption of a dose of 100 mg/kg bw per day was similar, but that of 1000 mg/kg bw per day fell to about 10%, indicating that there is a plateau for the achieved systemic dose after administration by gavage. Less saturation of absorption was seen after dietary administration, and the concentration of tissue residues and the frequency of liver enlargement generally showed dose-response relationships up to very high doses. Excretion was rapid (> 80% within 24 h), the proportion in urine and faeces varying between studies, with increased urinary excretion after repeated dosing. The primary urinary metabolite, representing up to 57% of the administered dose, was desisopropyl flutolanil, either free or as the glucuronide or, predominantly, the sulfate conjugate. There was evidence of induction of phase-I metabolism and/or conjugation of flutolanil after repeated administration. There was no evidence of cleavage at the amido bridge. Measurement of tissue residues after administration for 28 days or 2 years showed that flutolanil did not bioaccumulate in rats.

Flutolanil has very low acute toxicity after oral (LD_{50} , > 10 000 mg/kg bw), dermal, inhalation, intraperitoneal or subcutaneous administration. No evidence of specific acute toxicity was seen. Flutolanil was neither irritating nor sensitizing to skin but was a slightly irritating to the eye. WHO has classified flutolanil as "unlikely to present an acute hazard in normal use".

In studies with repeated doses in mice, rats and dogs for up to 2 years, the pattern of effects was comparable, comprising liver enlargement, depression of body-weight gain and mild haematological disturbances, with some evidence of increased thyroid weight seen in shorter studies in rats and dogs. In a 2-year study of toxicity and carcinogenicity in rats, an increased frequency of vacuolar degeneration of the liver was observed at 10 000 ppm (equal to 460 mg/kg bw per day), and splenic effects (decreased cellular elements) were observed at concentrations of 2000 ppm (equal to 87 mg/kg bw per day) and above. All the findings seen in a 90-day study of toxicity in dogs were not reproduced in a 2-year study of toxicity in dogs, perhaps because the vomiting seen at higher doses (250 mg/kg bw per day and above) towards the end of the 2-year study reduced the absorbed dose and might have reversed any effects. A range of other effects was found, with no consistent pattern among studies or species, no clear dose-response relationship and

no evidence of an association with treatment. In all three species, flutolanil could be administered at doses in excess of the accepted limit value without any clear evidence of severe toxicity. The NOAELs for non-neoplastic effects were 1500 ppm (equal to 170 mg/kg bw per day) in mice, 200 ppm (equal to 9 mg/kg bw per day) in rats and 50 mg/kg bw per day in dogs.

Flutolanil at a dietary concentration of 30 000 ppm, equivalent to 3300 mg/kg bw per day, increased the incidences of hepatocellular adenomas and carcinomas in mice and produced a 10–20% increase in liver weight. The increases in tumour incidences were not statistically significant, and the values were within the range seen in other controls. The Meeting concluded that the liver tumours were of no significance for human risk assessment.

In rats, flutolanil did not increase the overall tumour incidence or the incidences of hepatocellular or thyroid tumours. Nevertheless, the low, statistically nonsignificant increases in the incidences of uncommon cholangiomas of the liver and papillomas of the urinary bladder at dietary concentrations of 2000 ppm and above were of potential concern, because none were seen at 0, 40 and 200 ppm. The cholangiomas were also of interest in view of the fact that the liver is a target organ for the effects of flutolanil; however, the incidence of cholangiomas (1/50 in males and females at 10 000 ppm and in females at 2000 ppm) resulted in an overall incidence of 3/200 (1.5%) in the two groups combined, which was not significantly greater than the incidence in other controls of up to 1.4%. The incidence of papillomas of the urinary bladder (1/50 in females at 2000 ppm and in males at 10 000 ppm, 2/50 in females at 10 000 ppm) was marginally greater than that in other control groups of females (0–1.6%) and was within the range of other groups of male controls (0–3%). There was no evidence of a hyperplastic response in the bladder of animals given flutolanil. As papillomas of the urinary bladder and cholangiomas of the liver can occur spontaneously, and a clear NOAEL for these tumours was identified at 200 ppm (equal to 9 mg/kg bw per day), the Meeting concluded that the low incidences of these rare tumours were not of significance for the overall risk assessment.

A weak positive result was reported for chromosomal aberration in Chinese hamster lung cells at a moderately cytotoxic concentration of flutolanil in the presence of metabolic activation. Negative results were seen in five other adequate assays *in vitro* and in an assay for chromosomal effects (micronucleus induction) *in vivo*. Studies of bacterial gene mutation with four impurities present in the technical-grade material showed that the impurities did not induce reverse mutation. The Meeting concluded that the overall weight of evidence indicates that flutolanil (technical grade) is not genotoxic.

In view of the lack of genotoxicity and the finding of statistically nonsignificant increases in tumour incidences, for which clear NOAELs were identified, the Meeting concluded that flutolanil is unlikely to pose a carcinogenic risk to humans.

Flutolanil showed no specific reproductive effects in a two-generation study of reproductive toxicity in rats. The only sign of general toxicity, increased liver weight, occurred at similar frequency in both generations of parents, indicating that no specific effect was associated with exposure *in utero* or in early life. A slight but statistically nonsignificant increase in the frequency of atrophy of the testicular germinal epithelium in F₁ male offspring of dams at the highest dose was not associated with alterations in reproductive performance. The NOAEL for general and reproductive toxicity was 20 000 ppm, equal to 1600 mg/kg bw per day, the highest dose tested.

The results of studies of developmental toxicity in rats and rabbits indicated no specific fetotoxicity or teratogenicity at the highest dose tested, 1000 mg/kg bw per day. The Meeting concluded that flutolanil is not teratogenic.

The Meeting concluded that the available database was adequate to characterize the potential hazard of flutolanil to fetuses, infants and children.

No adverse findings have been reported in workers in production or formulation plants or in operators applying flutolanil.

The Meeting established an ADI of 0–0.09 mg/kg bw on the basis of the NOAEL of 200 ppm, equal to 9 mg/kg bw per day, for effects on erythrocytes and an increase in the incidence of decreased cellular elements of the spleen in the long-term study of toxicity and carcinogenicity in rats, and a safety factor of 100.

The Meeting concluded that it was unnecessary to establish an acute RfD for flutolanil in view of its low acute lethality, the absence of clinical signs and effects pertinent to administration of single doses, and the absence of developmental effects.

A toxicological monograph was prepared.

TOXICOLOGICAL EVALUATION

Levels relevant to risk assessment

Species	Study	Effect	NOAEL	LOAEL
Mouse	2-year study of toxicity and carcinogenicity ^a	Toxicity	1500 ppm, equal to 170 mg/kg bw per day	7000 ppm, equal to 840 mg/kg bw per day
		Carcinogenicity	30 000 ppm, equal to 3300 mg/kg bw per day ^d	–
Rat	2-year study of toxicity and carcinogenicity ^a	Toxicity	200 ppm, equal to 9 mg/kg bw per day	2000 ppm, equal to 87 mg/kg bw per day
		Carcinogenicity	200 ppm, equal to 9 mg/kg bw per day	2000 ppm, equal to 87 mg/kg bw per day
	Two-generation study of reproductive toxicity ^a	Parental and pup toxicity	20 000 ppm, equal to 1600 mg/kg bw per day ^d	–
	Developmental toxicity ^b	Maternal, embryo- and fetotoxicity	1000 mg/kg bw per day ^d	–
Rabbit	Developmental toxicity ^b	Maternal, embryo- and fetotoxicity	1000 mg/kg bw per day ^d	–
Dog	2-year study of toxicity ^c	Toxicity	50 mg/kg bw per day	250 mg/kg bw per day

^aDietary administration

^bGavage

^cCapsule

^dHighest dose tested

Estimate of acceptable daily intake for humans

0–0.09 mg/kg bw

Estimate of acute reference dose

Unnecessary

Studies that would provide information useful for continued evaluation of the compound
Further observations in humans

List of end-points relevant for setting guidance values for dietary and non-dietary exposure

Absorption, distribution, excretion and metabolism in mammals

Rate and extent of absorption	Rapid T _{max} (2 h); ~ 70% absorption at 20 mg/kg bw; evidence of saturation at higher doses by gavage
Distribution	Extensive; highest concentrations in liver, kidney and adipose tissue.
Potential for accumulation	None (data from 2-year study in rats)
Rate and extent of excretion	Relatively rapid (~50% within 12 h)
Metabolism in animals	De-isopropylation and conjugation; some evidence of auto-induction
Toxicologically significant compounds (animals, plants and environment)	<i>Flutolanil</i>

Acute toxicity

Rat, LD ₅₀ , oral	> 10 000 mg/kg bw
Rat, LD ₅₀ , dermal	> 5000 mg/kg bw
Rat, LC ₅₀ , inhalation	(4 h) > 6 mg/l
Skin irritation	Not irritating
Eye irritation	Slightly irritating
Skin sensitization	Not sensitizing (Magnusson and Kligman)

Short term studies of toxicity

Target/critical effect	Liver, erythrocytes, emesis
Lowest relevant oral NOAEL	50 mg/kg bw per day (2-year study in dogs)

Genotoxicity

Not genotoxic

Long-term studies of toxicity and carcinogenicity

Target/critical effect	Liver vacuolation, reduced cellular elements in spleen, erythrocyte parameters
Lowest relevant oral NOAEL	200 ppm, equal to 9 mg/kg bw per day (2-year study in rats)
Carcinogenicity	Unlikely to pose a risk to humans

Reproductive toxicity

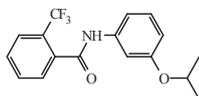
Target/critical effect for reproductive toxicity	None
Lowest relevant NOAEL for reproductive toxicity	20 000 ppm, equal to 1600 mg/kg bw per day, in rats, highest dose tested
Target/critical effect for developmental toxicity	None

Lowest relevant NOAEL for developmental toxicity	1000 mg/kg bw per day in rats and rabbits, highest dose tested		
<i>Neurotoxicity</i>	No evidence of neurotoxicity in routine studies		
<i>Medical data</i>	No effects reported in production or formulation plant workers or applicators		
<i>Summary</i>			
	Value	Study	Safety factor
ADI	0.09	2 years, rats	100
Acute RfD	Unnecessary		

RESIDUE AND ANALYTICAL ASPECTS

Residue and analytical aspects of flutolanil were considered for the first time by the present Meeting.

Flutolanil is a systemic fungicide with protective and curative action. It has registered uses for control of sheath blight (*Rhizoctonia solani*) in rice and Southern stem rot (white mould) and the limb/pod rot complex in peanuts. Flutolanil also has registered uses for disease control on potatoes, wheat, Japanese butterbur, lettuce, Welsh onion, pear, cucumber, tomato, egg plant, sweet peppers, sugar beet, honeywort, spinach and ginger.



The Meeting received information on flutolanil metabolism and environmental fate, methods of residue analysis, freezer storage stability, national registered use patterns, supervised residue trials, farm animal feeding studies, fate of residues in processing and national MRLs.

Animal metabolism

The Meeting received animal metabolism studies for rats, lactating goats and laying hens. Flutolanil ¹⁴C labelled in the aniline ring was used in all the metabolism studies.

After the oral administration of [¹⁴C]flutolanil to rats, approximately 57% of the dose was excreted as 3'-hydroxy-2-trifluoromethylbenzanilide (metabolite M-4) or its conjugates. Other identified metabolites were 4'-hydroxy-3'-isopropoxy-2-trifluoromethylbenzanilide (metabolite M-2) and 4'-hydroxy-3'-methoxy-2-trifluoromethylbenzanilide (metabolite M-7).

When lactating goats were dosed with [¹⁴C]flutolanil the ¹⁴C residue appeared mainly in the liver, kidney and milk with very little in muscle and fat. The main component of the residue

was metabolite M-4 with small amounts of M-7 and M-2. Flutolanil was not a component of the residue. Radiolabel reached a plateau in milk by approximately day 2-3.

Radiolabel was rapidly excreted (73 and 88% in 24 hours) after administration of [¹⁴C]flutolanil to laying hens. Very little radiolabel appeared in the muscle, skin and fat or eggs. Metabolite M-4 present as sulphate or glucuronide conjugates was the major identified part of the residue.

Flutolanil itself is not an identified component of the residue in animal tissues, milk and eggs. Residue levels in the fat tissue were too low for identification and it is theoretically possible that parent flutolanil is present at low levels in the fat. The main identified residue component is metabolite M-4 present as conjugates. The residue does not behave as a fat-soluble residue.

Plant metabolism

The Meeting received plant metabolism studies for rice, potatoes and peanuts.

Flutolanil parent was the major part (64%) of the residue in rice grain harvested at maturity 30 days after a second foliar treatment with [¹⁴C]flutolanil. Metabolite M-4 was a minor part of the residue (2.3%). Flutolanil and M-4 were translocated to all parts of the plant.

Flutolanil may be used on potatoes in two ways: directly on the seed potato tubers or as an in-furrow treatment at sowing. When [¹⁴C]flutolanil was used in these ways and tubers were harvested 4.3 months later flutolanil parent constituted 21% and 35% of the ¹⁴C in the tubers. Conjugated M-4 was found at 12% and 13% of the ¹⁴C and conjugated metabolite M-2 constituted 8% of the residue in the first treatment but was not identified in the second. This study demonstrates that flutolanil is quite persistent in the crop.

When [¹⁴C]flutolanil was applied to a peanut crop as a banded spray and the mature crop was harvested 84 days later the main identified components of the residue in the nuts were: free flutolanil (1%), conjugated M-4 (10%), conjugated metabolite M-3 (3.3%) and conjugated metabolite M-11 (2.0%). M-3 is 3'-(2-hydroxy-1-methylethoxy)-2-trifluoromethylbenzanilide. M-11 is 2-[3-(α,α,α -trifluoro-*o*-toluoylamino)phenoxy]propionic acid. Free flutolanil constituted 17% of the residue in peanut foliage with M-4 and M-11 also identified. Other metabolites were not fully characterised, but were shown to contain the trifluoromethylbenzoate group measured by the common moiety analytical method.

The major metabolites in plants and animals are the same (M-4, M-2 and M-7). Additional minor metabolites identified in crop tissues are present at only low percentages of the radiolabel. They are essentially oxidation and hydroxylation products of flutolanil.

In the edible part of peanuts two metabolites (M-3 and M-11) not seen to any extent in rats or goats were found at low levels. Both these compounds are closely related to parent structurally (oxidation of an isopropyl group to an alcohol or acid). There are also some unidentified metabolites at similar levels. It is unlikely that there will be any toxicological effects at the levels of exposure resulting from these residues (probably <0.0002 mg/kg bw/day - <1% of the proposed ADI for flutolanil).

Environmental fate in soil

Flutolanil was stable to soil surface photolysis.

When incubated in soils under aerobic conditions at 20°C the disappearance half-lives for [¹⁴C]flutolanil ranged from 119-400 days for the soils tested.

Under aerobic flooded and upland conditions the calculated half-lives (0-90 days data) in 3 soils at 30°C were 160-320 days with disappearance rates marginally higher in each case under the flooded conditions. The longer term disappearance rates were much slower, with only 2.5-15% of the residue lost from day 90 to day 180. Flutolanil was always the major part of the residue. Identified metabolites did not exceed 3% of the dose.

Under aerobic conditions at 25°C in a sandy loam soil the estimated half-life for unbound flutolanil was 21 days and 290 days for sorbed flutolanil. Metabolites M-4, M-6 and M-11 were minor parts of the residue and never individually exceeded 5% of the dose.

Flutolanil is strongly adsorbed to most soils and is classified as low mobility through soil.

Environmental fate in water-sediment systems

In a 30-days study at 25°C in the dark at pH 5, 7 and 9 in sterile solutions, the hydrolysis of [¹⁴C]flutolanil was insufficient to be observed.

Flutolanil was slowly degraded in non-sensitised solution photolysis with only 8% loss in 30 days. In sensitised photolysis (1% acetone) 32% was lost in the first 3 days and then another 7% by day 30.

When [¹⁴C]flutolanil was incubated at 20°C in an aerobic water-sediment system the flutolanil continued over the 105 days of the experiment to partition from the water to the sediment. Mineralisation was slow at 3.7% and 5.2% of the dose in 105 days. Small amounts of M-4 and M-11 were produced but flutolanil remained as the majority of the residue.

In an anaerobic water-sediment system at 25°C for 12 months [¹⁴C]flutolanil degraded very slowly with negligible mineralisation. The residue continued to partition from the aqueous phase to the sediment and at the end of 12 months only 0.3% of the dose was present in the aqueous phase.

Analytical methods

The Meeting received descriptions and validation data for analytical methods for flutolanil and its metabolites. Methods used in the Japanese trials on rice measured the intact flutolanil and metabolite M-4 separately. A common moiety method was used in the USA. It converts flutolanil and metabolites to methyl trifluoromethylbenzoate for measurement by GC. The method applies to crops, animal tissues, eggs and milk.

In the first method flutolanil is extracted from crops with acetone, cleaned up and the residue is measured by GLC-NPFID. In a modification, metabolite M-4 (a phenol) was extracted from an acid solution, methylated and subjected to a separate GLC measurement. Various modifications of these procedures were used in the Japanese rice trials. Procedural recoveries were generally in the 75-100% range for test concentrations of 0.1, 0.2 and 0.4 mg/kg. The stated LOQ was 0.005 mg/kg, but no recovery data were available at this level.

The common moiety analytical method for residues of flutolanil and metabolites convertible to 2-trifluoromethylbenzoic acid was used in the US trials on rice. The details of the extraction and base hydrolysis sections of the method depend on the substrate while the latter

portions of the method, i.e. methylation and GC analysis are largely independent of the substrate. Rice and peanuts are extracted with acetone. Animal fat is extracted with acetonitrile+hexane. The extracts are concentrated ready for base hydrolysis. Whole milk, eggs and animal tissues other than fat are hydrolysed directly. The base hydrolysis requires heating with 50% w/w NaOH at 200°C for 3-4 hours. After solvent partition cleanup, the residue is then methylated with a methyl iodide / tetrabutyl ammonium hydroxide mixture ready for GC-MSD analysis. Poor recoveries easily occur, but satisfactory recoveries (>70%) may be obtained with experience and attention to critical parts of the method. LOQ = 0.05 mg/kg.

Stability of pesticide residues in stored analytical samples

The Meeting received freezer storage stability data for flutolanil and metabolite M-4 for rice grain and rice straw. Samples were stored for 31 months in the dark at a nominal -20°C.

Flutolanil and M-4 residues were stable in freezer storage in rice with a loss of about 30% of the residue after 700-900 days. Flutolanil residues in rice straw declined by approximately 30% in 15 months. Metabolite M-4 residues in rice straw did not decline during the 31 months of the test.

The stability of flutolanil residues in brown rice during storage of analytical samples was tested during the supervised residue trials on rice in Japan. Flutolanil residues were spiked into ground samples from the control plot when the samples arrived at the laboratory. The fortified samples were then analysed at the same time as treated samples, giving a measure of the storage stability of the residues. Residues were stable for the tested intervals (45-315 days).

Residue definition

Flutolanil itself was not identified as a component of the residue in tissues, milk and eggs of farm animals. The main identified component of the residue in milk, liver and kidney of dosed dairy cows was metabolite M-4 present as sulphate and glucuronide conjugates. Levels of residue in muscle and fat were very low. The residue should not be classed as fat-soluble. In laying hens dosed with flutolanil the main identified residue in kidney and liver was metabolite M-4 as conjugates. Residue levels in muscle, skin and fat and eggs were very low.

Flutolanil itself was the major part of the identified residue in treated rice and potatoes.

Two analytical methods for flutolanil residues are available: the first measures intact flutolanil and metabolite M-4 separately; the second is a common moiety method for flutolanil and metabolites convertible to 2-trifluoromethylbenzoic acid. The common moiety method uses a very vigorous hydrolysis step (50% NaOH at 200°C for 3-4 hours) and poor recoveries are easily obtained. However, the common moiety method will better cover those situations where flutolanil itself is not part of the residue, as in animal commodities.

The Meeting preferred an analytical method for enforcement purposes that measures intact flutolanil and decided that flutolanil parent only would be suitable as a residue definition for crops for enforcement purposes. Because flutolanil is a major part of the residue in rice it is also a suitable residue definition for risk assessment.

In animal commodities parent flutolanil is not present and the common moiety method is necessary to measure levels of the identified residue. The Meeting decided that the residue

measured by the common moiety method would be suitable for enforcement and risk assessment for animal commodities.

Definition of the residue for plant commodities (for compliance with MRL and for estimation of dietary intake): flutolanil.

Definition of the residue for animal commodities (for compliance with MRL and for estimation of dietary intake): flutolanil and transformation products containing the 2-trifluoromethylbenzoic acid moiety, expressed as flutolanil.

The residue is not classed as fat-soluble.

Results of supervised trials

Rice. In Japan, flutolanil may be used in a number of ways on rice. The results of supervised residue trials on rice with these different treatments were provided to the Meeting.

Rice paddies may be treated with granules by application to submerged surfaces at 2.1-2.8 kg ai/ha with harvest permitted 45 days later. In a trial matching these conditions the residue in brown rice at 60 days was higher than at 45 days and was taken for evaluation: 0.050 mg/kg. In a second trial the residue at day 44 was 0.034 mg/kg. In two further trials the second and third applications were of soluble bag formulations at 2.0 kg ai/ha with harvest 42 and 45 days later and were accepted as equivalent to GAP. Residues in brown rice were 0.06 and 0.03 mg/kg. In summary, the residues from the 4 trials were: 0.03, 0.034, 0.05 and 0.06 mg/kg.

Flutolanil may also be used in Japan by application of a soluble oil to the water surface at 1.5-2.2 kg ai/ha with harvest 54 days later. Residues in brown rice following this method of use were 0.01 and 0.04 mg/kg.

In Japan rice may be treated directly with a flutolanil dust at 0.6 kg ai/ha with harvest 14 days later. In 6 trials where application rates were 0.6-0.8 kg ai/ha and the PHI was 14 days (in some cases residues were higher at 21 and 30 days) the residues in brown rice were: 0.03, 0.033, 0.063, 0.08, 0.18 and 0.20 mg/kg.

Flutolanil SC may be sprayed on rice in Japan at 0.17-0.20 kg ai/ha with a PHI of 14 days. In 6 trials matching these conditions (rates 0.17-0.23 kg ai/ha), with one trial where residues after 28 days were higher than at 14 days and in 2 trials with an EC formulation, flutolanil residues in brown rice were: 0.04, 0.12, 0.17, 0.20, 0.28 and 0.31 mg/kg.

The Japanese trial residues on brown rice from indirect treatment (treatment of the water or submerged surfaces) are: 0.01, 0.03, 0.04, 0.046, 0.06 and 0.062 mg/kg, and from direct treatment (treatment of the rice plants) are: 0.03, 0.04, 0.033, 0.063, 0.08, 0.12, 0.17, 0.18, 0.20, 0.20, 0.28 and 0.31 mg/kg. The residues from the indirect and direct treatments appear to be from different populations and should not be combined.

In USA flutolanil may be applied on rice as a WP at 0.39-0.78 kg ai/ha and the rice may be harvested 30 days later. In 10 US trials where the application rate was 0.56-0.62 kg ai/ha of a WP or WG formulation the residue levels in rank order, median underlined, for whole rice were: 0.22, 0.25, 0.62, 0.99, 1.1, 1.3, 1.4, 1.7, 1.7 and 6.2 mg/kg. The residues in the US trials were measured by the common moiety method but are considered essentially equivalent to residues of flutolanil only because flutolanil is the major component of the residue in rice.

The processing factor for whole rice → brown rice is 0.32. When this factor is applied to the US residue data the calculated residue levels for brown rice become (rank order, median underlined): 0.070, 0.080, 0.20, 0.32, 0.35, 0.42, 0.45, 0.54, 0.54 and 1.98 mg/kg.

The Japanese trial data on brown rice from direct treatment and the US data on brown rice appear to be from different populations and should not be combined. The Meeting used the US data for the rice evaluation.

The Meeting estimated a maximum residue level and an STMR value of 2 and 0.39 mg/kg, respectively for flutolanil residues in husked rice.

Rice straw. Rice straw was collected from the US trials described previously. Flutolanil residue levels in the rice straw, in rank order, median underlined, were: 0.95, 1.0, 1.3, 3.1, 3.6, 3.8, 4.4, 5.7, 6.4 and 7.4 mg/kg.

The Meeting estimated a maximum residue level and an STMR value of 10 and 3.7 mg/kg, respectively for flutolanil residues in rice straw and fodder, dry.

Processing

In a processing study, rice was treated according to US GAP and a portion of approximately 450 kg was milled and polished. Calculated processing factors from the residue in the raw whole grain were: rice hulls 3.5, brown rice 0.32, rice bran 1.4 and polished rice <0.16. Flutolanil residues in the polished rice were below LOQ (0.05 mg/kg) so the processing factor is a 'less than' value.

The Meeting used the processing factors and the estimated STMR and maximum residue level for brown rice to estimate STMRs and maximum residue levels for the other processed commodities

Farm animal dietary burden

The Meeting estimated the farm animal dietary burden for flutolanil based on the residues resulting from its use on rice.

Maximum farm animal dietary burden estimation

Commodity	group	residue mg/kg	basis	% dry matter	residue, on dry wt mg/kg	Choose diets, %			Residue contribution, mg/kg		
						Beef cattle	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Rice grain	GC	2	MRL	88	2.3	40	40	60	0.91	0.91	1.36
Rice straw	AS	10	MRL	90	11.1	10	10		1.11	1.11	
Rice hulls	CM	4.3	STMR-P	90	4.8	10	10	15	0.48	0.48	0.72
Rice bran	CM	1.7	STMR-P	90	1.9						
					TOTAL	60	60	75			
						Maximum dietary burden			2.50	2.50	2.08

STMR farm animal dietary burden estimation

Commodity	group	residue mg/kg	basis	% dry matter	residue, on dry wt mg/kg	Choose diets, %			Residue contribution, mg/kg		
						Beef cattle	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Rice grain	GC	0.39	STM R	88	0.44	40	40	60	0.18	0.18	0.27
Rice straw	AS	3.7	STM R	90	4.1	10	10		0.41	0.41	
Rice hulls	CM	4.3	STM R-P	90	4.8	10	10	15	0.48	0.48	0.72
Rice bran	CM	1.7	STM R-P	90	1.9						
					TOTAL	60	60	75			
						STMR dietary burden			1.07	1.07	0.98

The flutolanil dietary burdens for animal commodity MRL and STMR estimation (residue levels in animal feeds expressed on dry weight) are: beef cattle 2.5 and 1.07 mg/kg, dairy cattle 2.5 and 1.07 mg/kg and poultry 2.08 and 0.98 mg/kg.

Farm animal feeding studies

The Meeting received information on the residue levels arising in animal tissues and milk when dairy cows were dosed with flutolanil for 28 consecutive days at the equivalent of 39, 116 and 388 ppm in the diet. Residues in milk and tissues were measured by the common moiety method with a LOQ of 0.05 mg/kg.

Residues did not exceed the LOQ in milk at the two lower feeding levels and did not exceed the LOQ in muscle at any feeding level.

At the lowest feeding level of 39 ppm, residues of 2.0 and 1.4 mg/kg flutolanil moiety appeared in liver and 0.05 and 0.79 mg/kg in kidney with corresponding higher residues at the higher feeding levels.

Residues in eggs and tissues were measured by the common moiety method when laying hens were dosed with flutolanil for 28 consecutive days at the equivalent of 0.78, 2.4 and 7.8 ppm (dry-weight) in the diet and slaughtered on day 29.

Residues did not exceed the LOQ (0.05 mg/kg) in eggs, muscle, fat or skin at any feeding level.

Residues in the liver were not detected (LOQ 0.05 mg/kg) at the lowest and middle feeding groups and were present at 0.08, 0.10 and 0.20 mg/kg in the liver from the highest feeding group.

Animal commodity maximum residue levels

The Meeting agreed to apply the results of the dietary burden calculations and the dairy cow feeding study to mammalian food-producing farm animals generally.

Dietary burdens were the same for beef and dairy cattle: maximum 2.5 mg/kg, STMR 1.07 mg/kg.

At a feeding level of 39 ppm, residues in milk were below LOQ. At the second feeding level, 116 ppm, residues in milk and cream were below LOQ except for one sample of cream where the residue was 0.06 mg/kg. The dietary burdens for dairy cattle were far below these feeding levels and effectively nil residues should occur in milk. The Meeting estimated a maximum residue level and an STMR value for flutolanil residues in milks of 0.05* mg/kg and 0 mg/kg, respectively.

No residues exceeded LOQ in muscle at any feeding level. Again effectively nil residues should occur in muscle. The Meeting estimated a maximum residue level and an STMR value for flutolanil residues in mammalian meat of 0.05* mg/kg and 0 mg/kg, respectively.

The lowest feeding level (39 ppm) did produce measurable levels of flutolanil moiety residues in liver (2.0 and 1.4 mg/kg) and kidney (0.05 and 0.79 mg/kg). Estimated residues were calculated by multiplying the residues found in the feeding trials by the dietary burdens and dividing by the feeding level (39 ppm). The results are shown in the following table.

Feeding level [ppm] (interpolated)	Flutolanil moiety residues, mg/kg									
	Actual	Milk Mean	Fat high	mean	Muscle high	mean	Liver high	mean	Kidney high	mean
MRL beef (2.5) [39]			(0.004) 0.06		(<0.003) <0.05		(0.13) 2.0		(0.051) 0.79	
MRL dairy (2.5) [39]										
STMR beef (1.07) [39]				(0.001) 0.05		(<0.001) <0.05	(0.047) 1.7		(0.012) 0.42	
STMR dairy (1.07) [39]										

The Meeting estimated a maximum residue level and an STMR value for flutolanil residues in liver of cattle, goats, pigs and sheep of 0.2 mg/kg and 0.047 mg/kg, respectively.

The Meeting estimated a maximum residue level and an STMR value for flutolanil residues in kidney of cattle, goats, pigs and sheep of 0.1 mg/kg and 0.012 mg/kg, respectively.

The Meeting agreed to apply the results of the dietary burden calculations and the laying hen feeding study to poultry. Dietary burdens were: maximum 2.08 mg/kg and STMR 0.98 mg/kg.

At feeding levels of 0.78 and 2.4 ppm, residues in eggs, muscle, liver, fat and skin were all

below LOQ (0.05 mg/kg). The maximum dietary burden (2.08 mg/kg) was less than the second feeding level. Therefore the Meeting estimated a maximum residue levels of 0.05* mg/kg for eggs, poultry meat and poultry edible offal.

At the highest feeding level of 7.8 ppm residues in eggs, muscle, fat and skin were all below LOQ (0.05 mg/kg), suggesting that the residues in eggs, muscle, fat and skin were substantially below the LOQ at the STMR dietary burden (0.98 mg/kg). The Meeting estimated STMR values of 0 for eggs and poultry meat. Residues of 0.08, 0.10 and 0.20 mg/kg appeared in liver at a feeding level of 7.8 ppm, suggesting that residues in liver cannot be considered as "effectively zero." The Meeting estimated an STMR value of 0.05 mg/kg for poultry edible offal.

DIETARY RISK ASSESSMENT

Chronic intake

The International Estimated Daily Intakes of flutolanil, based on the STMRs estimated for 9 commodities, for the five GEMS/Food regional diets were in the range of 0 to 1% of the ADI (Annex 3). The Meeting concluded that the long-term intake of residues of flutolanil resulting from its uses that have been considered by JMPR is unlikely to present a public health concern.

Short-term intake

The Meeting decided that an acute RfD is unnecessary and concluded that the short-term intake of flutolanil residues is unlikely to present a public health concern.

4.14 FOLPET (041)

TOXICOLOGY

The 1999 JMPR concluded that it might be necessary to establish an acute RfD for folpet [*N*-(trichloromethylthio)phthalimide]. The 2000 JMPR concluded that it was unnecessary to establish an acute RfD for captan, which is closely related chemically and toxicologically to folpet. The present Meeting therefore considered whether it was necessary to establish an acute RfD for folpet.

On the basis of the guidance developed for establishing acute RfDs (see section 2.2), the Meeting considered that the toxicological effects of folpet, such as developmental toxicity and gastrointestinal irritation, could serve as the basis for an acute RfD. Therefore, the Meeting concluded that it would have to re-examine the entire toxicological database on the compound before it could determine whether an acute RfD was required. The Meeting further concluded that, in view in the similarity of the effects of captan and folpet, captan should be reconsidered at the same time to determine whether an acute RfD should also be established for this compound.

4.15 IMIDACLOPRID (206)

RESIDUE AND ANALYTICAL ASPECTS

Residue and analytical aspects of the new insecticide imidacloprid [1-(6-chloro-3-pyridylmethyl)-*N*-nitroimidazolidin-2-ylideneamine], which acts as an agonist at postsynaptic nicotinic acetylcholine receptors of insects, were considered for the first time by the present Meeting.

The 2001 JMPR established an ADI of 0.06 and an acute RfD of 0.4 mg/kg bw.

The manufacturer sent the Meeting information on metabolism in animals and plants, environmental fate in soil and water, methods of residue analysis and stability of residues in stored analytical samples, uses, residue supervised trials and processing data as well as national MRLs. Information on national GAP data and MRLs were provided by the governments of Australia, Germany and The Netherlands.

Pure imidacloprid is a beige powder with a melting point of 144°C and low volatility. It has low solubility in water and medium to high solubility in certain organic solvents. The log P_{OW} of 0.57 suggests that the compound is not fat soluble.

Metabolic Products

The parent, metabolites and degradation products are identified by code numbers as shown below.

<u>Code</u>	<u>Chemical name</u>	<u>Short name</u>
	<u>1-(6-chloro-3-pyridylmethyl)-<i>N</i>-nitroimidazolidin-2-ylideneamine</u> <u>imidacloprid</u>	
<u>M01</u>	1-(6-chloro-3-pyridylmethyl)-5-hydroxy- <i>N</i> -nitroimidazolidin-2-ylideneamine	5-hydroxy compound
<u>M02</u>	1-(6-chloro-3-pyridylmethyl)-4-hydroxy- <i>N</i> -nitroimidazolidin-2-ylideneamine	4-hydroxy compound
<u>M03</u>	1-(6-chloro-3-pyridylmethyl)-4,5-dihydroxy- <i>N</i> -nitroimidazolidin-2-ylideneamine	dihydroxy compound
<u>M04</u>	1-(6-chloro-3-pyridylmethyl)-5-hydroxy- <i>N</i> -nitroimidazolidin-2-ylideneamine 5-hydroxy glucuronide	glucuronide
<u>M05</u>	1-(6-chloro-3-pyridylmethyl)-4-hydroxy- <i>N</i> -nitroimidazolidin-2-ylideneamine 4-hydroxy glucuronide	glucuronide
<u>M06</u>	1-(6-chloro-3-pyridylmethyl)- <i>N</i> -nitro-4-imidazolin-2-ylideneamine	olefin
<u>M07</u>	1-(6-chloro-3-pyridylmethyl)- <i>N</i> -nitrosoimidazolidin-2-ylideneamine	nitrosimine
<u>M08</u>	1-(6-chloro-3-pyridylmethyl)- <i>N</i> -aminoimidazolidin-2-ylideneamine	amino compound
<u>M09</u>	1-(6-chloro-3-pyridylmethyl)imidazolidin-2-ylideneamine	denitro compound
<u>M10</u>	1-(6-chloro-3-pyridylmethyl)guanidine sulfate	guanidine sulfate
<u>M11</u>	1-(6-chloro-3-pyridylmethyl)-2-nitroguanidine	nitroguanidine
<u>M12</u>	1-(6-chloro-3-pyridylmethyl)imidazolidin-2-one	2-ketone
<u>M13</u>	1-(6-chloro-3-pyridylmethyl)urea	urea compound
<u>M14</u>	6-chloronicotinic acid CNA	6-
<u>M15</u>	<i>N</i> -(6-chloronicotinoyl)glycine	
<u>M16</u>	6-chloro-3-pyridylmethylamine	
<u>M17</u>	1-(6-chloro-3-pyridylmethyl)-4,5-dihydroxyimidazolidin-2-ylideneamine	dihydroxyimine
<u>M28</u>	6-chloro-3-pyridylmethanol	CHMP

M29 6-chloro-3-pyridylmethanol glucoside
M30 6-chloro-3-pyridylmethanol gentiobioside

CHMP glucoside

Animals metabolism

The rat metabolism was reviewed by the 2001 JMPR. Metabolites identified in urine and faeces as well as in kidney and liver are 6-chloronicotinic acid [M14] and its glycine conjugate [M15], further M01, M02, M06 and M09.

Absorption, distribution and elimination of imidacloprid was a rather fast process in lactating goat and laying hen after administration of 3 oral doses of 10 mg/kg bw on 3 consecutive days. Within 50 hours after the first administration the excretion amounted to about 54 % (goat) and 50 % (hen) of the radioactivity totally administered until sacrifice. Excretion with urine was the predominant route of elimination in goat, accounting for about 43 % of the dose. Faecal excretion was low with about 11 % of the total dose. Although the excrete of birds represents a mixture of urine and faeces, it can be concluded from the high concentration in the kidneys that the bulk of the radioactivity was excreted with the urinary fraction of the excreta. An amount of 0.3 % of the total dose was secreted with the milk of goat. At sacrifice, 2 hours after the final administration, the total residue in the edible organs was estimated to be about 5 % in goat. 7.8 % were found in tissues of hens.

The extent of metabolism of imidacloprid in kidney of goat and in liver of goat and poultry was very high. In muscle and fat tissues of goat about 65 % of total radioactive residues (TRR) were identified as imidacloprid. In milk about 10 % of TRR was identified as imidacloprid, 24 h after each application. In laying hens imidacloprid amounted to about 5 % of TRR in eggs, 6 % in muscle and 12 % in fat.

The metabolism of imidacloprid in goat and laying hen followed three similar, but not identical degradation routes with different metabolites as follows:

Goats

The first step of metabolism the hydroxylation of the imidazolidine ring of imidacloprid took place to form 5-hydroxy and 4-hydroxy imidacloprid [M01, M02] plus the glucuronide conjugate of the monohydroxy metabolites [M04, M05], and the dihydroxy imidacloprid [M03] followed by the loss of water to form the olefin metabolite [M06].

After reduction and loss of the nitro group on the imidazolidine ring the amino metabolite [M08] was formed, followed by the denitro compound [M09] and finally the 2-ketone [M12].

The third route followed opening of the imidazolidine ring by removal of the ethylene bridge and subsequent oxidation. The first step is forming the nitroguanidine compound [M11] followed by guanidine sulfate [M10] which can also be formed from both the denitro metabolite [M09] and the dihydroxyimine metabolite [M17]. This metabolite M10 can form the urea compound [M13] and [M16]. A further degradation to 6-chloronicotinic acid [M14] took place which conjugated with glycine [M15].

Hens

The first important biodegradation step starts with the hydroxylation of the imidazolidine ring to form the 5- and 4-hydroxy imidacloprid [M01, M02]. The loss of water yields the olefinic

compound [M06]. These three metabolites accounted for about 25 - 38% of the identified radioactivity.

The reduction and loss of the nitro group on the imidazolidine ring yielded dihydroxyimine [M17].

A third route of degradation follows opening of the imidazolidine ring with loss of the ethyl group and subsequent oxidation. The first step is forming the nitroguanidine [M11] followed by guanidine sulfate [M10] that can also be formed by the dihydroxyimine metabolite [M17]. This metabolite M10 can form the urea compound [M13] and [M16] which is oxidized to 6-chloronicotinic acid [M14].

Plants metabolism

The fate of imidacloprid in plants was investigated with [pyridinyl-¹⁴C-methyl]-imidacloprid in 11 different plant species using three different application forms. Ten metabolism studies and one confined rotational crop study were performed:

foliar spray treatment	apple, tomato, potato
soil granular application	eggplant, potato, rice
soil granular plus foliar spray application	tobacco
seed treatment	maize, cotton
nursery box treatment	rice

In most crops (eggplant, potatoes, rice, cotton) uptake of imidacloprid from the soil after granular application or seed treatment was low, ranging from 1.8 to 4.9 % of the applied radioactivity in the aerial part of mature plants. In rice and eggplants (in cotton and potatoes this question was not investigated) uptake was completed after half a growing period and did not increase appreciably in the second half. In maize plants radioactivity increased continuously to the end of the growing period and amounted to finally 20 % of the applied radioactivity in mature plants.

In all studies it was found that translocation in the plants goes off obviously by acropetal transport mainly from the roots to the leaves. After soil application, the main part of the radioactivity was found in the foliage, while only minor amounts were detected in fruits, grain or seed. A trial with spray application in potatoes showed that transport from the top (sprayed leaves) to the bottom (tubers) was negligible. Acropetal translocation was also demonstrated in special translocation experiments in apples and tomatoes. 14 days after application of imidacloprid to leaves radioactivity in fruits was negligible while the distribution in other plant parts (shoot, stem, untreated leaves) was not further investigated.

After translocation in the plants imidacloprid was significantly metabolised to a number of metabolites. In all studies and in nearly all plant parts three different routes of metabolic degradation were established:

Hydroxylation of the imidazolidine ring leading to the mono- and dihydroxylated compounds [M01, M02, M03] and subsequent removal of water to form the olefin metabolite [M06].

Reduction of the nitro group to form the nitrosimine compound [M07] and loss of this group with formation of the metabolites M09, M10 and M12.

Oxidative cleavage of the methylene bridge to form 6-chloro-3-pyridylmethanol (and conjugates) [M28, M29, M30] and further oxidation to 6-chloronicotinic acid [M14].

The only exceptions were residues in rice grains after granular application and in potato tubers after spray application. In these cases the total amount of recovered radioactivity was very low so that only very few metabolites could be detected.

Analysis of non-extracted residues in rice and maize grains showed furthermore that degradation of imidacloprid to CO₂ and subsequent incorporation into natural constituents as starch, glutelin or lignin seemed to be possible.

Amounts of unchanged parent compound depended on the application form. After spray application, penetration through the peel into fruits or leaves occurred relatively slow. Consequently, the metabolic degradation of imidacloprid was slow (half-life of imidacloprid in potato vines and tomato fruits: 5 to 7 weeks), and unchanged parent compound was found as the major component up to 88 % of the TRR. Uptake via roots after soil application led in most cases to more intensive biotransformation and to smaller amounts of unchanged imidacloprid.

Environmental fate

The DT50 values of imidacloprid will be generally below 180 days. The parent compound is completely mineralized without the occurrence of any metabolite at concentrations greater than 10 % of the applied radioactivity. Due to its spectral characteristics degradation on soil surfaces can play an important role in the environmental dissipation of imidacloprid. The compound exhibits a low soil mobility with a negligible leaching potential.

The nature of metabolites in the rotational crops was essentially the same as in crops from plant metabolism studies. The following compounds were identified: the denitro compound [M09], 5- and 4-hydroxy compounds [M01 and M02], 6-CNA [M14], olefin compound [M06], CHMP glucoside [M29], dihydroxy compound [M03], guanidine sulfate [M10], nitrosimine compound [M07] and CHMP [M28]. The sum of uptake of radioactivity in all rotational crops together was in the range from 1.1 to 2.4 % of TRR in the soil at the planting dates.

Imidacloprid is stable with regard to hydrolysis in aqueous solutions at environmentally relevant pH-values. In contrast, photolytic degradation occurs rapidly due to the nitro-chromophore. Though generally the photolytic effect is less important under environmental conditions since light of the relevant wavelengths (> 290 nm) will be absorbed by turbidities and impurities to a certain degree, in the case of imidacloprid it must be taken into account. In the water-sediment system the portion translocated to the sediment and converted into bound residues can become large though it is not generally the case. Calculated half-lives for three different water-sediment systems investigated were 30, 129 and 169 days. Complete mineralization occurs slowly but steadily and there is no tendency for accumulation of any of the intermediates.

Methods of analysis

In metabolism studies in plants, all metabolites identified in plants after treatment with imidacloprid contained the 6-chloropicolyl moiety. Therefore, an analytical method was developed for the determination of imidacloprid and the total residues in plants including all compounds containing the 6-chloropicolyl moiety. After extraction with methanol/water and sulphuric acid, hexane partitioning is performed. The extract is further cleaned up via column chromatography

with XAD 4 (polystyrene resin). Then imidacloprid and its metabolites containing the 6-chloropyridine moiety are oxidized to 6-chloronicotinic acid with alkaline KMnO_4 solution. Subsequently, the 6-chloronicotinic acid is derivatized with N-methyltrimethylsilyltrifluoroacetamide (MSTFA), and detected by gas chromatography with mass selective detection (GC-MS). Mean recoveries per sample material and fortification level (0.5 mg/kg and 0.05 mg/kg = LOQ) for the total residue were in the range of 68-113% (n=152). Blank values normally were below 30% of the LOQ.

For the determination of parent compound residues, an aliquot of the extract is evaporated to the aqueous remainder. After partitioning with dichloromethane on a ChemElut[®] cartridge and chromatography on Florisil[®], the residues are detected via HPLC with UV detection. Mean recoveries per sample material and fortification level (0.1 mg/kg and 0.01 mg/kg = LOQ) for the parent compound residues were in the range of 72-114% (n=143). Blank values normally were below 30% of the LOQ.

The method described above was validated in an independent laboratory (ILV). Recoveries were determined with representative sample materials (melon peel and pulp, peppers, tomato) for the total residue and also for parent compound residues at fortification levels of 0.01 to 1 mg/kg. For the total residue, the individual recoveries obtained ranged from 69-112%; the mean recovery per sample material and fortification level ranged from 72-100%, with typical RSDs of approx. 10%. For the parent compound, individual recovery levels were between 68% and 83%; the mean recovery per sample material and fortification level ranged from 70-79%, with typical standard deviations of about 5%. Blank values were below 30% of the corresponding LOQ (0.05 mg/kg for the total residue and 0.01 mg/kg for the parent) in all samples.

Residues of imidacloprid and related metabolites in animal matrices can be determined in a similar manner. Samples are extracted with a mixture of methanol and water (methanol only for milk samples), filtered, and evaporated to the aqueous remainder. For fat samples, partitioning against n-hexane is performed. The extracts are further cleaned up via column chromatography with XAD 4 (polystyrene resin); the column is washed with water, after which the residues are eluted with methanol. Subsequently, imidacloprid and its metabolites containing the 6-chloropyridinyl moiety are oxidized with alkaline KMnO_4 to 6-chloronicotinic acid. The 6-chloronicotinic acid is extracted from the aqueous phase with t-butylmethyl ether and derivatized with N-methyltrimethylsilyltrifluoroacetamide (MSTFA), and then determined by gas chromatography with mass-selective detection (GC-MS). Recovery rates were in the range from 76-124% after spiking animal materials (bovine muscle, kidney, liver, fat, milk; eggs) with imidacloprid at levels of 0.02 and 0.1 mg/kg. The LOQ was 0.02 mg/kg for all materials.

The method for animal matrices was validated in an independent laboratory (ILV). Recoveries determined with representative sample materials (milk, egg, poultry liver) ranged from 72 to 97% at fortification levels of 0.02 and 0.1 mg/kg (milk, egg), and 0.1 and 0.5 mg/kg (liver). Each sample was fortified with a mixture of imidacloprid and two metabolites (M09 denitro compound and M14 6-chloronicotinic acid). No "blank values" from control samples were observed.

Soil samples are extracted with boiling methanol in Soxtec extraction equipment, and subsequently cleaned up over a Chromabond SPE silica gel cartridge. After evaporation of the solvent and reconstitution in acetonitrile/water, the residues are quantified by HPLC with UV detection. Two columns of differing selectivity (LiChrospher 60 B and Zorbax SB-CN) were tested so as to avoid interferences. The recovery rates per spiking level were in a range between 94-101% (LiChrospher) and 88-89% (Zorbax) at fortification levels of 0.01 and 0.1 mg/kg, with respective

RSDs of 3.6-6.6% and 3.3-4.3%. The LOQ was 0.01 mg/kg and the limit of detection (LOD) was 0.003 mg/kg. Blank values were below 0.004 mg/kg in all samples.

Imidacloprid is concentrated from water samples by solid phase extraction (C_{18} cartridges), after which surface water samples are further cleaned up over silica gel cartridges. After evaporation, the residues are determined by HPLC with UV detection. Recoveries for drinking water at fortification levels of 0.03 and 0.3 $\mu\text{g/l}$ were 93% and 96%, respectively, with relative standard deviations of 4.3% and 3.1%. For surface water, the recovery rates were 76% (RSD 5.3%) and 87% (RSD 6.9%).

Stability of residues in stored analytical samples

The storage stability of imidacloprid and various important metabolites (M01, M06, M07, M09, M14) was tested in multiple plant materials and animal tissues, organs, and products. Tests on animal matrices were carried out to assess the stability of the total residue. For plants, tests were carried out to assess the stability both of residues of the active substance itself as well as of the total residue; additional tests were also conducted with radio-labelled substances. The results all of the studies indicate that the compounds are stable in frozen storage in the tested plant commodities for a minimum period of approximately 2 years, and in animal commodities for at least 1 year. Hence, the results of the storage stability studies validate the residue values obtained from the trials presented in this evaluation.

Definition of residue

In the studies on the metabolism of imidacloprid in lactating goat and laying hen imidacloprid and a number of metabolites were detected. The qualitative and quantitative composition of the metabolic spectrum varied among the animal species and tissues. However, all metabolites identified contain the 6-chloropyridyl moiety of imidacloprid.

A rather consistent picture of uptake, translocation and metabolism of imidacloprid in plants was observed. In all crops the metabolic pathway runs via the same routes of degradation and results in qualitatively and quantitatively similar composition of the metabolic spectrum. All identified transformation products of imidacloprid still contain the 6-chloropyridinyl moiety of the parent compound.

Therefore, the relevant residue to be analyzed in products of animal and plant origin can be defined as the sum of imidacloprid and its metabolites containing the 6-chloropyridinyl moiety, expressed as imidacloprid.

This definition applies for both compliance with MRLs and estimation of dietary intake.

Residues resulting from supervised trials on crops

Citrus fruits. Residue field trials on citrus fruits were performed with spray or soil drench applications of imidacloprid on clementine, grapefruit, lemon, mandarin and orange trees in Europe and USA.

The GAP in Greece, Italy and Spain ranges from 1 - 2 foliar sprays of 0.01 – 0.015 kg ai/hl (Portugal 0.007 – 0.01 kg ai/hl) and PHIs of 14 – 30 days. In Italy, a total of eight residue field trials were conducted with two foliar spray applications of a 200 SL formulation on clementine trees at an interval of 15 - 30 days. In all trials a spray concentration of 0.01 kg ai/hl was applied.

At the shortest PHI of 14 days, registered in Italy and Portugal, the total residues in whole fruit were 0.06, 0.07, 0.12, 0.16, 0.21, 0.29, 0.38 and 0.44 mg/kg.

In Italy two residue field trials were conducted with 2 spray applications (interval 30 days) of 0.01 kg ai/hl on lemon trees. Considering the PHI of 14 days, the residues were 0.07 and 0.11 mg/kg in pulp and 0.26 and 0.57 mg/kg in whole fruit.

A total of five residue field trials were performed on mandarin trees with two applications (interval Italy 30, Portugal 34, Spain 118 days) of 0.01 – 0.015 kg ai/hl. In one Italian trial the spray concentration was 0.01 kg ai/hl, corresponding to 0.12 kg ai/ha. In one Portuguese trial a spray concentration of 0.015 kg ai/hl corresponded to 0.2 kg ai/ha. Three further trials (2 x 0.015 kg ai/hl) were performed in Spain, with a first rate of 0.3 kg ai/ha a second rate of 0.75 kg ai/ha was applied. The residues in the edible portion and whole fruit were <0.05, <0.05, 0.05, 0.06 mg/kg and 0.16, 0.16, 0.17, 0.28, 0.29 mg/kg with a 14-day PHI.

In southern European countries a total of 9 residue field trials were performed in orange with two foliar applications of 0.01 – 0.015 kg ai/hl and a 14-day PHI. In two Italian trials orange trees received two foliar spray applications (interval 30 days), each of a spray concentration of 0.01 kg ai/hl, corresponding to an application rate of 0.12 kg ai/ha. In Spain four trials were performed with 0.01 kg ai/hl at the first and 0.015 kg ai/hl at the second application (interval 101-130 days), corresponding to rates of 0.3 kg ai/ha and 0.45 - 0.75 kg ai/ha. Three further trials were performed in Greece (2) and Portugal (1). Two spray applications (interval Greece 9 – 10 days, Portugal 31 days) were made each with a spray concentration of 0.015 kg ai/hl, corresponding to a rate of about 0.3 kg ai/ha. The residues in the edible portion were <0.05 (7), 0.05 and in whole fruit 0.11, 0.12, 0.12, 0.16, 0.24, 0.35, 0.44, 0.53 and 0.88 mg/kg with a 14-day PHI.

The combined residues in the European foliar sprayed trials (14-day PHI) in whole clementine, mandarin, lemon and oranges in rank order were: 0.06, 0.07, 0.11, 0.12 (3), 0.16 (4), 0.17, 0.21, 0.24, 0.26, 0.28, 0.29, 0.29, 0.35, 0.38, 0.44, 0.44, 0.53, 0.57, 0.88 mg/kg. The residues in the corresponding edible portion samples were: <0.05 (14), 0.05 (4), 0.06 (2) 0.07 and 0.11 mg/kg.

GAP in USA includes 1- 2 foliar sprays of 0.005 – 0.007 kg ai/hl, 0.14 – 0.28 kg ai/ha and a 0-day PHI. In the USA five residue field trials were performed in lemon with 2 spray applications (interval 9 – 11 days) of imidacloprid at a rate of 0.28 kg ai/ha. The spray concentration was 0.01 – 0.043 kg ai/hl. The residues in whole fruit were 0.21, 0.3, 0.31, 0.38 and 0.62 mg/kg with a 0-day PHI.

A total of six residue field trials were performed in grapefruit, also in the USA. The trees received two foliar spray applications, each at a rate of about 0.28 kg ai/ha. The interval between applications was 10 (\pm) days. Spray concentrations were about 0.011 - 0.015 kg ai/hl, resulting in whole fruit residues of 0.14, 0.17, 0.3 mg/kg, and 0.04 - 0.043 kg ai/hl, resulting in whole fruit residues of 0.17, 0.18, 0.32 mg/kg with a 0-day PHI. No difference was seen in the order of magnitude of the residues resulting from the two spray concentrations. Residues in rank order were 0.14, 0.17, 0.17, 0.18, 0.3 and 0.32 mg/kg.

Twelve other US field trials were with 2 spray applications (interval 3 – 13 days) of a 240 SC formulation. trees of each trial were treated with imidacloprid at a rate of 0.28 kg ai/ha. Spray The orange concentrations were 0.011 - 0.015 kg ai/hl, resulting in whole fruit residues of 0.18, 0.26, 0.26, 0.36, 0.37 mg/kg, and 0.04 - 0.043 kg ai/hl, resulting in whole fruit residues of 0.15, 0.21, 0.28, 0.29, 0.34, 0.36, 0.61 mg/kg with a 0-day PHI. No difference was seen in the order of

magnitude of residues resulting from both spray concentrations. Residues in rank order were 0.15, 0.18, 0.21, 0.26, 0.26, 0.28, 0.29, 0.34, 0.36, 0.36, 0.37 and 0.61 mg/kg.

The combined residues of the USA foliar sprayed trials (0-day PHI) of whole lemon, grapefruit and oranges were, in rank order: 0.14, 0.15, 0.17, 0.17, 0.18, 0.18, 0.21, 0.21, 0.26, 0.26, 0.28, 0.29, 0.3, 0.3, 0.31, 0.32, 0.34, 0.36, 0.36, 0.37, 0.38, 0.61, 0.62 mg/kg.

Three residue field trials were conducted in South Africa with soil drench application in oranges. The trees of each test plot had been treated around the trunks with a single label use rate of 2 – 8 g ai/tree. Oranges were sampled 179 and 212 days after treatment. Because only the parent compound imidacloprid was analyzed, the results were not used for estimation of maximum residue levels.

In the USA a total of twenty residue trials on citrus fruits were performed with soil application according to GAP (max. 0.56 kg ai/ha). In 1993 a total of twelve residue field trials were performed on grapefruit trees (6 trials) and orange trees (6 trials). The trees of each field trial received one application to the soil at a rate of 0.56 kg ai/ha. The application was made either late in spring or in fall. After late spring treatment, grapefruit and oranges were harvested after 120, 150, 180, 210, 240, 270, and 365 days. With treatment in fall, grapefruit and oranges were harvested after 0, 7, 15, 30, 60, 90, 120, and 150 days. The highest residues in each trial were <0.05 (5) and 0.05 mg/kg in whole grapefruit and <0.05 (3), 0.06, 0.08, 0.12 mg/kg in whole oranges, from samples at all sampling dates.

An additional three grapefruit, three lemon, and two orange residue trials with soil treatment were performed in 1994 - 1995. The trees of each field trial also received one application to the soil at a rate of 0.56 kg ai/ha. Mature grapefruits, oranges, and lemons were harvested 0, 4, 7, 15, 30, 56 to 62, about 90, 119 to 120, 149 to 153, 208 to 215, 240 to 244, 270 to 274, and about 365 days after treatment. The residues were <0.05 (3) mg/kg in whole grapefruit, <0.05 (3) in whole lemon, and <0.05 (2) mg/kg in whole orange, at all sampling dates.

The combined residues of the USA soil treatment trials of whole lemon, grapefruit and oranges in rank order were: <0.05 (16), 0.05, 0.06, 0.08, 0.12 mg/kg. These residues were considered to belong to a different population from those resulting from foliar spray use and were excluded from the evaluation.

The Meeting noted that the data obtained by the USA and Europe for whole fruits of clementine, mandarin, lemon, grapefruit and orange with foliar treatment, constituted one population. The combined residues for whole fruits of the two data sets from the USA and Europe were: 0.06, 0.07, 0.11, 0.12 (3), 0.14, 0.15, 0.16 (4), 0.17 (3), 0.18, 0.18, 0.21 (3), 0.24, 0.26 (3), 0.28, 0.28, 0.29 (3), 0.3, 0.3, 0.31, 0.32, 0.34, 0.35, 0.36, 0.36, 0.37, 0.38, 0.38, 0.44, 0.44, 0.53, 0.57, 0.61, 0.62 and 0.88 mg/kg. The Meeting estimated a maximum residue level of 1 mg/kg for citrus fruits.

The residue concentrations in the edible portion samples of the European trials were: <0.05 (14), 0.05 (4), 0.06 (2), 0.07 and 0.11 mg/kg. The Meeting estimated an STMR of 0.05 mg/kg and an HR of 0.11 mg/kg for citrus fruits on the basis of foliar spray use.

Pome fruits. Residue field trials with imidacloprid on apples were performed with foliar spray treatment in Canada, Europe, Korea, South Africa and the USA, and with soil drench applications in Australia and South Africa.

The GAP for apples in northern Europe (Austria, northern France, Germany, the Netherlands) includes 1 – 2 foliar spray treatments of 0.007 kg ai/hl (0.07 – 0.11 kg ai/ha), with a PHI of 14 days. Seven residue trials were carried out according to GAP in Germany. In these trials, one or two spray or low-volume spray applications were performed (interval 14 – 21 days). With a water application rate of 1500 l/ha, the spray concentration was 0.007 kg ai/hl, corresponding to 0.11 kg ai/ha. With a water rate of 200 or 250 l/ha, the concentration ranged from 0.052 to 0.063 kg ai/hl, corresponding to 0.11 to 0.13 kg ai/ha. After a 14-day PHI, the total residue concentrations were <0.05 (3), 0.06, 0.07, 0.08 and 0.11 mg/kg.

The GAP in southern Europe (Italy, Portugal, Spain) for apples includes 1 – 2 foliar spray treatments with 0.01 kg ai/hl (0.1 - 0.15 kg ai/ha) and PHIs from 14 – 28 days. 13 residue trials were performed in Italy, Spain and France. In all except one trial, one or two applications were made at spray concentrations ranging from 0.008 to 0.01 kg ai/hl, corresponding to 0.08 to 0.15 kg ai/ha. The remaining trial was performed with 2 applications including one pre-blossom application at a concentration of 0.02 kg ai/hl (0.3 kg ai/ha). With a 14-day PHI, the total residue concentrations were <0.05, 0.06, 0.06, 0.06, 0.07, 0.08, 0.08, 0.13, 0.17, 0.17, 0.18, 0.2 and 0.23 mg/kg.

In Canada and the USA, the GAP for apples includes 1 – 2 foliar spray treatments with about 0.05 – 0.1 kg ai/ha (0.0015 – 0.003 kg ai/hl) and a 7-day PHI. A total of 14 residue trials were performed with 5 x of 0.07 – 0.19 kg ai/ha. With a 7-day PHI, the total residues ranged from <0.05 to 0.74 mg/kg. The Meeting noted that the trials were inadequate because they did not reflect the GAP.

In South Korea, 5 apple trials were performed with a foliar spray concentration of 0.005 kg ai/hl. Two to 6 treatments were made at an application rate of 0.25 kg ai/ha. Because the parent imidacloprid was determined instead of the total residue, the trials could not be used for evaluation.

Imidacloprid is registered in South Africa for apples with one foliar spray treatment of 0.021 kg ai/hl (0.51 – 0.74 kg ai/ha) and a 70-day PHI or one soil drench treatment with 1.1 g ai/tree and no fixed PHI. Three residue trials were performed according to GAP by foliar spray (1 x 0.021 kg ai/hl, 0.53 kg ai/ha, 65 – 79 days PHI) and showed residues of 0.07, 0.08 and 0.12 mg/kg. In three trials with one soil drench application of 1 g ai/tree, no residue higher than the LOQ could be determined at PHIs of 69 – 154 days (<0.01, <0.02, <0.03 mg/kg).

In Australia, soil drench application of imidacloprid in apples is registered with 0.6 – 2.4 g ai/tree without a fixed PHI. Five residue trials were conducted according to GAP (1 x 2.4 g ai/tree, PHIs 91 – 110 days) and resulted in residue concentrations of <0.05, 0.02, 0.03, 0.14 and 0.16 mg/kg.

The combined apple residue results of the 20 European trials with foliar spray and the eight trials from South Africa and Australia with soil drench application were, in rank order: <0.01, <0.02, 0.02, <0.03, 0.03, <0.05 (5), 0.06, 0.06, 0.06, 0.06, 0.07 (3), 0.08 (4), 0.11, 0.12, 0.13, 0.14, 0.16, 0.17, 0.17, 0.18, 0.2 and 0.23 mg/kg. The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in apples of 0.5, 0.07 and 0.23 mg/kg, respectively.

Residue field trials with imidacloprid as foliar spray treatment on pears were performed in Europe, Canada and the USA. The GAP in northern Europe (northern France, the Netherlands) for pears is the same as for apples and includes 1 – 2 foliar spray treatments of 0.007 kg ai/hl (0.07 – 0.11 kg ai/ha) and a PHI of 14 days. The GAP in southern Europe (Italy, Portugal, Spain) for pears

is the same as for apples and includes 1 – 2 foliar spray treatments with 0.01 kg ai/hl (0.1 - 0.15 kg ai/ha) and a PHI of 14 days (Italy 50 days). A total of 8 GAP residue trials were performed with foliar spray application in southern Europe, one in Greece, four in Italy and three in Spain. Only one application was carried out in the Greek and Spanish studies; two applications were carried out in Italy (interval 21 or 139 days). In 2 of the 4 Italian studies, the first treatment was a pre-blossom application at a rate of 0.3 kg ai/ha. The spray concentration was 0.01-0.012 kg ai/hl, corresponding to 0.1-0.18 kg ai/ha. The residue concentrations were <0.05, 0.05, 0.06, 0.07, 0.08, 0.1, 0.23 and 0.26 mg/kg after a 14-day PHI.

In the USA, imidacloprid is registered in pears with 1- 2 foliar spray applications of 0.28 kg ai/ha, 0.0075 kg ai/hl and a 7-day PHI, and cannot be compared with the GAP for apples (0.05 – 0.1 kg ai/ha, 0.0015 – 0.003 kg ai/hl, 7-day PHI). Residue trials in pears were carried out in Canada and the USA with 2 methods of foliar spray application. Two treatments were made in each trial. Five studies were performed with a concentrated spray volume, and 4 with a diluted spray volume. The spray concentration ranged from 0.06 to 0.063 kg ai/hl for the “concentrate” sprays, and from 0.01 to 0.015 kg ai/hl for the “dilute” ones. This corresponded to an application rate of 0.28-0.31 kg ai/ha. With a 7-day PHI, the residues were 0.25, 0.27, 0.33, 0.33, 0.38, 0.4, 0.5, 0.53 and 0.71 mg/kg.

The Meeting compared both pear data sets from Europe and the USA by the Mann-Whitney U-test (see FAO Manual, p. 73) and decided that they belonged to different populations and could not be combined. Based on the US data set, the Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in pears of 1, 0.38 and 0.71 mg/kg, respectively.

Stone fruits. Imidacloprid is registered in southern France and Greece in peach with 1 - 2 foliar spray treatments of 0.005 – 0.007 kg ai/hl and in Italy, Portugal and Spain with 0.01 kg ai/hl. The PHI is 14/15 days with exception of Italy with 21 days. An identical GAP like for peach exists in Spain for nectarine, in France for apricot, in Spain for apricot and nectarine and, apart from the PHI of 35 days, in Italy for apricot. No trials according to GAP were carried out in apricots.

A total of 20 peach residue trials were performed in southern Europe according to the registered uses. Some of samples were separated in flesh and stones and the residue in whole fruit was calculated, in other cases whole fruits were analysed. The use patterns in 6 French studies (1 x 0.007 kg ai/hl, 0.07 kg ai/ha) were according to the French GAP resulting, after a 14-day PHI, in residue concentrations of <0.05, 0.07, 0.07, 0.11 mg/kg in fruits without stone and of <0.05, 0.06, 0.06, 0.06, 0.06 and 0.1 mg/kg in whole fruits. In the remaining 14 trials from Greece (1 trial), Italy (5 trials) and Spain (7 trials), 2 applications (interval 19 – 30 days) were carried out at a spray concentration of 0.01 kg ai/hl (0.008 kg ai/hl in 2 trials). The application rates ranged between 0.08 and 0.15 kg ai/ha. The trials matched the GAP from Italy, Portugal and Spain and showed, after a 14-day PHI, residues of <0.05, 0.07, 0.07, 0.13, 0.16, 0.22, 0.26, 0.32 mg/kg in fruits without stone and of <0.05, <0.05, 0.06, 0.06, 0.11, 0.11, 0.12, 0.15, 0.15, 0.19, 0.2, 0.2, 0.29, 0.35 mg/kg in whole fruits. Four further trials from Australia could not be used for evaluation because only the parent compound imidacloprid was determined.

Three nectarine residue trials were performed in Italy. In each trial, two applications (interval 30 or 142 days) were carried out at a spray concentration of 0.01 kg ai/hl (except for one trial in which the first treatment was a pre-blossom application at a concentration of 0.02 kg ai/hl). The application rates ranged from 0.12 to 0.15 kg ai/ha (0.24 kg ai/ha for the pre-blossom application). The last trial showed no residue higher than the LOQ at any sampling time, including the initial residue after treatment, and was therefore excluded from evaluation. The residues in the

two remaining trials were 0.13 (2) mg/kg in fruits without stone and 0.12 (2) mg/kg in whole fruits after the shortest southern European PHI of 14 days.

The Meeting noted that the residue data sets for peaches and nectarines can be combined and were in whole fruits <0.05 (3), 0.06 (6), 0.1, 0.11, 0.11, 0.12 (3), 0.15, 0.15, 0.19, 0.2, 0.2, 0.29 and 0.35 mg/kg. Based on identical GAPs in southern Europe, the residue levels estimated for peaches and nectarines should be extrapolated for apricots. The Meeting estimated a maximum residue level for imidacloprid in peaches, nectarines and apricots of 0.5 mg/kg.

The combined residues in the edible portion of peaches and nectarines were <0.05, <0.05, 0.07 (4), 0.11, 0.13 (3), 0.16, 0.22, 0.26, 0.32 mg/kg. The Meeting estimated an STMR value and an HR value for imidacloprid in peaches, nectarines and apricots of 0.12 and 0.32 mg/kg, respectively.

Imidacloprid is registered for use in sweet cherries in Italy with one foliar spray treatment, 0.15 kg ai/ha, 0.01 kg ai/hl and a 21-day PHI. Nine field studies were performed on sweet cherry in southern Europe with a 200 SL formulation: 6 in Italy and 3 in Spain. Five trials made in Italy were performed with 2 foliar applications (interval 30 days) at a spray concentration of 0.01 kg ai/hl, except for one in which the first application was carried out at a concentration of 0.02 kg ai/hl (interval 67 days). With a 21-day PHI, residues in whole fruits (or fruits without stone) were 0.11, 0.14 (0.17), 0.15, 0.15, 0.28 (0.3) mg/kg. In the remaining 4 trials performed in Spain and Italy, only one application was carried out at a spray concentration of 0.01 kg ai/hl, resulting in residue concentrations in whole fruits of 0.07, 0.08, 0.12, 0.16 mg/kg after a 21-day PHI. Four further trials from Australia could not be used for evaluation because only the parent compound imidacloprid was determined.

The Meeting noted that in the case of two applications with intervals of 30 – 67 days only the last one is of importance for the concentration of residues, and therefore the results from trials with one and two applications were combined: 0.07, 0.08, 0.11, 0.12, 0.14, 0.15, 0.15, 0.16, 0.28 mg/kg. As for two of nine trials only results for the edible portion were available, the STMR and HR was derived from the whole fruit data set. The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in cherries, sweet, of 0.5, 0.14 and 0.28 mg/kg, respectively.

The current French label indicates imidacloprid may be applied on plums 1 – 2 times at 0.007 kg ai/hl with a PHI of 56 days. A total of 14 residue trials with foliar spray application on plums were performed in Europe with 1 x 0.007 kg ai/hl; 10 in France, 2 in Germany and 2 in UK. The total residues were <0.05 (14) mg/kg in whole fruits after a 21- or 56-day PHI.

Imidacloprid is registered in Italy in plums with one foliar spray treatment of 0.01 kg ai/hl and 21-day PHI. Ten trials were performed in France, Italy and Spain according to the Italian GAP spray concentration of 0.01 kg ai/hl. In each trial, 2 treatments (interval 30 days) were made at application rates of 0.1 or 0.15 kg ai/ha (except for one trial in which the first application had a rate of 0.3 kg ai/ha, interval 144 days). The whole fruit residue concentrations were <0.05 (7), 0.05, 0.09, 0.12 mg/kg after a 21-day PHI.

The Meeting decided to combine the values. The ranked order of concentrations of residues was: <0.05 (21), 0.05, 0.09 and 0.12 mg/kg. The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in plums of 0.2, 0.05 and 0.12 mg/kg, respectively.

Grapes. Imidacloprid is registered for foliar spraying in grapes in Portugal (1 x 0.007 kg ai/hl, 0.07 kg ai/ha, PHI 14 days) and in the USA (1 – 2 x 0.04 – 0.052 kg ai/ha, 0-day PHI). Three residue trials were performed in Portugal and one each in Italy and Spain and complied approximately with the GAP (1 x 0.01 kg ai/hl). The residue concentrations were <0.05 (3), 0.12 and 0.2 mg/kg after a 14-day PHI.

A total of 16 residue trials were performed according to GAP in the USA in 1991/92. In each trial, 2 applications (interval 11-16 days) were made. All applications were carried out approximately at the highest label application rate (0.053 kg ai/ha). Based on a concentrated spray volume of 374-477 l/ha, the spray concentration ranged between 0.011 and 0.014 kg ai/hl. Based on a diluted spray volume of 935-1189 l/ha, the spray concentration ranged between 0.0045 and 0.0057 kg ai/hl. At the 0-day PHI, the concentrations of residues were: <0.05, 0.05, 0.06, 0.06, 0.06, 0.11, 0.11, 0.11, 0.12, 0.12, 0.12, 0.16, 0.17, 0.19, 0.2, 0.21 and 0.61 mg/kg.

The Meeting decided to combine the values from European and US trials. The ranked order of concentrations of residues was: <0.05 (4), 0.05, 0.06 (3), 0.11 (3), 0.12 (3), 0.16, 0.17, 0.19, 0.2, 0.2, 0.21, 0.61 mg/kg. The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in grapes of 1, 0.11 and 0.61 mg/kg, respectively.

Tropical fruits. Imidacloprid is registered for banana in Cameroon and Ivory Coast with application of 0.25 g ai/plant of the non-diluted product to the base of the pseudo-trunk and a 1-day PHI. A further use is bud flower (bell) injection with 0.012 kg ai/hl in the Philippines.

Four residue trials from Martinique with application of 0.25 g ai/plant to the base of pseudo-trunk and twelve trials with single basal drench application of 0.21 – 0.29 g ai/plant in Costa Rica, Ecuador, Guatemala and Honduras complied with GAP in Cameroon and in Ivory Coast. In the Martinique trials, the total residue was below the LOQ of 0.05 mg/kg in all samples (pulp, peel, whole fruit) and at all sampling dates. In the Central and South America trials, the total residues were below or at the LOQ of 0.01 mg/kg in all banana whole fruit samples (PHIs 0 – 35 days).

The residues in whole banana in rank order were: <0.01 (10), 0.01, 0.01, <0.05 (4) mg/kg. The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in banana of 0.05, 0.01 and 0.05 mg/kg, respectively.

Imidacloprid is registered for mango in the Philippines with 1 – 2 x 0.002 – 0.0025 kg ai/hl, 0.02 – 0.062 kg ai/ha, PHI 20 days and in the USA with 6 x 0.093 kg ai/ha., PHI 30 days. Four residue trials were conducted in the Philippines with 2 – 5 foliar spray applications at a spray concentration of 0.0025 kg ai/hl. The trials could not be used for evaluation because the PHIs were 30 – 92 instead of 20 days. Six further trials were performed in the USA. In each trial, six treatments were made. Three trials were performed with diluted sprays at a concentration of 0.004 kg ai/hl and the remaining 3 were made with concentrated sprays at a concentration of 0.16 kg ai/hl. The application rates ranged from 0.072 to 0.097 kg ai/ha. With a PHI of 30 days, the total residues in de-pitted fruits were <0.05 (3), 0.11, 0.15 mg/kg.

The Meeting noted that no data were received for whole mango fruits. Taking into account the stone weight of about 20% of the fruit, a maximum residue level of 0.2 mg/kg was estimated for mango.

The Meeting estimated an STMR an HR for imidacloprid in mango of 0.05 and 0.15 mg/kg, on the basis of the data for fruits without stone.

Bulb vegetables. Imidacloprid is an authorised minor use for dressing of leek seed in Germany with an application rate of 45 g ai/unit (250 000 seeds) and a maximum rate of 0.09 kg ai/ha. Four trials were performed in northern European countries with a seed dressing rate of 60g ai/unit, which corresponds to 0.06 to 0.072 kg ai/ha. The total residues in shoots were <0.05 mg/kg (4) with PHIs of 158 – 190 days.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in leek of 0.05*, 0.05 and 0.05 mg/kg.

Imidacloprid is an authorized minor use for dressing of onion seed in Germany with an application rate of 45 g ai/unit (250 000 seeds) and a maximum rate of 0.18 kg ai/ha. Further use is foliar spray in Brazil and Thailand, but no adequate residue data were submitted. In northern Europe a total of eight residue trials were performed on onions with a seed treatment rate of 45 g ai/unit according to German GAP. The total residues in bulb were <0.05 (7), 0.06 mg/kg at PHIs of 179 – 199 days.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in onions of 0.1, 0.05 and 0.06 mg/kg, respectively.

Brassica vegetables, head cabbage, flowerhead brassicas. The residue trials for broccoli, cauliflower, Brussels sprouts and head cabbage were evaluated together for mutual support.

Imidacloprid is registered world-wide in broccoli for foliar spray, drench or soil application. Spanish GAP allows 2 foliar sprays with 0.1 kg ai/ha and a 14-day PHI. Four residue field trials performed in Italy (3 trials) and Spain (1 trial) on broccoli complied with Spanish GAP. The residues were 0.08, 0.1, 0.29, 0.31 mg/kg. Australian broccoli GAP allows foliar spray at 0.06 kg ai/ha and a 7-day PHI. The concentration of residues in broccoli in one trial that complied with GAP (4 x 0.05 – 0.06 kg ai/ha) was 0.19 mg/kg. The current USA labels allow soil application with 0.18 – 0.42 kg ai/ha with a 21-day PHI and 1 – 5 foliar spray applications of 0.053 kg ai/ha with a 7-day PHI. Twelve field studies were conducted using three applications of imidacloprid. The first was a soil drench application, localised at the base of the plants, fourteen days after transplanting, at a rate of 0.01 g ai/plant (0.56 kg ai/ha). The remaining applications were two foliar spray applications at a rate of 0.12 kg ai/ha. These overdosed trials could not be used for evaluation.

In South Africa drench application over seedlings prior to transplanting with 0.1 – 0.2 kg ai/ha and a 76-day PHI is registered. One trial complied with GAP and did not show residues in curds higher than the LOQ of 0.05 mg/kg at 76 days after treatment.

The combined residues from broccoli trials according to GAP were <0.05, 0.08, 0.1, 0.19, 0.29, 0.31 mg/kg.

Imidacloprid is registered world-wide in cauliflower for foliar spray, drench or soil application. Spanish GAP allows 2 foliar sprays with 0.1 kg ai/ha and a 14-day PHI. Five residue field trials performed in Italy complied with Spanish GAP. The residues were 0.06, 0.07, 0.08, 0.09 and 0.11 mg/kg.

Australian GAP allows foliar spray at 0.06 kg ai/ha and a 7-day PHI. The concentration of residues in cauliflower in one trial that complied with GAP (2 x 0.06 kg ai/ha) was 0.01 mg/kg. The current USA labels allow soil application with 0.18 – 0.42 kg ai/ha with a 21-day PHI and 1 – 5 foliar spray applications of 0.052 kg ai/ha with a 7-day PHI. Twelve cauliflower field studies were

conducted using three applications of imidacloprid. The first application was a soil drench application, localized at the base of the plants. Fourteen days after transplanting, a rate of 0.01 g ai/plant was applied (0.56 kg ai/ha). The remaining applications were two foliar spray applications at rates of 0.12 kg ai/ha. These overdosed trials could not be used for evaluation.

In South Africa drench application over seedlings prior to transplanting with 0.1 – 0.2 kg ai/ha and a 136-day PHI is registered. One trial complied with GAP and residues in curds were below than the LOQ of 0.05 mg/kg at 136 days after treatment.

The combined residues from trials according to GAP in cauliflower were 0.01, <0.05, 0.06, 0.07, 0.08, 0.09 and 0.11 mg/kg.

Australian GAP for Brussels sprouts allows foliar spray at 0.06 kg ai/ha and a 7-day PHI. The concentration of residues in two trials that complied with GAP (2 – 3 x 0.06 kg ai/ha) was 0.03 and 0.32 mg/kg.

In South Africa drench application over Brussels sprouts seedlings prior to transplanting with 0.1 – 0.2 kg ai/ha and a 91-day PHI is registered. One trial complied with GAP, another was overdosed with residues below the LOQ of 0.05 mg/kg at 91 or 136 days after treatment.

The concentration of residues in Brussels sprouts were in rank order: 0.03, <0.05, <0.05, 0.32 mg/kg.

Australian GAP for head cabbage allows foliar spray at 0.06 kg ai/ha and a 7-day PHI. The concentration of residues in heads in two trials that complied with GAP (3 - 5 x 0.06 kg ai/ha) were 0.02 mg/kg and 0.22 mg/kg. The value of 0.22 mg/kg was not included in evaluation because in this trial 'heart and wrapper leaves' was analyzed.

The current USA labels allow soil application in head cabbage with 0.18 – 0.42 kg ai/ha with a 21-day PHI and 1 – 5 foliar spray applications of 0.053 kg ai/ha with a 7-day PHI. Thirteen field studies were conducted using three applications of imidacloprid. The first application was a soil drench application, localized at the base of the plants. Fourteen days after transplanting, a rate of 0.01 g ai/plant was applied (0.56 kg ai/ha). The remaining applications were two foliar spray applications at a rate of 0.12 kg ai/ha. These overdosed trials could not be used for evaluation.

Thirty bridging studies to compare the residues from the various types of soil application patterns were carried out in the USA with 0.19 - 0.6 kg ai/ha in broccoli, cauliflower and head cabbage. Treatments were made as soil drench, in-furrow or sidedress applications at the time of planting, or 14 days after planting at the latest. On the one hand, some trials treated with application rates of 0.19 or 0.27 kg ai/ha did not match the maximum GAP of 0.42 kg ai/ha, on the other hand the trials applied with 0.56 and 0.6 kg ai/ha exceeded the maximum GAP for 33 – 42% and were outside of the tolerance. Only one trial on cauliflower treated with 0.51 kg ai/ha approximately matched the GAP and showed residues of 0.21 mg/kg at a 38-day PHI. As the Meeting was informed that the waiting period of 21 days ('do not apply a soil application within 21 days of harvest'), prescribed in the US label of the 240 SC formulation for cabbages and flowerhead brassicas is not a normal residue-related PHI, the result was used for evaluation.

The Meeting noted that the data on broccoli, cauliflower, Brussels sprouts and head cabbage (without wrapper leaves) were similar and could be combined for mutual support. The combined residues were, in rank order: 0.01, 0.02, 0.03, <0.05 (4), 0.06, 0.07, 0.08, 0.08, 0.09, 0.1, 0.11, 0.19, 0.21, 0.29, 0.31, 0.32 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in broccoli, cauliflower, Brussels sprouts and head cabbages of 0.5, 0.08 and 0.32 mg/kg, respectively.

Cucurbits. Imidacloprid is registered in cucumber in Europe (indoor Denmark, Netherlands; in- and outdoor Spain, Greece) as foliar spray, treatment with the irrigation water or treatment in nutrition solution in rock wool.

A total of six indoor residue trials were conducted in cucumber with drip irrigation application in the Netherlands. The plants were grown on rock wool. In two of the trials, 2.5 mg imidacloprid was applied in 10 ml water to the base of each plant. This amount is equal to a rate of 0.024 - 0.034 kg ai/ha, which is in accordance with the lowest rate, registered in The Netherlands. The plants in the four further trials received 10 mg imidacloprid per plant, which corresponds to an application rate of about 0.12 - 0.15 kg ai/ha. The use rate of 10 mg ai/plant is in accordance with the maximum label rate in The Netherlands, Denmark, Greece, and Spain. The registered PHI is 1 day but the highest residues were found after about 5 – 7 days. The residues were in rank order: 0.25, 0.31, 0.39 and 0.39 mg/kg.

Ten further indoor trials were performed in cucumber in southern France (8 trials) and Spain (2 trials) with drip irrigation application. Each plant received 25 mg ai/plant. This rate represented 2.5 times the recommended label use rate in Greece and Spain and could not be used for evaluation.

In Spain, imidacloprid is registered in cucumber with 1 – 2 foliar spray treatments of 0.1 kg ai/ha, 0.01 kg ai/hl and a 3-day PHI in glasshouse or in the field. In Italy one indoor trial in cucumber was conducted with foliar spray application of 0.15 kg ai/ha (0.015 kg ai/hl) and was not in accordance with the Spanish GAP. In Spain three residue outdoor field trials were performed according to GAP with application rates of 0.1 kg ai/ha (2 treatments, interval 15 days, 0.01 kg ai/hl) but samples were not taken at the registered PHI of 3 days.

The current Australian label indicates imidacloprid may be applied as foliar spray with a rate of 0.05 kg ai/ha in the field to cucumber. The concentration of residues in cucumbers in one trial that complied with GAP (4 x 0.06 kg ai/ha) was 0.04 mg/kg.

The residues from trials according to maximum GAP from the Netherlands and Australia were in rank order: 0.04, 0.25, 0.31, 0.39, 0.39 mg/kg. The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in cucumber of 1, 0.31 and 0.39 mg/kg, respectively.

The use patterns of imidacloprid for summer squash and cucumber in the Netherlands and in Spain are identical. In Italy two summer squash trials were conducted with foliar spray application of 2 x 0.15 kg ai/ha, which is not in accordance with the Spanish GAP.

The Meeting agreed to extrapolate the data on residues in cucumber to summer squash and estimated a maximum residue level, an STMR value and an HR value for imidacloprid in summer squash of 1, 0.31 and 0.39 mg/kg, respectively.

Imidacloprid is registered in melons in Spain and Portugal with 1 – 2 foliar spray treatments of 0.1 kg ai/ha, 0.01 kg ai/hl and 3-day PHI. A total of ten residue field trials were performed in southern Europe (Italy and Spain) according to Spanish GAP. The residue

concentrations in whole fruit were in rank order: <0.05 (4), 0.05, 0.06, 0.07, 0.08, 0.13, 0.15 mg/kg and in pulp <0.05 (6), 0.05, 0.11 mg/kg. In Spain, application of 0.1 – 0.15 kg ai/ha in the irrigation water is registered. Two indoor residue trials were conducted in melon using drip irrigation application of 0.1 kg ai/ha and did not match the maximum GAP.

The current Australian label indicates foliar spray treatments with 0.06 kg ai/ha and a 1-day PHI. Two trials were conducted with four foliar spray applications each (interval 7-17 days) of 0.06 kg ai/ha and showed residues of 0.03 and 0.07 mg/kg in whole fruits.

In South Africa one residue field trial in melons was performed according to GAP using drench application of 0.02 g ai/plant at planting. The residue was <0.01 mg/kg in whole fruits 100 days after planting.

The residues from trials according to GAP from Italy, Spain, Australia and South Africa were <0.01, 0.03, <0.05 (4), 0.05, 0.06, 0.07, 0.07, 0.08, 0.13, 0.15 mg/kg in whole fruit. The Meeting estimated a maximum residue level of 0.2 mg/kg for imidacloprid in melons.

The residues were <0.05 (6), 0.05, 0.11 mg/kg in the edible portion. The Meeting estimated an STMR and an HR for imidacloprid in melons of 0.05 and 0.11 mg/kg.

Imidacloprid is registered in watermelons in Spain with 1 – 2 foliar spray treatments of 0.1 kg ai/ha, 0.01 kg ai/hl and 3-day PHI. A total of ten residue field trials were conducted in southern Europe (Greece, Italy and Spain) with 2 applications (interval 7 – 20 days) of 0.1 kg ai/ha according to Spanish GAP. The residues were <0.05 (6), 0.05, 0.07, 0.09, 0.1 mg/kg in whole fruit. The Meeting estimated a maximum residue level of 0.2 mg/kg for imidacloprid in watermelons.

The residues were <0.05 (7), 0.05, 0.06 mg/kg in the edible portion. The Meeting estimated an STMR value and an HR value for imidacloprid in watermelons of 0.05 and 0.06 mg/kg.

Fruiting vegetables, other than cucurbits. Imidacloprid is registered for indoor and outdoor use with foliar spray treatment in egg plants in Italy (1 x 0.1 - 0.15 kg ai/ha, 0.01 - 0.015 kg ai/hl, 7-day PHI) and in Spain (1 – 2 x 0.1 kg ai/ha, 0.01 kg ai/hl, 3-day PHI). The residue concentrations from trials according to GAP were <0.05 (6), 0.06, 0.06, 0.08, 0.14 mg/kg. Four further trials from Italy and two from Brazil did not match the GAP.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in egg plant of 0.2, 0.05 and 0.14 mg/kg, respectively.

Imidacloprid is registered in peppers world-wide as foliar spray, treatment with the irrigation water or treatment in nutrition solution on rock wool.

Imidacloprid is registered for indoor and outdoor use with foliar spray treatment in peppers in Italy (1 x 0.1 - 0.15 kg ai/ha, 0.01 - 0.015 kg ai/hl, 7-day PHI) and in Spain (1 – 2 x 0.1 kg ai/ha, 0.01 kg ai/hl, 3-day PHI). The southern European trials (13 indoor, 6 outdoor) treated with 0.15 kg ai/ha complied with Italian GAP (PHI 7 days) and those with 0.1 kg ai/ha with Spanish GAP (PHI 3 days). The residue concentrations from trials according to GAP were <0.05, 0.07, 0.07, 0.09, 0.1, 0.1, 0.11, 0.11, 0.12, 0.15, 0.15, 0.15, 0.17, 0.21, 0.22, 0.24, 0.26, 0.27 and 0.48 mg/kg.

In Australia three indoor pepper residue trials were performed with application rates at the recommended label use rate of 0.05 kg ai/ha as well as at the double and four fold rates of 0.1 kg ai/ha and 0.2 kg ai/ha. Eight applications were made in each trial (interval 14-16 days). Because

only imidacloprid was analysed in the pepper fruits, the data could not be used for evaluation. Two further foliar spray trials from Brazil did not match the GAP.

A total of four residue trials were conducted in sweet pepper simulating drip irrigation application in greenhouses in the Netherlands. The pepper crop was grown on rock wool. 10 mg imidacloprid was applied in 10 ml water at the base of each plant. This quantity corresponds to an application rate of 0.2 - 0.32 kg ai/ha, which is in accordance with GAP (9.8 g/1000 plants). The residue concentrations were 0.16, 0.17, 0.24 and 0.27 mg/kg.

In two pepper greenhouse residue trials (Italy, Portugal) a rate of 0.2 kg ai/ha imidacloprid was applied with the irrigation water to the soil. The trials were in accordance with Danish GAP. Residues below the LOQ were found at all sampling dates (3 – 60 days). The residues were <0.05 (2) mg/kg.

The current USA labels allow soil application with 0.28 – 0.56 kg ai/ha with a 21-day PHI and 5 foliar spray applications of 0.053 kg ai/ha with a 0-day PHI. Nine pepper field studies were conducted with three applications of imidacloprid. The first application was a soil drench application, localised at the base of the plants. Fourteen days after transplanting, a rate of 0.025 g ai/plant was applied (0.41 – 0.67 kg ai/ha). The remaining applications were two foliar spray applications at rates of 0.12 kg ai/ha. These overdosed trials could not be used for evaluation.

The remaining sixteen US pepper residue trials were bridging studies to compare the residues from the various types of soil applications and formulations. Treatments were made at the time of planting, or two weeks after planting at the latest. Only two trials for sweet pepper and one for hot pepper with soil drench application of 0.41-0.49 kg ai/ha matched the GAP resulting in concentrations of residues of <0.05, 0.06 and 0.24 mg/kg at PHIs of 54 – 60 days. As the Meeting was informed that the waiting period of 21 days ('do not apply a soil application within 21 days of harvest'), prescribed in the US label of the 240 SC formulation for fruiting vegetables is not a normal residue related PHI, the results were used for evaluation..

The Meeting considered that the data from indoor and outdoor trials as well as from the different treatments are from the same pool and combined them, resulting in a ranked order as follows: <0.05 (4), 0.06, 0.07, 0.07, 0.09, 0.1, 0.1, 0.11, 0.11, 0.12, 0.15 (3), 0.16, 0.17, 0.17, 0.21, 0.22, 0.24 (3), 0.26, 0.27, 0.27 and 0.48 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in peppers of 1, 0.15 and 0.48 mg/kg, respectively.

Imidacloprid is registered in tomatoes world-wide as foliar spray, application with the irrigation water or treatment in nutrition solution in rock wool.

Imidacloprid is registered for indoor and outdoor use with foliar spray treatment in tomatoes in Italy (200 SL: 1 x 0.1 - 0.15 kg ai/ha, 0.01 - 0.015 kg ai/hl, 7-day PHI; 100 EC: 0.09 kg ai/ha, 0.011 kg ai/hl, 3-day PHI greenhouse, 7-day PHI field) and in Spain/Portugal (1 – 2 x 0.1 kg ai/ha, 0.01 kg ai/hl, 3-day PHI). The southern European trials (9 indoor, 9 outdoor) treated with 0.015 kg ai/ha complied with Italian GAP (PHI 7 or 3 days) and those with 0.1 kg ai/ha with Spanish GAP (PHI 3 days). The residue concentrations from trials according to GAP were <0.05 (6), 0.05, 0.06, 0.06, 0.07 (3), 0.08 (3), 0.09, 0.09, 0.1, 0.1, 0.12, 0.13, 0.14, 0.17, 0.18 and 0.29 mg/kg. Two further foliar spray trials from Brazil did not match the GAP.

A total of six residue trials were conducted in tomatoes simulating drip irrigation application in the greenhouse in the Netherlands. The crop was grown on rock wool. 10 mg imidacloprid was applied in 10 ml water at the base of each plant. This quantity corresponds to an application rate of 0.23 - 0.29 kg ai/ha, which is in accordance with GAP (9.8 g/1000 plants). The residue concentrations were 0.05, 0.08, 0.09, 0.14, 0.15 and 0.16 mg/kg.

In two greenhouse residue trials (Italy, Portugal) a rate of 0.2 kg ai/ha imidacloprid was applied with the irrigation water to the soil. The trials were in accordance to Danish GAP. Residues were below the LOQ at all sampling dates (3 – 60 days). The residues were <0.05 (2) mg/kg.

The current USA labels for tomato allow soil application with 0.28 – 0.42 kg ai/ha with a 21-day PHI and 5 foliar spray applications of 0.05 kg ai/ha with a 0-day PHI. Eleven field studies (9 in the USA, 2 in Canada) were conducted utilising three applications of imidacloprid. The first application was a soil drench application, localized at the base of the plants. Fourteen days after transplanting, a rate of 0.025 g ai/plant was applied (0.5 – 0.56 kg ai/ha). The remaining applications were two foliar spray applications at rates of 0.12 kg ai/ha. These overdosed trials could not be used for evaluation.

The remaining US tomato residue trials were bridging studies to compare the residues from the various types of soil applications and formulations. Treatments were made at the time of planting, or two weeks after planting at the latest. As the application rate of 0.56 kg ai/ha exceeded the maximum GAP rate of 0.42 mg/kg for more than 30%, the trials were not used for evaluation.

The Meeting considered that the data from indoor and outdoor trials as well as from the different treatments are from the same pool and combined them, resulting in the following ranked order of concentrations of 33 residue values: <0.05 (8), 0.05, 0.05, 0.06, 0.06, 0.07 (3), 0.08 (4), 0.09 (3), 0.1, 0.1, 0.12, 0.13, 0.14, 0.14, 0.15, 0.16, 0.17, 0.18 and 0.29 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in tomatoes of 0.5, 0.08 and 0.29 mg/kg, respectively.

The Australian label indicates imidacloprid may be applied as seed treatment in sweet corn with 0.26 kg ai/100 kg seed. Three trials each were carried out with 0.26 or 0.35 kg ai/100 kg seed and two trials with 0.52 kg ai/100 kg seed. In all samples, the residues in cobs were lower than the LOQs: <0.01 (6), <0.02 (2) mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in sweet corn (corn-on-the-cob) of 0.02*, 0.01 and 0.02 mg/kg, respectively.

Leafy vegetables. Imidacloprid is registered in Spain for use in lettuce as foliar spray treatment (1 – 2 x 0.1 kg ai/ha, 0.01 kg ai/hl, 3-day PHI). A total of seven field residue trials on head lettuce were performed according to Spanish GAP in southern Europe (1 Greece, 2 Italy, 4 Spain) in 1989 - 2001. Residues in rank order were: 0.69, 0.87, 0.88, 0.9, 0.98, 0.99, 1.2 mg/kg. One further trial on leaf lettuce was carried out in Spain according to GAP and showed residues of 1.5 mg/kg.

Another Spanish lettuce use pattern is application in irrigation water with 0.01 g ai/plant. Twenty four indoor and outdoor residue trials in France and Germany carried out with drench application of 0.0024 g ai/plant and one trial from Italy with 0.3 kg ai/ha did not match Spanish GAP and could not be used for evaluation.

The current USA labels allow soil application in lettuce with 0.18 – 0.42 kg ai/ha with a 21-day PHI and 5 foliar spray applications of 0.05 kg ai/ha with a 7-day PHI. Fourteen field studies on head lettuce and twelve on leaf lettuce were conducted utilizing three applications of imidacloprid. The first application was a soil drench application, localized at the base of the plants. Fourteen days after transplanting, a rate of 0.01 g ai/plant was applied (0.56 kg ai/ha). The remaining applications were two foliar spray applications at rates of 0.12 kg ai/ha. These overdosed trials could not be used for evaluation.

The remaining US lettuce residue trials (10 leaf lettuce, 7 head lettuce) were bridging studies to compare the residues from the various types of soil applications. Treatments on head and leaf lettuce were made at the time of planting, or two weeks after planting at the latest. As the application rate of 0.56 kg ai/ha exceeded the maximum GAP rate of 0.42 kg ai/ha for more than 30%, the trials were not used for evaluation.

Based on the southern European head lettuce residue data, the Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in head lettuce of 2, 0.9 and 1.2 mg/kg, respectively.

Legume vegetables. Imidacloprid is registered in Spain for use in green beans with foliar spray treatment (1 – 2 x 0.1 kg ai/ha, 0.01 kg ai/hl, 3-day PHI). A total of 11 field residue trials were performed in 1991 – 1996 in Europe (2 France, 3 Italy, 6 Spain) according to Spanish GAP. Residues in beans with pods were, in rank order: 0.16, 0.24, 0.32, 0.33, 0.38, 0.39, 0.41, 0.44, 0.55, 0.61 and 0.66 mg/kg.

Four Brazilian trials were carried out with 5 x 0.18 or 5 x 0.35 kg ai/ha by foliar spraying. One of them complied with Brazilian GAP (0.18 kg ai/ha, PHI 21 days) and showed in beans without pods a residue of 0.01 mg/kg at a PHI of 21 days.

The current USA labels allow soil application with 0.28 – 0.42 kg ai/ha with a 21-day PHI and 3 foliar spray applications of 0.049 kg ai/ha with a 7-day PHI. Trials with different treatment scenarios were made in the USA.

Five field studies in common bean were conducted using five applications of imidacloprid. The first application was seed treatment with 0.25 kg ai/100 kg seed, one in-furrow spray application at planting with 0.42 kg ai/ha and three foliar spray applications of about 0.05 kg ai/ha. At a 7-day PHI, the residues were in beans with pods: 0.23, 0.38, 0.52, 0.61, 0.88 mg/kg.

Five field studies in lima bean were conducted using four applications of imidacloprid. One in-furrow spray application at planting with 0.42 kg ai/ha followed by three foliar spray applications of about 0.05 kg ai/ha. At a 7-day PHI, residues in beans without pods were: <0.05, <0.05, 0.12, 0.17, 0.25 mg/kg.

The combined residues for beans with pods in rank order were: 0.16, 0.23, 0.24, 0.32, 0.33, 0.38, 0.38, 0.39, 0.41, 0.44, 0.52, 0.55, 0.61, 0.61, 0.66 and 0.88 mg/kg. The combined residues for beans without pods in rank order were: 0.01, <0.05, <0.05, 0.12, 0.17 and 0.25 mg/kg. The Meeting considered the two data sets to be from different populations and agreed to use those for beans with pods (higher values) for making estimates.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in beans, except broad bean and soya bean, of 2, 0.4 and 0.88 mg/kg, respectively.

Pulses. Three residue trials with dry beans were conducted in Brazil, none of them complied with the Brazilian GAP for seed treatment with 0.14 kg ai/100 kg seed. The Meeting considered that the data were inadequate to allow assessment of residues of imidacloprid in dry beans.

Potatoes. Imidacloprid is registered world-wide in potatoes as seed treatment, soil treatment at planting and foliar spraying.

Eight residue trials were carried out in Germany with two procedures: direct spray on potatoes and in-furrow spray during planting or in-furrow spray on seed potatoes and soil band spray. The application rate was 12 g ai/100 kg seed potatoes according to the Netherlands' GAP (soil treatment in-furrow at planting with 11 g ai/100 kg seed). The residues were <0.05 mg/kg (8).

Eight further trials were performed in France (2 trials), Greece (1), Germany (2), Italy (1), Spain (1) and UK (1) with seed treatment of 7.2 g ai/100 kg according to German GAP. The residues were <0.05 (7) and 0.05 mg/kg.

Seven trials were performed in France (2 trials), Germany (1), Italy (2) and Spain (2) with seed treatment of 14 g ai/100 kg according to Spanish GAP. The residues were <0.05 (3), 0.09, 0.1, 0.12 and 0.12 mg/kg.

Three trials were performed in Italy at seed treatment of 25 g ai/100 kg seed according to maximum Italian GAP. The residues were 0.06, 0.15 and 0.2 mg/kg.

Foliar spray treatment is registered in Europe with 1 - 2 x 0.1 kg ai/ha in Greece, 1 x 0.1 - 0.15 kg ai/ha in Spain or 1 - 2 x 0.072 - 0.15 kg ai/ha in Italy/Portugal. The PHI is 14 days in Greece and Italy, 21 days in Portugal and 30 days in Spain. Fifteen trials were performed with foliar spraying of 2 x 0.09 - 0.1 kg ai/ha in Italy (13) and Spain (2). Residues in samples taken after 7, 14 or 21 days were <0.05 mg/kg (15).

In Canada imidacloprid is registered for use in soil and for foliar application on potatoes. The use rates for soil application are 0.2 - 0.31 kg ai/ha, and for spray application 0.048 kg ai/ha. In the USA imidacloprid is also registered for use in soil at rates of 0.02 - 0.03 g ai/m, corresponding to between 0.28 and 0.35 kg ai/ha, and as a foliar spray with an application rate of about 0.05 kg ai/ha and a PHI of 7 days. Regardless of formulation or type of application (soil or foliar) it is not allowed to apply more than a total of 0.56 kg ai/ha per season.

In Canada three trials were conducted with in-furrow application (0.03 g ai/m row) at planting, followed by four spray applications at rates of 0.053 kg ai/ha. The residues were <0.1, <0.1 and 0.12 mg/kg.

Three residue field trials were performed in the USA with in-furrow application of 0.33 - 0.34 kg ai/ha only. The residues were 0.02, 0.07 and 0.18 mg/kg.

A total of nineteen residue field trials were performed in the USA with both in-furrow application and foliar spray application. A rate of 0.03 g ai/m row was applied as an in-furrow spray, which corresponds to 0.29-0.4 kg ai/ha. Four foliar sprays at rates of 0.053 kg ai/ha followed. The residues were <0.05 (12), 0.05, 0.05, 0.05, 0.07, 0.13, 0.16 and 0.28 mg/kg.

In South Africa, use of imidacloprid on potatoes is registered for soil treatment with application rates of 1.1 to 1.6 g ai/100 m row, corresponding to 0.14 - 0.21 kg ai/ha. Three trials

were received with in-furrow application of 0.1, 0.2 and 0.3 kg ai/ha. The residues in the two trials according to GAP were <0.04 and 0.04 mg/kg.

In South Korea, imidacloprid is registered for soil application with 0.06 kg ai/ha and a 30-day PHI. Three residue trials were performed in South Korea with 1 to 4 applications of 0.06 kg ai/ha and incorporation into the soil. Only the parent compound imidacloprid was determined. The trials could not be used for evaluation.

In total, the following three data sets according to GAP were available (i) in-furrow treatment and in-furrow treatment followed by foliar spraying: 0.02, <0.04, 0.04, <0.05 (20), 0.05, 0.05, 0.05, 0.07, 0.07, <0.1, <0.1, 0.12, 0.13, 0.16, 0.18, 0.28 mg/kg, (ii) seed treatment <0.05 (10), 0.05, 0.06, 0.09, 0.1, 0.12, 0.12, 0.15, 0.2 mg/kg, and (iii) foliar spray only <0.05 mg/kg (15).

Because a residues were below the LOQ in tubers after foliar spraying, the Meeting noted that these data are a different population and agreed to combine only the data sets for seed dressing and in-furrow treatment/in-furrow treatment followed by foliar spray for making estimations. The combined 53 residue concentrations were in rank order: 0.02, <0.04, 0.04, <0.05 (30), 0.05 (4), 0.06, 0.07, 0.07, 0.09, <0.1, <0.1, 0.1, 0.12 (3), 0.13, 0.15, 0.16, 0.18, 0.2, 0.28 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in potatoes of 0.5, 0.05 and 0.28 mg/kg, respectively.

Sugar beets. Imidacloprid is registered in European countries in sugar beet for seed treatment with 0.09 kg ai/unit (100 000 seeds). 20 residue trials were performed in France (1), Germany (8), Italy (5), Sweden (2) and UK (4) with application rates of 0.09 – 0.11 kg ai/unit. Residues in sugar beet at harvest were <0.05 mg/kg (20).

Further use is foliar spray with 1 – 2 x 0.072 kg ai/ha and a 30-day PHI in Italy. In Italy a total of 8 residue field trials were performed in sugar beet with 2 spray applications of 0.09 kg ai/ha. With the PHI of 30 days, residues in sugar beet were <0.05 mg/kg (8).

Based on the combined residues of <0.05 mg/kg (28), the Meeting estimated a maximum residue level and an STMR value for imidacloprid in sugar beet of 0.05* and 0.05 mg/kg.

Celery. The current US labels for celery allow soil application with 0.18 – 0.42 kg ai/ha with a 45-day PHI. 12 trials with different treatment scenarios were made in the USA: Six residue field trials were conducted with plant drench application. Application rates of 0.54 kg ai/ha (1 trial) and 0.56 to 0.59 kg ai/ha (5 trials) were applied, 43 - 46 days prior to harvest. The remaining six other residue trials were bridging studies to compare the residues from the various types of soil applications. As the application rate of 0.56 – 0.6 kg ai/ha exceeded the maximum GAP rate of 0.42 mg/kg for more than 30%, the trials were not used for evaluation.

The Meeting concluded that there were insufficient data to estimate a maximum residue level for celery.

Cereal grains. Imidacloprid is registered for seed treatment in barley, oat, rye, triticale and wheat with 0.35 kg ai/100 kg seed in Germany, 0.07 kg ai/100 kg seed in Belgium or France and with 0.07 – 0.14 kg ai/100 kg seed in Australia.

Barley. In one German and one UK trial the seed treatment was performed with 0.035 and 0.11 kg ai/100 kg seed. In 13 residue field trials conducted in different European countries and Australia

imidacloprid was applied as seed treatment with 0.07 kg ai/100 kg seed. In 3 Australian trials the seed treatment was performed with 0.14 kg ai/100 kg seed. Residues in barley grains were: <0.02, <0.02, <0.05 (15) mg/kg.

Oat. In one German, two Swedish and two Australian trials seed treatment was performed with 0.035, 0.11 and 0.07 kg ai/100 kg seed. Residues in oat grains were: <0.02, <0.02, <0.05 (3) mg/kg.

Triticale. In two Australian trials seed treatment was performed with 0.07 or 0.14 kg ai/100 kg seed. Residues in triticale grain were: <0.05 (2) mg/kg.

Wheat. In eight Australian, two Brazilian, six German, four French and three UK trials, seed treatment was performed with 0.035, 0.05, 0.07, 0.1, 0.11, 0.14 kg ai/100 kg seed. Residues in wheat grains were: 0.04, <0.05 (21), 0.05 mg/kg. All residue values of barley, oat, triticale and wheat were in rank order: <0.02 (4), 0.04, <0.05 (41), 0.05 mg/kg.

Imidacloprid is registered for seed treatment in maize with 0.35 kg ai/100 kg seed in South Africa, with 54 g/unit = 0.47 kg ai/100 kg seed in Germany and 0.7 kg ai/100 kg seed in Italy. In four German trials the seed treatment was performed with 0.47 kg ai/100 kg seed. In 10 residue field trials conducted in different European countries imidacloprid was applied as seed treatment with 0.7 kg ai/100 kg seed. In one South African trial the seed treatment was performed with 0.35 kg ai/100 kg seed. The residues were in maize grains <0.02 and <0.05 (14) mg/kg.

Imidacloprid is registered for seed treatment in rice in Brazil and Japan and/or for foliar spray in Japan, South Korea and Thailand. The use pattern allows foliar spray treatments in Thailand 1 – 2 x 0.038 kg ai/ha, in South Korea 1-3 x 0.03 kg ai/ha and in Japan 3 x 0.03 – 0.075 kg ai/ha. Six residue trials were received from Thailand, four of them were treated with 2 x 0.015 – 0.024 kg ai/ha and could not be used for evaluation. Two further trials treated with 2 x 0.05 kg ai/ha complied approximately with Thailand's GAP. At PHIs of 48 or 56 days, no residues higher than the LOQ of 0.05 mg/kg were analysed. Four trials received from South Korea (3 – 6 x 0.064 kg ai/ha) could not be used for evaluation because only parent compound imidacloprid was determined.

The Meeting concluded to combine the seed treatment residue data on barley, oats, maize, triticale, rice and wheat which were in rank order <0.02 (5), 0.04, <0.05 (57) and 0.05 mg/kg.

The Meeting estimated a maximum residue level, an STMR and an HR for imidacloprid in cereal grains each of 0.05 mg/kg.

Tree nuts. Imidacloprid is registered in pecan in USA for foliar spray treatment with 2 x 0.2 kg ai/ha and soil application with maximum 0.56 kg ai/ha (no PHI). Sixteen trials with foliar treatment and seven with soil treatment according to US GAP were received. Residues in nuts without shell were at each sampling date: <0.01 (9), 0.011 and <0.05 (13) mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in pecan of 0.05 mg/kg.

Oilseed. The use of imidacloprid in cotton is authorized as seed dressing, foliar spray and soil application before or at planting. Seed treatment trials were conducted in Greece, Brazil, Egypt and Australia.

One residue trial each was performed in Greece and Brazil at a rate of 0.7 kg ai/100 kg seed according to Spanish GAP and one further trial according to Brazilian GAP (0.35 kg ai/100 kg seed). Residues in cotton seed were <0.05 (3) mg/kg. Two trials from Egypt complied with GAP (0.49 kg ai/100 kg seed) and showed residues of 0.06, 0.09 mg/kg. The ten Australian trials could not be used for evaluation because only parent compound imidacloprid was determined. Altogether, the residue data in cotton seed from seed treatment use were <0.05 (3), 0.06 and 0.09 mg/kg.

Two foliar spray trials were conducted in Spain on cotton (0.1 + 0.15 kg ai/ha) resulting in residues of 0.49, 0.95 mg/kg in seed but were overdosed in comparison with Greek GAP (2 x 0.1 kg ai/ha). Also one South African trial (0.08 kg ai/ha) and 26 US trials with different treatment scenarios were not made according to the respective GAP.

The Meeting concluded that five seed treatment trials only were insufficient to estimate a maximum residue level or STMR value for imidacloprid in cotton seed.

Imidacloprid is registered for rape seed treatment in Australia, Germany and the UK with 0.2 – 0.24 kg ai/100 kg seed. Four residue trials were conducted in Sweden (1.4 kg ai/100 kg seed), 9 in France, 4 in Germany and 2 in UK (1.05 kg ai/100 kg seed) which were 4-to-5fold overdosed. The residues from these trials in rape seed were <0.05 (19) mg/kg. Two trials from Australia were carried out with 0.25 and 0.5 kg ai/100 kg seed. Residues in rape seed were <0.05 (2) mg/kg. Altogether, the data set is <0.05 mg/kg (21).

The Meeting estimated a maximum residue level, an STMR value and an HR value for imidacloprid in rape seed of 0.05*, 0.05 and 0.05 mg/kg.

Coffee beans. The current Brazilian label allows drench treatment with 0.7 – 0.91 kg ai/ha and a 45-day PHI. Three trials according to Brazilian GAP were submitted. In one of them only parent imidacloprid was determined. With a 45-day PHI, the residue data were: <0.05 (2) mg/kg for total residues and <0.02 mg/kg for imidacloprid.

The Meeting concluded that three trials were insufficient to estimate a maximum residue level or STMR value for imidacloprid in coffee beans.

Hops. Imidacloprid is registered in Europe (Austria, Germany, Spain, UK) and the USA in hops for foliar spray, stem painting or spray directed at stem base. Eight German foliar spray trials according to German GAP (1 x 0.13 kg ai/ha, 0.004 kg ai/hl, 35-day PHI) showed residues in kiln-dried cones of 0.48, 0.59, 0.73, 0.73, 0.81, 1.2, 1.3, 1.6 mg/kg. Brush application was carried out in four German trials and complied with German GAP (1 x 0.14 kg ai/ha, 2.3 kg ai/hl, PHI 35 days). The residues were in kiln-dried cones 0.43, 0.52, 0.75, 0.83 mg/kg. All residue data in rank order were 0.43, 0.48, 0.52, 0.59, 0.73, 0.73, 0.75, 0.81, 0.83, 1.2, 1.3 and 1.6 mg/kg.

Three US trials complied with US GAP (foliar spray 3 x 0.11 kg ai/ha, PHI 28 days). The residues were 1.3, 5.5 and 5.8 mg/kg in dried cones.

Eight UK trials complied with UK GAP (foliar spray 1 x 0.13 kg ai/ha, 0.03 – 0.055 kg ai/hl, PHI 103 – 120 days). The residues were <0.2 (5), 0.25, 0.29, 0.7 mg/kg in kiln-dried cones.

All data in rank order were <0.2 (5), 0.25, 0.29, 0.43, 0.48, 0.52, 0.59, 0.7, 0.73, 0.73, 0.75, 0.81, 0.83, 1.2, 1.3, 1.3, 1.6, 5.5 and 5.8 mg/kg.

The Meeting estimated a maximum residue level and an STMR value for imidacloprid in dried hops of 10 and 0.7 mg/kg.

Tea. The use of imidacloprid in tea is registered in Japan as a foliar spray with 0.01 kg ai/hl, 0.1 - 0.4 kg ai/ha and a 14-days PHI. Two residue trials each were performed in Japan in 1990 and 1998 according to GAP with 0.01 kg ai/hl, 0.2 kg ai/ha. With a 14-day PHI, residues of imidacloprid *per se* in dried leaves were 1.8, 1.9, 2.3, 3 mg/kg. Because only parent compound was analysed, these trials could not be used for evaluation.

Sugar beet leaves and tops. Imidacloprid is registered in Europe in sugar beets for seed treatment with 0.09 kg ai/unit (100 000 seeds). Altogether, 20 residue trials were performed in sugar beet in France (1), Germany (8), Italy (5), Sweden (2) and UK (4) with application rates of 90 -110 g ai/unit. Residues in sugar beet leaves at harvest (PHI >140 days) were <0.05 (9), 0.05, 0.06 (3), 0.07 (3), 0.09, 0.11, 0.11 and 0.14 mg/kg.

Further use is foliar spray with 1 – 2 x 0.072 kg ai/ha and a 30-day PHI in Italy. In Italy a total of 8 residue field trials were performed in sugar beet after 2 spray applications of 0.09 kg ai/ha. With a PHI of 30 days, residues in sugar beet leaves were 0.23, 0.31, 0.33, 0.4, 0.45, 0.47, 0.61 and 0.67 mg/kg.

The Meeting considered the two data sets to be from different populations and agreed to use those from foliar spray treatment (higher values) for making estimations. Allowing for the standard 23 % dry matter (*FAO Manual*), the Meeting estimated a maximum residue level and an STMR value (dry weight) for imidacloprid in sugar beet leaves and tops of 5 mg/kg and 1.8 mg/kg.

Cereals, forage and fodder. Imidacloprid is registered for seed treatment in barley, oat, rye, triticale and wheat with 0.35 kg ai/100 kg seed in Germany, 0.07 kg ai/100 kg seed in Belgium or France and with 0.07 – 0.14 kg ai/100 kg seed in Australia. The residues from trials according to GAP were as follows:

Barley. With PHIs from 50 - 79 days, residues in forage were: <0.02, 0.03, 0.03, 0.05, 0.06, 0.07, 0.09, 0.12, 0.12, 0.13, 0.15, 0.19, 0.24, 0.52, 0.67 mg/kg on fresh weight basis. The residues in straw were at harvest: <0.05 (6), 0.05, 0.05, 0.06, 0.09, 0.09, 0.11, 0.11, 0.12, 0.16, 0.28, 0.32 mg/kg.

Oat. With a 63-day PHI, residues in oat forage were: <0.02, 0.06, 0.09 mg/kg (fresh weight). The residues in straw were at harvest: <0.02, <0.02, <0.05, 0.05, 0.08 mg/kg (fresh weight). Triticale. With a 50 - 63-day PHI, residues in triticale forage were: 0.04, <0.05 mg/kg (fresh weight). The residues in straw were at harvest: <0.05, <0.05 mg/kg (fresh weight).

Wheat. With PHIs from 62 to 77 days, residues in wheat forage were: 0.02, 0.03, <0.05, 0.05, 0.07, 0.09, 0.1, 0.1, 0.1, 0.11, 0.12, 0.19, 0.19, 0.27, 0.39 mg/kg on fresh weight basis. The residues in straw were at harvest: <0.05 (6), 0.05 (3), 0.06, 0.06, 0.08, 0.09, 0.09, 0.11, 0.11, 0.13, 0.21, 0.23, 0.24, 0.45 mg/kg (fresh weight).

All residue values in barley, oats, triticale and wheat forages were in rank order: <0.02, <0.02, 0.02, 0.03 (3), 0.04, <0.05, <0.05, 0.05, 0.05, 0.06, 0.06, 0.07, 0.07, 0.09 (3), 0.1 (3), 0.11, 0.12 (3), 0.13, 0.15, 0.19 (3), 0.24, 0.27, 0.39, 0.52, 0.67 mg/kg on fresh weight basis. Allowing for the standard 28 % dry matter (average of wheat, rye and oat forage, *FAO Manual*), the Meeting estimated the following residue levels for cereal forage commodities listed as animal feed item:

A maximum residue level and an STMR of 5 mg/kg and 0.32 mg/kg for rye and oat forage. An highest residue level and an STMR of 2.4 mg/kg and 0.32 mg/kg for triticale and wheat forage.

All residue values in straw of barley, oats, triticale and wheat were in rank order: <0.02, <0.02, <0.05 (15), 0.05 (6), 0.06 (3), 0.08, 0.08, 0.09 (4), 0.11 (4), 0.12, 0.13, 0.16, 0.21, 0.23, 0.24, 0.28, 0.32, 0.45 mg/kg (fresh weight).

Allowing for the standard 89 % dry matter (average of barley, wheat, rye and oat straw, *FAO Manual*), the Meeting estimated a maximum residue level and an STMR value for imidacloprid in straw and fodder (dry) of barley, oats, rye, triticale and wheat of 1 mg/kg and 0.056 mg/kg.

Imidacloprid is registered for seed treatment in maize with 0.35 kg ai/100 kg seed in South Africa, with 54 g/unit = 0.47 kg ai/100 kg seed in Germany and 0.7 kg ai/100 kg seed in Italy. In four German trials the seed treatment was performed with 0.47 kg ai/100 kg seed. In 10 residue field trials conducted in different European countries imidacloprid was applied as seed treatment with 0.7 kg ai/100 kg seed. In one South African trial the seed treatment was performed with 0.35 kg ai/100 kg seed. At the ripening stage of maize for silage [BBCH code 85: Dough stage] the residues were in maize forage <0.02, <0.05 (8), 0.05, 0.06, 0.1 mg/kg on a fresh weight basis. The residues were in maize straw <0.02, <0.05 (2), 0.1 mg/kg.

Allowing for the standard 83 % dry matter for maize stover (*FAO Manual*, p. 147), the Meeting estimated a maximum residue level and an STMR value for imidacloprid in maize fodder of 0.2 and 0.06 mg/kg.

Allowing for the standard 40% dry matter, the Meeting estimated a maximum residue level and an STMR value (dry weight) for imidacloprid in maize forage of 0.5 mg/kg and 0.125 mg/kg.

Fate of residues during storage and processing

One hydrolysis study to determine the effects of processing on the nature of residues shows that imidacloprid was stable after simulated pasteurisation, baking/boiling and sterilisation. Considering the hydrolytic stability under the conditions tested, it is not expected that hydrolysis will contribute to the degradation of imidacloprid or affect the nature of imidacloprid residues during processing.

The effect of processing on the concentrations of residues of imidacloprid has been studied in oranges, lemon, apples, cherries, grapes, tomatoes, lettuce, green beans, potatoes, rice, wheat, cotton seed, hops and tea. The processing factors calculated from total residues were used for estimation of STMR-P and HR-P values.

Citrus fruits (RAC residues in oranges 0.12, 0.2, 0.19 mg/kg, in lemon 0.26 mg/kg) were processed into marmalade, juice and dried pulp with processing factors of 0.625 (mean of 0.5, 0.75), 0.28 (mean of 0.19, 0.25, 0.26, 0.42) and 7.47, respectively. Based on the STMR value of 0.05 mg/kg for citrus fruits, the STMR-Ps were 0.03 mg/kg for marmalade and 0.014 mg/kg for citrus juice. A maximum residue level of 10 mg/kg and an STMR of 0.374 mg/kg is estimated for citrus dried pulp.

Apples (RAC residues 0.06, 0.11, 0.13, 0.16, 0.23 mg/kg) were processed into juice, sauce, pomace wet, pomace dry, and dried fruit, with processing factors of 0.656 (mean of 0.4, 0.45, 0.77, 0.83, 0.83), 0.75 (mean of 0.6, 0.73, 0.83, 0.83), 1.6, 5.2 (mean of 3.7, 5.7, 6.3) and 0.865 (mean of 0.83, 0.9), respectively. Based on the STMR value of 0.07 mg/kg for apples, the STMR-P for apple

juice was 0.046 mg/kg, 0.053 mg/kg for sauce, 0.11 mg/kg for wet apple pomace, and 0.061 mg/kg for dried apple fruit. A maximum residue level of 5 mg/kg and an STMR of 0.364 mg/kg is estimated for apple pomace, dry.

Cherries, sweet, (RAC residues 0.08, 0.08, 0.09, 0.09 mg/kg) were processed into preserve (canned fruits) with a processing factor of <0.6 (mean of <0.56, <0.56, <0.63, <0.63). Based on the STMR value of 0.14 mg/kg for sweet cherries, the STMR-P was 0.084 mg/kg for canned sweet cherries.

Peaches (RAC residue 0.13 mg/kg) were processed into preserve (canned fruits) and jam with processing factors of <0.38 each. Based on the STMR value of 0.12 mg/kg for peaches, nectarines and apricots, the STMR-P was 0.046 mg/kg for canned fruits and jam of peaches, nectarines and apricots.

Grapes (RAC residues 0.05, 0.06, 0.06, 0.07, 0.1, 0.1, 0.2 mg/kg) were processed into wine, juice and raisins with processing factors of 1.17 (mean of 0.86, 1.2, 1.3, 1.33), 0.73 (mean of <0.5, <0.5, 1.2) and 1.05 (mean of 1.0, 1.1), respectively. Based on the STMR value of 0.11 mg/kg for grapes, the STMR-P for wine was 0.13 mg/kg, 0.08 for juice and 0.12 mg/kg for raisins (dried grapes).

Tomatoes (RAC residues 0.05, 0.11, 0.16, 0.44 mg/kg) were processed into paste, puree, ketchup, preserve (canned fruits) and juice with processing factors of 5.73 (mean of 3.4, 5.1, 8.7), 2.3 (mean of 1.89, 2.7), 2.0, 0.91 and 1.37 (mean of 1, 1.3, 1.8) respectively. Based on the STMR value of 0.08 mg/kg for tomato, the STMR-Ps were 0.458 mg/kg for tomato paste, 0.184 mg/kg for puree, 0.16 mg/kg for ketchup, 0.073 mg/kg for canned fruits and 0.11 mg/kg for juice.

Beans, green with pods, (RAC residues 0.29, 0.32 mg/kg) were processed into cooked beans with pods and preserves (canned fruits) with processing factors of 0.975 (mean of 0.81, 1.14) and 0.43 (mean of 0.375, 0.48). Based on the STMR value of 0.4 mg/kg for beans, except broad bean and soya bean, the STMR-Ps were 0.39 and 0.17 mg/kg for cooked beans with pods and their canned fruits.

Potatoes (RAC residue 0.26 mg/kg) were processed into wet peel, chips and granules with processing factors of 0.65, 1.35 and 0.92, respectively. Based on the STMR value of 0.05 mg/kg for potatoes, the STMR-Ps were 0.033 mg/kg for potato wet peel, 0.068 mg/kg for potato chips and 0.046 mg/kg for potato granules.

Rice (RAC residues <0.05 mg/kg) were processed into polished rice, bran and glume. No detectable residues were reported in the processed commodities (<0.05 mg/kg) with one exception of glume (0.08 mg/kg). As the concentration of total residues was at the LOQ in the RAC, no STMR-P values could be estimated.

Wheat (RAC residue 0.02 mg/kg) was processed into milled by-products (bran) and flour with processing factors of 3.5 and 0.5. Based on the STMR value of 0.05 mg/kg for wheat grain, the STMR-Ps were 0.175 mg/kg for wheat milled by-products (bran) and 0.025 for wheat flour. The Meeting recommended a maximum residue level of 0.3 for wheat bran and 0.03 for wheat flour.

Cotton seed (RAC residues 0.54, 0.66, 2.7, 2.9 mg/kg) were processed into hulls, meal, crude oil and refined oil. The processing factors were 0.38, 1.45, <0.09 (mean of <0.019, <0.076, <0.093, <0.17) and <0.09 (mean of <0.019, <0.17) for hulls, meal, crude oil and refined oil.

STMR-P values could not be recommended because no maximum residue limit or STMR was estimated for cotton seed.

Hops (RAC residues in kiln-dried cones 5.8, 6.4 mg/kg) were processed into beer with a processing factor of 0.0035 (mean of 0.002, 0.005). Based on the STMR value of 0.7 mg/kg for hops, dry, the STMR-P was 0.0025 mg/kg for beer.

Tea leaf samples were twisted and dried in a tea-making machine. The infusion was prepared by extracting the dried tea leaves with hot water. Only the parent compound imidacloprid was analyzed in dried leaves and the infusion. Therefore, no maximum residue limit, STMR or STMR-P values could be estimated.

Residues in animal commodities

Dietary burden in animals

The Meeting estimated the dietary burden of imidacloprid residues in farm animals on the basis of the diets listed in Appendix IX of the FAO Manual. Calculation from MRLs, highest residues and STMR-P values provides the levels in feed suitable for estimating MRLs for animal commodities, while calculation from STMR and STMR-P values for feed is suitable for estimating STMR values for animal commodities. The percentage of dry matter is taken as 100% when MRLs and STMR values are already expressed as dry weight.

Estimated maximum dietary burden of farm animals

Commodity	Codex Commodity Group	Residue mg/kg	Basis	% Dry matter	Residue dry wt (mg/kg)	Choose diets, %			Residue contribution (mg/kg)		
						Beef cattle	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Apple pomace, wet	AB	0.11	STMR-P	40	0.275						
Barley grain	GC	0.05	MRL	88	0.057						
Barley straw	AS	1	MRL	100	1						
Citrus pulp, dried	AB	0.374	STMR-P	91	0.41	20	20		0.082	0.082	
Maize grain	GC	0.05	MRL	88	0.057			50			0.0285
Maize forage	AF	0.5	MRL	100	0.5						
Maize stover	AS	0.2	MRL	100	0.2						
Oats grain	GC	0.05	MRL	89	0.056						
Oats forage	AF	5	MRL	100	5	25	60		1.25	3	
Oats straw	AS	1	MRL	100	1						
Potato wet peel	AB	0.033	STMR-P	15	0.22						
Rye grain	GC	0.05	MRL	88	0.057						
Rye forage	AF	2.4	highest residue	100	2.4						
Rye straw	AS	1	MRL	100	1						
Sugar beet leaves and tops	AM	5	highest residue	100	5	20	10		1.0	0.5	

Wheat grain	GC	0.05	MRL	89	0.056						
Wheat forage	AF	2.4	highest residue	100	2.4						
Wheat straw	AS	1	MRL	100	1						
Wheat milled by-products	CF	0.175	STMR-P	88	0.199			50	0.07	0.0199	0.0995
TOTAL						100	100	100	2.402	3.6019	0.128

Estimated STMR dietary burden of farm animals

Commodity	Codex Commodity Group	Residue mg/kg	Basis	% Dry matter	Residue dry wt (mg/kg)	Choose diets, %			Residue contribution (mg/kg)		
						Beef cattle	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Apple pomace, wet	AB	0.11	STMR-P	40	0.275						
Barley grain	GC	0.05	STMR	88	0.057						
Barley straw	AS	0.056	STMR	100	0.056						
Citrus pulp, dried	AB	0.374	STMR-P	91	0.41	20	20		0.082	0.082	
Maize grain	GC	0.05	STMR	88	0.057			50			0.0285
Maize forage	AF	0.125	STMR	100	0.125						
Maize stover	AS	0.06	STMR	100	0.06						
Oats grain	GC	0.05	STMR	89	0.056						
Oats forage	AF	0.32	STMR	100	0.32	25	60		0.08	0.192	
Oats straw	AS	0.056	STMR	100	0.056						
Potato wet peel	AB	0.033	STMR-P	15	0.22						
Rye grain	GC	0.05	STMR	88	0.057						
Rye forage	AF	0.32	STMR	100	0.32						
Rye straw	AS	0.056	STMR	100	0.056						
Sugar beet leaves and tops	AM	1.8	STMR	100	1.8	20	10		0.36	0.18	
Wheat grain	GC	0.05	STMR	89	0.056						
Wheat forage	AF	0.32	STMR	100	0.32						
Wheat straw	AS	0.056	STMR	100	0.056						
Wheat milled by-products	CF	0.175	STMR-P	88	0.199	35	10	50	0.07	0.0199	0.0995
TOTAL						100	100	100	0.592	0.4739	0.128

The dietary burdens of imidacloprid for estimating MRLs, STMR and HR values for animal commodities (residue concentrations in animal feeds expressed as dry weight) are: 2.4 and 0.59 mg/kg for beef cattle, 3.6 and 0.47 mg/kg for dairy cattle and 0.13 mg/kg each for poultry.

Feeding studies

The Meeting received information on the concentrations of residues arising in tissues and milk in dairy cows dosed with imidacloprid in capsules at the equivalent of 5, 15 or 50 ppm in the diet for 28 days. The mean transfer factors (concentration of residue ÷ concentration in feed) for cattle tissues and milk were consistent at the three dietary levels:

liver 0.05/5, 0.13/15, 0.49/50 = 0.01, 0.009, 0.0098 → 0.01
kidney 0.03/5, 0.09/15, 0.29/50 = 0.006, 0.006, 0.0058 → 0.006
muscle <0.02/5, 0.03/15, 0.12/50 = <0.004, 0.002, 0.0024 → 0.002 (doses 15 and 50 ppm)
fat <0.02/5, <0.02/15, 0.06/50 = <0.004, <0.0013, 0.0012 → 0.0012 (dose 50 ppm)
milk <0.02/5, 0.041/15, 0.15/50 = <0.004, 0.0027, 0.003 → 0.0029 (dose 15 and 50 ppm)

No residues higher than the LOQ of 0.02 mg/kg were found in milk, muscle or fat from cows at the 5 ppm dose level. The highest concentrations in the three animals at 5 ppm in the diet were 0.054 mg/kg in liver and 0.032 mg/kg in kidney. The mean concentrations in the three animals at 5 ppm were 0.05 mg/kg in liver and 0.03 mg/kg in kidney.

In the 15 ppm group, the milk residue reached a plateau directly after the first administration but did not accumulate. With this dose level, the average plateau concentration in milk (day 1) was 0.041 mg/kg. The mean concentrations in the three animals with 15 ppm were 0.03 mg/kg in muscle, <0.02 mg/kg in fat, 0.13 mg/kg in liver and 0.09 mg/kg in kidney. The highest individual concentrations with 15 ppm in the diet were 0.054 mg/kg in milk, 0.033 mg/kg in muscle, <0.02 mg/kg in fat, 0.17 mg/kg in liver, 0.1 mg/kg in kidney.

The Meeting received information on the concentrations of residues in tissues and eggs of laying hens dosed with imidacloprid at the equivalent of 2, 6 or 20 ppm in the diet for 30 days. The mean transfer factors for hen tissues and eggs were consistent at the three dietary levels:

liver 0.04/2, 0.14/6, 0.35/20 = 0.02, 0.023, 0.0175 → 0.02
muscle <0.02/2, 0.02/6, 0.048/20 = <0.01, 0.003, 0.0024 → 0.0027 (doses 6 and 20 ppm)
fat <0.02/2, <0.02/6, <0.02/20 = <0.01, <0.003, <0.001 → 0.001 (dose 20 ppm)
eggs <0.02/2, 0.049/6, 0.13/20 = <0.01, 0.008, 0.0065 → 0.007 (dose 15 and 20 ppm)

No residues higher than the LOQ of 0.02 mg/kg were determined in eggs, muscle or fat from hens at 2 ppm. The highest and the mean concentrations in the three birds at 2 ppm in the diet were: 0.042 mg/kg and 0.04 mg/kg in liver.

In the 6 ppm group, the egg residues reached a plateau about 6 days after the first administration. In this group, the average plateau concentration in eggs was 0.042 mg/kg. The mean concentrations in the three animals in the 6 ppm dose group were 0.02 mg/kg in muscle, <0.02 mg/kg in fat, 0.14 mg/kg in liver. The highest individual concentrations at the dose of 6 ppm in the diet were 0.052 mg/kg in eggs, 0.021 mg/kg in muscle, <0.02 mg/kg in fat, 0.16 mg/kg in liver.

Maximum residue levels

The Meeting agreed that in the case of dairy cattle, extrapolation below the lowest feeding level (5 ppm) was appropriate as the transfer factors were reasonably consistent across the three dietary levels.

As the maximum dietary burdens of beef and dairy cattle (2.4 and 3.6 ppm) were lower than the lowest feeding level of 5 ppm, the highest residues in tissues and milk were therefore calculated by applying the transfer factors to the maximum dietary burdens (transfer factor • dietary burden in mg/kg feed).

As the maximum dietary burden of dairy cows exceeds that for beef cattle, the former (3.6 mg/kg) was used to estimate the maximum residue level in muscle, liver and kidney.

As the STMR dietary burdens of beef and dairy cattle (0.59 and 0.47 ppm) were lower than the lowest feeding level of 5 ppm, the resulting STMRs in tissues and milk were calculated by applying the transfer factors to the STMR dietary burdens.

Dietary burden (ppm) Feeding level [ppm]	Imidacloprid total residue, mg/kg									
	Milk mean	Muscle highest	mean	Liver highest	mean	Kidney highest	mean	Fat highest	mean	
MRL dairy/beef cattle (3.6) [5]	(0.01) <0.02	(0.007) <0.02		(0.036) 0.054		(0.022) 0.032		(0.004) <0.02		
STMR beef cattle (0.59) [5]			(0.0012) <0.02		(0.006) 0.05		(0.0035) 0.03		(0.0007) <0.02	
STMR dairy cattle (0.47) [5]	(0.0014) <0.02									

The maximum concentrations of residues expected in tissues are 0.007 mg/kg in muscle, 0.036 mg/kg in liver, 0.022 mg/kg in kidney, 0.004 mg/kg in fat and 0.01 mg/kg in milk. The mean extrapolated concentrations are 0.0012 mg/kg in muscle, 0.006 mg/kg in liver, 0.0035 mg/kg in kidney, 0.0007 mg/kg in fat and 0.0014 mg/kg in milk.

The Meeting estimated maximum residue levels of 0.02* mg/kg for meat (mammalian) and milks. For edible offal (mammalian), the estimated maximum residue level is 0.05 mg/kg. The Meeting recommended that the HR values should be 0.007 mg/kg in meat (mammalian), 0.036 mg/kg in edible offal (mammalian) and 0.004 in fat (mammalian). The estimated STMR values are 0.001 for meat (mammalian), 0.006 mg/kg for edible offal (mammalian), 0 for fat (mammalian) and 0.0014 mg/kg for milks.

The Meeting agreed that in the case of laying hens, extrapolation below the lowest concentration (2 ppm) was appropriate as the transfer factors were reasonably consistent across the three dietary levels. As the maximum and STMR dietary burden of 0.13 mg/kg each was lower than the lowest feeding level of 2 ppm, the resulting residues in tissues and eggs were calculated by

applying the transfer factors to the maximum dietary burden (transfer factor • dietary burden in mg/kg).

Dietary burden (ppm) Feeding level [ppm]	Imidacloprid total residue, mg/kg							
	Eggs		Muscle		Liver		Fat	
	highest	mean	Highest	Mean	highest	mean	highest	mean
MRL (0.13) [2]	(0.0009) <0.02		(0.00035) <0.02		(0.0026) 0.042		(0.00013) <0.02	
STMR (0.13) [2]		(0.0009) <0.02		(0.00035) <0.02		(0.0026) 0.04		(0.00013) <0.02

The Meeting estimated maximum residue levels of 0.02* mg/kg for eggs, poultry meat and edible offal. The Meeting recommended that the HR values should be 0.001 mg/kg in eggs, 0.0004 mg/kg in poultry meat, 0.0026 mg/kg in edible offal and 0 in fat. The STMR values are 0.0026 mg/kg in edible offal of poultry, but 0 in poultry eggs, meat and fat.

DIETARY RISK ASSESSMENT

Long-term intake

The International Estimated Daily Intakes of imidacloprid, based on the STMRs estimated for 47 commodities, for the five GEMS/Food regional diets were in the range of 0 to 2 % of the ADI (Annex 3). The Meeting concluded that the long-term intake of residues of imidacloprid resulting from its uses that have been considered by JMPR is unlikely to present a public health concern.

Short-term intake

The International Estimated Short term Intake (IESTI) of imidacloprid was calculated for 49 food commodities (and their processing fractions) for which MRLs, STMR values and/or HR values were established and for which data on consumption were available. The results are shown in Annex 4.

The IESTI represented 0 – 4 % of the acute RfD for the general population and 0 – 15 % of the acute RfD for children. The Meeting concluded that the short-term intake of residues of imidacloprid, resulting from its uses that have been considered by the JMPR, is unlikely to present a public health concern.

4.16 LINDANE (048)

TOXICOLOGY

Lindane (1 α ,2 α ,3 β ,4 α ,5 α ,6 β)1,2,3,4,5,6-hexachlorocyclohexane) is a broad-spectrum organochlorine compound used against a wide range of soil-dwelling and plant-eating insects. It is commonly used on numerous crops, as a seed treatment, in warehouses and to control insect-borne diseases. Lindane is also used in the treatment of scabies and lice in humans. Lindane was last evaluated by the JMPR in 1997, when a temporary ADI of 0–0.001 mg/kg bw was established on the basis of deaths and hepatic toxicity in a 2-year study of toxicity and carcinogenicity in rats. The ADI was made temporary because of concern about immunotoxic effects reported in mice given lindane (purity, 97%) at doses of 0.12 mg/kg bw per day and above. Lindane was re-evaluated at the present Meeting within the periodic review programme of the Codex Committee on Pesticide Residues.

Lindane is the *gamma* isomer of hexachlorocyclohexane. Five other isomers of hexachlorocyclohexane are commonly found in technical-grade lindane, but the *gamma* isomer is the predominant one, comprising at least 99% of the mixture.

After oral administration, [¹⁴C]lindane was rapidly absorbed from the gastrointestinal tract of mice and rats and was extensively distributed throughout the body. In mice, radiolabel was detected in fat, brain, kidney, muscle, liver, adrenals and ovary tissue after administration in the diet. Adipose tissue had the highest concentration of lindane. A similar distribution pattern was observed in rats. The major route of excretion was urine, with a small proportion of an oral dose eliminated in the faeces. The half-life of lindane in rats was estimated to be 3–5 days, approximately 80% of the administered dose being excreted within 8 days.

Lindane undergoes extensive metabolism in mammals, proceeding through a pathway involving stepwise dehydrogenation, dechlorination and dehydrochlorination, which may be followed by conjugation with sulfate or glucuronide.

Lindane induces a number of metabolizing enzymes, including the cytochrome P450 system, glutathione-S-transferase and UDP-glucuronosyl transferase. In contrast, it inhibits, for example, epoxide hydrolysis at concentrations of 100 ppm and more.

Lindane was moderately acutely toxic when given orally, with LD₅₀ values of 56–250 mg/kg bw in mice and 140–190 mg/kg bw in rats. The LD₅₀ and LC₅₀ values after dermal and inhalation administration to rats were 1000 mg/kg bw and 0.002 mg/l, respectively. Lindane did not irritate the skin or eye in rabbits and did not sensitize the skin of guinea-pigs. WHO has classified lindane as ‘moderately hazardous’.

Lindane was toxic to the kidney and liver after administration orally, dermally or by inhalation in short-term and long-term studies of toxicity and studies of reproductive toxicity in rats. The renal toxicity of lindane was specific to male rats and was considered not to be relevant to human risk assessment since it is a consequence of accumulation of α_{2u} -globulin, a protein that is not found in humans. Hepatocellular hypertrophy was observed in a number of studies in mice, rats and rabbits and was reversed only partially after recovery periods of up to 6 weeks. In a 2-year study of toxicity and carcinogenicity in rats, the NOAEL was 10 ppm in the diet (equal to 0.47

mg/kg bw per day) on the basis of increased liver weight, hepatocellular hypertrophy, increased spleen weight and deaths at 100 ppm (equal to 4.7 mg/kg bw per day).

Body weights and decrements in body-weight gain were reported in rats and rabbits, but not in mice. Decreased body-weight gain occurred at concentrations of 100 ppm (equal to 4.7 mg/kg bw per day) and higher.

In rats given lindane at a concentration of 400 ppm in the diet (equal to 35 mg/kg bw per day), marginal increases in blood phosphorus and calcium and a 45–110% increase in cholesterol concentration, a 20–54% increase in urea concentration and a statistically significant increase in platelet count were seen. In general, the haematological changes seen were marginal.

Acute administration by oral, dermal, intraperitoneal or intramuscular routes or by inhalation elicited effects characteristic of toxicity to the central nervous system, namely hypoactivity, dyspnoea, ataxia, convulsions and tremours. In addition, neurotoxic effects were observed after short- or long-term administration, including sensitivity to touch, aggressive behaviour, languor, piloerection, hunched posture, increased motor activity and paralysis of the hind quarters (rabbits only). In a study of acute neurotoxicity in rats, the NOAEL was 6 mg/kg bw on the basis of increased fore-limb grip strength and decreased grooming behaviour. In a 90-day study of neurotoxicity, the NOAEL was 100 ppm (equal to 7.1 mg/kg bw per day) on the basis of hypersensitivity to touch and hunched posture. In a study of developmental neurotoxicity, the NOAEL for maternal toxicity was 50 ppm (equal to 4.2 mg/kg bw per day) on the basis of decreased body weight, decreased food consumption and increased reactivity to handling, while the NOAEL for developmental toxicity was 10 ppm (equal to 0.8 mg/kg bw per day) on the basis of reduced pup survival, decreased body weight and body-weight gain during lactation, increased motor activity and decreased motor reflex.

Lindane did not induce a carcinogenic response in rats or dogs, but increased incidences of adenomas and carcinomas of the liver were observed in agouti and pseudoagouti mice at a dose of 23 mg/kg bw per day in a study of the role of genetic background in the latency and incidence of tumorigenesis. No tumours were observed in black mice in this study nor in any other strain of mice. In another study, a slightly increased incidence of lung adenomas was observed in female mice at the highest dose (21 mg/kg bw per day); however, there was a limited dose–response relationship and this tumour is common in the strain of mice used, the incidence (27%) only slightly exceeding that in other control groups (19%).

Lindane was not genotoxic *in vivo* or *in vitro*. Genotoxicity was found only at cytotoxic concentrations or in the presence of lindane precipitate. The Meeting concluded that lindane is not genotoxic.

In the absence of genotoxicity and on the basis of the weight of the evidence from the studies of carcinogenicity, the Meeting concluded that lindane is not likely to pose a carcinogenic risk to humans. Further, in an epidemiological study designed to assess the potential association between breast cancer and exposure to chlorinated pesticides, no correlation with lindane was found.

In a multigeneration study of reproductive toxicity in rats, the NOAEL for parental toxicity was 150 ppm (equal to 13 mg/kg bw per day), the highest dose tested. The NOAEL for reproductive toxicity was 20 ppm (equal to 1.7 mg/kg bw per day), on the basis of a decreased litter viability index and delays in tooth eruption and hair growth.

Oral administration of lindane to pregnant rats resulted in a NOAEL for maternal toxicity of 5 mg/kg bw per day on the basis of decreased body-weight gain and food consumption. In this study, the NOAEL for developmental toxicity was 5 mg/kg bw per day on the basis of an increased incidence of supernumerary ribs. In a study of developmental toxicity in rabbits, a NOAEL for maternal toxicity was not identified; the LOAEL for maternal toxicity was 5 mg/kg bw per day, on the basis of tachypnoea and lethargy after several days of administration. The NOAEL for developmental toxicity was 10 mg/kg bw per day, on the basis of an increased incidence of fetuses with 13 ribs.

The Meeting reviewed several published studies of the effect of lindane on the endocrine system. Although lindane had anti-estrogenic properties in several studies, effects were reported only at doses of 5 mg/kg bw per day or more.

In view of the report of immunotoxicity in mice, a 39-week study was conducted in which mice were given lindane (purity, 99%) to examine its effects on the total number of leukocytes and on the relative proportion of lymphocyte populations. In females, administration at a dietary concentration of 160 ppm (equal to 24 mg/kg bw per day) resulted in a 55% increase in the natural killer cell population. In the absence of effects on other lymphocyte parameters, the Meeting concluded that lindane is not immunotoxic.

The Meeting concluded that the existing database is adequate to characterize the potential hazard of lindane to fetuses, infants, and children.

The Meeting established an ADI of 0–0.005 mg/kg bw on the basis of the NOAEL of 10 ppm, equal to 0.47 mg/kg bw per day, in the long-term study of toxicity and carcinogenicity in rats, in which an increased incidence of periacinar hepatocellular hypertrophy, increased liver and spleen weights and increased mortality occurred at higher doses, and a safety factor of 100.

The Meeting established an acute RfD of 0.06 mg/kg bw on the basis of the NOAEL of 6 mg/kg bw in the study of acute neurotoxicity in rats in which clinical signs of toxicity (increased fore-limb grip strength and decreased grooming behaviour) were observed at higher doses, and a safety factor of 100.

The LOAEL of 5 mg/kg bw per day in the study of developmental toxicity in rabbits was not used for establishing the acute RfD because the observed effects (tachypnoea and lethargy) occurred only after several exposures. Similarly, the NOAEL of 10 ppm, equal to 0.8 mg/kg bw per day, in the study of developmental neurotoxicity in rats was not used since the effects (decreased pup survival on postnatal day 4, decreased body-weight gain during lactation and changes in motor activity) could not be attributed to a single exposure.

A toxicological monograph summarizing the data that had become available since the previous evaluation and relevant data from previous monographs and monograph addenda was prepared.

TOXICOLOGICAL EVALUATION

Levels relevant to risk assessment

Species	Study	Effect	NOAEL	LOAEL
Mouse	Long-term study of toxicity and carcinogenicity ^a	Toxicity	25 ppm, equal to 3.9 mg/kg bw per day	50 ppm, equal to 7.8 mg/kg bw per day
		Carcinogenicity	50 ppm, equal to 7.8 mg/kg bw per day ^b	–
Rat	28-day study of toxicity ^a	Toxicity	10 ppm, equal to 0.98 mg/kg bw per day	100 ppm, equal to 9.6 mg/kg bw per day
	Long-term study of toxicity and carcinogenicity ^a	Toxicity	10 ppm, equal to 0.47 mg/kg bw per day	100 ppm, equal to 4.7 mg/kg bw per day
		Carcinogenicity	400 ppm, equal to 20 mg/kg bw per day ^b	–
	Multigeneration study of reproductive toxicity ^a	Parental toxicity	150 ppm, equal to 13 mg/kg bw per day ^b	–
		Reproductive toxicity	20 ppm, equal to 1.7 mg/kg bw per day	150 ppm, equal to 13 mg/kg bw per day
	Acute neurotoxicity ^c	Neurotoxicity	6 mg/kg bw	20 mg/kg bw
Study of developmental neurotoxicity ^a	Maternal toxicity	50 ppm, equal to 4.2 mg/kg bw per day	120 ppm, equal to 8 mg/kg bw per day	
	Developmental toxicity	10 ppm, equal to 0.8 mg/kg bw per day	50 ppm, equal to 4.2 mg/kg bw per day	
Rabbit	Study of developmental toxicity ^c	Maternal toxicity	–	5 mg/kg bw per day ^d
		Developmental toxicity	10 mg/kg bw per day	20 mg/kg bw per day
Dog	2-year study of toxicity ^a	Toxicity	25 ppm, equal to 0.83 mg/kg bw per day	50 ppm, equal to 2.9 mg/kg bw per day

^a Dietary administration

^b Highest dose tested

^c Gavage

^d Lowest dose tested

Estimate of acceptable daily intake for humans

0–0.005 mg/kg bw

Estimate of acute reference dose

0.06 mg/kg bw

Studies that would provide information useful for continued evaluation of the compound

Further observations in humans

*List of end-points relevant for setting guidance values for dietary and non-dietary exposure**Absorption, distribution, excretion and metabolism in mammals*

Rate and extent of oral absorption	Rapid and extensive
Distribution	Extensive; highest concentration in adipose tissue
Potential for accumulation	Substantial potential for accumulation
Rate and extent of excretion	Slow (half-life of 3–5 days)
Metabolism in animals	Extensive; primarily excreted as sulfate and glucuronide conjugates
Toxicologically significant compounds	Lindane

Acute toxicity

Mouse, LD ₅₀ , oral	56–250 mg/kg bw (varied with strain)
Rat, LD ₅₀ , oral	140 mg/kg bw
Rat, LD ₅₀ , dermal	1000 mg/kg bw
Rat, LC ₅₀ , inhalation	0.002 mg/l, 4-h exposure (nose-only)
Rabbit, dermal irritation	Not irritating
Rabbit, eye irritation	Not irritating
Guinea-pig, skin sensitization	Not sensitizing (Magnuson & Klingman test)

Short-term studies of toxicity

Target/critical effect	Periacinar hypertrophy, increased platelet count and decreased body-weight gain
Lowest relevant oral NOAEL	100 ppm, equal to 9.6 mg/kg bw per day

Genotoxicity

Not genotoxic

Long-term studies of toxicity and carcinogenicity

Target/critical effect	Deaths, increased liver weight associated with hepatocellular hypertrophy, increased spleen weight and increased platelet count in rats
Lowest relevant NOAEL	10 ppm, equal to 0.47 mg/kg bw per day (rats)
Carcinogenicity	Unlikely to pose a carcinogenic risk to humans

Reproductive toxicity

Target/critical effect in reproductive toxicity	Decreased litter viability index, decreased pup weight, delays in tooth eruption and hair growth
Lowest relevant NOAEL for reproductive toxicity	20 ppm, equal 1.7 mg/kg bw per day
Parental target/critical effect	None
Lowest relevant parental NOAEL	150 ppm, equal to 13 mg/kg bw per day (highest dose tested; rats).
Target/critical effect in developmental toxicity	Supernumerary ribs
Lowest relevant NOAEL for developmental toxicity	10 mg/kg bw per day (rabbits)

Neurotoxicity

Acute neurotoxicity	NOAEL: 6 mg/kg bw; behavioural effects (rats)
90-day neurotoxicity	NOAEL: 100 ppm, equal to 7.1 mg/kg bw per day (hypersensitivity to touch and hunched posture; no neuropathology; rats)
Developmental neurotoxicity	Offspring NOAEL: 10 ppm, equal to 0.8 mg/kg bw per day (decreased pup survival, decreased body weight and body-weight gain during lactation, increased motor activity, decreased motor reflex; rats)

Other studies

Immunotoxicity	No concern
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Medical data

An epidemiological study indicated no correlation between exposure to lindane and breast cancer.

Summary

	Value	Study	Safety factor
ADI	0–0.005 mg/kg bw	2-year study of toxicity and carcinogenicity (rats)	100
Acute RfD	0.06 mg/kg bw	Rats, acute neurotoxicity	100

DIETARY INTAKE ASSESSMENT

The theoretical maximum daily intake of lindane in the five GEMS/Food regional diets, on the basis of existing MRLs, represented 70–160% of the ADI (Annex 3). The dietary intake estimates will be refined further during the periodic review of lindane.

4.17 METALAXYL-M AND METALAXYL (138)**TOXICOLOGY**

Metalaxyl is a 1:1 mixture of (R)-2-[(2,6-dimethylphenyl)methoxyacetyl amino]propionic acid methyl ester (R-enantiomer) and (S)-2-[(2,6-dimethylphenyl)methoxyacetyl amino]propionic acid methyl ester (S-enantiomer). Technical-grade metalaxyl-M consists of a minimum of 97% of the R-enantiomer and 3% of the S-enantiomer. The two compounds are fungicides used in agriculture, horticulture and forestry, which act by inhibiting mycelial growth and spore formation. Metalaxyl-M has not been evaluated previously; however, the toxicity of metalaxyl was evaluated by the 1982 Joint Meeting, which established an ADI of 0–0.03 mg/kg bw on the basis of a NOAEL of 2.5 mg/kg bw per day in a 2-year study in rats.

Investigations of the R-enantiomer were confined to studies of its absorption, distribution, metabolism and excretion, acute and short-term toxicity, mutagenicity and developmental toxicity, and were designed to establish whether there are qualitative or quantitative differences in the toxicological properties of metalaxyl-M and metalaxyl. As described below, none of the studies revealed any unexpected effects of metalaxyl-M, and the quantitative dose-effect relationships found with the racemate and the R-enantiomer were similar. The Meeting therefore concluded that the database on metalaxyl could be used for the toxicological evaluation of metalaxyl-M. Since the previous evaluation of metalaxyl by the Joint Meeting, several new studies have been conducted with the racemate. The present Meeting reviewed the available studies, consisting of the original studies and new studies on absorption, distribution, metabolism and excretion, a 2-year study in dogs and studies of developmental toxicity in rats and rabbits.

All the studies with metalaxyl-M and all the pivotal studies with metalaxyl were certified as being compliant with good laboratory practice.

Studies of the biokinetics and metabolism of both metalaxyl and metalaxyl-M have been performed. The absorption, distribution and excretion of the two compounds were similar, and both were rapidly absorbed and eliminated after oral administration. In rats, maximum blood concentrations were detected 0.5–1 h after administration. The decline in radioactivity was biphasic, with half-lives ranging from 1 to 3 h and 22 to 125 h (depending on the dose) for the first and second phases, respectively. Rats eliminated 90–100% of the total administered dose of either substance within 72 h, with the majority eliminated within 24 h. The rate of urinary excretion of radioactivity was higher in females than in males, whereas the faecal elimination rate was higher in males than in females. The similarity of the excretion pattern of radioactivity after oral and intravenous administration of metalaxyl indicates that the compound was probably well absorbed. Elimination of metalaxyl in the bile was substantial in a study with bile duct-cannulated rats, accounting for 55–70% of the total administered radioactivity (average bioavailability, approximately 90% after oral administration). The concentrations of residues of both compounds in organs and tissues were generally low, reflecting the rapid elimination.

Metalaxyl and metalaxyl-M were both extensively metabolized, showing a similar pattern of metabolites, irrespective of sex and administered dose. The profile of metabolites of metalaxyl was quantitatively similar in all three species studied (rats, goats and hens). Metabolism involved hydrolysis of side-chains and oxidation of the phenyl ring. Most of the phase I metabolites were excreted as conjugates with glucuronic acid and sulfate. Treatment with metalaxyl resulted in modest induction of hepatic and renal cytochrome P450 and some other drug metabolizing enzymes.

The LD₅₀ values in rats treated orally with metalaxyl or metalaxyl-M were 670 and 380–950 mg/kg bw, respectively. The LD₅₀ value in rats after dermal application of either substance was > 2000 mg/kg bw. The LC₅₀ values in rats treated by inhalation for 4 h were > 3.6 mg/l and > 2.3 mg/l, the highest achievable concentrations, for metalaxyl and metalaxyl-M, respectively. Neither substance was irritating to the skin of rabbits, nor did they sensitize the skin of guinea-pigs. Metalaxyl-M was considered to be a severe irritant to the eyes of rabbits, whereas metalaxyl was only slightly irritating. Metalaxyl has been classified by WHO as 'slightly hazardous'; metalaxyl-M has not been classified.

Metalaxyl-M and metalaxyl showed similar toxicological properties. A comparative 28-day study in rats given metalaxyl-M and metalaxyl by gavage confirmed the toxicological equivalence

of the R-enantiomer and the racemate, as the nature of the effects as well as the dose–effect relationships were similar. In studies in mice, rats and dogs treated orally, both substances had low toxicity, and treatment was well tolerated, even at relatively high doses.

The available data indicated that the major target organ is the liver and that the dog is the most sensitive species. Increased absolute and relative liver weights were observed in rats and dogs. Both substances caused hepatocellular enlargement in rats, while dogs showed changes in blood biochemical parameters indicative of hepatocellular damage (increased serum activity of alkaline phosphatase). Mild effects observed in the liver of rodents were considered not to be adverse.

After treatment with metalaxyl for 6 months, dogs showed slightly reduced erythrocyte parameters (red blood cell count, erythrocyte volume fraction and haemoglobin concentration), while no significant haematological effects were detected with metalaxyl-M in a 3-month study.

In 90-day studies in rats given metalaxyl-M or metalaxyl, the NOAEL was 1200 ppm, the highest dose tested, equal to 91 or 79 mg/kg bw per day, respectively. In dogs, the NOAELs were 250 ppm, equal to 7.3 mg/kg bw per day, in a 13-week study with metalaxyl-M and 250 ppm, equal to 7.4 mg/kg bw per day, in a 6-month study with metalaxyl, on the basis of increased alkaline phosphatase activity and liver weights at 1200 ppm of metalaxyl-M and 1000 ppm of metalaxyl.

Treatment of dogs for 2 years at the high dose of 80 mg/kg bw per day resulted in transient clinical signs and the deaths of two of six males and two of six females. The surviving animals showed mild anaemia starting after about 52 weeks of treatment (considered not to be relevant for acute intake) and elevated serum activities of alkaline phosphatase and alanine aminotransferase. In addition, increased liver (both sexes) and kidney (males) weights were noted. The NOAEL was 8 mg/kg bw per day on the basis of effects observed at 80 mg/kg bw per day.

Long-term studies of toxicity and carcinogenicity were conducted with metalaxyl in mice and rats. Male mice showed reduced body-weight gain at a dietary concentration of 1200 ppm (equal to 100 mg/kg bw per day), so that the NOAEL was 250 ppm, equal to 19 mg/kg bw per day. There was no evidence of a carcinogenic response to treatment. In rats, increased absolute and relative liver weights were recorded at a dietary concentration of 1200 ppm (equal to 43 mg/kg bw per day) in animals of each sex and a slight increase in relative liver weight in males at 250 ppm (equal to 8.7 mg/kg bw per day). In the group at the highest dose, histopathological examination revealed centrilobular hepatocyte enlargement and slightly increased incidences of fatty infiltration of liver cells in females. As the findings in the liver were mild and considered unlikely to be adverse, the NOAEL was 43 mg/kg bw per day. There was no evidence of a carcinogenic response to treatment. Since technical-grade metalaxyl contains approximately 50% of the R-enantiomer, the results also apply to metalaxyl-M. The Meeting concluded that metalaxyl and metalaxyl-M are not carcinogenic in rodents.

A comprehensive range of studies of genotoxicity with both metalaxyl and metalaxyl-M gave negative results. The Meeting concluded that neither metalaxyl nor metalaxyl-M is likely to be genotoxic.

In the absence of genotoxic and carcinogenic potential, the Meeting concluded that neither metalaxyl nor metalaxyl-M is likely to pose a carcinogenic risk to humans.

In a three-generation study of reproductive toxicity in rats with metalaxyl, the NOAEL for parental and pup toxicity and for reproductive performance was 1200 ppm, equal to 96 mg/kg bw per day, the highest dose tested. Four studies of developmental toxicity were performed with metalaxyl, two in rats and two in rabbits. They gave no indication of teratogenic or embryotoxic potential, even when the material was administered at a dose close to that which caused maternal lethality. In rats, the NOAELs were 50 mg/kg per day and 400 mg/kg per day (the highest dose tested) for maternal and developmental toxicity, respectively. In rabbits, the NOAELs were 150 mg/kg per day and 300 mg/kg per day (the highest dose tested) for maternal and developmental toxicity, respectively. In view of the similarity of the effects of the two substances and the lack of developmental or reproductive toxicity with metalaxyl, investigation of metalaxyl-M was confined to a study of developmental toxicity in rats. In this study, treatment of pregnant rats at maternally toxic doses had no adverse effect on the pups. The NOAELs were 50 mg/kg bw per day for maternal toxicity and 250 mg/kg bw per day (the highest dose tested) for developmental toxicity.

The metabolism of metalaxyl and metalaxyl-M is similar in animals and plants. The acute toxicity of the three major plant metabolites of metalaxyl, *N*-(2,6-dimethylphenyl)-*N*-(methoxyacetyl)alanine (M1), *N*-(2,6-dimethylphenyl)-*N*-(hydroxyacetyl)alanine (M6) and *N*-(2-carboxy-6-methylphenyl)-*N*-(methoxyacetyl)alanine (M12), was studied after oral administration. These metabolites showed little toxicity, with LD₅₀ values >2000 mg/kg bw and NOAELs in 28-day studies >1000 mg/kg bw per day, the highest dose tested. They also had no mutagenic potential in vitro. On the basis of these results and on the fact that all major plant metabolites except M12 also occur in rats and have thus been investigated in toxicological studies, the Meeting concluded that the plant metabolites are of no toxicological concern for humans.

No cases of adverse effects were reported in personnel involved in the production and formulation of metalaxyl or metalaxyl-M or in the field use of these products.

The Meeting concluded that there were sufficient toxicological data to assess both metalaxyl and metalaxyl-M. Further, the Meeting concluded that the existing database was adequate to characterize the potential hazard of metalaxyl and metalaxyl-M to fetuses, infants and children.

The Meeting established a group ADI of 0–0.08 mg/kg bw for metalaxyl and metalaxyl-M (alone or in combination), on the basis of the NOAEL of 8 mg/kg bw per day in the 2-year study in dogs with metalaxyl and a safety factor of 100.

The Meeting concluded that it was not necessary to establish an acute RfD because metalaxyl and metalaxyl-M have little acute toxicity and, in studies with repeated doses, no toxicological alerts for acute effects were observed that might indicate the need to establish one.

A toxicological monograph was prepared.

TOXICOLOGICAL EVALUATION

Levels relevant to risk assessment

Species	Study	Effect	NOAEL	LOAEL
Mouse	2-year study of toxicity and carcinogenicity ^{a,e}	Toxicity	250 ppm, equal to 19 mg/kg bw per day	1200 ppm, equal to 100 mg/kg bw per day
		Carcinogenicity	1200 ppm, equal to 100 mg/kg bw per day ^d	–
Rat	2-year study of toxicity and carcinogenicity ^{a,e}	Toxicity	1200 ppm, equal to 43 mg/kg bw per day ^d	–
		Carcinogenicity	1200 ppm, equal to 43 mg/kg bw per day ^d	–
	Three-generation study of reproductive toxicity ^{a,e}	Parental toxicity	1200 ppm, equal to 96 mg/kg bw per day ^d	–
		Pup toxicity	1200 ppm, equal to 96 mg/kg bw per day ^d	–
		Reproductive toxicity	1200 ppm, equal to 96 mg/kg bw per day ^d	–
	Developmental toxicity ^{b,f}	Maternal toxicity	50 mg/kg bw per day	250 mg/kg bw per day
Embryo- and fetotoxicity		250 mg/kg bw per day ^d	–	
Rabbit	Developmental toxicity ^{b,e}	Maternal toxicity	150 mg/kg bw per day	300 mg/kg bw per day
		Embryo- and fetotoxicity	300 mg/kg bw per day ^d	–
Dog	2-year study of toxicity ^{c,e}	Toxicity	8 mg/kg bw per day	80 mg/kg bw per day

^aDietary administration^bGavage^cGelatine capsule^dHighest dose tested^eStudy performed with metalaxyl^fStudy performed with metalaxyl-M*Estimate of acceptable daily intake for humans*

0–0.08 mg/kg bw (group ADI for metalaxyl and metalaxyl-M, alone or in combination)

Estimate of acute reference dose

Unnecessary

Studies that would provide information useful for continued evaluation of the compound

Further observations in humans

List of end-points relevant for setting guidance values for dietary and non-dietary exposure*Absorption, distribution, excretion and metabolism in mammals*

Rate and extent of oral absorption	Rapid and extensive
Dermal absorption	10% for spraying dilution and for concentrated EC formulation (in vivo and in vitro data)
Distribution	Uniformly distributed
Potential for accumulation	None
Rate and extent of excretion	Rapid and extensive
Metabolism in animals	Extensively metabolized
Toxicologically significant compounds	Parent compounds

Acute toxicity

Rat, LD ₅₀ , oral	380 mg/kg bw (metalaxyl-M) 670 mg/kg bw (metalaxyl)
Rat, LD ₅₀ , dermal	> 2000 mg/kg bw (metalaxyl-M) > 3200 mg/kg bw (metalaxyl)
Rat, LC ₅₀ , inhalation	> 2.3 mg/L (4 h, nose-only, aerosol) (metalaxyl-M) > 3.6 mg/L (4 h) (metalaxyl)
Skin irritation	Not irritating (4 h, rabbit) (metalaxyl-M) Not irritating (24 h, rabbit) (metalaxyl)
Eye irritation	Severely irritating (rabbit) (metalaxyl-M) Slightly irritating (rabbit) (metalaxyl)
Skin sensitization	Not sensitizing (Magnusson & Kligman or Buehler) (metalaxyl-M) Not sensitizing (Mauer or Buehler) (metalaxyl)

Short-term studies of toxicity

Target/critical effect	Liver
Lowest relevant oral NOAEL	8 mg/kg bw per day (dog; 13 weeks with metalaxyl-M and 6 months and 2 years with metalaxyl)
Lowest relevant dermal NOAEL	1000 mg/kg bw per day (highest dose tested, 4 weeks with metalaxyl-M in rats and 3 weeks with metalaxyl in rabbits)
Lowest relevant inhalation NOAEL	No relevant data

Genotoxicity

Not genotoxic

Long-term studies of toxicity and carcinogenicity

Target/critical effect	Liver
Lowest relevant NOAEL	250 ppm, equal to 19 mg/kg bw per day (2-year study with metalaxyl in mice)
Carcinogenicity	Not carcinogenic

Reproductive toxicity

Reproductive toxicity target/critical effect	No reproductive effects observed
Lowest relevant NOAEL for reproductive toxicity	Parents, pups and reproduction: 1200 ppm (equal to 96 mg/kg bw per day, highest dose tested; 3-generation study with metalaxyl in rats)
Developmental toxicity target/critical effect	No developmental effects at maternally toxic doses
Lowest relevant NOAEL for developmental toxicity	Maternal: 50 mg/kg bw per day Embryo- and fetotoxicity: 250 mg/kg bw per day (highest dose tested, metalaxyl-M in rats)

Neurotoxicity

No concerns arising from available information

Other toxicological studies

Metalaxyl is a mild inducer of xenobiotic metabolizing enzymes in liver and kidney
Toxicity of metabolites: no toxicological concern

Medical data

No adverse effects on health of manufacturing personnel

Summary

	Value	Study	Safety factor
ADI	0–0.08 mg/kg bw	2 years in dogs	100
Acute RfD	Unnecessary		

DIETARY RISK ASSESSMENT

The theoretical maximum daily intake of metalaxyl in the five GEMS/Food regional diets, on the basis of existing MRLs, represented 2–10% of the ADI (Annex 3). The Meeting concluded that the intake of residues of metalaxyl resulting from uses that have been considered by the JMPR is unlikely to present a public health risk.

4.18 METHAMIDOPHOS (100)**TOXICOLOGY**

Methamidophos (*O,S*-dimethyl phosphoramidothioate), an organophosphorus insecticide which acts by inhibiting cholinesterase activity, is a racemate and a major metabolite of acephate. It was last evaluated toxicologically by the 1990 JMPR, which established an ADI of 0–0.004 mg/kg bw on the basis of inhibition of erythrocyte cholinesterase activity in a short-term study in humans. Methamidophos was considered by the present Meeting within the periodic review programme of the Codex Committee on Pesticide Residues.

While many of the studies that were reviewed by the present Meeting were conducted prior to the development of good laboratory practice, most of the pivotal studies were carried out according to appropriate standards for study protocol and conduct.

[S-methyl-¹⁴C]- and [³²P]-Labelled methamidophos administered orally, intraperitoneally or intravenously to rats was rapidly absorbed and distributed, 50–77% of the administered dose being eliminated within the first 1–3 days after dosing. Urine and expired CO₂ were the major media of elimination of the ¹⁴C-labelled material and urine and faeces the major repositories of ³²P-labelled methamidophos. Some radioactivity was incorporated into the body in the form of ¹⁴C fragments and ultimately eliminated with the natural turnover of these compounds.

Oral administration of a single dose of [S-methyl-¹⁴C]methamidophos on day 18 to pregnant rats resulted in rapid absorption and distribution (within 1 h) to various tissues, including the placenta and the fetus, and elimination within 48 h by both dams and fetuses. In a corresponding study with suckling rats, methamidophos was also rapidly absorbed and subsequently distributed throughout the body. The concentrations in the pups indicated that it was present in milk.

The extent of percutaneous absorption of [S-methyl-¹⁴C]methamidophos over 24 h was about 40% in rats, 11% in monkeys and 5% in humans. The total recovery of administered radioactivity in humans was 72%, and 0.55% was excreted in urine.

Methamidophos was rapidly degraded through deamination and/or demethylation in rats. The first step was cleavage of P–O, P–N or P–S bonds, followed by demethylation. The major degradation products found, in addition to unchanged methamidophos, were desaminomethamidophos, methyl dihydrogen phosphate, *S*-methyl phosphorothioic acid, methyl hydrogen phosphoramidate, *S*-methyl hydrogen phosphoramidothioate, and phosphoric acid. The existence of volatile metabolites other than CO₂ at concentrations above the detection limit of 5 µg per animal could not be established unequivocally; however, their formation was considered to be very likely.

Methamidophos is acutely toxic when administered orally, with an LD₅₀ of 13–16 mg/kg bw in rats. The clinical signs of toxicity are those typical of cholinergic effects. Its toxicity to hens, guinea-pigs, rabbits, cats and dogs was comparable to that in rodents. Adult male rats were more sensitive to methamidophos than were females and young rats. The acute toxicity after oral administration was greater in fasted than in non-fasted mice and rats. Methamidophos had moderate-to-high acute toxicity when administered dermally to experimental animals (LD₅₀: 110–380 mg/kg bw in rats) and had high acute toxicity when administered by inhalation (LC₅₀: 0.063–0.21 mg/l of air in rats). Methamidophos was a mild dermal irritant and was slightly irritating to the eyes of rabbits. It was not a skin sensitizer. WHO has classified methamidophos as ‘highly hazardous’.

In a study of neurotoxicity with methamidophos in rats given a single oral dose of 0, 0.3, 0.7, 1, 3 or 9 mg/kg bw, a dose-dependent, statistically significant decrease in erythrocyte and brain cholinesterase activity (> 20%) was observed at 0.7 mg/kg bw but not at 0.3 mg/kg bw. A dose-related reduction in activity and signs of cholinergic intoxication were observed at 1–9 mg/kg bw. The NOAEL for inhibition of erythrocyte and brain cholinesterase activity was 0.3 mg/kg bw.

In a 90-day study of neurotoxicity in rats given methamidophos at 0, 1, 12 or 59 ppm of diet (equal to 0, 0.067, 0.79 and 4.3 mg/kg bw per day), dose-dependent, statistically significant decreases (> 20%) in erythrocyte and brain cholinesterase activity, a reduction in locomotor activity and other signs of cholinergic intoxication were seen at 12 and 59 ppm. The NOAEL for inhibition of erythrocyte and brain cholinesterase activity was 1 ppm, equal to 0.067 mg/kg bw per day.

In short-term studies of toxicity in mice (oral, dermal, intraperitoneal), rats (oral, dermal, inhalation, intraperitoneal), rabbits (dermal) and dogs (oral), methamidophos caused signs of toxicity related to inhibition of cholinesterase activity. Effects on organ weights were observed in only a few rats. The NOAEL was 2 ppm, equal to 0.13 mg/kg per day, in rats, and 2 ppm, equal to 0.06 mg/kg bw per day, in dogs on the basis of inhibition (> 20%) of erythrocyte and brain cholinesterase activity.

In long-term studies of toxicity in mice and rats, there was no evidence of organ-specific toxicity, and no additional effects were seen over those observed in the short-term studies. Inhibition of cholinesterase activity was the most sensitive end-point. During a recovery period of 2–4 weeks after long-term administration, cholinesterase activity returned to control levels in rats. In mice, the NOAEL was 5 ppm, equal to 0.67 mg/kg bw per day, on the basis of reduced body-weight gain and feed consumption. In rats, the NOAEL was 2 ppm, equal to 0.1 mg/kg bw per day, on the basis of inhibition (> 20%) of erythrocyte and brain cholinesterase activity.

In the absence of carcinogenic effects observed in mice or rats, the Meeting concluded that there was no evidence that methamidophos has a carcinogenic potential in either species.

An extensive range of tests for genotoxicity has been performed with methamidophos both *in vitro* and *in vivo*. The positive results obtained in a few assays were contradicted by the negative results obtained in a range of adequate tests, including assays in which positive findings were also observed. The Meeting concluded that methamidophos is unlikely to be genotoxic *in vivo*.

In view of the lack of evidence for genotoxicity or for carcinogenic potential in mice or rats, the Meeting concluded that methamidophos is unlikely to pose a carcinogenic risk to humans.

In two studies of reproductive toxicity in rats given methamidophos at 0, 3, 10 or 33 ppm in the diet, equivalent to 0, 0.15, 0.5 and 1.6 mg/kg bw per day, or 0, 1, 10 or 30 ppm, equal to 0, 0.1, 0.9 and 2.4 mg/kg bw per day, reproductive performance and pup development were affected only at the highest doses. The toxicity of methamidophos to parental rats was expressed as depression of body-weight gain and a reduced fertility index. Reductions in the body-weight gain and viability of pups were attributed to the parental toxicity. The NOAEL was 1 ppm, equal to 0.1 mg/kg bw per day, for parental toxicity, on the basis of inhibition of erythrocyte and brain cholinesterase activity (> 20 %) at higher doses.

Methamidophos was tested for its ability to induce developmental toxicity in mice, rats and rabbits at doses up to 4, 3 and 2.5 mg/kg bw per day, respectively. In rats at the highest dose, delays observed in pup development were associated with maternal toxicity, characterized by a depression in body-weight gain. Anencephaly was reported at a dose of < 1 mg/kg bw per day in a published study of the developmental toxicity of methamidophos in rats. However, in adequately conducted studies of developmental toxicity in rats and rabbits, no evidence of malformations was found at doses higher than 1 mg/kg bw per day. The Meeting concluded that methamidophos is not teratogenic.

The Meeting concluded that the existing database was adequate to characterize the potential for hazard of methamidophos to fetuses, infants and children.

Studies of delayed polyneuropathy were conducted with methamidophos [racemate, R(+) enantiomer or S(–) enantiomer] in hens. When the racemate was given at a single oral dose of 400 mg/kg bw, it resulted in weak-to-moderate delayed polyneuropathy. Hens dosed with the R(+)

enantiomer showed marked signs of delayed polyneuropathy and inhibition of neuropathy target esterase activity in the brain (by nearly 100%). Hens dosed with the S(-) enantiomer did not show signs of delayed polyneuropathy and had less inhibition of neuropathy target esterase activity in the brain (58–84%). Treatment with any of the compounds was associated with severe toxicity and death, despite administration of an antidote. The Meeting concluded that delayed polyneuropathy develops only at doses well above the LD₅₀.

Monitoring of production plant personnel indicated no adverse effects, except for slight, transient inhibition of cholinesterase activity in workers complying with normal safety precautions.

Delayed polyneuropathy was reported in humans after exposure to large, but unknown, quantities of methamidophos, usually by ingestion. When tested, reduced plasma and erythrocyte cholinesterase activities were observed. Long-term follow-up indicated complete recovery in some patients within several months to 2 years after the onset of symptoms.

A mixture of methamidophos and acephate (in a ratio of 1:4 or 1:9) was administered to volunteers in repeated doses over 21 days, and plasma and erythrocyte cholinesterase activities were measured. Erythrocyte cholinesterase activity did not appear to be inhibited in either sex at doses of the 1:9 mixture up to 0.3 mg/kg bw per day, equivalent to a dose of methamidophos of 0.03 mg/kg bw per day. As this study was not conducted according to current standards, the Meeting considered that it could be used only to support a reference value.

The Meeting established an ADI of 0–0.004 mg/kg bw on the basis of the NOAEL of 0.1 mg/kg bw per day for inhibition of erythrocyte and brain cholinesterase activity in the 2-year study of toxicity and carcinogenicity in rats and a safety factor of 25. This value is supported by the NOAEL of 0.1 mg/kg bw per day for inhibition of erythrocyte cholinesterase activity in the multigeneration study of reproductive toxicity in rats and by the NOAEL of 0.06 mg/kg bw per day for inhibition of erythrocyte and brain cholinesterase activity in the 1-year study of toxicity in dogs. Use of a safety factor of 25 is supported by the information provided by the 21-day study in volunteers, by the finding of negligible species differences in inhibition of cholinesterase activity in rats, dogs and humans *in vitro*, by the absence of differences in inhibition of erythrocyte and brain cholinesterase activity in various animal species and because the effect was dependent on the C_{max} (see section 2.2).

The Meeting established an acute RfD of 0.01 mg/kg bw on the basis of the NOAEL of 0.3 mg/kg bw for inhibition of erythrocyte and brain cholinesterase activity in the study of neurotoxicity in rats given single doses and a safety factor of 25. This safety factor was used for the same reasons as those given above.

The results of the study in volunteers were supportive of both the ADI and the acute RfD because methamidophos did not cause toxic effects other than those associated with, or secondary to, inhibition of cholinesterase activity.

A toxicological monograph summarizing data that had become available since the previous evaluation and relevant data from previous monographs and monograph addenda was prepared.

TOXICOLOGICAL EVALUATION

Levels relevant to risk assessment

Species	Study	Effect	NOAEL	LOAEL
Mouse	2-year study of toxicity and carcinogenicity ^a	Toxicity	5 ppm, equal to 0.67 mg/kg bw per day	25 ppm, equal to 3.5 mg/kg bw per day
		Carcinogenicity	25 ppm equal to 3.5 mg/kg bw per day ^b	–
Rat	2-year study of toxicity and carcinogenicity ^a	Toxicity	2 ppm, equal to 0.10 mg/kg bw per day	6 ppm, equal to 0.29 mg/kg bw per day
		Carcinogenicity	54 ppm, equal to 2.9 mg/kg bw per day ^d	–
	Multigeneration study of reproductive toxicity ^a	Parental toxicity	1 ppm, equal to 0.1 mg/kg bw per day	10 ppm, equal to 0.9 mg/kg bw per day
	Study of developmental toxicity ^b	Maternal toxicity	1 mg/kg bw per day	3 mg/kg bw per day
		Embryo- and fetotoxicity	1 mg/kg bw per day	3 mg/kg bw per day
Study of acute neurotoxicity ^c	Inhibition of cholinesterase activity	0.3 mg/kg bw	0.7 mg/kg bw	
	Neurotoxicity	9 mg/kg bw ^b	–	
Rabbit	Study of developmental toxicity ^c	Maternal toxicity	0.5 mg/kg bw per day	2.5 mg/kg bw per day
		Embryo- and fetotoxicity	2.5 mg/kg bw per day ^b	–
Dog	1-year study of toxicity ^a	Toxicity	2 ppm, equal to 0.06 mg/kg bw per day	8 ppm, equal to 0.24 mg/kg bw per day
Human	21-day study of toxicity ^d	Inhibition of cholinesterase activity	0.03 mg/kg bw per day ^b	–

^aDietary administration^bHighest dose tested^cGavage^dCapsule; only supportive for establishment of reference values*Estimate of acceptable daily intake for humans*

0–0.004 mg/kg bw

Estimate of acute reference dose

0.01 mg/kg bw

Studies that would provide information useful for continued evaluation of the compound

Further observations in humans

List of end-points relevant for setting guidance values for dietary and non-dietary exposure*Absorption, distribution, excretion and metabolism in mammals*

Rate and extent of oral absorption	Rapid and extensive
Distribution	Extensive
Potential for accumulation	None
Rate and extent of excretion	Rapid
Metabolism in animals	Very extensive through deamination or demethylation
Toxicologically significant compounds (animals, plants and environment)	Methamidophos

Acute toxicity

Rat, LD ₅₀ , oral	15–30 mg/kg bw
Rat, LD ₅₀ , dermal	50–380 mg/kg bw
Rat, LC ₅₀ , inhalation	0.063–0.21 mg/l (4 h, nose-only)
Mouse LD ₅₀ , oral	10–30 mg/kg bw
Skin irritation	Mildly irritating
Eye irritation	Mildly irritating
Skin sensitization	Not sensitizing (modified Buehler test)

Short-term studies of toxicity

Target/critical effect	Inhibition of cholinesterase activity
Lowest relevant oral NOAEL	2.1 ppm (equal to 0.1 mg/kg bw per day, 56-day study in rats) 2 ppm (equal to 0.06 mg/kg bw per day, 1-year study in dogs)

Genotoxicity

Unlikely to be genotoxic in vivo

Long-term studies of toxicity and carcinogenicity

Target/critical effect	Inhibition of cholinesterase activity
Lowest relevant NOAEL	2 ppm (equal to 0.1 mg/kg bw per day, 2-year study in rats)
Carcinogenicity	Unlikely to pose a carcinogenic risk to humans

Reproductive toxicity

Target/critical effect for reproductive toxicity	Reduced parental and pup weight and viability
Lowest relevant NOAEL for reproductivetoxicity	1 ppm (equal to 0.1 mg/kg bw per day, rats)
Target/critical effect for developmental toxicity	Decreased fetal body weight only at maternally toxic doses
Lowest relevant NOAEL for developmental toxicity	1 mg/kg bw (rats)

Neurotoxicity

Acute	NOAEL: 0.3 mg/kg bw for inhibition of cholinesterase activity (rats)
90-day	NOAEL: 1 ppm (equal to 0.067 mg/kg bw for inhibition of cholinesterase activity, rats)
Delayed polyneuropathy	Delayed polyneuropathy at doses well above the LD ₅₀
Human data ^a	In an older 21-day study in volunteers treated orally, no inhibition of erythrocyte cholinesterase activity at 0.03 mg/kg bw per day Delayed polyneuropathy developed after severe poisoning

Summary

	Value	Study	Safety factor
ADI	0–0.004 mg/kg bw	Rat (long-term study of toxicity) supported by short-term study in dogs, study in volunteers and multigeneration study of reproductive toxicity in rats	25
Acute RfD	0.01 mg/kg bw	Rat (single-dose study of neurotoxicity)	25

^aOnly supportive for establishment of reference values

DIETARY RISK ASSESSMENT

The theoretical maximum daily intake (TMDI) and international estimated daily intakes (IEDI) of methamidophos in the five GEMS/Food regional diets, on the basis of existing MRLs and STMR levels, represented 4–40% of the ADI (Annex 3). The Meeting concluded that intake of residues of methamidophos resulting from uses that have been considered by the JMPR is unlikely to present a public health risk.

4.19 OXAMYL (126)

TOXICOLOGY

Oxamyl [*N,N*-dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide] is a carbamate insecticide that acts by inhibiting acetylcholinesterase activity. It was evaluated by the JMPR in 1980, 1983, 1984 and 1985. An ADI of 0–0.03 mg/kg bw was established in 1984 on the basis of a NOAEL of 2.5 mg/kg bw per day in a 2-year feeding study in rats and a NOAEL of 2.5 mg/kg bw per day in a 2-year feeding study in dogs. Oxamyl was evaluated by the present Meeting within the periodic review programme of the Codex Committee on Pesticide Residues. The Meeting reviewed new data on oxamyl-induced neurotoxicity and inhibition of cholinesterase activity in brain, erythrocytes and plasma, which had been reported since the previous evaluations, and relevant data from previous evaluations.

Absorption of oxamyl was rapid and nearly complete after oral administration to rats and intraperitoneal administration to male mice. Elimination was rapid, urine being the main route of excretion (80% within 24 h and 95% within 168 h in rats; 89% within 96 h in mice). The tissue concentrations were low. Studies of biotransformation in vitro and in vivo indicated that oxamyl is metabolized in rats and mice via two major pathways: non-enzymatic hydrolysis to the oxime and enzymatic conversion to dimethyloxamic acid via dimethylcyanofornamide. These and other metabolites were present as polar conjugates in the urine of rats. No marked sex difference was observed in the excretion pattern, tissue distribution or metabolite profile in rats.

The oral LD₅₀ in rats was 2.5 mg/kg bw; the inhalation LC₅₀ (4-h, nose-only) in rats was 0.05 mg/l; and the dermal LD₅₀ in rabbits was > 2000 mg/kg bw. The signs of acute intoxication with oxamyl were consistent with inhibition of cholinesterase activity. WHO has classified oxamyl as 'highly hazardous'.

In studies in New Zealand white rabbits, oxamyl was not irritating to the eyes or skin; however, ocular treatment induced signs of acute intoxication consistent with inhibition of cholinesterase activity. Oxamyl did not sensitize the skin of guinea-pigs in the Buehler test.

The most sensitive effect of oxamyl was inhibition of cholinesterase activity, often accompanied at the same or higher doses by clinical signs. The effect of oxamyl on cholinesterase activity is rapid and transient. In rats given oxamyl at a single dose of 1 mg/kg bw by gavage, cholinesterase inhibition and clinical signs were observed within 0.5 h, and recovery was virtually complete within 2 h.

The NOAELs after dietary administration were higher than those after treatment by gavage. In a study of acute neurotoxicity in rats treated by gavage, inhibition of brain, erythrocyte and plasma cholinesterase activity, a variety of clinical signs and disturbances in a battery of functional tests indicative of cholinesterase inhibition were observed at doses of 0.75 and 1 mg/kg bw and above in females and males, respectively. A significant, 25% reduction in cholinesterase activity in the cerebellum of females at 0.1 mg/kg bw was considered not to be of toxicological significance because significant inhibition of cholinesterase activity was not observed in other brain structures or in a half-brain preparation or in erythrocytes or plasma of either sex at this dose. The NOAEL in this study was 0.1 mg/kg bw.

In a 90-day study in rats given oxamyl at a concentration of 10–300 ppm in the diet, behavioural effects in a battery of functional tests and clinical signs typical of cholinesterase inhibition were observed at doses of 100 ppm and higher. In addition, reductions in body weight, body-weight gain, food consumption and feed use efficiency were seen at these doses. Reductions in brain, erythrocyte and plasma cholinesterase activity were observed at 4, 8 and 13 weeks of treatment and remained constant during these three periods. The NOAEL was 30 ppm, equal to 1.7 mg/kg bw per day. In a 1-year study in beagle dogs treated in the diet, inhibition of brain and plasma cholinesterase activity was observed in males at 50 ppm (equal to 1.5 mg/kg bw per day), the lowest dose tested. Tremors were observed in females at this dose. On the basis of this study and a second 1-year study in dogs that was performed to determine the NOAEL for cholinesterase inhibition in dogs, the NOAEL was 35 ppm, equal to 0.93 mg/kg bw per day.

A number of studies of toxicity in mice, rats and dogs given repeated doses showed not only inhibition of cholinesterase activity but also effects on body weight and body-weight gain and, to a lesser degree, on food consumption and feed use efficiency, sometimes accompanied by effects on

organ weights. These results were seen in a 3-month study in rats, 2-year studies in mice and rats, a two-generation study of reproductive toxicity in rats and studies of developmental toxicity in rats and rabbits. The lowest NOAEL for these effects was 0.5 mg/kg bw per day in a study of developmental toxicity in rats treated by gavage.

In long-term studies in mice and rats, no carcinogenic effect of oxamyl was observed. The Meeting concluded that oxamyl is unlikely to pose a carcinogenic risk to humans.

The genotoxic potential of oxamyl in vitro was investigated in a number of assays for reverse mutation in bacteria, in tests for gene mutation and chromosomal aberration and in an assay for unscheduled DNA synthesis in mammalian cells. Negative results were obtained in all the studies. In view of the consistently negative results in a comprehensive range of well-conducted assays in vitro, the Meeting concluded that oxamyl is unlikely to be genotoxic. This conclusion was supported by the absence of other toxicological effects, such as carcinogenicity and reproductive toxicity, which could have a genotoxic mechanism.

In a two-generation study of reproductive toxicity in rats, oxamyl was administered in the feed at a concentration of 0, 25, 75 or 150 ppm. Parental animals showed reductions in body weight, body-weight gain, food consumption and feed use efficiency at concentrations of 75 ppm and above. Decreased pup body weight and an increase in the number of pups with low body weights were also seen at these concentrations. The NOAEL for parental and developmental toxicity (based on the oxamyl intake of the dams) was 25 ppm, equivalent to 1.7 mg/kg bw per day. At 150 ppm (equivalent to 10 mg/kg bw per day in dams), a reduction in number of pups per litter, indicative of reproductive toxicity, was observed. The NOAEL for reproductive toxicity was 75 ppm (equivalent to 5 mg/kg bw per day). Effects on pup weight were observed at similar doses in an older, three-generation study of reproductive toxicity. Cholinesterase activity in brain, erythrocytes or plasma was not measured in these studies.

A dose of 0.8 mg/kg bw per day given to rats by gavage caused tremors in the dams and reductions in weight gain and food consumption. A small (6.8%) but significant reduction in fetal body weight was also observed, which was considered to be related to the maternal toxicity. The NOAEL for maternal and fetotoxicity was 0.5 mg/kg bw per day. In a study in rabbits, decreased body-weight gain was observed in does at a dose of 2 mg/kg bw per day given by gavage. At 4 mg/kg bw per day, the percentage of resorptions was increased and fetal viability was lowered slightly. The NOAELs for maternal and fetal toxicity were 1 and 2 mg/kg bw per day, respectively. Oxamyl did not induce irreversible structural effects in either rats or rabbits, and the Meeting concluded that oxamyl has no teratogenic potential. Cholinesterase activity in brain, erythrocytes or plasma was not measured in these studies.

The Meeting concluded that the existing database was sufficient to characterize the potential hazard of oxamyl to fetuses, infants and children.

There was no evidence that a single dose of oxamyl to hens induced delayed polyneuropathy.

In general, the studies of biochemical effects and toxicity in animals did not reveal marked differences between males and females.

Male volunteers received a single gelatine capsule containing oxamyl at a dose of 0, 0.005, 0.015, 0.03, 0.06, 0.09 or 0.15 mg/kg bw. Cholinesterase activity was inhibited in plasma (within 0.5–2 h) and erythrocytes ($\geq 20\%$ inhibition within 0.5–1 h) by a dose of 0.15 mg/kg bw, and the effect was accompanied by increased production of saliva. Small ($< 12\%$) but significant

reductions in plasma and erythrocyte cholinesterase activity observed with a dose of 0.09 mg/kg bw were considered not to be adverse since the magnitude of the decrease was < 20% and similar changes in plasma and erythrocyte cholinesterase activity were observed in individuals in the control group. The NOAEL was 0.09 mg/kg bw.

Acute and short-term studies in rats given the metabolites dimethyloxamic acid, methyl *N*-hydroxy-*N*'-methyl-1-thioxamimidate, dimethylcyanoformamide and the oxime metabolite orally suggested that they were less toxic than oxamyl. Dimethylcyanoformamide did not induce reverse mutation in bacteria.

The toxicological profile of oxamyl showed rapid restoration of cholinesterase activity after inhibition, and repeated administration did not change the character of the recovery. Moreover, no sex differences were found with respect to the effects of oxamyl in experimental animals. The Meeting established an ADI of 0–0.009 mg/kg bw on the basis of the NOAEL of 0.09 mg/kg bw per day in male volunteers, in whom increased salivation and decreased erythrocyte cholinesterase activity were observed at a higher dose, and a safety factor of 10.

The Meeting established an acute RfD of 0.009 mg/kg bw on the basis of the NOAEL of 0.09 mg/kg bw in the study with volunteers and a safety factor of 10. This acute RfD is supported by the NOAEL of 0.1 mg/kg bw in the study of acute neurotoxicity in rats.

A toxicological monograph summarizing data that had become available since the previous evaluation and relevant data from previous monographs and monograph addenda was prepared.

TOXICOLOGICAL EVALUATION

Levels relevant for risk assessment

Species	Study	Effect	NOAEL	LOAEL
Mouse	2-year study of toxicity and carcinogenicity ^{a,b}	Toxicity	25 ppm, equivalent to 3.8 mg/kg bw per day	50 ppm, equivalent to 7.5 mg/kg bw per day
Rat	2-year study of toxicity and carcinogenicity ^b	Toxicity	50 ppm, equal to 2 mg/kg bw per day	100 ppm, equal to 4.2 mg/kg bw per day
Rat	Two-generation study of reproductive toxicity ^{a,b}	Parental and pup toxicity Reproductive toxicity	25 ppm, equivalent to 1.7 mg/kg bw per day 75 ppm, equivalent to 5 mg/kg bw per day	75 ppm, equivalent to 5 mg/kg bw per day 150 ppm, equivalent to 10 mg/kg bw per day
Rat	Developmental toxicity ^{b,c}	Maternal toxicity Fetotoxicity	0.5 mg/kg bw per day 0.5 mg/kg bw per day	0.8 mg/kg bw per day 0.8 mg/kg bw per day
Rat	Acute neurotoxicity ^c	Neurotoxicity	0.1 mg/kg bw	0.75 mg/kg bw
Rat	90-day neurotoxicity ^a	Neurotoxicity	30 ppm, equal to 1.7 mg/kg bw per day	250 ppm, equal to 15 mg/kg bw per day
Rabbit	Developmental toxicity ^{b,c}	Maternal toxicity Embryo- and fetotoxicity	1 mg/kg bw per day 2 mg/kg bw per day	2 mg/kg bw per day 4 mg/kg bw per day

Species	Study	Effect	NOAEL	LOAEL
Dog	1-year studies of toxicity ^{a,d}	Toxicity	35 ppm, equal to 0.93 mg/kg bw per day	50 ppm, equal to 1.6 mg/kg bw per day
Human	Study in volunteers with single doses ^e	Cholinesterase inhibition, salivation	0.09 mg/kg bw	0.15 mg/kg bw

^a Dietary administration

^b Capsule

^c Gavage

^d Two studies combined.

^e (Adequate) measurements of cholinesterase activity not included

Estimate of acceptable daily intake for humans

0–0.009 mg/kg bw

Estimate of acute reference dose

0.009 mg/kg bw

Studies that would provide information useful for continued evaluation of the compound:

- Further observations in humans

List of end-points relevant for setting guidance values for dietary and non-dietary exposure

Absorption, distribution, excretion and metabolism in animals

Rate and extent of absorption	Rapid and extensive
Dermal absorption	No data (rabbit: systemic toxicity at ≥ 50 mg/kg bw per day)
Distribution	Throughout body, highest concentrations in blood, heart, liver, kidney, lung, spleen and gastrointestinal tract
Potential for accumulation	Low
Rate and extent of excretion	Relatively rapid (mouse: 76% after 6 h, 89% after 24 h; rat: 81% after 24 h), mainly in urine
Metabolism in animals	Extensively metabolized, no parent compound found in urine
Toxicologically significant compounds	Oxamyl

Acute toxicity

Rat, LD ₅₀ , oral	2.5 mg/kg bw
Rabbit, LD ₅₀ , dermal	> 2000 mg/kg bw
Rat, LC ₅₀ , inhalation	0.05 mg/l (4 h, nose-only)
Dermal irritation	Not irritating, rabbit
Ocular irritation	Not irritating, rabbit
Dermal sensitization	Not sensitizing, guinea-pig (Buehler test)

Short-term toxicity

Target/critical effect	Inhibition of cholinesterase activity in brain and erythrocytes, clinical and behavioural effects associated with cholinesterase inhibition, reduction in body weight and body-weight gain
Lowest relevant oral NOAEL	35 ppm, equal to 0.93 mg/kg bw per day, dogs

Lowest relevant dermal NOAEL	2.5 mg/kg bw per day, rabbits		
<i>Long-term toxicity and carcinogenicity</i>			
Target/critical effect	Reduction in body weight and body-weight gain (cholinesterase activity not assessed)		
Lowest relevant NOAEL	50 ppm, equivalent to 2 mg/kg bw per day, rats		
Carcinogenicity	Not carcinogenic		
<i>Genotoxicity</i>	No concern about genotoxicity		
<i>Reproductive toxicity</i>			
Target/critical effect for reproductive toxicity	Reduction in number of pups per litter (in presence of parental toxicity)		
Lowest relevant NOAEL for reproductive toxicity	75 ppm, equivalent to 5 mg/kg bw per day, rats		
Target/critical effect for developmental toxicity	Reduction in body weight (in presence of maternal toxicity); not teratogenic		
Lowest relevant NOAEL for developmental toxicity	0.5 mg/kg bw per day		
<i>Neurotoxicity</i>			
Neurotoxicity	Inhibition of cholinesterase activity in brain, plasma and erythrocytes and clinical and behavioural effects associated with cholinesterase inhibition		
Lowest relevant oral NOAEL	0.1 mg/kg bw, rats		
Delayed neurotoxicity	No concern		
<i>Medical data</i>			
Single dose	Inhibition of cholinesterase activity in plasma and erythrocytes and increased saliva production		
Lowest relevant oral NOAEL	0.09 mg/kg bw		
Summary	Value	Study	Safety factor
ADI	0–0.009 mg/kg bw	Humans, single dose	10
Acute RfD	0.009 mg/kg bw	Humans, single dose	10

RESIDUE AND ANALYTICAL ASPECTS

Oxamyl was first evaluated in 1980 for toxicology and residues. The latest evaluation was in 1986 for residues. The compound was listed by the 1997 CCPR (29th Session, ALINORM 97/24A) for Periodic Re-evaluation for residues by the 2002 JMPR.

The manufacturer provided information to the Meeting on metabolism in animals and plants, environmental fate in soil and water, methods of residue analysis and stability of residues in stored analytical samples, uses, residue supervised trials and processing data as well as national

MRLs. Information on national GAP data was provided by the governments of Australia, Germany and The Netherlands. Germany and The Netherlands indicated that oxamyl is no longer authorized for use. National MRLs were provided by the governments of Australia, Germany, Poland and The Netherlands.

Pure oxamyl is a white crystalline solid with a melting point of 99.8°C and low volatility. It has medium-high solubility in water and high solubility in certain organic solvents. The log P_{OW} of 0.36 suggests that the compound is not fat soluble.

Metabolic products

The parent, metabolites and degradation products are identified by code numbers as shown below.

Code	Chemical name, Short name	
DPX-D1410	<i>N,N</i> -dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide	Oxamyl
IN-A2213	2-hydroxyimino- <i>N,N</i> -dimethyl-2-(methylthio)acetamide	Oxamyl oxime
IN-N0079	<i>N,N</i> -dimethyl-2-nitriloacetamide	DMCF
IN-D2708	dimethylamino(oxo)acetic acid,	DMOA
IN-L2953	2-hydroxyimino- <i>N</i> -methyl-2-(methylthio)acetamide	N-demethyloxime, NDMO
IN-KP532	methylamino(oxo)acetic acid	
IN-D1409	<i>N</i> -methyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide	<i>N</i> -demethyl-oxamyl
IN-T2921	<i>N,N</i> -dimethyloxamide	DMEA (also DMO)

Animals metabolism

Absorption, distribution, metabolism and excretion of ¹⁴C-oxamyl were studied in rats, goats and hens. The metabolism of rats dosed with ¹⁴C-oxamyl-oxime (the less toxic, principal hydrolysis product) was also studied to obtain sufficient metabolites to establish the metabolic pathway for oxamyl in rats. Oxamyl was rapidly and extensively metabolised in both livestock (goats and poultry) and laboratory animals (rats) and its metabolic products were mainly excreted in the urine or excreta. The initial steps in the metabolic pathway for oxamyl in goats and hens is similar to that described for rats. The proposed pathway involves oxamyl hydrolysis to oxamyl-oxime (IN-A2213), or Beckmann type rearrangement to IN-N0079 (IN-N0079 could also be formed directly from oxamyl-oxime). IN-N0079 is then converted to IN-D2708 and ultimately incorporated into natural products. Minor metabolites (IN-L2953, IN-KP532 and IN-D1409) resulting from demethylation reactions were also observed. In livestock studies, the detoxification of IN-N0079 as thiocyanate (through cyanide displacement) was a major part of the pathway. The major metabolite found in lactating goats and laying hens was thiocyanate and radioactivity resulting from incorporation into natural products (such as lactose). In rats, IN-N0079 conversion to thiocyanate was not observed, however conjugates of the principal metabolites were found.

Plants metabolism

Based on the metabolism studies conducted with ¹⁴C-oxamyl *via* direct foliage, fruit or soil applications in potatoes, peanuts, tobacco, tomatoes, oranges, and apples, IN-A2213 and IN-L2953 were identified as major breakdown products of oxamyl. The metabolic pathway of oxamyl was similar in the various crops. Metabolism of oxamyl in plant tissues included hydrolysis of the methylcarbamoyl group to yield oxamyl oxime (IN-A2213). IN-A2213 was

demethylated before or after glucose conjugation to give IN-L2953 and/or its glucose conjugate. Conjugation of the glucosides of IN-A2213 and IN-L2953 with additional sugar residues was also observed. IN-A2213 (or oxamyl) may also be metabolised to IN-N0079, which is metabolised to IN-D2708 and ultimately incorporated into plant natural products. The only residue of toxicological concern in any plant tissue is oxamyl.

Environmental fate

Laboratory soil degradation studies were conducted in a variety of differing soils. In these studies, IN-A2213 and IN-D2708 were the major (>10%) degradation products of oxamyl consistently observed in soil. The only other major products consistently observed were non-extractable residues and carbon dioxide. Carbon dioxide was the predominant degradation product in all cases. IN-N0079 was observed >10% in the soil photolysis study, but was never detected in any of the other topsoil degradation studies. The half live of oxamyl under aerobic and anaerobic conditions was about 20 days.

In three confined rotational crop studies, the presence of oxamyl, oxamyl-oxime and IN-D2708 in crop samples demonstrated that oxamyl, as well as its soil degradates (oxamyl-oxime and IN-D2708), were taken up by the succeeding crop. The identification of these components and the characterisation of several tentatively identified metabolites (IN-KP532, IN-T2921, IN-L2953 and IN-N0079) further support the metabolic profile in the rotated crop. The proposed metabolic pathway of oxamyl in rotated crops is consistent with the metabolic pathway observed in oxamyl plant metabolism studies. Oxamyl was hydrolysed to oxamyl-oxime, which was ultimately metabolised to IN-D2708 and other polar metabolites. The conversion of oxamyl-oxime to IN-D2708 has been reported to proceed through IN-N0079 and IN-T2921. Oxamyl-oxime can also be demethylated to give IN-L2953, which can be metabolised to IN-KP532. A major component in rotated crops (specifically barley) is proposed to be the glucose conjugate of oxamyl-oxime, a major plant metabolite. The field rotational crop study confirms that succeeding crops take up oxamyl equivalents (oxamyl and/or oxamyl-oxime) when planted 30 days after oxamyl application. However, in the human-edible portion of crops planted 120 days after oxamyl application, no significant oxamyl residues were detected.

IN-A2213 was observed as the only major degradation product in hydrolysis and aqueous photolysis studies. IN-A2213, IN-D2708, IN-N0079, and IN-T2921 were each observed as major degradation products in the water phase of the water/sediment study. Only IN-D2708 was observed exceeding 10% (10.4% to 12.1%) in the sediment phase of the water sediment study.

Methods of analysis

Oxamyl is considered the only relevant analyte in the total toxic residue. However, earlier GLC methods convert oxamyl to oxamyl-oxime and report the total residues of the two analytes in oxamyl equivalents. Oxamyl (including oxamyl-oxime) residues in plants are detected by initial extraction with ethyl acetate, followed by liquid-liquid partitioning cleanup, and alkaline hydrolysis to the more volatile oximino fragment (oxamyl-oxime, IN-A2213), and final determination by GLC with sulphur-sensitive flame photometric detection. LOQ is 0.02 mg/kg for dry and watery crops. The method can be used for animal products (LOQ fat, meat, kidney, liver 0.04 mg/kg; milk 0.02 mg/kg). Additional clean-up using GPC followed by conversion of oxamyl to oxamyl-oxime and analysis by GLC/MS improved the LOQ for animal products (0.01 mg/kg).

HPLC methods are able to analyse oxamyl only. Oxamyl is extracted with ethyl acetate using a homogeniser. Water is added to the extract and then the ethyl acetate is evaporated under vacuum. Cleanup is performed with liquid-liquid extractions. Reversed phase HPLC/UV under isocratic conditions is used to determine quantitatively oxamyl *per se*. Other methods performed extraction by accelerated solvent extraction rather than traditional mechanical extraction in ethyl acetate. The samples are extracted using an accelerated solvent extractor (ASE) and acetone. The acetone extract is passed through an SPE cartridge to remove pigments and other interfering molecules. The whole SPE eluate is then concentrated to about 0.5 ml by evaporation. The extract is dissolved in a mixture of 10% acetone in cyclohexane (v:v) and applied to a Silica Mega Bond Elute SPE cartridge to complete the clean-up. A HPLC/UV equipped with column switching valve is used. -The LOQ of oxamyl *per se* is 0.02 mg/kg.

Stability of residues in stored analytical samples

Oxamyl and oxamyl-oxime (IN-A2213) are stable in representative crop matrices (watery, starchy, oily, and dry crops) stored frozen for extended periods. These stability data support the magnitude of residue and residue decline supervised trials. In addition, oxamyl is shown to be stable in water and soil matrices when stored frozen.

Definition of residue

Oxamyl is rapidly metabolized in animals (rats, goats, hens) and has not been isolated intact in animal products. None of oxamyl's metabolites contain the carbamate moiety. The major metabolite identified in milk, eggs and tissues was thiocyanate.

Based on the metabolism studies conducted in potatoes, peanuts, tobacco, tomatoes, oranges, and apples, oxamyl-oxime (IN-A2213) and N-demetyloxime (IN-L2953) were identified as major breakdown products of oxamyl. None of the metabolites contain the carbamate moiety responsible for cholinesterase inhibition. The Meeting concluded that the only residue of toxicological concern in any plant tissue is oxamyl. However, most of residue supervised trials samples were analyzed by a GLC method which converts oxamyl to oxamyl-oxime and reports the total residues of the two analytes in oxamyl equivalents.

Due to the nature of the residues determined in supervised residue trials in plants submitted, the Meeting recommended that the definition of the residue for compliance with MRLs should be the sum of oxamyl and oxamyl-oxime expressed as oxamyl.

For the estimation of dietary intake the residue definition should be oxamyl *per se*. Because the estimated STMRs and HRs are based on the sum of oxamyl and oxamyl-oxime, the Meeting noted that an overestimate of the dietary intake calculations cannot be excluded.

This residue definition applies for both plant and animal commodities.

Resulting of supervised trials

Oxamyl is used world-wide as a foliar spray or soil treatment in citrus fruits but only US residue supervised trials were submitted. The current US label indicates oxamyl may be applied at either 0.56 - 1.1 kg ai/ha per foliar spray application (not more than 6.7 kg ai/ha per season) or 0.56 - 2.2 kg ai/ha as soil irrigation treatment (not more than 2.2 kg ai/ha in any 30 day period) with a 7-day PHI. No trials were submitted for soil treatment. Three foliar-sprayed grapefruit trials, five orange trials and two lemon trials (1 x 1.1 - 1.5 kg ai/ha, 0.0012 - 0.03 kg ai/hl PHI 7 - 8 days)

resulted in residues in whole fruits of 0.13, 1.2 and 2 mg/kg for grapefruit, of 0.14, 0.16, 0.3, 0.34 and 0.8 mg/kg for oranges and of 0.05 and 0.17 mg/kg for lemon. One further trial on oranges treated five times by foliar spraying in a monthly interval (1.1 kg ai/ha, 0.24 kg ai/hl) showed residues lower than the LOQ of 0.04 mg/kg at PHIs of 4 or 8 days. Further trials on tangelo and tangerine did not match the GAP. Combined residue levels of grapefruit, oranges and lemon in rank order (median underlined) were: <0.04, 0.05, 0.13, 0.14, 0.16, 0.17, 0.3, 0.34, 0.8, 1.2 and 2 mg/kg.

Based on residues in whole fruit (no data were available for edible portion), the Meeting estimated a maximum residue level, an STMR value and an HR value for oxamyl in citrus fruit of 3, 0.17 and 2 mg/kg, respectively. The estimated maximum residue level replaces the current MRL recommendation of 5 mg/kg for citrus fruits.

In the USA, oxamyl is registered for foliar treatment in apples at application rates of 0.56 – 2.2 kg ai/ha (not more than 2.2 kg ai/ha per season) with a PHI of 14 days. Oxamyl levels were after one treatment of 2.2 kg ai/ha (0.42 – 0.5 kg ai/hl) <0.1, 0.18, 0.24, 0.25, 0.26, 0.44, 0.49, 0.52, 0.59, and 0.81 mg/kg. The Meeting noted that a single residue of 1.2 mg/kg was found after two spray treatments at 1.1 kg/ha (interval of 7 days). This value was considered for maximum residue level and HR estimation.

The Meeting estimated a maximum residue level, an STMR value and an HR value for oxamyl in apples of 2, 0.35 and 1.2 mg/kg, respectively. The current MRL recommendation of 2 mg/kg was confirmed.

The current Australian label indicates oxamyl may be applied at the base of the plant on bananas three times at 1.8 to 3 g ai/plant on a minimum 90-day interval throughout the growing season with an unspecified PHI. Application rates in available Australian trials (1990) according to GAP were 3 x 1.8 or 2.4 g ai/plant (2 trials each). The residues after a PHI of 0 – 28 days were in whole fruit <0.01, 0.01, 0.02, 0.02 mg/kg, in peel <0.01, 0.02, 0.03, 0.03 mg/kg and in pulp <0.01 mg/kg (4). No trial according to the maximum GAP (3 x 3 g ai/plant) was submitted. Further overdosed trials (3 x 4.8 g ai/plant, 6 x 3 g ai/plant, 6 x 6 g ai/plant) show maximum residues in whole fruit, peel and pulp of 0.08, 0.2 and 0.01 mg/kg, respectively. These results indicate that detectable residues may occur in pulp.

The Meeting concluded that there were insufficient data to estimate a maximum residue level for banana, and withdrew the current recommendation of 0.2 mg/kg.

The current USA label indicates oxamyl may be applied on pineapple at 4.5 kg ai/ha at planting followed by applications at 1.1 - 2.2 kg ai/ha (not more than 8.9 kg ai/ha per season) on a minimum 2-week interval throughout the growing season with a 30-day PHI. For purposes of proposing an MRL, oxamyl residue data obtained from US trials with foliar applications of 4 – 5 x 2.2 kg ai/ha (PHI 23 – 35 days) were considered. The residue concentrations were 0.05, 0.17 and 0.59 mg/kg after 4 – 5 treatments with 2.2 kg ai/ha.

The Meeting concluded that there were insufficient data to estimate a maximum residue level for pineapple, and withdrew the current recommendation of 1 mg/kg.

Oxamyl is world-wide registered as foliar spray or soil treatment in onions, but no residue supervised trials data have been received. The Meeting agreed to withdraw the previous recommendation for onion, bulb (0.05* mg/kg).

The current USA label for cucumber and melons indicates oxamyl may be applied to the soil at 4.5 kg ai/ha at planting followed by foliar spray applications at 0.56 - 1.1 kg ai/ha (not more than 6.7 kg ai/ha per season) on a minimum 1-week interval throughout the growing season with a 1-day PHI. For foliar spray use on cucumber, altogether five US outdoor residue trials (1976 - 1978) according to the above named GAP (5 - 7 x 1.1 kg ai/ha) were submitted. Residue levels in rank order were: 0.3, 0.37, 0.38, 0.47 and 0.54 mg/kg. For melons, six US outdoor foliar-sprayed trials according to GAP (5 - 8 x 1.1 kg ai/ha) were submitted and showed residues of 0.16, 0.2, 0.26, 0.26, 0.39, 0.5 mg/kg.

The Meeting noted that the residue data on cucumber and melons were similar and could be combined for mutual support. The combined residues were, in rank order, 0.16, 0.2, 0.26, 0.26, 0.2, 0.37, 0.38, 0.39, 0.47, 0.5 and 0.54 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for oxamyl in cucumber and melons, except watermelons, of 1, 0.37 and 0.54 mg/kg, respectively. The estimated maximum residue level replaces the current recommendations (2 mg/kg).

Oxamyl is registered in the USA in watermelon with soil treatment pre-plant or at planting with 4.5 kg ai/ha followed by foliar spray of 1.1 kg ai/ha (not more than 6.7 kg ai/ha per season) with a 1-day PHI. Only one US trial according to GAP (8 x 1.1 kg ai/ha) was submitted and resulted in a residue of 0.77 mg/kg one day after application. The Meeting concluded that there were insufficient data to estimate a maximum residue level. The previous MRL recommendation of 2 mg/kg should be withdrawn.

Oxamyl is registered in the USA in summer squash with soil treatment pre-plant or at planting with 2.2 - 4.5 kg ai/ha followed by foliar spray of 0.56 - 1.1 kg ai/ha (not more than 6.7 kg ai/ha per season) with a 1-day PHI. Two overdosed supervised residue trials were submitted (5 x 2.2 mg/kg) but no trials carried out according to GAP were provided. The Meeting recommended to withdraw the previous MRL recommendation of 2 mg/kg.

The current USA label indicates oxamyl may be applied to peppers as a transplant water treatment at a maximum rate of 0.56 kg ai/ha. Following transplant, foliar or soil applications may be at a rate of 0.56 - 1.1 kg ai/ha (not more than 6.7 kg ai/ha) on a minimum 1-week interval through out the growing season with a 7-day PHI. For purposes of proposing an MRL, oxamyl residue data obtained from eight outdoor US trials with a 5 to 7-day PHI and 5 - 8 foliar applications at 1.1 kg ai/ha were considered. No information on variety etc. (bell/long, sweet/hot) was stated in report 9F 2266 (1975/76), but 2 trials were according to GAP resulting in residues of 0.62 and 0.73 mg/kg. In Residues were 0.13, 0.75 and 0.76 mg/kg in sweet pepper and 1.5, 1.8 and 4.3 mg/kg in hot pepper. All residues were in rank order 0.13, 0.62, 0.73, 0.75, 0.76, 1.5, 1.8 and 4.3 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for oxamyl in peppers of 5, 0.755 and 4.3 mg/kg, respectively. The previous recommendation of 2 mg/kg for sweet peppers is withdrawn.

Oxamyl is registered in tomato in the USA for foliar spray use at 0.56 – 1.1 kg ai/ha and for soil drip irrigation at 0.56 – 2.2 kg ai/ha (not more than 8.9 kg ai/ha/season) and a 3-day PHI. Field supervised trials were conducted in 1997 in tomato for both uses in the USA. (foliar spray; drip irrigation 9 - 10 x 1.1 – 2.2 kg ai/ha, PHI 3 days). Residues after 9 - 10 drip irrigation treatments with total 13.3 – 13.5 kg ai/ha/season ranged from 0.12 – 0.72 mg/kg at a 3-day PHI. These values were not included in the evaluation (overdosed). Residues after foliar spray with 8 x 1.1 kg ai/ha (PHI 3 days) were, in rank order, 0.06, 0.27, 0.33, 0.42, 0.48, 0.5, 0.54, 0.55, 0.61, 0.61, 0.69, 0.74, 0.76, 0.82, 0.93, 0.99 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for oxamyl in tomato of 2, 0.58 and 0.99 mg/kg, respectively. The previous recommendation was confirmed.

Oxamyl is registered in Peru and Saudi Arabia for beans but no residue supervised trials data have been received. The Meeting agreed to withdraw the previous recommendations for beans, except broad bean and soya bean of 0.2 mg/kg and for soya bean (dry) of 0.1 mg/kg.

In the USA, oxamyl is registered for soil directed spray use on carrots (3 x 1.1 kg ai/ha, PHI 14 days). Other uses are one soil broadcast treatment at 8.9 kg ai/ha pre-planting or 4.5 kg ai/ha in furrow at planting, all in all not more than 8.9 kg ai/ha per season. In five trials that matched GAP with one pre-emergence/in furrow/pre-plant soil treatment (4.5 – 5.6 kg ai/ha) and three further soil treatments (1.1 kg ai/ha), oxamyl residues, in rank order, were: <0.02, 0.02, 0.03, 0.04 and 0.07 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for oxamyl in carrots of 0.1, 0.03 and 0.07 mg/kg, respectively. The previous recommendation of 0.1 mg/kg for root and tuber vegetables is withdrawn.

The current US label indicates oxamyl may be applied to potatoes once prior to planting or at planting at up to 4.5 kg ai/ha. Post-planting, oxamyl may be applied as a foliar spray up to 6 times at a maximum rate of 1.1 kg ai/ha on a minimum 5-day interval throughout the growing season with a 7-day PHI. For MRL-purposes, oxamyl residue data obtained from 7 trials with 6-to-7-day PHI following one soil treatment with 4.5 kg ai/ha and five to six foliar applications at 1.1 kg ai/ha or five foliar sprays with 1.1 kg ai/ha only were considered. Oxamyl residues, in rank order, were <0.02 (4), 0.03 (2), 0.05 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for oxamyl in potatoes of 0.1, 0.02 and 0.05 mg/kg, respectively. The previous recommendation of 0.1 mg/kg for root and tuber vegetables is withdrawn.

In the USA, oxamyl is registered for use on celery with one treatment pre-planting (2.2 - 4.5 kg ai/ha) plus foliar spray treatments of 0.56 – 2.2 kg ai/ha (not more than 6.7 kg ai/ha) with a 21-day PHI. Eight US trials each carried out with 3 scenarios: (a) pre-planting 1 x 4.5 kg ai/ha plus foliar spraying 2 x 1.1 kg ai/ha, (b) 2 x 1.1 kg ai/ha banded plus 4 x 1.1 kg ai/ha foliar broadcast spray and (c) 6 x 1.1 kg ai/ha foliar broadcast spray (PHI 21 days) were submitted but did not match the maximum GAP (2.2 kg ai/ha, foliar spray).

The Meeting concluded that there were insufficient data according to maximum GAP to estimate a maximum residue level for celery. The previous MRL recommendation of 5 mg/kg should be withdrawn.

Oxamyl is registered in Saudi Arabia for maize but no residue supervised trials data have been received. The Meeting recommended to withdraw the previous MRL recommendation of 0.05* mg/kg for maize.

Oxamyl is registered in Saudi Arabia and Taiwan for sugar cane but no residue supervised trials data were received. The Meeting recommended to withdraw the previous MRL recommendation of 0.05* mg/kg for sugar cane.

The current USA label indicates oxamyl may be applied as a foliar spray on cotton at a maximum rate of 4 x 1.1 kg ai/ha on a minimum 6-day interval and 21 (SL 240) or 14 (SL 420) days PHI. Eight US supervised trials with 3 – 5 treatments of 1.1 kg ai/ha and a 14/15-day PHI showed the following residues in cotton seed: <0.02, <0.02, 0.02, 0.03, 0.04, 0.05, 0.07, 0.08 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for oxamyl in cotton seed of 0.2, 0.035 and 0.08 mg/kg, respectively. The previous recommendation was confirmed.

The current USA label indicates oxamyl may be applied on peanuts once prior to planting or at planting at up to 3.4 kg ai/ha. Following emergence, oxamyl may be applied as a foliar spray twice, with the first application 3 weeks post-emergence and the second application 3 weeks later. The maximum post-emergence rate is 1.1 kg ai/ha. The seasonal maximum usage is 5.6 kg ai/ha. No PHI is specified. Eight trials were conducted in 1988 in the USA side-by-side under each of two application scenarios: (a) a pre- or at-plant application of 3.4 kg ai/ha followed by 2 foliar applications at 1.1 kg ai/ha with a 3-week interval, and (b) a pre- or at-plant application of 6.7 kg ai/ha followed by 2 foliar applications at 2.2 kg ai/ha (overdosed) with a 3-week interval. Oxamyl residues in peanut nutmeat at PHIs from 78 – 118 days were less than the LOQ of 0.02 (8) mg/kg for both scenarios.

Four further trials were conducted in 1975/76 in the USA side-by-side under each of two application scenarios: (c) a pre- or at-plant application of 3.4 kg ai/ha followed by 2 foliar applications at 1.1 kg ai/ha, and (d) a pre- or at-plant application of 5 kg ai/ha followed by 2 foliar applications at 1.1 kg ai/ha. Oxamyl residues in peanut nutmeat were <0.02 mg/kg (2) in the trials (d) with 5 + 1.1 + 1.1 kg ai/ha and <0.02 and 0.03 mg/kg in trials (c) with 3.4 + 1.1 + 1.1 kg ai/ha (PHI 61 and 75 days). All residue values in rank order were: <0.02 (11) and 0.03 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for oxamyl in peanut of 0.05, 0.02 and 0.03 mg/kg, respectively. The estimated maximum residue level replaces the current recommendation (0.1 mg/kg) for peanut.

The corresponding residue values in peanut hay resulting from the above evaluated GAP trials of treatment scenarios (a), (c) and (d) were <0.02 (3), 0.03, 0.04, 0.05, 0.06, 0.07 mg/kg (fresh weight). Allowing for the standard 85% dry matter (FAO Manual), the Meeting estimated a maximum residue level and an STMR value for oxamyl in peanut fodder of 0.2 mg/kg and 0.041 mg/kg (0.035/0.85). The estimated maximum residue level replaces the current recommendation (2 mg/kg) for peanut fodder.

Oxamyl is registered in Central America for coffee but no residue supervised trials data have been received. The Meeting recommended to withdraw the previous MRL recommendation of 0.1 mg/kg for coffee beans.

Fate of residues during storage and processing

Oxamyl residues in tomatoes declined during 3-week storage at 15°C in air and in modified atmospheres. About 50, 40 and 20 % of the initial residue were determined in air, in modified atmosphere 1 (1.5% O₂, 98.5% N₂) and in modified atmosphere 2 (1.5% O₂, 4% CO₂, 79% N₂), respectively.

One hydrolysis study to determine the effects of processing on the nature of residues shows that oxamyl-oxime (IN-A2213) was the only degradation product after simulated pasteurization, baking/boiling and sterilization.

The effect of processing on the concentrations of residues of oxamyl has been studied in oranges, pineapple, tomato, potato, peanut and cotton seed.

Oranges. (RAC residues 0.55 mg/kg) were processed into dry pomace and cold pressed oil with a processing factor of <0.036 for both commodities. Based on the STMR value of 0.17 mg/kg for citrus fruits, the STMR-Ps were 0.006 mg/kg for orange dry pomace and orange oil.

Pineapple. (RAC residues 0.1 mg/kg) were processed into juice and wet skins (pineapple processed residue, wet bran) with processing factors of 1.2 and 1.7. As no maximum residue level could be estimated, no STMR-Ps were calculated.

Tomatoes. (RAC residues 1.5 mg/kg) were processed into canned fruit, juice, paste, catsup and puree with processing factors of 0.073, 0.12, 0.36, 0.24 and 0.16 respectively. Based on the STMR value of 0.58 mg/kg for tomato, the STMR-Ps were 0.042, 0.07, 0.21, 0.14 and 0.093 mg/kg for tomato canned fruit, juice, paste, catsup and puree, respectively.

Potatoes. (RAC residues 0.02 mg/kg) were processed into peels, French fries, chips and granules. No detectable residues were reported in the processed commodities (<0.02 mg/kg) with the exception of peels (0.022 mg/kg). As the concentration of oxamyl residues were near the LOQ in the RAC, no STMR-P value could be estimated.

Peanut nutmeat. (RAC residues 0.12 mg/kg) were processed into meal, crude oil and refined oil. The processing factors were <0.17 for the processed commodities. Based on the STMR value of 0.02 mg/kg for peanut nutmeat, the STMR-Ps were 0.0034 for peanut meal, crude oil and refined oil.

Cotton seed. (RAC residues 2.4 mg/kg) were processed into delinted seeds, hulls, meal, crude oil and refined oil. The processing factors were 0.288, 0.417 and 0.0125 for delinted seeds, hulls and meal and <0.008 for the other processed commodities. Based on the STMR value of 0.035 mg/kg for cotton seed, the STMR-Ps were 0.01 mg/kg for delinted seeds, 0.0146 mg/kg for hulls, 0.0004 mg/kg for meal, 0.0003 mg/kg for crude and refined oil.

Residues in animal commodities

Dietary burden in animals

The Meeting estimated the dietary burden of oxamyl residues in farm animals on the basis of the diets listed in Appendix IX of the FAO Manual. Calculation from MRLs and STMR-P values provides the levels in feed suitable for estimating MRLs for animal commodities, while

calculation from STMR and STMR-P values for feed is suitable for estimating STMR values for animal commodities. The percentage of dry matter is taken as 100% when MRLs and STMR values are already expressed as dry weight.

Estimated maximum dietary burden of farm animals

Commodity	Codex Commodity Group	Residue (mg/kg)	Basis	% Dry matter	Residue, dry wt (mg/kg)	Choose diets, %			Residue contribution (mg/kg)		
						Beef cattle	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Orange pomace, dried	AO	0.006	STMR-P	91	0.0066	20	10		0.0013	0.0007	
Cotton seed hulls	AM	0.0146	STMR-P	90	0.016	20	15		0.003	0.0024	
Cotton seed	SO	0.2	MRL	88	0.227	25	25		0.057	0.057	
Cotton seed meal		0.0004	STMR-P	89	0.00045			20			0.00009
Peanut meal		0.0034	STMR-P	85	0.004	10		25	0.0004		0.001
Peanut hay	AL	0.2	MRL	100	0.2	25	50		0.05	0.1	
TOTAL						100	100	45	0.1117	0.1601	0.00109

Estimated STMR dietary burden of farm animals

Commodity	Codex Commodity Group	Residue (mg/kg)	Basis	% Dry matter	Residue, on dry wt (mg/kg)	Choose diets, %			Residue contribution (mg/kg)		
						Beef cattle	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Orange pomace, dried	AO	0.006	STMR-P	91	0.0066	20	10		0.0013	0.0007	
Cotton seed hulls	AM	0.0146	STMR-P	90	0.016	20	15		0.003	0.0024	
Cotton seed	SO	0.035	STMR	88	0.0398	25	25		0.01	0.01	
Cotton seed meal		0.0004	STMR-P	89	0.00045			20			0.00009
Peanut meal		0.0034	STMR-P	85	0.004	10		25	0.0004		0.001
Peanut hay	AL	0.041	STMR	100	0.041	25	50		0.01025	0.0205	
TOTAL						100	100	45	0.025	0.0336	0.00109

The dietary burdens of oxamyl for estimating MRLs and STMR values for animal commodities (residue concentrations in animal feeds expressed as dry weight) are: 0.11 and 0.025 mg/kg for beef cattle, 0.16 and 0.03 mg/kg for dairy cattle and 0.001 mg/kg each for poultry.

Feeding studies

The Meeting received the information that no residues (<0.02 mg/kg) were detected in tissues (liver, kidney, muscle, fat) and milk (whole milk, milk fat, aqueous fraction) when dairy cows were dosed for 30 days with 2, 10 or 20 mg oxamyl/kg feed.

The Meeting received the information that no residues (<0.02 mg/kg) were detected in tissues and eggs when laying hens were dosed for 4 weeks with 1 and 5 mg oxamyl/kg feed.

The Meeting considered that it is unlikely that any oxamyl residues might occur in animal products as the maximum dietary burden is very low and the feeding studies did not show any residues in tissues, milk and eggs. MRLs at the LOQ of 0.02 mg/kg and STMRs/HRs of 0 were recommended for animal products as eggs, milks, meat of mammals, edible offal (mammalian), poultry meat and poultry, edible offal of.

DIETARY RISK ASSESSMENT

Long-term intake

The International Estimated Daily Intakes of oxamyl, based on the STMRs estimated for 19 commodities, for the five GEMS/Food regional diets were in range of 2 – 10 % of the ADI (Annex 3). The Meeting concluded that the long-term intake of residues of oxamyl resulting from its uses that have been considered by JMPR is unlikely to present a public health concern.

Short-term intake

The International Estimated Short term Intake (IESTI) for oxamyl was calculated for 20 food commodities for which maximum residue levels were estimated and for which consumption data were available. These results are shown in Annex 4.

The IESTI represented 0 – 610 % of the acute RfD for the general population and 0 – 1600 % of the acute RfD for children. The values 190, 190, 200, 300, 390, 390, 430, 610 and 610 % represent the estimated short-term intake for tomato, cucumber, lemon, melons, mandarins, oranges, apple, peppers and grapefruit respectively for the total population. The values 400, 650, 660, 730, 1100, 1100, 1300, 1400 and 1600 % represent the estimated short-term intake for cucumber, melons, tomato, lemon, peppers, grapefruit, apple, mandarins and oranges respectively for children.

The Meeting concluded that the short term intake of residues of oxamyl from uses, other than these 9 commodities, that have been considered by the JMPR is unlikely to present a public health concern.

4.20 OXYDEMETON-METHYL (166)

TOXICOLOGY

Oxydemeton-methyl (*S*-2-ethylsulfinyethyl *O,O*-dimethyl phosphorothioate) was evaluated toxicologically by the JMPR in 1973, 1982, 1984 and 1989. In 1989, the Meeting established a group ADI of 0–0.0003 mg/kg bw for demeton-*S*-methyl and related compounds, which included oxydemeton-methyl, demeton-*S*-methyl and demeton-*S*-methylsulfone. Residues of these compounds are measured after oxidation to demeton-methyl.

Oxydemeton-methyl is an organophosphorus compound which inhibits cholinesterase activity. Most of its toxic effects in mammalian species reflect this fact. Oxydemeton-methyl also caused effects on the testes, with equivocal reproductive consequences.

In 14-day studies in rats treated in the diet or by gavage, oxydemeton-methyl inhibited plasma, erythrocyte and brain cholinesterase activity. The inhibition of activity in plasma tended to be greater than that of erythrocyte or brain cholinesterase. On the basis of inhibition of erythrocyte and brain cholinesterase activity, the NOAEL after dietary administration was 0.21 mg/kg bw per day, and that after gavage was 0.15 mg/kg bw per day. In a 12-month study in dogs in which the compound was administered by gavage, the NOAEL was 0.12 mg/kg bw per day at 3 weeks and 0.012 mg/kg bw per day in the overall study; the former NOAEL was based on inhibition of erythrocyte cholinesterase activity and the latter on inhibition of brain and erythrocyte cholinesterase activity.

The Meeting evaluated a long-term study of toxicity in mice that had not been reviewed previously, in which the compound was administered in feed. The effects observed included inhibition of plasma, erythrocyte and brain cholinesterase activity and vacuolation of the cytoplasm of the epididymis. The NOAEL was 0.5 mg/kg bw per day on the basis of inhibition of erythrocyte and brain cholinesterase activity (in animals of each sex) and vacuolation of the cytoplasm of the epididymides.

In a study of developmental toxicity in rats, a NOAEL for maternal toxicity was not identified, as marginal inhibition of brain cholinesterase activity was observed at the lowest dose of 0.5 mg/kg bw per day. Neither fetotoxicity nor teratogenicity was observed, nor did oxydemeton-methyl affect fetal brain cholinesterase activity. Two studies of developmental toxicity in rabbits were available. In the first, the NOAEL for maternal toxicity was 0.1 mg/kg bw per day on the basis of clinical observations (loose stools) at the intermediate dose of 0.4 mg/kg bw per day. Neither fetotoxicity nor teratogenicity was seen. Cholinesterase activity was not measured in this study. In the second, supplementary study, in which plasma, erythrocyte and brain cholinesterase activity was measured in the does, the NOAEL for maternal toxicity was 0.4 mg/kg bw per day. Litter parameters were not measured.

In a multigeneration study of reproductive toxicity in rats, the NOAEL for effects on the parents was 1 ppm, equivalent to 0.07 mg/kg bw per day, on the basis of inhibition of erythrocyte and brain cholinesterase activity. The NOAEL for effects on the offspring was 9 ppm, equivalent to 0.6 mg/kg bw per day, on the basis of decreased weight gain and viability and inhibition of erythrocyte and brain cholinesterase activity. The NOAEL for reproductive toxicity was 9 ppm, equivalent to 0.6 mg/kg bw per day, on the basis of vacuolation of the epididymis, decreased numbers of corpora lutea and reduced litter size at the next highest dose.

Several studies were carried out to investigate the vacuolation of the cytoplasm of the epididymis seen with oxydemeton-methyl and effects on male fertility. These showed that the vacuolation of the cytoplasm of the epididymis was reversible even at the highest dose; the frequency and severity of the effect increased with duration of treatment and dose; the effect was not accompanied by changes in sperm count, morphology or motility; and similar changes were not produced by methylisobutylketone, a common solvent for oxydemeton-methyl in commercial preparations which was used in some of the studies evaluated. There was some indication of decreased fertility of males given high doses (3.3 mg/kg bw per day and above). The Meeting concluded that these effects were not relevant for the establishment of an acute RfD.

In a study of acute neurotoxicity in rats, a NOAEL was not identified. The LOAEL was 2.5 mg/kg bw, the lowest dose tested, at which inhibition of brain and erythrocyte cholinesterase activity was observed.

The NOAEL in a study in volunteers given single doses was 0.5 mg/kg bw on the basis of inhibition of plasma and erythrocyte cholinesterase activity. No other effect was observed. The NOAEL in a study in which oxydemeton-methyl was administered at repeated doses for 30 days or more was 0.05 mg/kg bw per day. In both these studies, a manometric method of analysis for cholinesterase activity was used, which is not very reliable, and in the study with single doses only one subject received each dose.

On the basis of the data reviewed and previous evaluations, the Meeting established an acute RfD of 0.002 mg/kg bw, using the NOAEL of 0.15 mg/kg bw per day in the 14-day study in rats treated by gavage and a safety factor of 100. This acute RfD is supported by the LOAEL of 2.5 mg/kg bw in the study of neurotoxicity in rats given single doses. The Meeting concluded that it would be inappropriate to use the studies in volunteers for establishing an acute RfD because of the limitations described above.

An addendum to the toxicological monograph was prepared.

4.21 2-PHENYLPHENOL AND ITS SODIUM SALT (056)

RESIDUE AND ANALYTICAL ASPECTS

The 1999 JMPR as a result of its periodic re-evaluation recommended MRLs for 2-phenylphenol (OPP) (biphenyl-2-ol) and its sodium salt (SOPP) in citrus and citrus commodities. The JMPR also recommended withdrawal of its previous recommendations for maximum residue levels for apples and pears. The CCPR retained the CXL for pears for four years under the Periodic Review procedures. The Pear Bureau Northwest (USA) has supplied information in support of maximum residue levels for pears.

Residues resulting from supervised trials

Pears. US GAP specifies the post-harvest treatment of pears as (1) foamer and spray cleaning with 2 kg sodium ortho-phenylphenate tetrahydrate/hl for 15-20 seconds followed by a rinse, or (2) dipping in 0.49 kg ortho-phenylphenate tetrahydrate /hl solution for 1.5-2 minutes, followed by a rinse. Ten trials using a dip at a nominal 0.49 kg/hl were reported from the US. The ranked order of 2-phenylphenol residues is 5.9, 6.3, 6.4, 6.9, 7.9, 8.0, 8.9, 10, 12, and 13 mg/kg. Two trials

conducted under similar conditions were considered by the 1999 Meeting with results of 0.82 and 1.4 mg/kg. The samples from the latter trials were stored for six months before analysis, and storage stability studies under freezer temperatures with pears have indicated a lack of residue stability beyond 4 months. Thus, these earlier results are considered unreliable.

The Meeting estimates a maximum residue limit of 20 mg/kg and an STMR of 8.0 mg/kg.

DIETARY INTAKE ASSESSMENT

Chronic intake

STMRs for two raw agricultural commodities, citrus and pears, and one processed commodity, orange juice, were used for a chronic dietary intake assessment. The International Estimated Daily Intakes for the 5 GEMS/Food regional diets, based on these STMRs, were all <1% of the ADI. The Meeting concluded that the intake of residues of 2-phenylphenol resulting from its uses that have been considered by the JMPR is unlikely to present a public health concern.

Acute intake

The 1999 JMPR decided that an acute RfD is unnecessary. The Meeting therefore concluded that the short-term intake of 2-phenylphenol residues is unlikely to present a public health concern.

2-PHENYL PHENOL (056)				ADI = 0.4 mg/kg bw		or		24000 µg/person		or		2200 µg/person		Far East
				Diets: g/person/day. Intake = daily intake:ug/person										
		MRL	STMR or STMR-P	Mid-East		Far-East		African		Latin American		European		
Code	Commodity	mg/kg	mg/kg	Diet	intake	diet	intake	diet	intake	Diet	intake	Diet	intake	
FC 0001	Citrus fruits		0.2	54.3	10.9	6.3	1.3	5.1	1.0	54.8	11.0	49	9.8	
JF 0004	Orange juice		0.12	7.3	0.9	0	0.0	0	0.0	0.3	0.0	4.5	0.5	
FP 230	Pear		8	3.3	26.4	2.8	22.4	0	0.0	1	8.0	11.3	90.4	
					0.0		0.0		0.0		0.0		0.0	
			TOTAL =		38		24		1		19		101	
			% ADI =		0%		0%		0%		0%		0%	
			Rounded		0%		0%		0%		0%		0%	

4.22 PIPERONYL BUTOXIDE (062)

RESIDUE AND ANALYTICAL ASPECTS

Piperonyl butoxide {5-[2-(-butoxyethoxy)ethoxymethyl]-6-propyl-1,3-benzodioxole} is a synergist used to prolong the effects of insecticides. The compound was reviewed by the 1992 JMPR for both residues and toxicology. Some critical data on the metabolism in plants and animals studies were not submitted. Furthermore, the studies of stability and processing that were received were related only to commercially stored wheat and wheat products. Therefore, withdrawal of all the MRLs was recommended. At its Twenty-sixth Session (1994), the CCPR decided to withdraw the CXLs for cereal grains and for all other commodities (ALINORM 95/24), except for wheat, which was advanced to step 5/8. The 1995 JMPR established an ADI of 0–0.2 mg/kg bw.

At its twenty-ninth session, the CCPR scheduled piperonyl butoxide for periodic review at the 1999 JMPR, but at its thirtieth session it re-scheduled the review for 2000 (ALINORM 99/24 App.VII). The compound was reviewed by the 2001 JMPR Meeting within the CCPR periodic review programme. At this Meeting, further clarification allowed refinement of the evaluation.

The Meeting received information from the manufacturer on physical and chemical properties, metabolism and environmental fate, analytical methods, stability in freezer storage, registered uses, the results of supervised trials on pre- and post-harvest uses, studies of processing, studies of animal transfer, residues in food in commerce and national residue limits. The Australian Government provided information on registered uses and national residue limits.

Animals metabolism

Three studies were conducted on metabolism in rats. In the first study, rats were dosed with [¹⁴C]piperonyl butoxide labelled in the glycol side-chain at a single dose of 50 or 500 mg/kg bw or repeated doses of 50 mg/kg bw per day. Seven days after treatment, 27–38% of the radiolabel had been excreted in urine, 55–66% in faeces and 0.89–1.5% in carcass and tissues, with no specific trends by sex or dose. The highest concentration of residue was found in the gastrointestinal tract (up to 2.0 mg/kg). Piperonyl butoxide was detected only in urine from female rats dosed with 50 mg/kg bw, and eight metabolites were identified (representing 0.8–6.7% of the administered dose). Piperonyl butoxide can be metabolized at the propyl side-chain, the glycolate side-chain and the dioxole ring. A product of cyclization of the propyl and glycolate chain (lactone of 6-hydroxymethyl-1,3-benzodioxol-5-ylacetic acid) was the main compound in male rat urine (5.2–6.8%). In faeces, piperonyl butoxide accounted for 2.2–31% of the administered dose. Of the four metabolites detected, 4-{{[2-(2-butoxyethoxy)ethoxy]methyl}-5-propyl-1,2-benzenediol}, a catechol with an intact glycolate chain, was the main one, representing 9.4–26% of the administered dose.

In a second study, formulated [¹⁴C]piperonyl butoxide applied to discs of skin excised from rats showed a potential for absorption through skin. After 24 h, 31% of the radiolabel was recovered in the skin homogenate. In a third study, rats received a single dose of ring-labelled piperonyl butoxide at a dose of 50 or 500 mg/kg bw. Most of the radiolabel was eliminated within the first 48 h after dosing, primarily in the faeces. During the 7 days of collection, 11–23% of the administered dose was found in urine and 70–85% in faeces, with a mean of 97% in the excreta of animals at the high dose and 98% in the excreta of those at the low dose. The carcass accounted for 0.28–0.44% of the administered dose. The metabolite profiles in excreta were similar at the two

doses, piperonyl butoxide being metabolized at the dioxole ring to produce either a catechol or a substituted anisole moiety, and at the glycolate side-chain. At the glycolate side-chain, metabolism occurred by hydroxylation at the terminal carbon, oxidation to acid, followed by successive losses of the acetate moiety to form alcohols and acids. At least 15 metabolites were identified in excreta of both male and female rats, the main metabolite being 4-{{2-(2-butoxyethoxy)ethoxy}methyl}-5-propyl-1,2-benzenediol, representing 19% of the administered dose.

One goat received a dermal application of a 10% solution of [¹⁴C]piperonyl butoxide uniformly labelled in the benzene ring for 5 days, and two other goats were given feed containing 10 or 100 ppm for 5 days. The radiolabel was excreted rapidly by the orally dosed goats and more slowly by the dermally dosed goat. Within 22 h after administration of the last dose, most of the dose had been excreted in urine (73% and 79% after oral and 44% after dermal administration) and faeces (22% and 22% after oral and 8.9% after dermal administration). The amounts excreted in milk were similar throughout the study, with all dose regimens: 0.33% of the applied dose was found in milk of orally dosed goats and 0.53% in milk of the dermally dosed goat. Little radiolabel was found in muscle, and radiolabel was concentrated in the fat of dermally dosed animal (0.20 mg/kg) and in the liver of the orally dosed animals (0.36 and 2.0 mg/kg at the low and high doses, respectively). The same metabolite profiles were found in tissues and urine. Piperonyl butoxide was detected at > 0.02 mg/kg only in liver and fat from the animals given the high oral dose (0.12 and 0.13 mg/kg) and in fat from the dermally treated animal (0.16 mg/kg). It was metabolized primarily at the glycolate side-chain. Two metabolites were detected in milk, at concentrations of 0.001–0.016 mg/kg, which had a carboxylic acid moiety at C-2 or C-4 of the glycolate chain (4-(6-propyl-1,3-benzodioxol-5-yl)-2-oxabutanoic acid and 2-{{2-[(6-propyl-1,3-benzodioxol-5-yl)methoxy]ethoxy}acetic acid). In kidney, the metabolites were found at concentrations of 0.001–0.045 mg/kg, and the alcohol precursor of the carboxylic acid at C-4 (2-{{2-[(6-propyl-1,3-benzodioxol-5-yl)methoxy]ethoxy}ethanol) was detected. In liver, a catechol of the latter metabolite (4-{{2-(2-hydroxyethoxy)ethoxy}methyl}-5-propyl-1,2-benzenediol) was detected at 0.14 mg/kg.

In two studies, laying hens received [¹⁴C]piperonyl butoxide uniformly labelled in the benzene ring for 5 consecutive days by dermal application at a dose of 14 mg/g under a sealed container 2.5 x 5 x 1.3 cm or in the feed at 10 or 100 ppm. Excreta from hens dosed dermally contained 59% of the applied radiolabel, and those from the hens dosed orally at the low and high doses contained 89% and 94%, respectively. In eggs, the concentration of radiolabel was higher in the white during the first 48 h (up to 0.63 mg/kg) and then concentrated in the yolk (up to 1.9 mg/kg at the higher oral dose). In tissues, the least radiolabel was found in muscle (0.002–0.124 mg/kg) and the most in fat (0.13–4.8 mg/kg). The concentrations in kidney and liver were 0.11–1.6 mg/kg. At the end of the study, piperonyl butoxide was found in eggs and tissues at 0.006–1.2 mg/kg (the latter in egg yolk from hens given the high oral dose), but not in liver or kidney from hens given the low oral dose. No metabolites were found in egg white or fat. Of the four metabolites found in egg yolk, liver, kidney and thigh muscle, (6-propyl-1,3-benzodioxol-5-yl)methoxyacetic acid, 2-{{2-[(6-propyl-1,3-benzodioxol-5-yl)methoxy]ethoxy}ethanol, 2-{{2-[(6-propyl-1,3-benzodioxol-5-yl)methoxy]ethoxy}acetic acid and 4-{{2-(2-hydroxyethoxy)ethoxy}methyl}-5-propyl-1,2-benzenediol), the penultimate predominated, reaching 0.19 mg/kg in kidney from animals at the high oral dose.

Thus, in animals, piperonyl butoxide can be metabolized at the glycolate side-chain, through hydroxylation at the terminal carbon, oxidation to acid, followed by successive losses of the acetate moiety to form alcohols and acids, which can be conjugated; at the propyl side-chain, through cyclization with the hydrolysed glycolate chain; and through opening of the dioxole ring. The main residue in animal tissues, egg and milk is piperonyl butoxide.

Plants metabolism

The behaviour of [¹⁴C]piperonyl butoxide labelled in the glycolate chain was studied after foliar application to cotton, potato and lettuce, leaf at the maximum rate of 0.56 kg ai/ha. Only minimal uptake or translocation of parent or degradates occurred in cotton and potato. The concentration of TRR found in potato tubers was 0.076% of that found in the leaves (617 mg/kg) 8 days after the fourth and last application. Cotton leaves collected 5 weeks after the fifth application had 142 mg/kg of total radiolabel. Hulls, lint and seed from cotton bolls collected 16 days after the sixth and last application contained 5, 0.4 and 0.3% of the radiolabel found in leaves. Piperonyl butoxide was not detected in potato tubers. The concentrations in cotton products ranged from 0.047 in lint to 1.23 mg/kg TRR in hulls, corresponding to 0.2–5% of that found in leaves (26.3 mg/g). In lettuce leaves, piperonyl butoxide was responsible for 51% of TRR on the day of the fifth application, but the percentage dropped to 24.4% after 10 days.

The aqueous fraction of the lettuce extract at day 0 (24.2% of TRR) contained at least three conjugated metabolites, two of which were identified, and a small amount of piperonyl butoxide (1.5% TRR). An aqueous extract from plants on day 10 contained five identified metabolites at concentrations of 0.2–2.0 mg/kg (0.9–7.6% TRR), consisting of conjugated alcohols formed after hydrolysis and truncation of the glycosate side-chain, with an intact dioxole ring.

Potato leaves contained at least seven degradates of high to moderate polarity, none of which represented more than 3% TRR. About 82% of the TRR was extracted into organic solvent, and more than 30 degradates were present, each at < 0.02 mg/kg (4% TRR). The metabolite profile was different in potato leaves and tubers. The degradation products in post-extraction solids of potato tubers were characterized as highly polar materials, probably the products of oxidation of one or both side-chains to benzyl alcohols or carboxylic acids and of opening of the dioxole ring to a catechol structure.

Cotton leaves contained 11 or more degradation products soluble in organic solvents; the predominant one (7.5% TRR) was similar to compounds found in lettuce, with one to three oxygen atoms remaining in the glycolate side-chain. The metabolites observed in the leaves were not observed in hulls, seeds or lint. In cotton seed, parent piperonyl butoxide was the only residue soluble in organic solvents. Mild acid hydrolysis of the post-extraction solids released almost 50% of the TRR, which presented two minor peaks (< 0.05 mg/kg) on the HPLC and a third, comprising 45% TRR (0.12 mg/kg), with characteristics similar to those in potato tubers. Cotton lint extract also contained a highly polar material that eluted at the HPLC solvent front (80% TRR, 0.19 mg/kg), which may have been the same dioxole ring-opened metabolite found in potato tubers and cotton seed, except that it was not bound. Cotton hulls contained five degradation products soluble in organic solvents (0.1% TRR). The predominant degradation products released by mild acid hydrolysis of the post-extraction solids was (6-propyl-1,3-benzodioxol-5-yl)methoxyacetic acid (5.1% TRR).

Thus, piperonyl butoxide is metabolized in plants in a manner similar to that in animals, except that more polar metabolites are formed, which are fully degraded molecules resulting from hydrolysis of the glycolate side-chain, oxidation of the propyl side-chain and opening of the dioxole ring. The main residue found in lettuce, potato and cotton leaves was piperonyl butoxide, and minimal translocation occurred to potato tubers and cotton products.

Environmental fate

Soil

A 2-mm layer of a sandy loam soil treated with [phenyl ring-¹⁴C]piperonyl butoxide at a rate equivalent to 10 kg ai/ha was exposed to artificial sunlight for 15 days (corresponding to 41 days of natural sunlight) or kept in the dark. The half-life in both soils was 1–3 days. Four degradation products were identified, resulting from loss of the glycolate side-chain and oxidation of the resulting benzyl alcohol to the corresponding aldehyde and acid. The concentration of hydroxymethyldihydrosafrole, a benzyl alcohol, reached a peak at day 3 (63 and 44% of the applied radiolabel in unirradiated and irradiated soil, respectively) and fell to 1.9 and 3.1% after 15 days. Hydroxymethyldihydrosafrole was oxidized to an acid (6-propyl-3-benzodioxole-5-carboxylic acid) which accumulated in unexposed soil after 15 days (49% of applied radiolabel). More decomposition and oxidation of the phenyl ring, observed as formation of CO₂, occurred in irradiated soil (28%) than in the control dark soil (1.3%). In another experiment, piperonyl butoxide incubated in the dark for 242 days was degraded with a half-life of approximately 14 days, in a pathway similar to that discussed above. Two additional metabolites with oxidized propyl side-chains were detected at 0.1–8.9% of the applied radiolabel during the incubation period. More than one-half the applied piperonyl butoxide had been mineralized to CO₂ by 242 days.

Terrestrial dissipation of piperonyl butoxide was studied in soil treated at rate of 5.2 kg ai/ha in the USA. The half-lives were 4.3 days in California and Georgia and 3.5 days in Michigan. At 15 cm depth, the concentration of piperonyl butoxide after 14 days was 0.11–0.22 mg/kg and fell to < 0.10 mg/kg after 30 days of application. No parent compound was detected at any site in soil collected at depths below 15 cm.

Water–sediment systems

A solution of 1 mg/l radiolabelled piperonyl butoxide was stable when incubated at 25 °C in the dark for 30 days at pH 5, 7 or 9 in sterile aqueous buffers (97–100 % of the applied radiolabel recovered). In another experiment, a 10 mg/l solution of [¹⁴C]piperonyl butoxide (at pH 7) exposed to natural sunlight for 84 h degraded with a half-life of 8.4 h. Two main photoproducts were observed: hydroxymethyldihydrosafrole (22% and 48% of the applied radiolabel after 4 and 84 h, respectively) and its aldehyde oxidation product (3,4-methylenedioxy-6-propylbenzaldehyde; 5.7–11% of the applied radiolabel). At least five other minor degradation products were found, each representing < 10% of the applied radiolabel. Unexposed samples contained up to 2% of radiolabel associated with metabolites.

Radiolabelled piperonyl butoxide in a sandy loam soil water–sediment system incubated under aerobic conditions in the dark (10 mg/kg sediment or 3.2 µg/ml of water) degraded slowly, and 72% of the piperonyl butoxide remained after 30 days. Under anaerobic conditions, 91% of the parent compound was still present after 181 days. In both systems, it degraded to hydroxymethyldihydrosafrole and further to 3,4-methylenedioxy-6-propylbenzaldehyde and acid, which represented up to 3.8% of the applied radiolabel.

The adsorption and desorption characteristics of piperonyl butoxide radiolabelled in the phenyl ring were assessed in sand, clay loam, sandy loam and silt loam soils at a concentration of 0.4, 2, 3 or 4 mg/l. The systems were equilibrated for 24 h at 25 °C in darkness at a soil:solution ratio of 1:10. Piperonyl butoxide showed low to moderate mobility in sandy loam, clay loam and silt loam (K_a , 8.4, 12 and 30, respectively) and high mobility in sandy soil (K_a , 0.98). The K_{oc}

values ranged from 399 in sandy loam to 830 in silt loam. A K_d value was not determined for sandy soil, but in the other soils it ranged from 8.2 to 42 after the first desorption step and from 6.3 to 95 after the second.

The leaching behavior of [^{14}C]piperonyl butoxide was investigated in sand, silt loam, sandy loam and clay loam soils after application at a rate equivalent to 5 kg ai/ha to the top of 30-cm columns (1 mg/column) and eluted with 0.01 mol/L calcium chloride. Piperonyl butoxide did not leach readily into loam soils (0.2–1.3% of the applied radiolabel in the leachate), but it was highly mobile in sandy soil (74% in the leachate), with a distribution coefficient of 0.42 ml/g. When the experiment was conducted with a sandy loam soil aged for 18 days and treated with [^{14}C]piperonyl butoxide, 33% of the applied radiolabel remained in the top of the column (up to 5 cm) and 14% was recovered in the leachate. The three degradation products found (hydroxymethyldihydrosafrole, 3,4-methylenedioxy-6-propylbenzaldehyde and the acid) were more mobile than the parent compound, being detected at 20–25 cm of the column. An extract of the aged soil contained 45% of the applied radiolabel as piperonyl butoxide.

Methods of analysis

One method for determining residues of piperonyl butoxide and its metabolites in raw and processed plant commodities involves extraction with acetonitrile, partition of piperonyl butoxide into petroleum ether and analysis by HPLC with fluorescence detection. The more polar metabolites remain in the aqueous phase, which is subjected to mild acid hydrolysis to convert the metabolites quantitatively to hydroxymethyldihydrosafrole, which is extracted and also analysed by HPLC with fluorescence detection. The LOQ for piperonyl butoxide and for total metabolites was 0.10 mg/kg, with an average recovery of 91–94%. In grapes and cranberries, < 70% of metabolites were recovered. In another method, the extract containing piperonyl butoxide was brominated and cleaned up by liquid–solid partition, and the eluate was analyzed by GC with ECD. The LOQ for piperonyl butoxide was 0.10 mg/kg, and average recovery was 56% in beans to 67% in peanuts. Other solvents can be used to extract piperonyl butoxide from wheat and the milled fraction, including methanol, hexane and ethyl acetate.

In the method used to determine residues of piperonyl butoxide in milk, eggs and tissues, samples were extracted with acetonitrile, the fat was removed with hexane, sodium chloride added, and piperonyl butoxide partitioned into hexane. The hexane solution was cleaned up on a silica gel solid-phase extraction column, and piperonyl butoxide was determined by GC–MS. The LOQ was validated at 0.05 mg/kg for tissues (liver, kidney, muscle and fat), with recovery of 70–108%. The recovery at 0.01 and 0.05 mg/kg from milk was 67–120%, and that from eggs was 71–104%.

Stability of residues in stored analytical samples

Piperonyl butoxide at 1.0 mg/kg was stable in samples stored frozen in the dark for up to 12 months. In potato tubers and chips, leaf lettuce, broccoli, cucumber, grapes, orange fruit, molasses, juice and dry pulp, tomato fruit, juice, puree, dry and wet pomace, succulent beans pod and vine, cotton seed, oil and soapstock and beans, 70–108% of the added piperonyl butoxide remained after a 12-month storage. In potato granules, potato wet peel and cotton meal, these values varied from 53 to 68%. When piperonyl butoxide was added to sweets, meat, bread, sugar and peanuts at a concentration of 0.2 mg/kg, 50–69% remained after 12 months of frozen storage.

Definition of the residue

On the day of application, piperonyl butoxide accounted for 51% of the TRR in lettuce, two metabolites being formed in approximately equal amounts and accounting for 24% of the radiolabel. After 10 days, the concentration of piperonyl butoxide had decreased by half, and at least 10 metabolites were formed, each representing < 10% of the TRR. Piperonyl butoxide was not translocated to potato tubers or cotton products when applied to the leaves of these plants. Some highly polar material was found in cotton seed and in lint, representing 44 and 80% TRR, respectively. Although these metabolites were not identified, they were highly degraded compounds and, owing to their high polarity, would probably not accumulate in animals if ingested. Although no studies of metabolism in stored plant commodities were conducted, the Meeting agreed that piperonyl butoxide is degraded mainly by photolysis and considered that such studies were not necessary, as the residues are very stable in cereal grains in storage. No major metabolite was found in edible animal commodities. The main compound in both plant and animal commodities is piperonyl butoxide.

The Meeting agreed that the residue definition for compliance with MRLs and for estimating dietary intake in plant and animal commodities should continue to be piperonyl butoxide.

Piperonyl butoxide has a log P_{ow} of 4.6 and is concentrated in the fat of animals dosed orally and dermally. The Meeting concluded that piperonyl butoxide is fat-soluble.

Results of supervised trials

Pre-harvest trials were conducted in crops in various regions of the USA between 1992 and 1996, with 10–12 applications of pyrethrins containing piperonyl butoxide, according to maximum GAP for piperonyl butoxide (0.56 kg/ha; no PHI).

Citrus. Seven supervised trials were conducted on citrus. The concentrations of residues of piperonyl butoxide in lemon were 3.1 and 1.7 mg/kg, those in oranges were 0.90, 0.98 and 1.0 mg/kg and those in grapefruit were 0.49 and 1.4 mg/kg. The concentrations in citrus were, in ranked order (median underlined): 0.49, 0.90, 0.98, 1.0, 1.4, 1.7 and 3.1 mg/kg. Although there were fewer trials on citrus fruits than would be required for a major crop, piperonyl butoxide is used to only a minor extent as a synergist in pre-harvest treatment in pyrethrin formulations. Recommendations for pyrethrins in citrus were made by the 2000 JMPR on the basis of trials conducted with a pyrethrin–piperonyl butoxide formulation. Therefore, the Meeting agreed to recommend an MRL of 5 mg/kg and an STMR of 1.0 mg/kg for piperonyl butoxide in citrus.

Berries and small fruits. Seven supervised trials were conducted on berries and small fruits. The concentrations of residues of piperonyl butoxide were 2.8 mg/kg in blackberry, 5.0 and 5.5 mg/kg in blueberry, 4.2 mg/kg in cranberry, 9.6 mg/kg in grapes and 3.0 and 3.1 in strawberry. As insufficient data from trials performed according to GAP were submitted, the Meeting agreed not to recommend a maximum residue level for piperonyl butoxide in berries, strawberry and grapes. There is no current recommendation for pyrethrins in berries and small fruits.

Brassica vegetables. Three supervised trials were conducted on broccoli, giving rise to concentrations of residues of piperonyl butoxide of 0.69, 1.7 and 2.3 mg/kg. In three trials conducted on cabbage, the concentrations were 0.09, 0.23 and 0.46 mg/kg, while those in cabbage with wrapper leaves were 1.1, 6.4 and 2.7 mg/kg. As insufficient data from trials performed according to GAP were submitted, the Meeting agreed not to recommend a maximum residue level

for piperonyl butoxide in broccoli and cabbage. There is no current recommendation for pyrethrins in broccoli and cabbage.

Curcubits. Eight supervised trials were conducted on curcubits. The concentrations of residues of piperonyl butoxide were 0.83 and 0.61 mg/kg in cantaloupe, 0.07 and 0.68 mg/kg in cucumber and 0.10, 0.20, 0.25 and 0.27 mg/kg in squash. The Meeting agreed that the data on residues in curcubits could be combined as 0.07, 0.10, 0.20, 0.25, 0.27, 0.61, 0.68 and 0.83 mg/kg, and estimated a maximum residue level of 1 mg/kg and an STMR of 0.26 mg/kg for piperonyl butoxide in curcubits.

Peppers and tomato. In three supervised trials conducted on peppers, the concentrations of residues of piperonyl butoxide were 0.39, 0.59 and 1.4 mg/kg. In three trials conducted in tomato, the values were 0.37, 0.76 and 1.0 mg/kg. Although there were fewer trials on peppers and tomato than required for these crops, the Meeting agreed to consider the data sufficient to recommend maximum residue levels, for the reasons outlined for citrus fruits. The data for peppers and tomato were combined, in ranked order, as 0.37, 0.39, 0.59, 0.76, 1.0 and 1.4 mg/kg. The Meeting estimated a maximum residue level of 2 mg/kg and an STMR of 0.675 mg/kg for piperonyl butoxide in peppers and tomato.

Leafy vegetables. Nine supervised trials were conducted on leafy vegetables. In head lettuce the concentrations of residues of piperonyl butoxide were 0.54 and 0.35 mg/kg; when the wrapper leaves were attached, the values were 5.0 and 3.6 mg/kg. Leaf lettuce contained concentrations of 19 and 23 mg/kg, mustard greens contained 37 and 38 mg/kg, radish leaves (crowns with leaves) contained 38 mg/kg and spinach contained 32 and 39 mg/kg. The concentrations in mustard greens, radish leaves and spinach are within the same range and provide mutual support. They were, in ranked order: 32, 37, 38 (2) and 39 mg/kg. The Meeting recommended a maximum residue level of 50 mg/kg and an STMR of 38 mg/kg for piperonyl butoxide in mustard greens, radish leaves, leaf lettuce and spinach.

Legume vegetables. Two supervised trials were conducted on succulent beans, giving concentrations of piperonyl butoxide in pods of 0.34 and 2.2 mg/kg. In two trials conducted in succulent peas, the values were 2.2 and 5.1 mg/kg. As insufficient data from trials performed according to GAP were submitted, the Meeting agreed not to recommend a maximum residue level for piperonyl butoxide in succulent beans and peas.

Root and tuber vegetables. In one supervised trial conducted on carrot, the concentration of residues of piperonyl butoxide in roots was 1.1 mg/kg. Three trials conducted on potato gave values in tubers of < 0.10 (2) and 0.11 mg/kg, one trial on radish gave a value in roots of 0.34 mg/kg and two trials conducted on sugar beet gave concentrations in roots of < 0.10 mg/kg. In a study of metabolism conducted with labelled piperonyl butoxide on potato at maximum GAP, no residues were detected in tubers. Although there were fewer trials on root and tuber vegetables than would be required for this group, the Meeting agreed to consider the data sufficient to recommend residue levels, for the reasons outlined for citrus fruits. As only one trial was conducted on carrots, giving a much higher value than for the other commodities in the group, the Meeting agreed to combine the values for all commodities except carrots. Those are, in ranked order: < 0.10 (3), 0.11 and 0.34 mg/kg. The Meeting estimated a maximum residue level of 0.5 mg/kg and an STMR of 0.10 mg/kg for piperonyl butoxide in root and tuber vegetables, except carrots.

Pulses. In two supervised field trials on dry beans and two on dry peas at GAP rate, the concentrations of piperonyl butoxide residues in seed were 0.10 and 0.11 mg/kg in beans and 0.27 and 0.57 mg/kg in peas. As insufficient data from trials performed according to GAP were

submitted, the Meeting agreed not to recommend a maximum residue level for piperonyl butoxide in pulses due to pre-harvest use.

Celery. In two supervised trials on celery, the concentrations of residues of piperonyl butoxide were 17 and 23 mg/kg in untrimmed leaf stalk and 0.98 and 2.3 mg/kg in the petiole. As insufficient data from trials performed according to GAP were submitted, the Meeting agreed not to recommend a maximum residue level for piperonyl butoxide in celery.

Mustard seed. One supervised trial was conducted on mustard seed, which gave a concentration of piperonyl butoxide residues of 2.1 mg/kg. As insufficient data from trials performed according to GAP were submitted, the Meeting agreed not to recommend a maximum residue level for piperonyl butoxide in mustard seed.

Cotton seed. In five supervised trials conducted on cotton seed, the concentrations of residues of piperonyl butoxide were < 0.10 (2), 0.10 (2) and 0.21 mg/kg. As insufficient data from trials performed according to GAP were submitted, the Meeting agreed not to recommend a maximum residue level for piperonyl butoxide in cotton seed. There is no current recommendation for pyrethrins in cotton seed.

Animal feed. In four trials conducted on succulent or dry beans, the concentrations of residues in vine were 16 (2), 26 and 28 mg/kg. In hay samples dried for 2–6 days in the open air, the values were 11, 14, 21 and 42 mg/kg, and those in forage were 14 and 25 mg/kg. In four trials on succulent or dry pea, the concentrations in vine were 26, 29, 47 and 96 mg/kg. In hay samples dried for up to 14 days in the field or in a greenhouse, the values were 3.7, 38, 48 and 153 mg/kg, and those in forage were 31 and 42 mg/kg.

The Meeting agreed that the data on residues in bean vines represent the same population as those for pea vines and could be used to support a recommendation for pea vines. The concentrations were, in ranked order: 16 (2), 26 (2), 28, 29, 47 and 96 mg/kg. When the median (27 mg/kg) and the maximum values (96 mg/kg) were corrected for moisture content (75%, *FAO Manual*, p. 125), the values were 108 mg/kg and 384 mg/kg, respectively, in dry matter. The Meeting recommended a maximum residue level of 400 mg/kg and an STMR of 108 mg/kg for piperonyl butoxide in pea vines, green (dry basis).

The Meeting agreed that the data on residues in bean and pea hay represented a single population and could be combined, in ranked order, as 3.7, 11, 14, 21, 38, 42, 48 and 153 mg/kg. The median (29.5 mg/kg) and the maximum (153 mg/kg) values were corrected for the moisture content of pea hay (12%, *FAO Manual*, p. 125), and became 19.9 and 174 mg/kg, respectively, on a dried basis. The Meeting estimated a maximum residue level of 200 mg/kg and an STMR of 19.9 mg/kg for piperonyl butoxide in bean hay and pea hay or fodder.

As insufficient data from trials performed according to GAP were submitted, the Meeting agreed not to recommend a maximum residue level for piperonyl butoxide in pea and bean forage.

In five supervised trials conducted on cotton forage, the concentrations of residues of piperonyl butoxide were 20, 28, 30 (2) and 37 mg/kg. As insufficient data from trials performed according to GAP were submitted, the Meeting agreed not to recommend a maximum residue level for piperonyl butoxide in cotton forage.

In two trials conducted with sugar beet leaf, the concentrations of residues of piperonyl butoxide in crowns with leaves attached were 37 and 12 mg/kg. As insufficient data from trials

performed according to GAP were submitted, the Meeting agreed not recommend a maximum residue level for piperonyl butoxide in sugar beet leaves.

Post-harvest treatment

Trials were conducted in which navy beans in cloth bags underwent treatment with up to 10 applications of piperonyl butoxide at the label rate in a warehouse by a space spray (0.25 kg ai/1000 m³) and a contact spray (0.3 kg ai/100 m²). One bag was collected for analysis after each application, for a total of 10 bags from each treatment. The concentrations of residues were < 0.05 (2) (LOD), < 0.10 (3) (LOQ), 0.10, 0.13 (2), 0.16 and 0.17 mg/kg in samples collected after the space spray treatment and < 0.05 (10) mg/kg in samples after the contact spray treatment. The concentrations of residues after post-harvest use were, in ranked order, < 0.05 (12), < 0.10 (3), 0.10, 0.13 (2), 0.16 and 0.17 mg/kg.

The Meeting estimated a maximum residue level of 0.2 mg/kg, an STMR value of 0.05 and a highest residue of 0.17 mg/kg for piperonyl butoxide in pulses after post-harvest use.

Trials were conducted with harvested peanuts in cloth bags treated in a warehouse with 10 applications at the label rate by a space spray (0.25 kg ai/1000 m³) and a contact spray (0.3 kg ai/100 m²). One bag was collected for analysis after each application, for a total of 10 bags from each treatment. The concentrations of residues in samples collected after each space spray treatment were < 0.10 (3), 0.20, 0.24, 0.28, 0.29, 0.36 and 0.54 (2) mg/kg, while those after contact spray treatment were < 0.05 (6) and < 0.10 (4) mg/kg. The concentrations after post-harvest use were, in ranked order: < 0.05 (6), < 0.10 (7), 0.20, 0.24, 0.28, 0.29, 0.36 and 0.54 (2) mg/kg.

The Meeting estimated a maximum residue level of 1 mg/kg and an STMR value of 0.10 mg/kg for piperonyl butoxide in peanuts after post-harvest treatment.

Trials were conducted with prunes treated in a warehouse with 10 applications at the label rate by a space spray (0.25 kg ai/1000 m³) or a contact spray (0.3 kg ai/100 m²). One bag was collected for analysis after each application, for a total of 10 bags from each treatment. The concentrations of residues in samples collected after each space spray treatment were < 0.05 (5), < 0.10 (4) and 0.11 mg/kg, while those after contact spray were < 0.05 (6) and < 0.10 (4) mg/kg. The concentrations of residues after post-harvest use were, in ranked order, < 0.05 (11), < 0.10 (8) and 0.11 mg/kg.

The Meeting agreed that the values for residues in prunes could be extended, and estimated a maximum residue level of 0.2 mg/kg and an STMR value of 0.05 mg/kg for piperonyl butoxide in dried fruits after post-harvest treatment.

Post-harvest trials were conducted on cacao beans, raisins and wheat flour in Germany during 1993–94 with eight space spray applications of pyrethrum–piperonyl butoxide formulation containing piperonyl butoxide at 21.3 g/1000 m³ at 14-day intervals, or two applications of piperonyl butoxide at 128 g/1000 m³. Samples were taken on days 0, 14, 30, 60 and 90 after treatment. In Germany, GAP for space spray treatment of stored products consists of 0.375–132 g ai/1000 m³.

Two trials were conducted on cacao beans in jute sacks. At the lower rate, the concentrations of residues in beans 0 and 14 days after the last application were 0.21 and 0.25 mg/kg and then fell to 0.08 mg/kg at day 90. At the higher rate, the concentrations varied from 0.52 mg/kg on day 0 to 0.75 mg/kg on day 30. In one trial conducted at the higher rate (128 g

ai/1000 m³) on raisins in stored polythene and cardboard, the concentration was < 0.01 mg/kg at all sampling times. In one trial on wheat flour at the same rate, the concentrations ranged from 0.12 mg/kg at day 14 to 0.46 mg/kg at day 60.

As insufficient data from trials performed according to GAP were submitted, the Meeting agreed not to recommend a maximum residue level for piperonyl butoxide in cacao beans or wheat flour after post-harvest treatment. The maximum residue level, STMR value and highest residue for raisins are covered by the recommendations for dried fruits after post-harvest treatment.

Two trials were conducted on wheat in Germany. The concentrations in grain after the lower rate of treatment (21.3 g/1000 m³) varied from 0.71 mg/kg after 30 days to 2.5 mg/kg on day 0. Samples taken after the higher rate of treatment (128 g/1000 m³) contained concentrations of 1.3 mg/kg on day 30 and 2.2 mg/kg on day 0.

In the USA, there are two further approved post-harvest uses for piperonyl butoxide as a pyrethrin formulation on stored grains: direct treatment of grain as it is carried to a silo (11.1–26 mg a.i./kg of grain) or application to grain in storage (0.12–0.24 kg ai/100 m²). A series of trials was conducted in the USA in 1959 with various formulations of piperonyl butoxide applied to wheat at various rates as it was transferred to the bins. Up to five bins were treated at each application rate, and samples were taken 3–25 months after application. In three trials conducted at maximum GAP, the highest concentrations of piperonyl butoxide residues in all bins were 12, 17 and 25 mg/kg. One trial at lower rate gave similar results (maximum, 12 mg/kg), and the highest value in one trial conducted at a rate below GAP was 5.2 mg/kg.

Although trials were conducted on wheat in the USA according to GAP in 1959–61, full reports were not provided. The concentrations of piperonyl butoxide residues during storage for up to 12 months ranged from 4.1 to 13 mg/kg.

In Australia, piperonyl butoxide can be used on grain in various insecticide formulations for post-harvest treatment at a rate of 2.4–8.5 mg ai/kg of grain. In a series of trials conducted in 1978–79, treated wheat was sampled after up to 9 months of storage. In nine trials conducted at maximum GAP, the highest concentrations during sampling were 3.4, 8.0, 7.1, 7.2, 6.2, 9.1, 7.5 (2) and 8.0 mg/kg. In 10 trials conducted at a lower GAP rate or at a higher rate, the concentrations ranged from 2.4 to 16 mg/kg.

In 31 trials conducted in Australia in 1981–82, wheat treated with piperonyl butoxide at 10 mg/kg of grain in various formulations was sampled up to 9 months after treatment. The highest concentrations of residues found were 5.7 (2), 7.9 (3), 4.2 (2), 7.3 (3), 5.3, 5.0, 7.0 (2), 4.5, 7.8 (2), 5.2, 4.8, 7.5, 8.1, 8.2, 10 (3), 8.6, 9.2, 11, 8.0, 9.4 and 30 mg/kg. In four further trials conducted under the same conditions, treated wheat was sampled after 10–31 months of storage. The highest concentrations during this period were 7.3, 6.7 and 5.9 (2) mg/kg.

In a series of 13 trials conducted in Australia in 1979–80, wheat grain treated with various piperonyl butoxide formulations at 10 mg ai/kg of grain were sampled after up to 9 months of storage. The highest concentrations were 9.7 (2), 8.6, 7.7, 8.7, 8.9, 9.3, 9.5, 10 (2), 7.3, 8.4 and 14 mg/kg. In two other trials conducted at lower GAP the concentrations were 4.5 and 2.3 mg/kg.

In three trials conducted in Australia in 1998 at 8 mg ai/kg of grain in various formulations, the highest concentrations of piperonyl butoxide residues found during a 9-month storage period were 13, 16 and 5.4 mg/kg. In a trial conducted at a lower GAP, the concentration was 1.7 mg/kg. Although another 27 trials were conducted between 1990 and 1998, at rates of 4–10.7 mg ai/kg of

grain, full reports of the studies were not provided. The highest concentrations found in each trial ranged from 1.5 to 8.9 mg/kg.

In Italy, piperonyl butoxide can be used after harvest in various formulations at a rate of 2.3–12.5 mg ai/kg of grain. In 18 trials conducted at various locations in Italy at a rate of 2.5, 5.0 or 10 mg/kg, samples were taken after up to 12 months of storage. The concentrations of residues in the trial at the highest GAP rate were 13, 3.9, 5.2, 4.2, 3.9 and 4.5 mg/kg. The highest concentrations in trials conducted at lower rates were 0.34–8.7 mg/kg.

Six post-harvest trials were conducted on barley in Australia in 1992–96 according to maximum GAP (6.33–8 mg ai/kg of grain) in three formulations. The grain was stored for up to 6.5 months. The highest concentrations of piperonyl butoxide residues were, in ranked order, 0.9, 6.0, 6.4, 6.5, 6.6 and 7.2 mg/kg. One trial at a lower rate gave values within the same range, but a full report of the study was not provided.

In 30 trials on maize in the USA conducted in 1952–57 with dust and spray formulation at rates of 10.4–29.4 mg ai/kg of grain, samples were taken after 1–50 months of storage. The highest concentrations of piperonyl butoxide found during storage in samples from the 10 trials conducted according to maximum GAP were 12, 11, 4.0, 8.0, 7.0, 8.0, 25, 6.0, 9.0 and 13 mg/kg, while those in trials conducted at lower GAP rates were 1–21 mg/kg. In another study, for which a full report was not provided, conducted at maximum GAP, the highest concentration found during 12 months of storage was 10 mg/kg.

Trials were conducted on maize with three concentrations of piperonyl butoxide applied by surface spray (49.7–149 g ai/m²) at various frequencies of application. Three months after treatment, 25–41% of the total applied remained in the maize; after 6 months, this value had dropped to 11–13%.

In Italy, two trials were conducted on maize at the lowest and highest GAP rates, and samples were taken for analysis after up to 6 months of storage. The highest concentrations of piperonyl butoxide found were 1.3 mg/kg at the lowest GAP rate and 4.1 mg/kg at the highest rate.

In two trials conducted on sorghum in Australia at maximum GAP, the concentrations of piperonyl butoxide residues on day 0 were 2.9 and 10 mg/kg; these were reduced after 3 months of storage. Two trials at lower and higher rates gave highest values of 0.50 and 20 mg/kg. In another trial conducted at maximum GAP, the highest concentration found during a 6-month storage period was 9.7 mg/kg. A full report of this trial was not provided.

GAP for post-harvest use of piperonyl butoxide on cereal grains is 10 mg/kg of grain in Australia, up to 12.5 mg/kg of grain in Italy and up to 26 mg/kg of grain in the USA. The Meeting agreed that the estimates should be derived from the critical GAP, that of the USA. The concentrations of residues in trials conducted according to GAP in the USA (10 trials on wheat, three on maize) were, in ranked order: 4.0, 6.0, 7.0, 8.0 (2), 11, 12 (2), 8.0, 9.0, 13 and 25 mg/kg. The Meeting estimated a maximum residue level of 30 mg/kg and an STMR value of 11 mg/kg for piperonyl butoxide in cereal grains after post-harvest treatment.

Fate of residues during processing

A series of studies was conducted on processing of orange, grapes, tomato, beans, potato, sugar beets and cotton that had been treated with at least 10 applications at five times the GAP rate. Samples were collected on the day of the last application, except for cotton, samples of which were

collected after 14 days. Bulk samples were processed into the required products by procedures that simulated commercial practice.

Three orange plots were treated and one bulk sample consisting of one-third of each treated plot was processed. The concentration of piperonyl butoxide residues in orange was 9.4 mg/kg. The residues concentrated in orange dry pulp and orange oil, with processing factors of 5.7 and 15. In orange molasses, the concentration of residues was reduced by a processing factor of 0.53, and no residue was found in orange juice (processing factor, < 0.01). On the basis of the recommended MRL of 5 mg/kg and the STMR value of 1.0 mg/kg in citrus fruits, the Meeting estimated an STMR-P value of 5.7 mg/kg in dried citrus pulp and a maximum residue level of 0.05 mg/kg and an STMR-P value of 0.01 mg/kg in citrus juice.

Three tomato plots were treated, and one bulk sample consisting of one-third of each treated plot was processed. The concentration of residues in tomato was 8.5 mg/kg, and was found in wet and dry pomace, with processing factors of 5.9 and 34, respectively. The concentrations of residues in tomato purée and juice were reduced, with processing factors of 0.33 and 0.15, respectively. On the basis of the recommended maximum residue level of 2 mg/kg and the STMR value of 0.675 mg/kg in tomato, the Meeting estimated a maximum residue level of 0.3 mg/kg and an STMR-P value of 0.10 mg/kg for tomato juice and an STMR-P of 0.22 mg/kg for tomato purée.

Three grape plots were treated, and samples were collected for processing. The concentrations of residues in fruit were 14 (2) and 11 mg/kg. In all samples, the concentration increased in raisin, raisin waste and wet and dry grape pomace, giving average processing factors of 1.1, 2.3, 2.1 and 5.5, respectively. The concentration in juice decreased to 0.22–0.24 mg/kg, giving a processing factor of 0.02. As no STMR value was recommended for grapes, the Meeting could not estimate an STMR-P value for grape products.

Samples from three treated potato plots contained no detectable residues (< 0.10 mg/kg), and no residues were found in granules or chips. The residues were concentrated in wet potato peel, giving an average processing factor > 1.5. On the basis of the STMR value of 0.10 mg/kg recommended for root and tuber vegetables, the Meeting estimated an STMR-P value for wet potato peel of 0.15 mg/kg.

The concentration of residues in sugar beet root in one treated plot was 0.08 mg/kg. The concentration increased after processing to dry pulp, with a processing factor of 3.6. No residues were detected in sugar or molasses (< 0.10 mg/kg), giving an estimated processing factor for both commodities of < 1.2.

In one treated plot of succulent bean, the concentration of residues in pods was 8.0 mg/kg. The residues concentrated in cannery waste, with a processing factor of 6.4.

Three treated cotton plots had concentrations of residues in seed of 0.10 mg/kg (3). Each sample was processed, and the residues were found mainly in hulls with an average processing factor of 1.1, in crude oil with an average processing factor of 6.2, in refined oil with an average processing factor of 20 and in soapstock with an average processing factor of 3.8. Residues were not detected in cotton meal (<0.10 mg/kg). As no STMR value was recommended for cotton, the Meeting could not estimate an STMR-P value for cotton products.

Various studies were conducted on processing of wheat at various locations. In three studies conducted in Australia, wheat treated with piperonyl butoxide at 8.0 mg ai/kg of grain was processed to bread and bran. The concentrations of residues in grain were 16 and 14 (2) mg/kg and

residues were found mainly in bran, giving processing factors of 4.45, 3.1 and 4.1 (average, 3.9); the values were reduced in bread, with processing factors of 0.023, ≤ 0.005 (no residues detected) and 0.06 (average 0.029). No information on the processing or analytical method was provided.

In a series of 12 studies in Australia, wheat was treated at a 15 mg ai/kg of grain, stored for 3 months and processed to bran and flour. The concentration of residues decreased after cleaning in flour, shorts and low-grade middling, with average processing factors of 0.82, 0.42, 0.56 and 0.50 respectively. In bran, the concentration increased, with an average processing factor of 1.7. A full report of the studies was not provided.

Eighteen processing studies were conducted in Italy with wheat treated at various rates and stored for 45 or 180 days. The processing factors of cleaned and decorticated grain ranged from 0.09 to > 1.8 (average 0.535) and from < 0.15 to 1.33 (average, 0.44), respectively. On average, the concentrations of residues in bran increased, with an average processing factor of 1.3 (< 0.02 –3.1). In all studies, the concentrations of residues in flour decreased, with an average processing factor of 0.19, ranging from < 0.02 to 0.62.

Five hundred and forty tonnes of wheat treated with two formulations containing piperonyl butoxide were milled at intervals during storage for nine months. Residues were increased in bran and pollard with mean processing factors of 3.1 and 1.7, and decreased in meal, flour, whole meal bread and white bread by mean factors of 0.85, 0.19, 0.56 and < 0.08 , respectively.

In one study conducted in Australia, wheat treated with piperonyl butoxide at 8 mg ai/kg of grain was stored for 1, 3 or 6 months and processed to bran, pollard, germ, gluten, meal, flour and bread. Two flour extraction rates and a 1:1 blend of the two were used. The concentrations of residues increased in bran, pollard, germ and gluten, with average processing factors of 3.9 ($n = 6$), 2.1 ($n = 3$), 3.3 ($n = 5$) and 1.5 ($n = 3$), respectively. In meal, flour and bread, the concentrations decreased with average processing factors of 0.85 ($n = 3$), 0.31 ($n = 6$) and 0.30 ($n = 9$), respectively.

Wheat treated with two formulations at application rates of 10 and 13 mg/kg of grain and stored for up to 24 weeks was processed in three commercial mills (50 t per sample) and a pilot mill (1 t per sample). The concentrations of residues increased in bran with processing factors of 3.1–5.5 (average, 4.1; $n = 10$), in germ with processing factors of 2.1–4.3 (average, 3.2; $n = 10$) and in pollard with processing factors of 1.8–5.5 (average, 2.8; $n = 6$). On average, the concentration increased in whole meal, with processing factors of 0.48–2.8 (average, 1.3; $n = 9$), but decreased in flour, with processing factors of 0.27–0.66 (average, 0.48; $n = 10$).

Wheat treated with piperonyl butoxide at 10 mg/kg of grain was stored for 2 or 4 h and processed to bran, pollard, germ, meal, flour and bread. The concentration of residues increased in bran, pollard and germ, with average processing factors of 3.8, 2.4 and 2.6, respectively. The concentrations decreased in flour, meal, whole meal bread and white bread, with processing factors of 0.22, 0.78, 0.41 and 0.11, respectively.

Five processing studies were conducted in Australia with wheat treated at the GAP rate or higher and stored for 7–26 weeks. The concentrations of residues increased in bran with an average processing factor of 3.8 (3.33–4.7, $n = 4$), in germ with an average processing factor of 2.2 (1.33–2.89, $n = 4$) and in gluten with a processing factor of 1.4. The concentrations decreased in flour with an average processing factor of 0.37 (0.24–0.51, $n = 5$), in bread (white pan, whole meal, flat Arabic and steamed) with processing factors of 0.18–0.83 (average, 0.44) and in noodles (yellow alkaline and white) with average processing factors of 0.24 and 0.28. On average, the

concentrations of residues decreased in wheat whole meal, with processing factors of 0.61–1.29 ($n = 4$; average, 0.98).

In summary, the concentrations of piperonyl butoxide residues increased in wheat bran, with an average processing factor of 2.7 ($n = 60$), in germ with an average processing factor of 3.0 ($n = 21$), in pollard with an average processing factor of 2.15 ($n = 19$) and in gluten with an average processing factor of 1.5 ($n = 4$). The concentrations decreased in wheat flour with an average processing factor of 0.31 ($n = 58$), in wheat whole meal with an average processing factor of 0.98 ($n = 23$), in bread with an average processing factor of 0.32 ($n = 47$) and in noodles, with an average processing factor of 0.26 ($n = 8$).

On the basis of the recommendations for cereal grains (maximum residue level of 30 mg/kg and of STMR of 11 mg/kg) and the calculated processing factors, the Meeting recommends a maximum residue level of 80 mg/kg and an STMR-P value of 29.7 mg/kg for wheat bran; a maximum residue level of 90 mg/kg and an STMR-P value of 33 mg/kg for piperonyl butoxide in wheat germ; a maximum residue level of 10 mg/kg and an STMR-P value of 3.5 mg/kg for wheat flour; a maximum residue level of 30 mg/kg and an STMR-P value of 10.8 mg/kg for wheat whole meal and a maximum residue level of 100 mg/kg and an STMR-P value of 30.8 mg/kg for piperonyl butoxide in wheat germ.

In Italy, six processing studies were conducted on maize treated with piperonyl butoxide at two rates and stored for 42 or 182 days. Degermination was conducted in the laboratory under conditions that matched the industrial procedure, by starch processing (wet conditions) and mill processing (dry conditions). The concentrations of residues in germ and oil decreased, with average processing factors of < 0.3 and < 2.7 , respectively ($n = 6$). On the basis of the recommended MRL and the STMR value for cereal grains, the Meeting recommended a maximum residue level of 80 mg/kg and an STMR-P value of 29.7 mg/kg for maize oil, crude.

Two processing studies were conducted in France on dried and undried cargo rice treated with piperonyl butoxide at 2.5 mg/kg of grain, but only a short summary of the study was provided.

Cocoa beans and soya beans were treated with piperonyl butoxide formulations at 7.5 or 10 mg ai/kg and stored for up to 1 year. Samples were then processed and analyzed. The processing factors were 0.15–0.85 (average, 0.58; $n = 10$) for roasted cocoa beans and < 0.1 –0.53 (average, < 0.20 ; $n = 6$) for chocolate paste. The concentration of residues increased in soya oil, with processing factors of 6.18, 22 and 13 (average, 13.9), and changed little in soya cake, with processing factors of 0.86, 0.75 and 1.4 (average, 1.0). Only a summary of the studies was provided.

Residues in animal commodities

The new recommendations for pea hay and wheat bran, will be included in the dietary burden calculation of farm animal.

The Meeting estimated the dietary burden of piperonyl butoxide residues in cows and poultry on the basis of the diets listed in Appendix IX of the *FAO Manual* (FAO, 2002) and the maximum residue levels and STMR values estimated by the current and the previous Meeting.

Estimate of maximum dietary burden of farm animals

Commodity	Group	Residues		Dry matter (%)	Residues, dry weight (mg/kg)	% of diet			Residue contribution (mg/kg)		
		(mg/kg)	Basis			Beef cattle	Dairy cows	Poultry	Beef cattle	Dairy cows	Poultry
Citrus, dried pulp	AB	5.7	STMR-P	91	6.2	20	10	–	1.2	0.6	–
Potato peel, wet	AB	0.15	STMR-P	20	0.27			–			–
Sorghum	GC	30	MRL	86	34.2	5		20	1.7		27.4
Wheat	GC	30	MRL	89	33.3						
Wheat bran	GC	80	MRL	89	89.9	50	40	80	44.9	36.0	71.9
Rice	GC	30	MRL	88	33.6						
Maize	GC	30	MRL	88	33.6						
Pea vines	AL	400	MRL	–	400	25	50	–	100	200	–
Pea hay	AL	200	MRL	–	200						
Total						100	100	100	144.9	236.6	99.3

Estimated STMR value for dietary burden of farm animals

Commodity	Group	Residues		Dry matter (%)	Residues, dry weight (mg/kg)	% of diet			Residue contribution (mg/kg)		
		(mg/kg)	Basis			Beef cattle	Dairy cows	Poultry	Beef cattle	Dairy cows	Poultry
Citrus, dried pulp	AB	5.7	STMR-P	91	6.2	20	10	–	1.2	0.6	–
Potato peel, wet	AB	0.15	STMR-P	20	0.27			–			–
Sorghum	GC	11	STMR	86	12.5	5		20	0.6		2.5
Wheat	GC	11	STMR	89	12.2						
Wheat bran	GC	29.7	STMR	89	31.1	50	40	80	15.6	12.4	24.9
Rice	GC	11	STMR	88	12.3						
Maize	GC	11	STMR	88	12.3						
Pea vines	AL	108	STMR	–	108	25	50	–	27	54	–
Pea hay	AL	33.5	STMR	–	33.5			–			
Total						100	100	100	44.4	67	27.4

Feeding and dermal application to animals

Cows were given diets containing piperonyl butoxide at a concentration of 100, 300, 900 or 3000 ppm (dry weight basis) once daily for 28–30 consecutive days. The average concentration of residues in milk from three cows at 100 and 300 ppm remained approximately constant throughout the dosing period within ranges of < 0.01–0.02 mg/kg and 0.03–0.07 mg/kg, respectively. The concentrations in milk reached a plateau rapidly at higher doses. The average concentration of piperonyl butoxide in milk from cows at 900 ppm was 0.41 mg/kg, and that in milk from cows at the highest dose was 5.6 mg/kg. The residues in all treated animals were concentrated in liver and fat, and none were detected in kidney or muscle at the lowest dose. In liver, the mean concentration ranged from 0.14 mg/kg at 100 ppm to 12 mg/kg at 3000 ppm. The concentrations in animals at

100 ppm and 3000 ppm were 0.21 and 146 mg/kg in fat, <0.05 and 10 mg/kg in kidney and <0.05 and 7.6 mg/kg in muscle.

In Costa Rica and the USA, piperonyl butoxide may be sprayed directly onto livestock and poultry at a rate of 0.42–8.9 g ai/animal. Three cows were treated dermally twice daily for 28 consecutive days at a maximum GAP dose of 2.28 g/day (3.78 mg/kg bw per day). The average concentration of residues in milk was 0.06 mg/kg on the first day and increased to 0.14 mg/kg on day 3, 0.12 mg/kg on day 7 and 0.16 mg/kg on day 27.

Laying hens were given diets containing 20.4, 61.2 or 199 ppm piperonyl butoxide equivalents. The concentrations of residues in eggs from hens at 61.2 ppm reached a plateau on day 7, at 0.16–0.21 mg/kg on days 7–21 and an increase on day 27. Residues were detected in liver only at the highest dietary level (at a concentration of 0.13 mg/kg). In muscle, residues were present in hens at the two higher dietary levels at mean concentrations of 0.09 and 0.74 mg/kg, respectively. The mean concentration in fat was 0.30 mg/kg at the lowest dietary level and 12 mg/kg at the highest.

Laying hens exposed dermally for 28 consecutive days to piperonyl butoxide at a GAP application rate of 37.8 g/1000 m³ had residues in their eggs from day 3, at a concentration of 0.02 mg/kg, which increased steadily up to day 27 (0.46 mg/kg) and did not reach a plateau. The average concentrations in tissues ranged from 0.96 mg/kg in muscle to 3.0 mg/kg in fat and 5.1 mg/kg in skin.

Residues in animal products

Cattle

The maximum calculated dietary burden of piperonyl butoxide for cattle was 144.9 mg/kg feed for beef cattle and 236.6 mg/kg for dairy cows. The highest dietary burden was used to estimate the maximum residue level in milk and tissues of cattle. The mean intake calculated for dairy cattle (67 mg/kg feed) was higher than that for beef cattle (44.4 mg/kg) and was used to estimate the STMR value for milk and cattle tissues.

The highest concentrations of residues in tissues in the feeding studies and the mean value in milk after the plateau were used to estimate the maximum residue level. The values at the calculated dietary burden (236.6 mg/kg) were estimated by interpolation of values for residues found at 100 and 300 ppm in feed. The mean concentrations of residues in tissues and milk were used to estimate the STMR value. The concentration of residue at the calculated dietary burden (67 mg/kg) were estimated by interpolating the residues found at 100 ppm.

Residues in cattle milk and tissues from animals treated orally

Dose (ppm)	Piperonyl butoxide concentration (mg/kg)								
	Milk (mean)	Liver Highest t	Mean	Kidney Highest	Mean	Muscle Highest	Mean	Fat Highest	Mean
MRL									
236.6 /	0.03/	0.55/		<0.11/		<0.057/		1.3/	
100	0.01	0.15		< 0.05		< 0.05		0.42	
300	0.04	0.73		0.14		0.06		1.7	

STMR

67/	0.007/	0.094/	<0.034/	<0.034/	0.14/
100	0.01	0.14	<0.05	<0.05	0.21

The mean concentration of residue in milk after dermal treatment was used to estimate the maximum residue level and the typical value for cattle milk. The highest and median concentrations in tissues were used to estimate the maximum residue level and the typical value, respectively (FAO Manual, 2002, pg. 81).

Residues in cattle milk and tissues from animals treated dermally

Piperonyl butoxide concentration (mg/kg)								
Milk	Liver		Kidney		Muscle		Fat	
(mean)	Highest	Median	Highest	Median	Highest	Median	Highest	Median
0.14	0.14	0.03	0.21	0.21	0.21	0.16	2.7	2.6

The concentrations of residues in milk, kidney, muscle and fat from cows treated dermally are higher than those from cows fed piperonyl butoxide and will be used in the estimations for cattle. The Meeting estimated a maximum residue level for piperonyl butoxide of 0.2 mg/kg in cattle milk, 0.3 mg/kg in cattle kidney and 5 mg/kg in cattle meat (fat).

The Meeting estimated values for typical piperonyl butoxide median residues after direct use of 0.14 mg/kg in cattle milk, 0.21 mg/kg in cattle kidney, 0.16 mg/kg in cattle muscle and 2.6 mg/kg in cattle meat (fat). These values can be used in the same way as STMR values for long-term intake estimations on residue concentrations in tissues and milk (FAO Manual, 2002, pg. 81).

The concentration of residues in liver from cows fed piperonyl butoxide is higher than from cows treated dermally and will be used for the estimations. The Meeting recommends maximum residue level of 1 mg/kg, and a STMR of 0.094 mg/kg for piperonyl butoxide in liver of cattle, goats, pigs and sheep.

The Meeting also estimates a maximum residue level of 0.05 mg/kg and a STMR of 0.007 mg/kg for milk of mammals, except cattle; a maximum residue 0.2 mg/kg and a STMR of 0.034 mg/kg for kidney of goats, pigs and sheep and a maximum residue level of 2 mg/kg and a STMR of 0.14 mg/kg for meat (fat) (from mammals other than marine mammals, except cattle). The Meeting also estimates a STMR of 0.034 mg/kg of muscle (from mammals other than marine mammals, except cattle).

Poultry

The calculated maximum and mean intakes of piperonyl butoxide for poultry, 99.3 and 27.4 mg/kg feed respectively, were used in the estimations for tissues and egg. For the estimation of the maximum residue level in tissues, the values at the calculated dietary burden (99.3 mg/kg feed) were estimated by interpolation from the highest residue values at 61.2 and 199 ppm in feed. For the STMR estimation, the values at the 27.4 mg/kg feed dietary burden were estimated by interpolation of the mean residue data at 20.4 and 61.2 ppm. For eggs, the highest and the mean

values after residues plateau (7 days) were used for the estimations of maximum residue level and STMR.

Residues in poultry products from poultry treated orally

Dose (ppm)	Piperonyl butoxide (mg/kg)							
	Eggs		Liver		Muscle		Fat	
Interpolated / Actual	Highest	Mean	Highest	Mean	Highest	Mean	Highest	Mean
MRL								
99.3/	0.88/		<0.08/		0.38/		5.6/	
61.2	0.35		< 0.05		0.12		1.7	
199	1.9		0.15		0.88		13	
STMR								
27.4 /		0.056/		<0.01/		<0.058/		0.52/
20.4		0.03		–		< 0.05		0.30
61.2		0.18		< 0.05		0.09		1.3

For poultry dermally treated, the highest and median concentrations of residues in tissues and eggs (at day 27, no plateau reached) were used for the estimations.

Residues in poultry products from poultry treated dermally.

Piperonyl butoxide (mg/kg)									
Eggs		Liver		Skin		Muscle		Fat	
Highest	Median	Highest	Media	Highest	Median	Highest	Median	Highest	Median
0.79	0.36	0.44	0.26	8.3	3.8	1.2	1.0	5.0	2.0

The residues in poultry products in higher in the dermal study and will be used in the estimations. The Meeting recommends an maximum residue level of 1 mg/kg for eggs, a maximum residue level of 10 mg/kg in poultry edible offal (based on liver and skin), and a maximum residue level of 7 mg/kg for poultry meat (fat). The medium residue levels will be used to estimate a typical medium residue level of piperonyl butoxide in eggs of 0.36 mg/kg, of 2.0 mg/kg in poultry edible offal (mean of 0.26 and 3.8 mg/kg), of 2 mg/kg in poultry meat (fat) and of 1.0 mg/kg in poultry muscle. These values can be used in the same way as STMR values for estimating long-term dietary intake.

DIETARY RISK ASSESSMENT

Long-term intake

Currently, the ADI for piperonyl butoxide is 0.2 mg/kg bw. IEDIs were calculated for commodities for human consumption for which STMR values had been estimated by the present Meeting. The results are shown in Annex 3.

The IEDIs for the five GEMS/Food regional diets, on the basis of the estimated STMRs, ranged from 20 to 40% of the ADI. The Meeting concluded that the intake of residues of piperonyl butoxide resulting from its uses that have been considered by the JMPR is unlikely to present a public health concern.

Short-term intake

The 2001 JMPR concluded that an acute RfD for piperonyl butoxide was unnecessary. The Meeting therefore concluded that short-term dietary intake of piperonyl butoxide residues is unlikely to present a risk to consumers.

4.23 PHOSMET

RESIDUE AND ANALYTICAL ASPECTS

Phosmet (*O,O*-dimethyl *S*-phthalimidomethyl phosphorodithioate) was evaluated under the periodic review in 1994 for toxicology and in 1997 for residues. The 1997 JMPR agreed to withdraw previous recommendations for blueberries, citrus fruits, nectarines, pears and tree nuts, among others. The 31st CCPR (1999) decided to retain the CXLs under the periodic review procedure.

The Meeting received information on phosmet national registered use patterns, supervised residue trials and fate of residues in processing and national MRLs.

Supervised trials

Supervised trials were available for the use of phosmet on many crops: citrus (oranges, mandarins, lemons, grapefruit), pears, nectarines, blueberries and tree nuts (almonds, hazelnuts, walnuts, pistachios and pecans).

Citrus. Phosmet is registered in the USA for use on oranges and grapefruit in Florida at 0.8-1.6 kg ai/ha with a PHI of 7 days. None of the USA trials matched GAP.

GAP was reported by the 1997 JMPR for the use of phosmet on citrus in Argentina. Application is at a spray concentration of 0.06 kg ai/hl with no harvest interval specified. None of the Argentina trials matched GAP in Argentina.

Phosmet is registered in the Spain for use on citrus fruits at 0.075-0.125 kg ai/hl with a PHI of 30 days. The residues resulting from Spain trials meeting those conditions were: mandarins/tangerines 0.09, 0.47, 0.61, 0.67, 0.90, 1.0, 1.4, 1.5 and 1.6 mg/kg; oranges 0.05, 0.10, 0.32, 0.36, 0.57, 0.73 and 1.8 mg/kg. Residues from the two fruits appear to be from the same population and may be evaluated together. Phosmet residues in citrus from 16 trials matching GAP in the Spain in rank order (median underlined) were: 0.05, 0.09, 0.10, 0.32, 0.36, 0.47, 0.57, 0.61, 0.67, 0.73, 0.90, 1.0, 1.4, 1.5, 1.6 and 1.8 mg/kg.

The Meeting estimated a maximum residue level and STMR value for phosmet in citrus fruits of 3 and 0.64 (whole fruit) mg/kg, respectively. The estimated maximum residue level of 3 mg/kg for citrus fruits replaces the previous recommendation for withdrawal.

Four orange and four mandarin samples from the trials were peeled and residues were measured in the peeled fruit. Residues in the peeled oranges (pulp) were 0.09, 0.15 and 0.52 mg/kg (whole oranges 0.41, 0.57, 0.73 and 1.8 mg/kg). In peeled mandarins the residues of phosmet were 0.12, 0.21, 0.30, 0.33 mg/kg (whole mandarins 0.90, 1.4, 1.4 and 1.6 mg/kg). As residues from the two fruits appear to be from the same population they may be evaluated together. The residues in peeled oranges and mandarins were (median underlined) 0.09, 0.12, 0.15, 0.21, 0.30, 0.33 and 0.52 mg/kg.

The Meeting estimated STMR and HR values for phosmet in citrus edible portion of 0.21 and 0.52 mg/kg, respectively.

Pears. The trials from Chile (0.75-0.9 kg ai/hl, PHI 7 days) and the UK (no GAP) did not match GAP and trials from these countries were not evaluated further. The Canadian trials did not match the GAP of that country and were evaluated against GAP in the USA. One of the Canada trials matched GAP in the USA, however the residue in the untreated control (0.22 mg/kg) was more than 10% of the treated sample (0.84 mg/kg). This trial was not used to estimate a maximum residue level.

In the US phosmet is registered for use on pears at 1.7-5.6 kg ai/ha or at a spray concentration of 0.025-0.05 kg ai/hl and with a PHI of 7 days. Residues of phosmet in pears in rank order (median underlined) were: 1.3, 1.7 and 1.8 mg/kg in pears for 3 trials in the USA matching USA GAP.

The 1997 estimated a maximum residue level for apples based on GAP in the USA (1.7-4.1 kg ai/ha; PHI 7 days). The residues in apples approximating GAP, in rank order, were: 1.8, 1.8, 2.8, 3.3, 3.4, 3.4, 3.7, 4.2, 4.3 and 7.3 mg/kg. The current Meeting considered that the residues in apples and pears could be combined for the purposes of estimating a maximum residue level and decided to pool the data to estimate a pome fruit maximum residue level, residues in rank order (median underlined): 1.3, 1.7, 1.8 (3), 2.8, 3.3, 3.4, 3.4, 3.7, 4.2, 4.3 and 7.3 mg/kg.

The Meeting estimated a maximum residue level, an STMR and an HR value for phosmet in pome fruits of 10, 3.3 and 7.3 mg/kg, respectively. The estimated maximum residue level of 10 mg/kg for pome fruits replaces the previous recommendation for apples of 10 mg/kg.

Nectarines. Data on nectarines from Chile did not approximate GAP for that country (spray concentration 0.05-0.06 kg ai/ha; PHI 14 days) and were not further evaluated.

US GAP permits phosmet application on nectarines at 1.7-3.3 kg ai/ha with harvest 14 days after the final application. A single trial in the USA was conducted according to GAP and had a residue of 0.55 mg/kg in whole fruit. The number of trials is insufficient to estimate an MRL, STMR or HR for phosmet on nectarines.

The Meeting noted that the GAP reported for peaches in the evaluation by the 1997 JMPR was the same as for nectarines and agreed that the residue trials reported for peaches and apricots by the 1997 JMPR could be used to support a recommendation for a maximum residue level for nectarines. The residues of phosmet in trials on peaches, nectarines and apricots according to GAP were (median underlined): 0.45, 0.55, 0.87, 1.2, 1.5, 1.6, 2.9, 4.2, 4.7, 6.4 and 6.8 mg/kg. The Meeting recommended a maximum residue level, an STMR and an HR value for phosmet in nectarines of 10, 1.6 and 6.8 mg/kg, respectively, the same as for peaches. The estimated maximum residue level of 10 mg/kg for nectarines replaces the previous recommendation for withdrawal.

Blueberries. US GAP permits application of phosmet to blueberries at a 1 kg ai/ha and harvest 3 days after the final application. In 9 trials in the USA in matching the application rate and with PHIs of 3-4 days, phosmet residues in rank order (median underlined, residues from replicate analyses averaged) were: 1.0, 2.4, 3.4, 3.7, 4.0, 4.0, 5.8, 6.6 and 9.9 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for phosmet in blueberries of 15, 4.0 and 9.9 mg/kg, respectively. The estimated maximum residue level of 15 mg/kg for blueberries replaces the previous recommendation for withdrawal.

Tree nuts The commodity to which the MRL applies in the case of tree nuts is the nutmeat. For phosmet the residue is essentially located in the hulls and shell. The meeting was of the opinion that residues in the nut arise as a result of contamination during processing to extract the nutmeat. In this case, the interval between the last spray and harvest is not as important as for other crops and the Meeting decided to only consider the application rate in deciding whether on not trials matched GAP.

Phosmet is registered in the USA for use on almonds at 3.4-4.2 kg ai/ha with harvest permitted 30 days after the final application. In one of the trials that matched GAP, significant residues were reported in the untreated control sample of hulls though residues in the control nutmeat samples were all <LOQ for the same trial. The Meeting considered that as residues in nutmeat were below the LOQ for this trial that they could be used to estimate a maximum residue level. Phosmet residues in almond nutmeat from 4 trials that approximated GAP (median underlined) were: <0.05 (2), 0.05 and 0.07 mg/kg at 21-40 days after application at 3.4-4.5 kg ai/ha.

None of the USA trials of hazelnuts matched USA GAP.

Phosmet is registered in the USA for use on pecans at 1.6-2.45 kg ai/ha or at a spray concentration of 0.05 kg ai/hl with harvest permitted 14 days after the final application. Phosmet residues in pecan nutmeat were <0.05 (2), and 0.09 mg/kg at 14-15 days after application at 1.6-2.0 kg ai/ha.

Phosmet is registered in the USA for use on pistachios at 3.4-4.4 kg ai/ha with harvest permitted 14 days after the final application. Phosmet residues in pistachio nutmeat were <0.05 (4) mg/kg at 14-15 days after application at 4.5 kg ai/ha.

Phosmet is registered in the USA for use on walnuts at 3.4-6.7 kg ai/ha with harvest permitted 14 days after the final application. Phosmet residues in walnut nutmeat were <0.05 mg/kg in a single trial that matched USA GAP.

The meeting agreed that the residues found in nutmeat from the various tree nuts were consistent and that a group MRL could be estimated by combining the available data. Phosmet residues in tree nuts (median underlined) were <0.05 (7), 0.05, , 0.06, 0.07 and 0.09 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for phosmet in tree nuts of 0.2, 0.05 and 0.09 mg/kg, respectively noting the possibility for contamination during processing. The estimated maximum residue level of 0.2 mg/kg for tree nuts replaces the previous recommendations for withdrawal.

Processing

The meeting received information on the fate of incurred residues of phosmet residues during the processing of oranges. Processing factors were calculated for processed commodities derived from these raw agricultural commodities. When residues in the processed commodity did not exceed the LOQ the processing factor was calculated from the LOQ and was prefixed with a 'less than' symbol (<).

The phosmet processing factors for oranges to juice and dried pulp were <0.05 and <0.05 respectively. These factors applied to the STMR (0.64 mg/kg) and MRL (3 mg/kg) for citrus whole fruit provide the STMR-P for orange juice (0.03 mg/kg) and STMR-P for dried processed citrus pulp (0.03 mg/kg).

DIETARY RISK ASSESSMENT

Chronic intake

The evaluation of phosmet has resulted in recommendations for MRLs and STMRs for raw and processed commodities. Consumption data were available for 12 food commodities and were used in the dietary intake calculation. The results are shown in Annex 3.

The International Estimated Daily Intakes for the 5 GEMS/Food regional diets, based on estimated STMRs were in the range 0-40% of the ADI of 0-0.01 mg/kg bw (Annex 3). The Meeting concluded that the long-term intake of residues of phosmet from uses that have been considered by the JMPR is unlikely to present a public health concern.

Short-term intake

The international estimated short-term intake (IESTI) for phosmet was calculated for the food commodities (and their processing fractions) for which maximum residue levels and HRs were estimated and for which consumption data were available. Where group MRLs were estimated (e.g. for citrus fruits) the IESTI was calculated for the specific commodities with data supporting that group MRL (e.g. grapefruit, lemon and orange supporting citrus). The results are shown in Annex 4.

The IESTI varied from 0-1200 % of the acute RfD (0.02 mg/kg bw) for the general population. The IESTI varied from 0-3500% of the acute RfD for children 6 years and below. The estimated short-term intakes that exceeded the acute RfD were apple (1200%), blueberry (120%), nectarine (780%) and pear (900%) for the general population and apple (3500%), blueberry (390%), citrus fruit (grapefruit, 150%, oranges 170%), nectarine (2200%) and pear (3000%) for children 6 years and below. The information provided to the Meeting precluded a conclusion that the acute dietary intake of the above commodities would be below the acute RfD.

The Meeting noted that the existing acute RfD is conservative because it is based on a developmental end-point, which is not appropriate for children. Therefore, the acute RfD for children, and possibly for the general population including women of child bearing age, might be refined if an appropriate single-dose study would be available.

The Meeting concluded that the short term intake of residues of phosmet from use on tree nuts is unlikely to present a public health concern.

4.24 PROPARGITE (113)

Propargite [2-(4-*tert*-butylphenoxy)cyclohexyl prop-2-ynyl sulfite] is an acaricide. It is widely registered for foliar use, primarily on fruits, cotton, hops and tea. It was first evaluated for residues in 1977, followed by additional considerations in 1978, 1979, 1980, and 1982. Toxicological assessments of propargite were performed by the 1977, 1980, 1982, and 1999 JMPRs. The 1999 JMPR session determined that the acceptable daily intake for humans is 0 – 0.01 mg/kg bw and that an acute reference dose is not necessary. The present review of residues is part of the periodic review program.

The manufacturer has submitted data on metabolism, analytical methods of analysis, animal transfer (feeding studies), supervised field trials, GAP, processing, frozen storage stability of residues, and environmental fate. Australia submitted information on GAPs, labels, and residues in food in commerce or at consumption and national residue limits. Thailand submitted information on GAPs and Germany submitted information on GAPs and national MRLs.

Propargite is currently formulated as wettable powders and as emulsifiable concentrates. It is a viscous liquid with low solubility in water (<1 mg/l). Its octanol/water partition coefficient (4 - 6) suggests that it is fat soluble.

RESIDUE AND ANALYTICAL ASPECTS

Animal metabolism

The metabolism of ¹⁴C-propargite has been studied in the rat, goat, and hen. The radiolabel is uniformly distributed in the phenyl ring. In ruminants and poultry, propargite undergoes hydrolysis, thereby losing the propynyl sulfite side chain and generating 2-(4-*tert*-butylphenoxy)cyclohexanol (TBPC). The TBPC undergoes oxidation on the *tert*-butyl group and/or on the cyclohexanol ring, yielding diols and triols. The hydroxymethyl-TBPC is further oxidized to carboxy-TBPC, carboxy-TBPC-diol, and carboxy-TBPC-triol. The various carboxy and hydroxy compounds were found to form sulfate and glucuronide conjugates. For goats, the major residue in fat and milk was propargite, about 60% and 45%, respectively. The major metabolites in muscle were TBPC-diol (20%) and free and conjugated carboxy-TBPC (45%). The major metabolite in liver and kidney was carboxy-TBPC, free and conjugated, about 25%. Propargite was minor to absent in liver, kidney, and muscle.

A similar situation was found with chickens. From the oral administration of radiolabeled material, propargite was found in egg yolk (10%) and fat (50%), but was absent in kidney, muscle, and egg white. The major metabolite in these matrices was hydroxymethyl-TBPC-diol, 40%, 40%, 60%, respectively.

The rat metabolism study was reviewed by the 1999 JMPR. The same metabolites were found in the rat studies previously considered as those reported for goats and hens.

Plant Metabolism

The metabolism of ^{14}C -propargite has been studied on corn, apple, potato, and beans. The radiolabel is uniformly distributed in the phenyl ring. In corn, the major metabolite on kernels harvested six weeks after application was hydroxymethyl-TBPC-diol (45%), although propargite was present (10%), whereas in forage (3 weeks after application) and stover propargite was the major component of the residue, 40% and 25%, respectively.

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Apple fruits and leaves were painted with radiolabeled propargite and harvested 23 days later. About 30% of the total radioactive residue on the apple was removable with acetone or acetone/water wash of the whole fruit. The pulp (peeled fruit) contained about 1% of the total radioactive residue in/on the fruit. The remaining 68% was on the (washed) peel. In the pulp, 30% of the residue present was propargite, and the major metabolite was hydroxymethyl-TBPC at 30%. Some 90% of the residue on the peel was propargite. On washed leaves, 60% of the remaining residue was propargite and 25% was TBPC.

Potato vines were sprayed with a radiolabeled formulation and harvested 3 weeks later. The total radioactivity on potato peels (fresh weight) was 0.012 mg/kg and on tubers (fresh weight) 0.004 mg/kg. The radioactivity on the vines (270 mg/kg, dry weight) was examined. Propargite comprised 30% of the total residue on vines, hydroxymethyl TBPC-diol comprised 15%, and hydroxymethyl TBPC comprised 10%.

Green bean pods were painted or sprayed with radiolabeled propargite and harvested 7 days later. About 80 -90% of the total radioactive residue was propargite. TBPC was a minor component (1%).

The studies are consistent with a metabolism that involves hydrolysis to TBPC and oxidation of TBPC to hydroxymethyl-TBPC and hydroxymethyl-TBPCdiol. TBPC diol and hydroxymethyl-TBPC triol were also found in some studies, but carboxy-TBPC derivatives were never found. Also, the potato and apple studies indicate that propargite does not translocate.

Environmental fate

Soil

Confined rotational crop studies with radiolabeled propargite were not provided. However, field rotational crop studies with propargite were submitted. Wheat, carrot, and lettuce were rotated with cotton that had been treated 3 times at 1.8 kg ai/ha with propargite. With plantback intervals of 82 and 120 days, no propargite (<0.05 mg/kg), no TBPC (<0.04 mg/kg), and no TBPC diol (<0.02 mg/kg) were found in any commodity at normal harvest. In another study, barley, carrot, radish, and lettuce were rotated with cotton that had been treated three times at rates of 1.8 or 3.7 kg ai/ha. The plantback intervals were 60 days and 119 days. The maximum residues found were in carrot root, 0.16 mg/kg for propargite and 0.02 mg/kg for TBPC at 119 days and 3.7 kg ai/ha. In all other cases, propargite residues were ≤ 0.05 mg/kg and TBPC residues were ≤ 0.01 mg/kg, with the exception of barley straw, 0.09 mg/kg propargite. These findings were confirmed by additional similar studies.

The Meeting concluded that propargite may persist in root type rotational crops for plantback intervals of 120 days or less, with potential residues at longer plantback intervals unknown. Residues in other food crops are none or minimal (<0.05mg/kg) at plantback intervals of 60 days or greater.

The aerobic degradation of propargite in sandy loam soils proceeded with a calculated first order kinetics half-life of 40 - 60 days. Extractable residue (acetone or methanol) decreases from about 100% on the day of application to 30% by day 90 - 100. At day 100, carbon dioxide accounted for 40% of the applied radioactivity. After 365 days, 9 metabolites were detected, including TBPC, p-tertiarybutyl phenol (PTBP), and TBPC-sulfate.

The anaerobic degradation of propargite in sandy loam soils yielded propargite (40% applied radioactivity) and TBPC (20% applied radioactivity) as the major components after 60 days. The time to 50% degradation was calculated by linear regression to be 65 days.

The mobility of propargite in 6 soil types was studied. Propargite was strongly adsorbed by all soil types and may be considered only slightly mobile. The mobility of TBPC was also measured in numerous soil types. It was not adsorbed and was easily desorbed. The metabolite TBPC may be classified as very mobile.

When propargite was applied to orange trees with an airblast sprayer and soil samples were taken at various intervals and depths, neither propargite nor TBPC were detected beyond the first 15 cm for post-treatment intervals up to one year. In a study with cotton, propargite was found in the 15 - 30 cm cores (0.1 mg/kg) and 30 - 60 cm cores (0.07 mg/kg) within less than 4 days of application, but declined to <0.05 mg/kg by day 7. TPBC was found (0.1 mg/kg) at the 30 - 60 cm depth at 4 - 7 days after application. Again, propargite appears not to be mobile.

Numerous field dissipation studies were reported, wherein crops bordering bodies of water were sprayed with propargite and the residue of propargite in the water and sediment were determined as a function of time. Generally, residues were as great as 0.1 mg/kg in sediment and 0.12 mg/kg in water immediately after the treatments. Sediment residues declined to <0.025 mg/kg after 10 days, and concentrations in water declined to <0.005 mg/kg over 10 days to 4 months.

The photolysis of propargite on soil showed a half-life of about 60 days with full sunlight (no dark periods) based on a 20 day study. TPBC was identified as a degradate.

Water-sediment systems

The hydrolysis of radiolabeled propargite at various pHs revealed that propargite's stability decreases with increasing pH, with a half life of 100 - 700 hours at pH 5 and 2 - 3 hours at pH 9.

The aerobic degradation of radiolabeled propargite in a pond water/sand sediment mixture led to a calculated 50% loss of propargite in 38 days. The composition of the water/sand extract as a percentage of the applied radioactivity on day 30 was 60% propargite, 26% TBPC, 0.1% carboxy-TBPC compounds, 0.3% hydroxymethyl-TBPC, and 1% PTBP. Less than 1% of the applied radioactivity was recovered as volatiles.

The anaerobic degradation of propargite was studied in a lake water/pond sediment system spiked with glucose and purged with nitrogen. The radioactivity extractable with ethyl acetate decreased from 96% on day 0 to <50% after one year. The levels of radioactivity in the water fraction remained low (13% maximum). TBPC maximized at 60% of the applied dose on day 270. The calculated half-life in "hydrosol" was about 50 days.

The Meeting concluded that propargite is not mobile in soils and that it degrades under various conditions in soil and sediment/water with half-lives of 40 - 60 days, forming TBPC, which may further degrade to various diols. Under aerobic conditions in soil, significant degradation to carbon dioxide may occur. Because it is not mobile, propargite may accumulate in rotational root crops such as carrots when short plantback intervals are used.

Methods of Analysis

Several methods were provided for the determination of propargite in raw and processed agricultural commodities. The method most frequently used entails sample maceration, extraction with solvent, purification on Florisil and/or alumina columns and/or gel permeation chromatography, followed by determination of the extracts by gas chromatography with a flame photometric detector in the sulfur mode. This method, with modifications such as the use of capillary columns and different extraction solvents, has been traditionally used for data collection in field trials and animal feeding studies. It is also the basis of the enforcement method in the United States, with limits of quantification of 0.1 mg/kg, except 0.08 mg/kg for milk. Where used for data collection with modifications, the demonstrated limits of quantification are 0.01 - 0.05 mg/kg.

More recently, gas chromatography/mass spectrometry (GC/MS) has been substituted for the flame photometric detector. Usually the MS is operated to monitor ions specific to propargite. The limits of quantification are generally 0.01 - 0.05 mg/kg.

An HPLC method has also been used for residue determinations in field trials, especially for fruits. Extracts are purified on solid phase extraction cartridges and analyzed on HPLC, isocratic mode, with a UV detector (225 nm). Acceptable recoveries are reported for 1 - 2 mg/kg fortifications, although a limit of quantification of 0.1 mg/kg is claimed.

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The metabolite TBPC has been determined in plant commodities by heptafluorobutyric anhydride (HFBA) derivatization and analysis by GC/ECD. Direct analysis of the extract by GC/MS has also been reported. The limit of quantification is 0.01 mg/kg in both methods. For animal commodities, the derivatization procedure with GC/FPD has been used, with a 0.02 mg/kg limit of quantification.

The GC/FPD method has been radiovalidated. The method recovered 26% of the total radioactive residue (TRR) from corn forage as propargite, whereas the metabolism study yielded 40%. For milk, the values were 35% from the GC/FPD method and 43% from the metabolism study. The Meeting concluded that the method provided adequate extraction of the target analyte, propargite.

The Meeting concluded that adequate methods exist for the collection of data for the residues of propargite in/on raw and processed agricultural commodities both for monitoring and MRL enforcement purposes.

Stability of pesticide residues in stored analytical samples

Storage stability studies were conducted on about 51 commodities in support of the storage intervals encountered in the various field trials and feeding studies. Most studies indicated stability (>70% remaining) for the longest period studied, typically one year. There were exceptions, mainly forages and fodders. Maize forage and fodder had a 40% loss at 6 - 8 months, barley straw lost 50% of the propargite residue between 9 and 12 months. Study periods for animal commodities

were shorter. Thus, propargite in muscle and in kidney was stable for the period studied, 6 months, and stable for the 3 month period in milk, fat (bovine and chicken), liver (bovine and chicken), and eggs.

The Meeting concluded that propargite is stable in frozen plant commodities for about one year, but that animal commodities should be analyzed within 3 months because of the lack of adequate storage stability data for longer intervals.

Residue definition

Whereas propargite forms the majority portion of the residues in the plant metabolism studies, whereas propargite is the major residue component in fat and milk, and a significant portion of the residue in egg yolk, as ascertained from the animal metabolism studies, whereas analytical methods suitable for use by national authorities exist for the determination of propargite in raw and processed plant and animal commodities, whereas analytical methods for the major metabolite TBPC have not been validated as enforcement methods by national authorities and require extensive additional efforts beyond the determination of the parent (derivatization, use of GC/MS), and whereas the 1999 JMPR noted no special concern for the metabolites of propargite, the Meeting concluded that the appropriate residue definition for monitoring and risk assessment was propargite. The Meeting noted that propargite will most likely not be found in the lean muscle, offal, and egg white of animals exposed to propargite in the diet, based on the results of the metabolism studies.

Definition of the residue for compliance with MRLs for plant and animal commodities and for estimation of dietary intake:
Propargite. The residue is fat-soluble.

Results of the supervised trials

Supervised trials were conducted for the foliar application of WP and EC and EW formulations to many crops, primarily in Europe and the USA. Trials were also reported from Asia and Africa for tea.

Trial data were not submitted for several crops with current maximum residue level recommendations: apricot, common bean, cranberry, and fig. The Meeting agreed to withdraw the previous maximum residue level recommendations for these commodities.

Oranges and mandarins. Field trial data was received from Spain, California (USA), and South Africa. The GAP for Spain is 1.1 kg ai/ha in at least 4000 l water/ha with a 14 day PHI for the EC, WP, and EW formulations. Four trials each for oranges and mandarins were at GAP. Oranges: 0.22, 0.28, 0.55, and 0.61 mg/kg; Mandarins: 0.19, 0.33, 0.71, and 0.77. The GAP for the USA is use of the WP (CR) formulation at 3.8 kg ai/ha in 9400 l water/ha, 28 day PHI. No trials were at the GAP conditions. The GAP for South Africa is 3.6 kg ai/ha in 6000 l/ha of the WP formulation, or 0.06 kg ai/hl, 14 day PHI. Three trials were at GAP for oranges: 0.26, 1.5, and 2.1 mg/kg. Combining the values for oranges and mandarins for mutual support, the residues in ranked order are: 0.19, 0.22, 0.26, 0.28, 0.33, 0.55, 0.61, 0.71, 0.77, 1.5, and 2.1.

Residue values for pulp were supplied for the trials from Spain (<0.01 (5), 0.01, 0.02 (2) mg/kg) and South Africa (<0.1 (2), 0.34 mg/kg). The ranked order of the residues is: <0.01 (5), 0.01, 0.02 (2), <0.1 (2), 0.34. The Meeting estimated an STMR of 0.01 mg/kg for orange and mandarin pulps.

Lemons. Field trial data were reported from the USA. However, the data did not support the current GAP: 3.8 kg ai/ha and 28 day PHI. All data were for a 7 day PHI and a 5 kg ai/ha application rate.

Grapefruit. Field trial data were reported from the USA. However, the data did not support the current GAP: 3.8 kg ai/ha and 28 day PHI. All data were for a 7 day PHI and a 5 kg ai/ha application rate.

Citrus. The Meeting agreed to withdraw the previous maximum residue level recommendation for citrus fruits (5 mg/kg), to be replaced by a new recommendation for citrus (3 mg/kg).

Apple. Field trial data were received from the Czech Republic, Brazil, Hungary, Moldova, Italy, France, and the USA. The USA has no GAP for apples, and the trials are discarded. No GAP was available for the Czech Republic, but the GAP of Hungary may be applied (1.1 kg ai/ha, 10 or 14 day PHI). The data for the two trials do not support this GAP.

Two trials were submitted from Brazil, but no relevant GAP was available.

Three trials from Hungary may be evaluated against the critical GAP of Hungary: WP, 1.8 kg ai/ha, 10 day PHI. No trials support the GAP

One trial from Moldova is not supported by the Moldova GAP: 1.7 kg ai/ha, 45 day PHI.

Ten trials from Italy support the Italian GAP: EC, EW, WP 0.9 kg ai/ha, 1000 l/ha water minimum, 15 day PHI. The residues are: <0.01, 0.01, <0.10 (5), 0.22, 0.58, 0.65 mg/kg. In addition, four trials from France may be evaluated against the Italian GAP: 0.11, 0.16, 0.21, and 0.24 mg/kg.

Twenty trials from France support the French GAP: WP, 1.5 kg ai/ha, 500 l/ha water minimum, 7 day PHI. The residues are: 0.2, 0.21, 0.29, 0.44, 0.47, 0.55(2), 0.60, 0.64(2), 0.73(2), 0.79, 0.8, 0.81, 0.94, 1.1, 1.2, 1.7, and 1.8 mg/kg.

Combining the values from Italy and France gives the following ranked order for 34 trials: <0.01, 0.01, <0.10 (5), 0.11, 0.16, 0.2, 0.21(2), 0.22, 0.24, 0.29, 0.44, 0.47, 0.55(2), 0.58, 0.60, 0.64(2), 0.65, 0.73(2), 0.79, 0.8, 0.81, 0.94, 1.1, 1.2, 1.7, and 1.8 mg/kg. The Meeting estimated an STMR of 0.51 mg/kg. The Meeting agreed to withdraw the previous maximum residue level recommendation level for apple (5 mg/kg), to be replaced by a new recommendation for apple (3 mg/kg).

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Pear. Numerous trials for pears were submitted from the USA, but the USA does not have a current GAP for the use of propargite on pears. The Meeting recommended withdrawal of its previous recommendation for a maximum residue level on pears (5 mg/kg).

Cherry. Numerous field trials were submitted from the USA, but the USA does not have a current GAP for the use of propargite on cherries (sweet and sour). The Meeting could not make a recommendation for a maximum residue level on cherries.

Plum. Field trials for the use of propargite on plums (prunes) were submitted from France and the USA. The USA has no current GAP for plums. The GAP for France is: WP, 1.2 kg ai/ha or 0.24

kg ai/hl, 21 day PHI. Ten trials support this GAP: 0.38, 0.39, 0.59, 0.63, 0.65, 0.71, 0.74, 0.97, 1.1, 3.0 mg/kg.

Nectarine. Nectarine field trial studies were made available from France and the USA. The GAP in France, using the Peach GAP, is: WP, 1.5 kg ai/ha or 0.3 kg ai/hl, 14 day PHI. Three trials support the GAP: 0.94, 1.0, 1.2 mg/kg. The GAP in the USA is: WP, 3.2 kg ai/ha, 14 day PHI. Two trials support this GAP: 1.3, 1.4 mg/kg. Combining residue values, the ranked order is: 0.94, 1.0, 1.2, 1.3, 1.4 mg/kg.

Peach. Peach field trial studies were reported from France, Hungary, Italy, and the USA. The USA has no current GAP for peaches. The GAP for France is: WP, 1.5 kg ai/ha or 0.3 kg ai/hl, 14 day PHI. Ten trials support this GAP: 0.57, 0.73, 0.80, 0.86, 0.82, 0.87, 0.89, 0.99, 1.2, and 1.9 mg/kg. The GAP for Hungary is: EC, 1.1 kg ai/ha, 10 day PHI at 0.09 kg ai/ha and 14 day PHI at 0.14 kg ai/ha. The two available trials do not support the GAP. The GAP for Italy is: EW, EC, 0.9 kg ai/ha, 0.09 kg ai/hl, 15 day PHI. The one available trial supports the GAP: 0.11 mg/kg. However, the Meeting concluded that the value from Italy is not from the same population as the data of France.

The Meeting agreed that the residue data for peach, nectarine, and plum were from the same population and could be combined. The GAPs are similar, 1.5 – 3.2 kg ai/ha, PHI 14 or 21 days. The 25 values in ranked order are: 0.38, 0.39, 0.57, 0.59, 0.63, 0.65, 0.71, 0.73, 0.74, 0.80, 0.82, 0.86, 0.87, 0.89, 0.94, 0.97, 0.99, 1.0, 1.1, 1.2 (2), 1.3, 1.4, 1.9, 3.0 mg/kg. The Meeting estimated a maximum residue level of 4 mg/kg for stone fruit (excluding cherry). The Meeting further agreed to recommend the withdrawal of previous maximum residue level recommendations for peach (7 mg/kg) and plums (7 mg/kg). The Meeting estimated an STMR of 0.87 mg/kg for stone fruit (excluding cherry) with stone.

Strawberry. Numerous field trials for strawberries were reported from the USA, but the USA does not have a current GAP. The Meeting could not estimate an STMR or maximum residue level. The Meeting recommended withdrawal of the previous recommendation for a maximum residue level for strawberry (7 mg/kg).

Currant. Field trial reports for black currants were supplied from the UK, but no GAP was available. The Meeting could not estimate an STMR or maximum residue level.

Grape. Field trial reports for grapes were provided from the Czech Republic, France, Hungary, Italy, and the USA. The GAP for the Czech Republic is: EW, 0.88 kg ai/ha; WP, 0.6 kg ai/ha, 28 day PHI. The one trial supported the GAP: 0.29 mg/kg.

The GAP for France is: EW, 0.85 kg ai/ha or 0.43 kg ai/hl, 21 day PHI. Twenty-four trials support this GAP: 0.11, 0.18 (2), 0.23, 0.28, 0.29 (2), 0.30 (2), 0.35, 0.38, 0.45, 0.51, 0.6, 0.67, 0.7, 0.8, 0.83, 0.93, 0.96, 1.1, 1.9, 2.4, 2.7 mg/kg.

The GAP for Hungary is: EC, 1.1 kg ai/ha, 10 day PHI with 0.09 kg ai/hl and 14 day PHI with 0.14 kg ai/ha; WP, 0.9 kg ai/ha, 14 day PHI. The one trial supports the GAP: 0.36 mg/kg.

The GAP for Italy is: EW, EC, WP, 0.9 kg ai/ha or 0.09 kg ai/hl, 15 day PHI. Five trials support the GAP: <0.10, 0.26, 0.31, 0.33, 0.48 mg/kg.

The GAP for the USA is: WP, 3.8 kg ai/ha, 28 day PHI. Four trials support this GAP: 0.49, 1.3, 3.4, 4.8 mg/kg.

The combined residue results in ranked order are: <0.10, 0.11, 0.18 (2), 0.23, 0.26, 0.28, 0.29 (3), 0.30 (2), 0.31, 0.33, 0.35, 0.36, 0.38, 0.45, 0.48, 0.49, 0.51, 0.6, 0.67, 0.7, 0.8, 0.83, 0.93, 0.96, 1.1, 1.3, 1.9, 2.4, 2.7, 3.4, 4.8 mg/kg.

The Meeting agree to withdraw the previous maximum residue level recommendation for grape (10 mg/kg), to be replaced by a new recommendation for grape (7 mg/kg). The Meeting also estimated an STMR of 0.45 mg/kg.

Avocado. Two trials were received from the USA on avocado. However, there is no current GAP in the USA for the use of propargite on avocado. Therefore, the Meeting could not estimate a maximum residue level or STMR for avocado.

Cucumber. One field trial study was made available from Hungary. The GAP for Hungary was not available, and the trial does not support the GAP of the Czech Republic: EW, WP, 0.3 kg ai/ha, 5 day PHI. The Meeting could not estimate a maximum residue level or STMR for cucumber. The Meeting agreed to withdraw the previous maximum residue level recommendation (0.5 mg/kg).

Melon. One field trial study was received from France. The GAP for France was not available, but the GAP of Italy may be applied: WP, 0.9 kg ai/ha, 0.09 kg ai/ha, 15 day PHI. The one field trial supports the GAP: 0.05 mg/kg. The Meeting concluded that one field trial was an insufficient data base upon which to estimate the maximum residue level and STMR.

Pepper. One field trial was received from Hungary, but the GAP for the WP formulation was not available. The Meeting could not estimate a maximum residue level or STMR.

Tomato. Field trial studies on tomatoes were received from France, Italy, and the USA. The GAP for France was not available for the one trial from France.

The GAP for Italy is: EW, EC, WP, 0.9 kg ai/ha, 0.09 kg ai/ha, 15 day PHI. Fifteen trials support the GAP: <0.10 (5), 0.14 (2), 0.17, 0.23, 0.27 (2), 0.28, 0.29, 1.4 (2) mg/kg.

One trial study was submitted from the US, but the information was incomplete and the US has no GAP for tomatoes.

Based on the 15 trials from Italy, the Meeting confirmed the previous maximum residue level recommendation for tomato (2 mg/kg). The Meeting also estimated an STMR of 0.17 mg/kg.

Soya bean. Field trial studies were submitted from the USA, but the USA does not currently have a GAP for the use of propargite on soybeans. The Meeting could not estimate a maximum residue level or STMR.

Bean (dry). A single study was submitted from the USA, but the USA does not currently have a GAP for beans (dry). The Meeting could not estimate a maximum residue level and STMR for beans (dry). The Meeting agreed to withdraw the previous maximum residue level recommendation (0.2 mg/kg) for beans (dry).

Potato. The details of two studies in the USA were submitted. The GAP in the USA is: EC, 2.3 kg ai/ha, 14 day PHI, chemigation. The trials support the GAP: <0.05 (2). The Meeting decided that 2 trials provide an insufficient data base upon which to estimate a maximum residue level or an STMR. The Meeting agreed to withdraw the previous recommendation for a maximum residue level of 0.1 (*) mg/kg.

Maize. A field trial study was submitted from France. The GAP in France was not provided, and available GAPs do not match the trial condition (1.4 kg ai/ha, 41 day PHI)..

Field trial studies were submitted from the USA on the foliar application of propargite to corn (maize). The GAP is: EC, 2.8 kg ai/ha, 30 day PHI; California, 1.7 kg ai/ha, 56 day PHI. Nine trials support the GAP, including 4 trials conducted in the USA under the GAP for California: <0.05 (8), 0.06 mg/kg. The Meeting agreed to withdraw the previous recommendation for a maximum residue level (0.1 mg/kg(*)) and recommended a new maximum residue level (0.1 mg/kg). The Meeting also estimated an STMR of 0.05 mg/kg.

Sorghum. Grain sorghum trials were reported for the USA. The GAP in the USA is: EC, 1.9 kg ai/ha, 30 day PHI silage, 60 day PHI grain. One of the three trials supported the GAP: <0.05 mg/kg. The Meeting concluded that the data base was insufficient to estimate a maximum residue level or STMR and agreed to withdraw the previous recommendation for a maximum residue level for sorghum (5 mg/kg).

Almond. Field trial studies were submitted from the USA. The GAP in the USA is: WP, 3.6 kg ai/ha, 28 day PHI (California and Arizona only). Fourteen trials support the GAP. The ranked order of residues on almond kernels (nutmeats) is: <0.05 (11), 0.05 (2), 0.076 mg/kg. The Meeting agreed to withdraw the previous recommendation for a maximum residue level for almond 0.1 (*) mg/kg and recommended a new maximum residue level for almonds (0.1 mg/kg). The Meeting also estimated an STMR of 0.05 mg/kg.

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Filbert nuts (Hazel nuts). Field trial studies from the USA for the application of propargite to filbert nuts were presented, but the USA currently does not have a GAP for filbert nuts. The Meetings could not estimate a maximum residue level or STMR.

Pecan. Field trial studies from the USA for the application of propargite to pecans were presented, but the USA currently does not have a GAP for pecans. The Meetings could not estimate a maximum residue level or STMR.

Walnut. Field trials were provided for France and the USA. The GAP in France was not provided, but the GAP in Italy for nuts is: WP, 0.9 kg ai/ha, 0.09 kg ai/hl, 15 day PHI.. The single field trial does not support this GAP.

Two trials were reported from the USA, but there is no current GAP for walnuts in the USA. The Meeting could not estimate a maximum residue level or STMR for walnuts. The Meeting agreed to withdraw the previous recommendation for a maximum residue level (0.1 mg/kg (*)).

Cotton seed. Field trial studies on cotton seed were provided for the USA. The GAP in the USA is: EC, 1.9 kg ai/ha, 50 day PHI. Ten studies support the GAP, and the residues on undelinted cottonseed are in ranked order: 0.095, <0.1 (4), 0.10, 0.11, 0.12, 0.42, 0.44 mg/kg. A single processing study (see below) yielded a processing factor of 0.18 for the delinting process. Delinted cottonseed values in ranked order are: ≤0.02 (5), 0.02 (3), 0.08 (2) mg/kg. The Meeting agreed to

withdraw its previous recommendation for a maximum residue level (0.1 mg/kg (*)) and recommended a new maximum residue level (0.1 mg/kg). The Meeting also estimated an STMR (0.02mg/kg).

Peanut. Field trials for peanuts were provided for the USA. The GAP in the USA is: EC, WP, 1.9 kg ai/ha, 14 day PHI, with a restriction against grazing and haying. Ten trials support the GAP: <0.05 mg/kg (10). The Meeting confirmed the previous recommendation for a maximum residue level (0.1 mg/kg (*)) and estimated an STMR (0.05 mg/kg).

Mint. Trials on mint were reported from the USA. The GAP is: EC, 2.5 kg ai/ha, 14 day PHI. The three trials (fresh mint tops) support the GAP: 1.6, 5.2, 5.6 mg/kg. Data were not provided on mint hay. The Meeting agreed to withdraw the previous recommendation for mint hay (50 mg/kg).

Alfalfa. A single trial for alfalfa (fodder, forage) was provided from the USA. The USA has no current GAP for alfalfa. The Meeting decided to withdraw the previous recommendation for maximum residue levels on alfalfa fodder (75 mg/kg) and alfalfa forage (green) (50 mg/kg).

Peanut hay (fodder). Trial studies for the foliar application of propargite to peanut plants were reported for the USA. The GAP is: EC, WP, 1.9 kg ai/ha, 14 day PHI, no grazing or cutting forage for hay. Ten trials support the GAP: 3.6, 3.9, 4.0, 5.6 (2), 5.8, 7.5, 8.2, 8.5, 14 mg/kg. The Meeting agreed to withdraw the previous recommendation for a maximum residue level for peanut fodder (10 mg/kg) and declined to recommend a new maximum residue level for peanut fodder because the US GAP forbids the production of fodder from treated peanuts. Thus, the commodity ought not be available in trade. The Meeting also agreed to withdraw the previous recommendation for a maximum residue level for peanut forage (green) (10 mg/kg).

Maize forage. Field trials were presented from France and the USA. The GAP in France was not provided.

Field trial studies were submitted from the USA on the foliar application of propargite to corn (maize). The GAP is: EC, 2.8 kg ai/ha, 30 day PHI; California, 1.7 kg ai/ha, 56 day PHI. The trials do not support the GAP.

The Meeting agreed to withdraw the previous recommendation for maximum residue levels for maize forage (10 mg/kg).

Maize fodder. Field trial studies were submitted from the USA on the foliar application of propargite to corn (maize). The GAP is: EC, 2.8 kg ai/ha, 30 day PHI; California, 1.7 kg ai/ha, 56 day PHI. The four trials do not support the GAP.

The Meeting agreed to withdraw the previous recommendation for a maximum residue level for maize fodder (10 mg/kg).

Sorghum fodder. One trial was provided for the USA. The GAP in the USA is: EC, 1.9 kg ai/ha, 30 day PHI silage, 60 day PHI grain. The trial supports the GAP: 0.05 mg/kg.

The Meeting concluded that one trial provided an insufficient data base upon which to estimate a maximum residue level and an STMR. The Meeting agreed to withdraw the previous recommendation for a maximum residue level for sorghum straw and fodder, dry (10 mg/kg).

Almond hulls. Field trial studies were submitted from the USA. The GAP in the USA is: WP, 3.6 kg ai/ha, 28 day PHI (California and Arizona only). Fourteen trials support the GAP. The ranked order of residues on almond hulls is: 12, 14, 15, 30, 35 mg/kg. The Meeting estimated an STMR (15mg/kg) for almond hulls. The Meeting estimated a maximum residue level of 50 mg/kg for almond hulls.

Cotton gin byproducts. Field trial studies were submitted from the USA. The GAP in the USA is: EC, 1.9 kg ai/ha, 50 day PHI. Five trials support the GAP: 1.0, 5.8, 8.4, 16 (2) mg/kg. The Meeting estimated an STMR of 8.4 mg/kg for cotton gin byproducts.

Hops. Field trials on hops were reported for Germany, the UK, and the USA. The GAP for Germany was not available, and the trials do not support the GAPs of France or the Czech Republic. Likewise, the GAP for the UK was not available.

The GAP for the USA is: EC, CR (WP), 1.8 kg ai/ha, 14 day PHI. Twenty trials support the GAP: 6.9, 9.1, 12, 14 (2), 15 (2), 16, 17, 18 (3), 19, 20, 25, 28, 33, 46, 75, 90 mg/kg. The Meeting agreed to withdraw the recommendation for the previous maximum residue level (30mg/kg) and to recommend a new maximum residue level for hops (dry) (100 mg/kg). The Meeting also estimated an STMR for hops (dry) (18 mg/kg).

Tea. Field trials for the foliar application of propargite to tea were provided for India, Indonesia, Japan, and Kenya. Two trials from India support the GAP of India (0.81 kg ai/ha, 7 day PHI): <0.05, 1.7 mg/kg for black tea. Two trials from Indonesia do not support the Indonesia GAP (0.11 kg ai/hl, no PHI specified) because of no data for post treatment day 0 – 1.. The GAP for Japan is: EW, WP, 0.04 kg ai/hl, 14 day PHI. Two trials support the GAP: 0.16, 0.26 mg/kg on fresh tea leaves. The GAP for Kenya is: EC, 0.86 kg ai/ha, with no PHI specified. No field trial data were available for a 0 or 1 day PHI.. Processing studies (see below) for the production of black tea and green tea yielded processing factors of 8.5 and 3.9 for black tea and 3.9 and 2.3 for green tea. The average factor is 5.0. Using this factor for the Japan samples, the ranked order of residues for tea, black and green, is: 0.05, 0.8, 1.3, 1.7 mg/kg. The Meeting agreed to withdraw the previous recommendation for a maximum residue level for tea, green, black (10 mg/kg) and to replace it with a recommendation for a maximum residue level for tea, green, black (5 mg/kg). The Meeting also estimated an STMR of 1.0 mg/kg.

Fate of residues during processing

Processing studies were presented for 13 raw agricultural commodities. All studies were conducted with field-incurred residues of propargite, typically from application rates in excess of the GAP, and the processing studies simulated commercial practices, except where consumer practices are indicated, i.e., tea brewing and avocado peeling. Propargite concentrated in three types of commodities: oils (peanut, orange, mint, maize), surface residues (sorghum bran, orange peel, apple pomace, maize dust, grape pomace, raisin waste, cotton gin byproducts), and dried commodities (plum prune, grape raisin). This confirms that propargite does not translocate and that it is fat/oil soluble.

The STMRs and MRLs determined above are multiplied by the relevant processing factor to obtain the STMR-Ps and MRL-Ps (where appropriate) for the processed commodities of raw agricultural commodities.

Orange

Orange, in a single study, was processed into juice, molasses, oil, and dried peel (pulp). The factors were <0.09, 0.25, 23, and 2.6. Using the maximum residue level estimates and STMR estimates for whole orange, the Meeting calculated maximum residue level estimates and STMR-Ps, as appropriate, for juice and orange pulp dry. The STMR for orange juice is 0.05 mg/kg (0.09 X 0.55) and the maximum residue level is 0.3 mg/kg (0.09 X 3).

The Meeting agreed to withdraw the previous recommendation for a maximum residue level for citrus pulp, dry (40 mg/kg) and recommended a new maximum residue level for citrus pulp, dry (10 mg/kg), based on the 2.6 factor and a maximum residue level of 3 mg/kg. The STMR for citrus pulp, dry is 1.4 mg/kg (2.6 X 0.55).

Apple

Two studies were provided for the processing of apple to apple juice and wet pomace, and one study, with two variants, was presented for the processing of apple to apple pomace (sauce). The factors for apple to juice were <0.07 and <0.03, average 0.05. Applying this factor to the recommendations for apple maximum residue level and STMR yields maximum residue level and STMR-P estimates for apple juice of 0.2 (3 X 0.05) and 0.03 mg/kg (0.51 X 0.05), respectively..

Two variations were conducted on the processing of apples to sauce. In one, the apples were peeled before crushing and in the second, the apples were crushed and the peel was strained. The factors were 0.02 and 2.6, respectively. This confirms the presence of the residue on the peel. Using factor 2.6, the STMR-P for apple sauce is estimated as 1.4 mg/kg (2.6 X 0.51).

The processing factors for apple pomace (wet) were 4.2 and 4.1, average 4.2. Applying this factor to the STMR for apple (0.51 mg/kg) yields the STMR-P for apple pomace (wet), 2.2 mg/kg. No information was supplied on water content and/or the study was not extended to a drying process. The Meeting agreed to withdraw the previous recommendation for apple pomace (dry) (80 mg/kg).

Grapes

Two studies were provided on the processing of grapes into raisins, and two studies were provided on the processing into juice. One study was provided for wine. The STMR for grapes is 0.45 mg/kg and the maximum residue level is 7 mg/kg. Based on average processing factors, the STMR-P for grape juice is 0.05 mg/kg (0.10 X 0.45), and the STMR-P for raisins is 0.72 mg/kg (1.6 X 0.45), and the STMR-P for wine is 0.01 mg/kg (0.02 X 0.45).

The Meeting estimated maximum residue levels for dried grapes (12 mg/kg, 1.6 X 7), for grape pomace dry (40 mg/kg, 4.2 X 7), for grape juice (1 mg/kg, 0.10 X 7), and for wine (0.2 mg/kg, 0.02 X 7). The Meeting confirmed the previous recommendation of a maximum residue level for grape pomace dry (40 mg/kg) and agreed to withdraw the previous recommendation for a maximum residue level for dried grapes (10 mg/kg)

Tomato

Two studies were provided for the processing of tomatoes to canned tomatoes (skinless) and tomato puree, with average factors of 0.05 and 1.2, respectively. Applying these factors to the

STMR for tomatoes (0.17 mg/kg), the Meeting estimated STMR-Ps of 0.01 mg/kg for canned tomatoes and 0.2 mg/kg for tomato puree.

Maize

Maize was subjected to both dry milling and wet milling processes. The processing factors for refined oil from dry and wet milling were 2.9 and 5.2, respectively. Using the higher factor and the STMR and maximum residue level for maize (0.05, 0.1 mg/kg(*)), the Meeting estimated an STMR-P and a maximum residue level for maize oil edible of 0.26 mg/kg and 0.5 mg/kg, respectively. The factors for crude oil from dry and wet milling were 2.9 and 5.6, respectively. Using the higher factor and the maximum residue level for maize (0.1 mg/kg (*)), the Meeting estimated a maximum residue level for maize oil crude of 0.7 mg/kg.

The processing factors for aspirated grain fractions (dust), flour, grits, and meal were 31, 1.6, 0.9, and 1.1. The Meeting estimated STMR-Ps for aspirated grain fractions, flour, grits, and meal of 1.6, 0.08, 0.05, 0.06 mg/kg, respectively. The Meeting recommended maximum residue levels of 0.2 mg/kg for maize flour.

Cotton seed

A processing study for cottonseed gave processing factors from delinted cottonseed of 3.1 for hulls, <0.07 for meal, and 1.2 for refined oil. Using these factors and the STMR and maximum residue level for cotton seed, 0.02 and 0.1 mg/kg, respectively, the Meeting estimated STMR-Ps for hulls (0.06 mg/kg), meal (0.002 mg/kg), and refined oil (0.02 mg/kg), and the meeting recommended a maximum residue level processed for cotton seed oil, edible, 0.2 mg/kg.

Peanut

A processing study for peanuts gave processing factors of 3.0 for crude oil, 2.5 for refined oil, and 0.56 for meal. Using the STMR and maximum residue level for peanut kernels, 0.05 and 0.1 (*) mg/kg, respectively, the Meeting estimated STMR-Ps for refined oil (0.12 mg/kg), and meal (0.03 mg/kg) and recommended maximum residue levels processed for peanut oil crude (0.3 mg/kg) and peanut oil edible (0.3 mg/kg).

Hops

A study was provided on the use of hops (dry cones) to brew beer. The overall factor was <0.043 at both the wort and beer stages. However, this factor exceeds the maximum theoretical factor of 0.001. This discrepancy arises from the lack of a quantifiable residue in the beer from the processing study, i.e., less than the limit of quantitation. Using the STMR for dried hops, 18 mg/kg, the Meeting estimated an STMR-P for propargite in beer (0.02 mg/kg).

Residues in animal commodities

Dietary burden in animals

The plateau concentration of propargite in cow milk and in eggs was attained slowly (> 2 weeks). Therefore, the STMR and STMR-P values for commodities were used in calculating the dietary burden of dairy and beef cattle and chickens. This burden was then compared with the results of the feeding studies at various exposure levels (ppm) to estimate the maximum residue levels and STMRs in animal commodities (meat, milk, poultry, eggs, etc).

Commodity	Group	STMR or STMR- P (mg/kg)	Dry matter (%)	Residue, dry weight (mg/kg)	Diet Selection (%) Maximum/Selected			Residue concentration (mg/kg)		
					Beef cattle	Dairy cattle	Poult ry	Beef Cattle	Dairy Cattle	Poultry
Almond hulls	AM	15	90	20	10/10	10/10		1.7	1.7	
Citrus pulp, dry	AB	1.4	91	1.5	20/20	20/20		0.30	0.30	
Cotton seed	SO	0.10	88	0.11	25/25	25/25		0.03	0.03	
Cotton seed hulls	AM	0.06								
Cotton gin byproducts	AM	8.4	90	9.3	20/20	20/20		1.9	1.9	
Cotton seed meal	-	0.002	89	0.002	15/0	15/0	20			
Maize	GC	0.05	88	0.06	80/5	40/5	80/80	0.00 3	0.00 3	0.048
Maize grain dust	CF	1.6	85	1.9	20/20	20/20		0.38	0.38	
Peanut meal	-	0.03	85	0.04	15/0	51/0	25/20			0.008
TOTAL					/100	/100	/100	4.3	4.3	0.06

Feeding studies were provided for both chickens and cows. Dairy cattle received daily oral doses of propargite equivalent to feed levels of 0, 50, 150, and 500 ppm for 28 consecutive days. The residue range in milk at the 50 ppm level was <0.01 - 0.01 mg/kg. At the 500 ppm feeding rate, the residues in milk had not attained a plateau by day 28, with a maximum value of 2.7 mg/kg. At the 500 ppm feeding rate, the residue in kidney ranged from <0.01 to 0.01 mg/kg. At the 150 mg/kg feeding rate, the residue in liver ranged from 0.02 - 0.04 mg/kg. At the 50 ppm feeding rate, the residues in tissues were: muscle, <0.01 - 0.02; liver, 0.02 - 0.04 mg/kg; kidney, <0.01 mg/kg; fat, 0.09 - 0.20 mg/kg. Extrapolating from the maximum values at the 50 ppm feeding level to the exposure level of 4.3 ppm, yields the following residue levels: milk, 0.001 mg/kg; muscle, 0.002 mg/kg; liver, 0.004 mg/kg; kidney, <0.001 mg/kg; fat, 0.02 mg/kg

As the current enforcement methods for animal commodities typically rely upon GC/FPD with established limits of quantification of 0.1 mg/kg, except milk at 0.08 mg/kg, the Meeting agreed to recommend maximum residue levels for milks at 0.1 mg/kg (*) (F) and for meat (from mammals other than marine animals) at 0.1 mg/kg (*) (fat). This confirms the previous recommendations for maximum residue levels. The Meeting also estimated a maximum residue level for offal of mammals at 0.1 (*) mg/kg.

The Meeting estimated STMRs as the residues levels from extrapolation, using the fat value (0.02 mg/kg) for meat. Because the extrapolation was over an order of magnitude, it seemed prudent to use the more conservative maximum values rather than median values for estimating STMRs for mammalian commodities. The estimated STMRs are: meat (fat), 0.02 mg/kg; milk, 0.001 mg/kg; offal, 0.004 mg/kg. The calculations are summarized in the following table:

Dietary burden (mg/kg) Feeding level [ppm]	Propargite total residue, mg/kg				
	Milk Mean	Muscle Highest	Liver Highest	Kidney Highest	Fat Highest
MRL/STMR beef cattle (4.3) [50]		0.0017 0.02	0.0034 0.04	<0.0009 ¹ <0.01	0.017 0.20
MRL/STMR dairy cattle (4.3) [50]	0.0009 0.01	0.0017 0.02	0.0034 0.04	<0.0009 ¹ <0.01	0.017 0.20

¹ Effectively 0.000 mg/kg. Note results at 500 ppm feeding level.

Laying hens received daily oral doses of propargite equivalent to feed levels of 0, 5, 15, and 50 ppm for 28 consecutive days. After 28 days, the propargite concentration in eggs at all feeding levels was <0.01 mg/kg. The propargite concentration in fat from the 5 ppm feeding level was <0.01 mg/kg. Liver and muscle were not analyzed for propargite, as the metabolism studies indicated that propargite would not be found. The poultry dietary burden is estimated as 0.06 mg/kg. The Meeting confirmed the existing maximum residue levels for poultry meat (0.1 mg/kg *(fat)) and eggs (0.1 mg/kg *), and estimated a maximum residue level of 0.1 mg/kg * for poultry offal. The Meeting estimated the STMRs for poultry meat, offal, and eggs as 0.000 mg/kg each, based on extrapolation from the 5 ppm feed level to the estimated exposure at 0.06 ppm.

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The calculations are summarized in the following table:

Dietary burden (mg/kg) Feeding level (ppm) MRL/STMR	Propargite total residue, mg/kg			
	Eggs Highest	Muscle Highest	Liver Highest	Fat Highest
MRL/STMR (0.06) [5]	<0.00012 ¹ <0.01	ND ²	ND ²	<0.00012 ¹ <0.01

¹ Effectively 0.000

² Not determined. No expectation of residue (see metabolism).

DIETARY RISK ASSESSMENT

Long-term intake

The International Estimated Daily Intakes of propargite, based on the STMRs estimated for 19 commodities, for the five GEMS/Food regional diets were in the range of 2% to 10% of the ADI (Annex 3). The Meeting concluded that the long-term intake of residues of propargite resulting from its uses that have been considered by JMPR is unlikely to present a public health concern.

Short-term intake

The 1999 JMPR decided that an acute RfD is unnecessary. The Meeting therefore concluded that the short-term intake of propargite residues is unlikely to present a public health concern.

4.25 TOLYLFLUANID (162)

TOXICOLOGY

The fungicide tolyfluanid (*N*-dichlorofluoromethylthio-*N,N'*-dimethyl-*N-p*-tolylsulfamide) was last reviewed toxicologically by the Joint Meeting in 1988, which established an ADI of 0–0.1 mg/kg bw. It was considered by the present Meeting within the periodic review programme of the Codex Committee on Pesticide Residues.

[¹⁴C]Tolyfluanid was rapidly and extensively absorbed after oral administration to rats, with peak plasma concentrations of radiolabel 1 h after dosing, followed by rapid metabolism and almost complete excretion, mainly in the urine and to a lesser extent in the bile, within 48 h. High tissue concentrations were seen soon after dosing in the kidney and liver, with lower concentrations in perirenal fat, brain, gonads and thyroid. By 48 h, all tissue concentrations were low.

Metabolism involves cleavage of the fluorodichloromethylthio group from tolyfluanid to form *N,N*-dimethyl-*N-p*-tolylsulfamide (dimethylaminosulfotoluidine, DMST). The fluorodichloromethylsulfenyl side-chain undergoes further metabolism to form thiazolidine-2-thioxo-4-carboxylic acid, which is the main metabolite in the urine of rats and is of toxicological significance because of its potential anti-thyroid effects. Dimethyltolylsulfamide is also further metabolized, producing a range of metabolites that are not of toxicological significance. The release of the fluoride ion and its distribution in the body have not been clearly characterized.

Tolyfluanid is of low toxicity in mice (LD₅₀, > 1000 mg/kg bw) and rats (LD₅₀, > 5000 mg/kg bw) after oral administration and is of low toxicity in rats (LD₅₀, > 5000 mg/kg bw) after dermal application. It was highly toxic after inhalation for 4 h through the nose only (LC₅₀, 0.16 to > 1 mg/l, depending on particle size and micronization). Common signs observed after single doses were sedation, decreased motility, disturbed behaviour and dyspnoea. After intraperitoneal injection, signs consistent with local irritation were seen. After exposure by inhalation, the signs included extreme difficulties in breathing, sneezing, serous nasal discharge and cyanosis, with histopathological findings consistent with severe respiratory irritation. Tolyfluanid was a severe skin irritant and moderately to severely irritating to the eye. It was a skin sensitizer in a Magnusson and Kligman maximization test, in an open epicutaneous test and in a local lymph node assay in mice, but was not a skin sensitizer in a Buehler test. Overall, tolyfluanid is considered to be a skin sensitizer. WHO has concluded that tolyfluanid is 'unlikely to present an acute hazard in normal use'.

Decreased body-weight gain was seen in mice and rats given tolyfluanid in the diet at concentrations of 1500 ppm and above in long-term studies, with variable effects on food consumption. Water intake was increased in mice and rats at 7500 ppm. Liver toxicity was seen in mice, rats and dogs at dietary concentrations of 1500 ppm and above, the signs including altered liver enzyme activity, increased liver weights and histopathological changes. Signs of renal toxicity were seen in mice, rats and dogs at 1500 ppm and above, which included decreased urine osmolality and increased urine volume at 7500 ppm, increased kidney weight at 1500 ppm and above and histopathological changes at 7500 ppm.

In all species tested, the concentrations of fluoride in the bone and teeth were increased in a dose-related manner. At high doses, this increase was associated with discolouration, particularly of the skull cap and incisors, in both sexes but starting at lower doses in male rats. In long-term studies, rats at 7500 ppm, equal to 500 mg/kg bw per day, required treatment for overgrown

incisors more frequently than controls, presumably because fluoride deposition in the incisors had increased their strength and thus decreased the wear on these teeth. Hyperostosis of the skull and sternum was seen at high doses in mice and rats of either sex, and histopathological changes were seen in the bones of female mice at 300 ppm (equal to 120 mg/kg bw per day) and female rats at 1500 ppm (equal to 100 mg/kg bw per day). In both sexes, increased fluoride deposition was seen at 300 ppm, equal to 76 mg/kg bw per day, in mice and 18 mg/kg bw per day in rats. The NOAEL for fluoride deposition was 60 ppm, equal to 15 mg/kg bw per day, in mice, and 60 ppm, equal to 3.6 mg/kg bw per day, in rats. In dogs, the fluoride concentration in bone was increased in males at doses of 80 mg/kg bw per day and in females at 20 mg/kg bw per day and above, while the fluoride concentration in teeth was increased in males at 80 mg/kg bw per day and in females at all doses including the lowest one tested, 5 mg/kg bw per day, although not in a dose-related manner. The increase in fluoride deposition raises concern because mottling of dental enamel (or dental fluorosis) occurs in humans after exposure to high concentrations of fluoride, particularly where water has a high concentration of fluoride or has been inappropriately supplemented. While this is mainly a cosmetic defect, it is generally recognized as adverse.

Alterations in thyroid hormone levels were observed in a number of studies in rats. These included decreased concentrations of triiodothyronine and thyroxine at 1650 and 9000 ppm in the diet (equal to 110 and 640 mg/kg bw per day, respectively) and increased concentrations of thyroid-stimulating hormone at 9000 ppm in a 13-week study. In a 2-year study, increased incidences of thyroid follicular-cell hyperplasia and adenomas were seen at 7500 ppm in the diet (equal to 500 mg/kg bw per day). As rats do not have thyroid-binding globulin in their serum, they are more sensitive to certain types of thyroid toxicants than are humans. The half-life of thyroxine is about 12 h in rats and 5–9 days in humans. In rats, chemicals that induce hepatic microsomal enzymes increase the hepatic clearance of thyroid hormones, resulting in a compensatory increase in thyroid hormone secretion. This effect is not seen in humans treated with the same substances. It was not clear if this mechanism was involved in the effects on the thyroid seen after dosing with tolylfluanid. One of the metabolites of tolylfluanid, thiazolidine-2-thione-4-carboxylic acid, reversibly inhibits thyroid peroxidase and might have contributed to the effects on the rat thyroid.

No treatment-related tumours were seen in long-term studies in mice, rats or dogs, other than a slight increase in the incidence of thyroid follicular-cell adenomas in rats. This finding was considered unlikely to be of concern at doses that do not perturb thyroid homeostasis in humans.

Tests for genotoxicity *in vitro* gave negative results in the absence of cytotoxicity. The results of all tests *in vivo* were negative. The results of tests for the genotoxicity on the metabolites of tolylfluanid were also negative. The Meeting concluded that tolylfluanid is unlikely to be genotoxic.

On the basis of the results of the tests for genotoxicity and carcinogenicity in animals, the Meeting concluded that tolylfluanid is unlikely to pose a carcinogenic risk to humans.

Studies of reproductive toxicity in rats showed effects on reproductive performance, pup survival and pup weight only at doses that were maternally toxic, including 7500 ppm in the diet in a two-generation study in which decreased body-weight gain was seen in females at 7500 ppm and in males at 1500 ppm. In a second two-generation study, decreased pup birth weight and weight gain to weaning and a decreased lactation index were seen at 4800 ppm in the diet, while decreased body-weight gains were seen in the parental animals at 1200 and 4800 ppm. Adverse clinical signs (bloody snouts) and decreased pup viability were seen at 700 ppm (equal to 58 mg/kg bw per day) in a third two-generation study of reproductive toxicity. The contribution of fluoride in milk to

these effects was not clearly established, as the concentration was not measured. The NOAEL in this study was 100 ppm, equal to 7.9 mg/kg bw per day.

In a study of developmental toxicity in rats, decreased body-weight gain was observed in dams at 300 and 1000 mg/kg bw per day. Reduced fetal body weight was also seen at these doses, and an increased resorption rate was seen at 1000 mg/kg bw per day. The NOAEL was 100 mg/kg bw per day. In a second study in rats, decreased body-weight gain was seen among dams in all groups (100, 300 and 1000 mg/kg bw per day), but there were no effects on fetuses at any dose. In a study of developmental toxicity in rabbits, decreased maternal body-weight gain and late resorptions were seen at 70 mg/kg bw per day. There were no treatment-related abnormalities, and the Meeting concluded that tolylfluanid is not teratogenic.

In studies of neurotoxicity in rats given single or repeated doses, there was no evidence of neurotoxic effects at any dose. In females, slight decreases in reactivity and motor activity were attributed to the general toxic effects of tolylfluanid, with a NOAEL after acute administration of 50 mg/kg bw.

The Meeting concluded that the existing database on tolylfluanid was adequate to characterize the potential hazards of tolylfluanid to fetuses, infants and children.

Routine medical surveillance of individuals working in tolylfluanid manufacture and formulation plants and of workers using tolylfluanid revealed a low incidence of skin sensitization, but no other adverse effects attributable to tolylfluanid.

The Meeting established an ADI of 0–0.08 mg/kg bw on the basis of the NOAEL of 60 ppm, equal to 3.6 mg/kg bw per day, in the 2-year study in rats, in which increased fluoride deposition was seen at higher doses, and a safety factor of 50. This safety factor was used because of the limited differences noted between species in the deposition of fluoride in bones and teeth after administration of tolylfluanid. The NOAEL in the 2-year study in rats treated in the diet was used in preference to the LOAEL of 5 mg/kg bw per day in the 1-year study in dogs given tolylfluanid by capsule, as increased fluoride concentrations were seen only in the teeth and only in females at the low dose in the study in dogs, without a clear dose–response relationship.

The Meeting established an acute RfD of 0.5 mg/kg bw on the basis of the NOAEL of 50 mg/kg bw in the study of acute neurotoxicity in rats and a safety factor of 100.

A toxicological monograph was prepared, summarizing data received since the previous evaluation and including relevant data from the previous monograph.

TOXICOLOGICAL EVALUATION

Levels relevant to risk assessment

Species	Study	Effect	NOAEL	LOAEL
Mouse	2-year study of toxicity and carcinogenicity ^a	Toxicity	60 ppm, equal to 5.3 mg/kg bw per day	300 ppm, equal to 86 mg/kg bw per day
		Carcinogenicity	7500 ppm, equal to 2300 mg/kg bw per day ^b	–
Rat	2-year study of toxicity and carcinogenicity ^a	Toxicity	60 ppm, equal to 3.6 mg/kg bw per day	300 ppm, equal to 18 mg/kg bw per day
		Carcinogenicity	1500 ppm, equal to 90 mg/kg bw per day	7500 ppm, equal to 500 mg/kg bw per day
	Multigeneration study of reproductive toxicity ^a	Maternal and pup toxicity	100 ppm, equal to 7.9 mg/kg bw per day	700 ppm, equal to 70 mg/kg bw per day
	Study of developmental toxicity ^d	Maternal toxicity	–	100 mg/kg bw per day ^c
		Embryo- and fetotoxicity	100 mg/kg bw per day	300 mg/kg bw per day
Study of acute neurotoxicity ^d	Decreased motor activity in females	50 mg/kg bw per day	150 mg/kg bw per day	
Rabbit	Study of developmental toxicity ^d	Maternal, embryo- and fetotoxicity	25 mg/kg bw per day	70 mg/kg bw per day
Dog	1-year study of toxicity ^e	Toxicity	–	5 mg/kg bw per day ^c

^a Dietary administration^b Highest dose tested^c Lowest dose tested^d Gavage^e Capsule*Estimate of acceptable daily intake for humans*

0–0.08 mg/kg bw

Estimate of acute reference dose

0.5 mg/kg bw

Studies that would provide information useful for continued evaluation of the compound

- Further characterization of the distribution and excretion of fluoride and thiazolidine-2-thione-4-carboxylic acid, particularly in milk
- Investigation of the cause of decreased pup survival during lactation
- Further observations in humans

*List of end-points relevant for setting guidance values for dietary and non-dietary exposure**Absorption, distribution, excretion and metabolism in mammals*

Rate and extent of oral absorption	Rapid and extensive
Distribution	Extensive, highest concentrations in liver and kidney
Potential for accumulation	Fluoride accumulation in teeth and bones
Rate and extent of excretion	Complete
Metabolism in animals	Extensive, with no parent compound in urine or faeces
Toxicologically significant compounds	Tolyfluanid, thiazolidine-2-thion-4-carbonic acid, dimethylaminosulfoluidine, fluoride

Acute toxicity

Rat, LD ₅₀ , oral	> 5000 mg/kg bw
Rat, LD ₅₀ , dermal	> 5000 mg/kg bw
Rat, LC ₅₀ , inhalation	0.16 mg/l (4-h nose-only)
Irritation	Severe skin irritant and moderate-to-severe eye irritant
Skin sensitization	Sensitizer (Magnusson & Kligman, Klecak open epicutaneous test, local lymph node assay in mice)

Short-term toxicity

Target/critical effect	Liver, kidney, thyroid
Lowest relevant oral NOAEL	300 ppm, equal to 20 mg/kg bw per day (13-week, rats)
Lowest relevant dermal NOAEL	LOAEL, 1 mg/kg bw per day in rabbits, local skin effects; NOAEL, 300 mg/kg bw per day, systemic effects
Lowest relevant inhalation LOAEC	0.0012 mg/l (4-week, nose-only, rats)

Genotoxicity

Unlikely to be genotoxic

Long-term toxicity and carcinogenicity

Target/critical effect	Fluoride accumulation in bones and teeth, bone changes
Lowest relevant NOAEL	60 ppm, equal to 3.6 mg/kg bw per day (2-year, rats, diet)
Carcinogenicity	Unlikely to pose a carcinogenic risk to humans.

Reproductive toxicity

Target/critical effect for reproductive toxicity	Decreased pup viability at maternally toxic doses
Lowest relevant NOAEL for reproductive toxicity	100 ppm, equal to 7.9 mg/kg bw per day (2-generation study, diet, rats)
Target/critical effect for developmental toxicity	Not teratogenic; embryo- and fetotoxic at maternally toxic doses
Lowest relevant NOAEL for developmental toxicity	25 mg/kg bw per day (rabbits)

Neurotoxicity

Acute neurotoxicity	No specific neurotoxicity seen, general toxicity seen at 150 mg/kg bw; NOAEL, 50 mg/kg bw
Short-term neurotoxicity	No neurotoxic signs seen

Medical data

Low incidence of skin sensitization in production workers.

Summary

	Value	Study	Safety factor
ADI	0–0.08	Rat, 2-year, diet	50
Acute RfD	0.5	Rat, acute neurotoxicity	100

RESIDUE AND ANALYTICAL ASPECTS

Tolyfluanid, fungicide closely related to dichlofluanid, was first evaluated for toxicology and residues by the Meeting in 1988, with subsequent residue evaluation in 1990. The Meeting in 1988 recommended the residue definition of tolyfluanid. Currently there are Codex MRLs for currants, black, red, white; gherkin; lettuce, head; pome fruits; strawberry; and tomato. The compound was included in the Codex priority list for periodic review included in the Codex priority list at the 30th Session of the CCPR (1998; ALINORM 99/24, Appendix VII).

The Meeting received extensive information on the metabolism and environmental fate of tolyfluanid, methods of analysis for residues, stability in freezer storage, national registered use patterns, the results of supervised trials in support of the existing CXLs for pome fruits, strawberry, black currant, tomato and head lettuce and new maximum residue levels for blackberry, raspberry, grapes, cucumber, melons, sweet pepper, leek and hop, the fate of residues in processing and national MRLs. Poland provided the GAP information and summary trial data on apple and strawberry. Germany and the Netherlands provided the GAP information.

Animal metabolism

The metabolism of tolyfluanid was studied in rats, a lactating goat and laying hens using [phenyl-¹⁴C]tolylfluanid and [dichlorofluoromethyl-¹⁴C]tolylfluanid.

When rats were dosed orally with [phenyl-¹⁴C]tolylfluanid or [dichlorofluoromethyl-¹⁴C]tolylfluanid at up to 100 mg/kg bw, radioactivity was rapidly absorbed; higher than 95% of the administered [phenyl-¹⁴C]tolylfluanid was absorbed and about 70 to 80% of the administered [dichlorofluoromethyl-¹⁴C]tolylfluanid was absorbed. The absorbed radioactivity, whether [phenyl-¹⁴C]tolylfluanid or [dichlorofluoromethyl-¹⁴C]tolylfluanid was used, was eliminated almost completely at a fast rate, mainly via urine and to much lesser extent via feces. Two days after oral administration, only a small portion (less than 0.5% in the case of [phenyl-¹⁴C]tolylfluanid and less than 1.8% in the case of [dichlorofluoromethyl-¹⁴C]tolylfluanid) of the administered radioactivity was retained in body excluding gastrointestinal tract. This implies that no accumulation of tolyfluanid was expected. The main radioactive metabolites in urine, when phenyl-labelled tolyfluanid was used, were identified as 4-(dimethylaminosulfonylamino)benzoic acid (mean, 68% of the recovered radioactivity), and 4-(methylaminosulfonylamino)benzoic acid (mean, 5%). The parent compound, tolyfluanid, and *N,N*-dimethyl-*N'*-*p*-tolylsulfamide.

(dimethylaminosulfonotoluidine DMST) were found only in faeces (8% and 7% respectively). When dichlorofluoromethyl-labelled tolylfluanid was used, the main metabolite in urine was thiazolidine-2-thioxo-4-carboxylic acid (TTCA)(73-74% of the recovered radioactivity).

[Phenyl-U-¹⁴C]tolylfluanid administered by gavage to a lactating goat at a rate equivalent to 250 ppm in diet was also rapidly absorbed and then eliminated in urine (49% of the administered radioactivity 2 hours after the last dose) and feces (10% of the administered radioactivity). At the time of slaughter, only 2.8% of the administered dose remained in edible tissues and organs: mostly in kidney and liver with only a small portion (0.24%) in milk. The main metabolites in organs and milk were 4-(dimethylaminosulfonylamino)hippuric acid and 4-(dimethylaminosulfonylamino)-benzoic acid. Smaller amounts of 4-(methylaminosulfonylamino)benzoic acid and 4-(methylaminosulfonylamino)hippuric acid were also found. The parent compound was not detected in any of edible tissues/organs or milk while DMST was present at a significant amount in muscle, liver and fat.

[Phenyl-U-¹⁴C]tolylfluanid administered orally to laying hens at a rate equivalent to 83 ppm in diet was readily absorbed and eliminated (84% of the administered radioactivity 8 hours after the last dose). On average less than 0.01% of the administered radioactivity was found in eggs. At sacrifice the total radioactive residues in the tissues and organs were about 0.18% of the administered radioactivity, highest levels being found in kidney and liver. The main metabolite in tissues/organs was 4-(dimethylaminosulfonylamino)benzoic acid. The parent compound was not detected in muscle, fat, liver or eggs. DMST was the major metabolite in fat.

Plant metabolism

The Meeting received information on the fate of tolylfluanid after application to apples, grapes, strawberries and lettuce.

Individual apples were sprayed with radio-labelled tolylfluanid. A majority of the total radioactive residues (TRR) was located on the surface of apples collected (92% of TRR on day 7 and 88% on day 14 in a study using [phenyl-U-¹⁴C]tolylfluanid and 71% on day 28 in a study using [dichlorofluoromethyl-¹⁴C]tolylfluanid). These residues on the surface were removed by surface washing. The predominant radioactive component on apples was identified as the parent compound (88% of TRR on day 7 and 82% on day 14 in a study using [phenyl-U-¹⁴C]tolylfluanid and 72% on day 28 in a study using [dichlorofluoromethyl-¹⁴C]tolylfluanid). A small amount of DMST was formed on the surface and in the peel plus pulp after the application of tolylfluanid.

Grape bunches were sprayed twice with [phenyl-U-¹⁴C]tolylfluanid at a total rate of approximately 1.3 mg a.i./bunch. Thirty-five days after the last application, the TRR in the bunch of grapes (excluding stems and stalks) declined to about 50% of the applied dose, in which unchanged tolylfluanid and DMST accounted only for 13% and 1.9% of the TRR. The major metabolites on/in grapes were identified as 4-hydroxymethyl-DMST-glucoside (46% of the TRR), 2-hydroxyphenyl-DMST-glucoside (13%) and 3-hydroxyphenyl-DMST-glucoside (1.8%). Eight minor metabolites were identified which were derived through further conjugation of the above-mentioned glucosides.

Fourteen days after the last aerial application of [phenyl-U-¹⁴C]tolylfluanid to strawberries, a total of 72.5% of the TRR was located on the surface of berries, of which 63% was attributed to unchanged tolylfluanid. The washed fruit contained 27.5% of the TRR. The major metabolites were identified as DMST (6.2% of the TRR in surface rinse and 8.7% in fruit), 4-hydroxymethyl-DMST-glucoside (1.0% in surface rinse and 5.6% in fruit), 4-hydroxymethyl-DMST (0.8% in

surface rinse and 2.1% in fruit), and hydroxyphenyl-DMST-glucoside (0.3% in surface rinse and 1.5% in fruit; the position of hydroxyl group not determined). When strawberry plants were sprayed with [dichlorofluoromethyl-¹⁴C]tolylfluanid in a form of spray in a closed air-flow controlled system, ¹⁴CO₂ was released (4.3-12% of the applied radioactivity). The analysis of radioactive compounds in fruits showed that the parent compound accounted for 1.3% of the TRR and TTCA 50% of the TRR. However, the presence of TTCA was detected only in one study employing artificial conditions of closed chamber. TTCA was not detected in studies more reflective of agricultural practices.

Lettuce plants at three different growth stages were sprayed with [phenyl-U-¹⁴C]tolylfluanid. The TRR in lettuce declined sharply with longer period after the last application. The predominant residue component in lettuce leaves was unchanged tolylfluanid accounting for more than 90% of the TRR on 7, 14 and 21 days after the last application. DMST, 4-hydroxymethyl-DMST-glucoside were identified as minor metabolites.

In plant metabolism, tolylfluanid was the major residue component except in the case of grapes in which the major component was 4-hydroxymethyl-DMST-glucoside followed by tolylfluanid and 2-hydroxyphenyl-DMST-glucoside. Tolylfluanid was found mostly on the surface of crops tested. The metabolic patterns were similar in all plants studied although the metabolic rates differed from species to species with a higher rate seen in grapes.

Environmental fate

Soil

The incubation of [phenyl-U-¹⁴C]tolylfluanid in four different soils in the dark under aerobic conditions at 22°C for 99 days revealed rapid degradation of tolylfluanid mainly to DMST, which was further degraded to 4-(dimethylaminosulfonylamino)benzoic acid, 4-(methylaminosulfonylamino)benzoic acid and methyltolylsulfamide and to CO₂ (25-40% of the applied radioactivity on day 99). The increase of unextractable radioactivity was observed over time after the application (52-72% of the applied radioactivity on day 99). The incubation of [dichlorofluoromethyl-¹⁴C]tolylfluanid in two different soils in the dark under aerobic conditions at 22°C for 65 days showed the degradation of tolylfluanid to CO₂ (65-77% of the applied radioactivity after 65 days) while formation of unextractable residues occurred over time (7-40% of the applied radioactivity). The calculated half life of tolylfluanid at 20 or 22°C was shorter than 3 days in all studies conducted and that of DMST at 20 or 22°C was in a range of 1.3-6.7 days indicating that the degradation of DMST was also fast.

Adsorption/desorption experiments with soil/water systems were not applicable to tolylfluanid due to its rapid hydrolysis. A K_{oc} value of tolylfluanid was estimated using an HPLC method to be 2220 ml/g and logK_{oc} was 3.35. This result indicates that tolylfluanid could be classified as an immobile substance. Adsorption/desorption studies were carried out for DMST, the only major metabolite of tolylfluanid formed in the aerobic soil degradation studies (see above). DMST was classified as a substance with low to intermediate mobility.

In leaching studies in which soil samples were aged with [phenyl-U-¹⁴C]tolylfluanid and then placed on top of a saturated column, tolylfluanid was demonstrated to be immobile in soil while DMST slightly mobile. These results indicate that the leachate of either tolylfluanid or DMST was not likely to contaminate groundwater. This was confirmed by a computer simulation of environmental concentrations of tolylfluanid and DMST in groundwater recharge.

Due to the very short half-life of tolylfluanid, no studies could be conducted on photolysis in the field conditions.

Water-sediment systems

In a study of hydrolysis, tolylfluanid was readily hydrolyzed into DMST under all conditions used (pH 4, 7 and 9; 20, 30 and 40°C). The half life of tolylfluanid was calculated to be 11.7 days at pH 4 and 29.1 hours at pH 7 at 22°C in respective sterile buffer solutions. Tolyfluanid was so unstable at pH 9 that no parent compound was left to be detected even in immediate analysis of the sample making the estimation of half life impossible. Another hydrolysis study demonstrated that tolylfluanid was hydrolyzed into DMST, fluoride ion, chloride ion, sulfur and carbon dioxide. DMST, on the other hand, was stable at pH 4, 7 and 9 up to 55°C in respective sterile buffer solutions. The half life of DMST was calculated to be > 1 year at 22°C at pH 4, 7 and 9.

The major degradation product in aqueous hydrolysis, DMST, showed resistance against direct photodegradation in aqueous solution without yielding major degradation products. The half life of environmental direct photolysis of DMST was estimated using one modeling to be a minimum of approximately 2 months (at 30° N) or 3 months (at 50° N) for the period of main use (July-August) and using another to be longer than 1 year. These results indicate that direct photodegradation in aqueous solution was expected to contribute little to the elimination of DMST in the environment.

The biological degradation of tolylfluanid and DMST was examined in three aqueous sediment systems. Tolyfluanid was degraded so rapidly in the three systems tested that it was not detected in the sample taken on day 14 and therefore its half life could not be estimated. The radioactivity in the water decreased and the unextractable radioactivity increased continuously. DMST, the predominant degradation product in water and sediment, was further degraded to demethylated compound, methyltolylsulfamide, and finally mineralized to CO₂. The half life of DMST in the supernatant water was calculated to be 42 – 76 days. In another aerobic aquatic degradation study using aquatic model water/sediment systems, the half life of tolylfluanid was calculated to be 1.4-5 hours.

Methods of analysis

For the determination of residues of tolylfluanid and DMST, gas chromatographic methods with various detectors and HPLC/MS/MS methods were reported for various matrices.

The gas chromatographic methods generally employ extraction, partition, clean-up and determination using electron capture detector, flame photometric detector, nitrogen-phosphorus detector, or mass spectrometry. Most methods are capable of determining both tolylfluanid and DMST residues in supervised trials. Some methods were developed to determine residues arising from the use of not only tolylfluanid but also organohalogen, organophosphorus, triazine, etc.. The limit of quantification for tolylfluanid or DMST was in most cases, either 0.02 mg/kg or 0.05 mg/kg. For enforcement purposes, gas chromatographic methods were validated for apple, grapes, strawberry, canola seed/rapeseed, hops, water-containing matrices and commodities of animal origin. Confirmatory methods are available for all of these matrices. Gas chromatographic methods have also been validated for enforcement and confirmatory purposes for soil, water and air.

HPLC/MS/MS methods generally employ extraction, evaporation, partition/clean-up and determination using liquid chromatography with a triple-stage quadrupole mass spectrometer with an electrospray interface in the multiple-reaction monitoring mode. The limit of quantification is 0.02 mg/kg for tolyfluanid and DMST in black currant, strawberry, tomato and tomato products, lettuce, peppers and leek.

Stability of residues in stored analytical samples

Stability of tolyfluanid and metabolites in freezer storage was tested for a range of plant commodities under conditions representative of intended uses of tolyfluanid. Studies were conducted on apples (fruit), grapes (fruit, juice and wine), tomatoes (fruit, puree and juice), and hops (green and dry hop cones). In all studies, tolyfluanid and DMST were determined. In studies on grapes 4-hydroxymethyl-DMST-glucoside and 2-hydroxyphenyl-DMST-glucoside were determined as well as tolyfluanid and DMST because these two glucosides were also major residue components found in bunches of grapes treated with tolyfluanid. Tolyfluanid and DMST were generally stable in samples for the intervals tested:

- ✓ 2.2 years: grapes and grape juice
- ✓ 1.5 years: apples and tomatoes
- ✓ 1 year: green hop cones and dry hop cones
- ✓ 4 months: tomato juice and tomato puree

In grape wine, the degradation of tolyfluanid into DMST was observed. The sum of tolyfluanid and DMST remained relatively constant over 2.2 years. However, the concentration of tolyfluanid showed some decrease already on day 29 of storage. 4-Hydroxymethyl-DMST-glucoside and 2-hydroxyphenyl-DMST-glucoside were stable for up to 2.2 years in grapes, grape juice and grape wine in deep freezer.

Tolyfluanid is very susceptible to hydrolysis. Aqueous extracts of grapes and aqueous samples (grape juice and wine) were fortified with tolyfluanid, DMST, 4-hydroxymethyl-DMST-glucoside or 2-hydroxyphenyl-DMST-glucoside and kept at 4-8°C for 21 to 31 days. In aqueous extracts only DMST was stable and in juice and wine the two glucosides were also stable. The degradation of tolyfluanid into DMST was observed also in this study. This indicates that aqueous extracts and aqueous samples must be analyzed at once for determining tolyfluanid without storing them in refrigerator.

Definition of the residue

When applied to crops, tolyfluanid is metabolized to form DMST. DMST is further metabolized to hydroxylated metabolites and their glucosides. Generally tolyfluanid is the main residue found in plants after application of tolyfluanid except that in grape 4-hydroxymethyl-DMST-glucoside and 2-hydroxymethyl-DMST-glucoside accounted for about 60% of the TRR. Thiazolidine-2-thione-4-carbonic acid (TTCA), a substance of toxicological concern, was identified in one strawberry study under an artificial test condition and is not expected to arise under normal agricultural conditions.

In animals, tolyfluanid is rapidly metabolized and no parent compound was detected in tissues and organs of farm animals. DMST, 4-(dimethylaminosulfonylamino)benzoic acid and 4-(dimethylaminosulfonylamino)hippuric acid are significant metabolites present in tissues and organs.

Products of further metabolism of DMST are not of toxicological significance. Due to the rapid metabolism of tolyfluanid to DMST, it is not possible to distinguish long term effects of DMST from those of tolyfluanid except for fluoride deposition. The acute oral toxicity of DMST is comparable to that of tolyfluanid.

The Meeting recommended that definition of the residue for commodities derived from plants should be as follows:

For compliance with MRLs: tolyfluanid

For the estimation of dietary intake: tolyfluanid and DMST expressed as tolyfluanid.

Results of supervised trials

The results of supervised trials were available for use of tolyfluanid on apples and pears, grapes, black currants, blackberries, raspberries, strawberries, cucumber, melons, tomato, peppers, lettuce, leek and hop. Relevant GAP information is available for all of the above crops.

The sum of tolyfluanid and DMST was calculated and expressed as tolyfluanid on the basis of the molecular weight of tolyfluanid (347.3 g/mol) and DMST (214.3 g/mol). When tolyfluanid or DMST was found to be below the respective limit of quantification or when both were below their respective limits of quantification, the sum of tolyfluanid and DMST was calculated following the examples below and expressed as tolyfluanid:

Tolyfluanid	DMST	Total (expressed as tolyfluanid)
<0.02	<0.02	<0.02
0.10	<0.02	0.10
<0.02	0.10	0.16
0.10	0.10	0.26

Pome fruits. Trials on pome fruits were conducted in France, Germany, Italy, the Netherlands, Poland and Spain.

In Germany, tolyfluanid is registered for use on pome fruits up to a total of 15 applications at 1.1 kg a.i./ha or 0.076 kg a.i./hl with a PHI of 7 days. The concentrations of tolyfluanid residues, in ranked order, in apples from 14 trials in Germany that matched GAP were: 0.18, 0.24, 0.35, 0.46 (2), 0.48, 0.5, 0.55, 0.59, 0.60, 0.92, 1.7, 2.0 and 2.3 mg/kg.

The GAP in the Netherlands allows tolyfluanid application of a maximum of 1.12 kg a.i./ha or 0.075 kg a.i./hl, 7 applications and a PHI of 7 days on apples. The concentrations of tolyfluanid residues in apples from 2 trials in the Netherlands that matched the GAP, in ranked order, were: 0.19 and 0.58 mg/kg.

The residue concentration of tolyfluanid in apples in a trial conducted in Poland in accordance with its GAP (1 kg a.i./ha or 0.20 kg a.i./hl, 2 applications, PHI of 7 days) was 0.44 mg/kg. DMST was not determined in this trial.

The French use pattern on pome fruits allows tolyfluanid to be sprayed at 0.075 kg a.i./hl with a PHI of 7 days. Two apple trials in France, 4 trials in Italy and 1 trial in Spain were

evaluated against the French GAP. The concentrations of tolyfluanid residues, in ranked order, were: 0.14, 0.22, 0.50, 0.51, 0.65, 1.2 and 2.3 mg/kg.

The concentrations of tolyfluanid residues, in ranked order, in pears from 2 trials in Germany that matched GAP were: 1.5 and 3.4 mg/kg.

Two pear trials in Italy and one in Spain were evaluated against the French GAP for pome fruits. The concentrations of tolyfluanid residues, in ranked order, were: 0.26, 0.40 and 0.54 mg/kg.

The Meeting agreed to combine the above results for estimating a maximum residue level for pome fruits. The combined results of 29 trials were, in ranked order: 0.14, 0.18, 0.19, 0.22, 0.24, 0.26, 0.35, 0.40, 0.44, 0.46 (2), 0.48, 0.5, 0.50, 0.51, 0.54, 0.55, 0.58, 0.59, 0.60, 0.65, 0.92, 1.2, 1.5, 1.7, 2.0, 2.3 (2) and 3.4 mg/kg for tolyfluanid; and 0.18, 0.19 (2), 0.26, 0.27, 0.29, 0.41, 0.46 (2), 0.51, 0.56, 0.60, 0.64, 0.66, 0.70, 0.74, 0.76, 0.8, 0.83, 0.87, 1.10, 1.3, 1.86, 2.0, 2.6, 2.7, 3.1 and 4.0 mg/kg for the sum of tolyfluanid and DMST expressed as tolyfluanid.

The Meeting confirmed the previous recommendation for maximum residue level of 5 mg/kg for pome fruits and estimated an STMR (sum of tolyfluanid and DMST expressed as tolyfluanid) of 0.68 mg/kg and an HR (sum of tolyfluanid and DMST expressed as tolyfluanid) of 4.0 mg/kg.

Grapes. Trials on grapes were conducted in Chile, France, Italy and Spain.

In Germany tolyfluanid was registered for use on wine grapes up to a total of 8 applications at a maximum of 1.6 kg a.i./ha with a PHI of 35 days. The concentrations of tolyfluanid in ranked order in grapes in 7 trials in Germany that matched GAP were: 0.06, 0.35, 0.49, 0.63, 0.67, 0.91 and 1.7 mg/kg.

The results of trials in Southern France, Italy and Spain were evaluated against the GAP reported for Spain (0.1 kg a.i./hl, PHI of 15 days for table grape and 21 days for wine grape). The concentrations of tolyfluanid residue in grapes in 2 trials that matched the GAP were, in ranked order: 0.11 and 0.13 mg/kg.

The concentrations of tolyfluanid in 3 trials in Chile that matched the GAP in Chile (1.5 kg a.i./ha or 0.125 kg a.i./hl, PHI of 21 days), in rank order, were: 0.24, 0.98 and 1.8 mg/kg.

The above results were regarded to come from similar populations. The combined concentrations from 12 trials, in ranked order, were: 0.06, 0.11, 0.13, 0.24, 0.35, 0.49, 0.63, 0.67, 0.91, 0.98, 1.7 and 1.8 mg/kg for tolyfluanid; and 0.06, 0.11, 0.13, 0.29, 0.46, 0.67, 0.83, 0.84, 1.04, 1.19, 1.9 and 2.0 mg/kg for the sum of tolyfluanid and DMST expressed as tolyfluanid.

The Meeting estimated a maximum residue level of 3 mg/kg, an STMR (sum of tolyfluanid and DMST expressed as tolyfluanid) of 0.75 mg/kg, and an HR (sum of tolyfluanid and DMST expressed as tolyfluanid) of 2.0 mg/kg.

Black currant. Trials were conducted on black currants in Germany and in the United Kingdom.

The GAP in the Netherlands allows the use of tolyfluanid on currants two applications at 1.50 kg a.i./ha or 0.125 kg a.i./hl with a PHI of 21 days. The results of 4 trials in Germany and 4 trials in the United Kingdom were evaluated against GAP in the Netherlands. The concentrations

of tolyfluanid in black currants in 8 trials in ranked order were: 0.07, 0.10, 0.12, 0.17, 0.21, 0.28 (2) and 0.31 mg/kg; and the sum of tolyfluanid and DMST expressed as tolyfluanid were: 0.18, 0.25, 0.33, 0.34, 0.35, 0.39, 0.57 and 0.68 m/kg.

The Meeting estimated maximum residue level at 0.5 mg/kg for currants, black, red, white to replace the previous recommendation of 5 mg/kg. It also estimated an STMR (sum of tolyfluanid and DMST expressed as tolyfluanid) of 0.345 m/kg and an HR (sum of tolyfluanid and DMST expressed as tolyfluanid) of 0.68 mg/kg.

Blackberry and raspberry. Trials were conducted on black berry and raspberry in Germany and the United Kingdom.

The UK GAP allows the use of tolyfluanid on blackberry and raspberry up to 4 applications at 1.7 kg a.i./ha with a PHI of 14 days. The results of blackberry trials conducted in Germany and the United Kingdom were evaluated against the UK GAP. The concentrations of tolyfluanid in blackberries in 2 trials in Germany and 2 trials in the United Kingdom were, in ranked order: 0.61, 1.6, 1.7 and 2.0 mg/kg; and the sum of tolyfluanid and DMST expressed as tolyfluanid: 0.72, 1.9, 2.1 and 2.2 mg/kg.

The results of raspberry trials in Germany and the United Kingdom were evaluated against the above-mentioned UK GAP. The concentrations of tolyfluanid in raspberries in 2 trials in Germany and 2 trials in the United Kingdom were, in ranked order: 0.42, 1.4, 1.7 and 2.4 mg/kg; and the sum of tolyfluanid and DMST expressed as tolyfluanid: 0.48, 1.5, 2.0 and 2.9 mg/kg.

The results of blackberry trials and those of raspberry trials were mutually supportive. The combined results in ranked order were: 0.42, 0.61, 1.4, 1.6, 1.7 (2), 2.0 and 2.4 mg/kg for tolyfluanid; 0.48, 0.72, 1.5, 1.9, 2.0, 2.1, 2.2 and 2.9 mg/kg for the sum of tolyfluanid and DMST expressed as tolyfluanid.

The Meeting estimated the following values for both blackberry and raspberry: maximum residue level, 5 mg/kg; an STMR (sum of tolyfluanid and DMST expressed as tolyfluanid), 1.95 mg/kg; and an HR (sum of tolyfluanid and DMST expressed as tolyfluanid), 2.9 mg/kg.

Strawberry. Trials were conducted outdoors in France, Germany, Italy, the Netherlands, Poland and Spain.

The concentrations of tolyfluanid in 9 trials in Germany matching the German GAP (0.125 kg a.i./hl, 2.5 kg a.i./ha, 3 applications, PHI of 7 days) were, in ranked order: 0.05, 0.47, 0.75, 0.77(2), 0.90, 1.1, 1.4 and 1.9 mg/kg.

The concentration of tolyfluanid in one trial in the Netherlands matching the GAP in the Netherlands (0.125 kg a.i./hl, 0.75-1.25 kg a.i./ha, 5 applications, PHI of 7 days) was: 0.73 mg/kg.

The concentration of tolyfluanid in one trial in Poland matching the GAP in Poland (0.5 kg a.i./hl, 2.5 kg a.i./ha, 3 applications, PHI of 7 days) was: 2.65 mg/kg (DMST not determined).

The results of trials conducted in Southern France, Italy and Spain were evaluated against the GAP in Slovenia (0.1-0.125 kg a.i./hl, PHI of 7 days). The concentrations of tolyfluanid in 14 trials matching the GAP were, in ranked order: 0.03(2), 0.08, 0.12, 0.14, 0.20, 0.23, 0.32, 0.35, 0.41, 0.43, 0.55, 1.7 and 2.6 mg/kg.

These two sets of results seem to belong to similar populations. The combined concentrations from 25 trials in ranked order were: 0.03(2), 0.05, 0.08, 0.12, 0.14, 0.20, 0.23, 0.32, 0.35, 0.41, 0.43, 0.47, 0.55, 0.73, 0.75, 0.77(2), 0.90, 1.1, 1.4, 1.5, 1.7, 1.9, 2.6 and 2.65 mg/kg for tolylfluanid; and 0.14, 0.26, 0.27 (2), 0.35, 0.36, 0.51, 0.54, 0.59 (2), 0.64, 0.71, 0.95, 0.99, 1.06, 1.12, 1.20, 1.32, 1.41, 1.5, 1.7, 2.0, 2.7 and 3.0 mg/kg for the sum of tolylfluanid and DMST expressed in tolylfluanid. The Meeting estimated a maximum residue level of 5 mg/kg to replace the previous recommendation of 3 mg/kg. It also estimated an STMR (sum of tolylfluanid and DMST expressed in tolylfluanid) of 0.84 mg/kg and HR (sum of tolylfluanid and DMST expressed in tolylfluanid) of 3.0 mg/kg.

Cucumber. Trials were conducted in Germany (outdoor and indoor), Italy (indoor) and Spain (indoor).

The results of trials conducted outdoors in Germany were evaluated against the GAP in Belgium (both indoor and outdoor; 0.075 kg a.i./hl, PHI of 3 days). The concentrations of tolylfluanid residue found in 4 trials that matched the GAP were, in ranked order: <0.02 and 0.02(3) mg/kg. These values were not used for the estimation of maximum residue level as these values and those obtained in indoor trials seem to belong to two different populations.

The results of trials conducted indoors in Germany, Italy and Spain were evaluated against the GAP in Belgium (both indoor and outdoor; 0.075 kg a.i./hl, PHI of 3 days). The concentrations of tolylfluanid residue found in 8 trials that matched the GAP were, in ranked order: 0.05, 0.11, 0.18 (2), 0.30, 0.55, 0.57 and 0.64 mg/kg. The sum of tolylfluanid and DMST expressed as tolylfluanid were, in ranked order: 0.05, 0.16, 0.31, 0.34, 0.40, 0.67, 0.68 and 0.96 mg/kg.

The Meeting estimated a maximum residue level of 1 mg/kg, STMR (sum of tolylfluanid and DMST expressed as tolylfluanid) of 0.37 mg/kg, and HR (sum of tolylfluanid and DMST expressed as tolylfluanid) of 0.96 mg/kg.

The Meeting withdrew the MRL of 2 mg/kg for gherkin as no data were submitted.

Melons except watermelon. Trials were conducted in France and Greece.

The trials were conducted using a spray concentration of 0.45 kg a.i./hl, which is much higher than any of approved use pattern (except those not specified). Only those trials conducted in Northern France could be evaluated against the GAP of Sweden (1.5 kg a.i./ha, 3-4 applications, PHI of 3 days). The concentrations of tolylfluanid in trials that matched the GAP were: 0.03 and 0.08 mg/kg. There is no reported GAP that supports trials conducted in Southern France or Greece.

The Meeting concluded that there is not sufficient data to estimate a maximum residue level, STMR or HR at present.

Tomato. Trials were conducted in Belgium (indoor), France (outdoor, indoor), Germany (outdoor, indoor), Italy (outdoor, indoor), Mexico (outdoor) and Spain (outdoor, indoor).

The results of trials conducted outdoors in Germany were evaluated against the GAP in Germany (1.2 kg a.i./ha, 6 applications, PHI of 3 days). The concentrations of tolylfluanid in 8 trials matching the GAP are, in ranked order: 0.15(2), 0.18, 0.20, 0.27, 0.34, 0.47 and 0.99 mg/kg.

The results of trials conducted outdoors in Southern France, Italy and Spain were evaluated against the GAP in Slovenia (1.25 kg a.i./ha, PHI of 3 days). The concentrations of tolylfluanid in

16 trials matching the GAP are, in ranked order: 0.04, 0.05(2), 0.07, 0.19, 0.21, 0.23, 0.27, 0.31, 0.34, 0.40, 0.42, 0.47, 0.48, 0.49 and 0.50 mg/kg.

The results of trials conducted in greenhouse in Belgium, France, Germany, Italy and Spain were evaluated against the GAP in Belgium (0.075 kg a.i./hl, PHI of 3 days). The concentrations of tolylfluanid in 9 trials matching the GAP are, in ranked order: 0.08, 0.16, 0.24, 0.42, 0.49, 0.59 and 0.72, 1.4 and 2.0 mg/kg.

There is no matching GAP reported for outdoor trials conducted in Mexico.

The Meeting concluded that the results of trials conducted indoors and outdoors were regarded to come from similar populations. The combined results from 33 trials were, in ranked order: 0.04, 0.05 (2), 0.07, 0.08, 0.15 (2), 0.16, 0.18, 0.19, 0.20, 0.21, 0.23, 0.24, 0.27 (2), 0.31, 0.34 (2), 0.40, 0.42 (2), 0.47 (2), 0.48, 0.49 (2), 0.50, 0.59, 0.72, 0.99, 1.4 and 2.0 mg/kg for tolylfluanid; and 0.05 (2), 0.07, 0.10, 0.14, 0.18, 0.22, 0.24, 0.27, 0.29, 0.30, 0.34, 0.35 (2), 0.39, 0.40 (2), 0.42, 0.47 (2), 0.49, 0.50, 0.54, 0.56, 0.58, 0.60 (2), 0.67, 0.70, 0.77, 1.27, 1.5 and 2.2 mg/kg for the sum of tolylfluanid and DMST expressed as tolylfluanid.

The Meeting estimated a maximum residue level of 3 mg/kg to replace the previous recommendation at 2 mg/kg, an STMR (sum of tolylfluanid and DMST expressed in tolylfluanid), 0.39 mg/kg and an HR (sum of tolylfluanid and DMST expressed in tolylfluanid), 2.2 mg/kg.

Peppers. Trials were conducted on sweet peppers indoors in Italy, the Netherlands and Spain.

The results of trials conducted in greenhouse in Italy, the Netherlands and Spain were evaluated against the GAP in the Netherlands for peppers in greenhouse (up to 1.12 kg a.i./ha, 0.075 kg a.i./hl, 3 applications, PHI of 3 days). The concentrations of tolylfluanid residue in 10 trials matching the GAP were, in ranked order: 0.07, 0.20, 0.24, 0.26, 0.28, 0.49, 0.61, 0.66, 0.77 and 1.3 mg/kg for tolylfluanid; and 0.12, 0.34, 0.43, 0.44, 0.62, 0.72, 0.85, 0.95, 1.01 and 1.6 mg/kg for the sum of tolylfluanid and DMST expressed as tolylfluanid.

The Meeting estimated a maximum residue level of 2 mg/kg for peppers, sweet and an STMR (sum of tolylfluanid and DMST expressed in tolylfluanid) of 0.67 mg/kg and an HR (sum of tolylfluanid and DMST expressed in tolylfluanid) of 1.6 mg/kg.

Lettuce, head. Trials were conducted in Belgium, France, Germany, Greece, Italy, Portugal, Spain and the United Kingdom.

The results of trials conducted in Germany were evaluated against the GAP of Germany (0.1 kg a.i./hl, 0.6 kg a.i./ha, 6 applications, PHI of 21 days). The concentrations of tolylfluanid in 8 trials that matched the GAP were, in ranked order: <0.05 (7) and 0.17 mg/kg. The results of trials carried out in Southern France, Italy and Spain could not be evaluated as the closest GAP, which was of Slovenia, requires a PHI of 21 days while the maximum sampling interval of these trials was 10 days. The concentrations of the sum of tolylfluanid and DMST expressed in tolylfluanid were: <0.07 (7) and 0.17 mg/kg.

The Meeting estimated a maximum residue level of 0.2 mg/kg to replace the previous recommendation of 1 mg/kg. It also estimated an STMR of 0.05 mg/kg and an HR of 0.17 mg/kg.

Leek. Trials were conducted in Belgium, Northern France, Germany, the Netherlands and the United Kingdom.

The results of these trials were evaluated against the GAP in the Netherlands (1.25 kg a.i./ha, 4-5 applications, PHI of 21 days). The concentrations of residues in 9 trials were, in ranked order: <0.02, 0.17, 0.34, 0.36, 0.58, 0.84, 0.92, 0.94 and 1.2 mg/kg for tolyfluanid; and <0.02, 0.17, 0.41, 0.45, 0.97, 1.07, 1.16, 1.52 and 1.8 mg/kg for the sum of tolyfluanid and DMST expressed in tolyfluanid.

The Meeting estimated a maximum residue level of 2 mg/kg; an STMR (sum of tolyfluanid and DMST expressed in tolyfluanid) of 0.97 mg/kg; and an HR (sum of tolyfluanid and DMST expressed in tolyfluanid), 1.8 mg/kg.

Hops, dry. Trials were conducted in Germany.

The results of trials in Germany were evaluated against GAP in Poland (0.075 kg a.i./hl, 600-3000 l/hl depending on the growth stage, PHI of 14 days). The concentrations of residues in dry hops in 8 trials were, in ranked order: 2.8, 5.4, 7.8, 8.9, 9.1, 10, 11 and 27 mg/kg for tolyfluanid; and 8.8, 13.5, 18, 19.3, 30.0, 31.8, 32 and 71 mg/kg for the sum of tolyfluanid and DMST expressed in tolyfluanid.

The Meeting estimated a maximum residue level of 50 mg/kg, an STMR (sum of tolyfluanid and DMST expressed in tolyfluanid), 25 mg/kg, and an HR (sum of tolyfluanid and DMST expressed in tolyfluanid), 71 mg/kg.

Fate of residues during processing

According to plant metabolism studies, tolyfluanid residue is mainly located on the surface of apples and strawberries and surface washing significantly removed the residues from these fruits (92% in the case of apples harvested 7 days after spray in experimental application; and 73% in the case of strawberries harvested 14 days after spray.).

Processing studies were conducted using apples, black currants, grapes, hops, lettuce, strawberries and tomatoes.

For those commodities for which MRLs were estimated, STMR-P and HR of processed products are calculated using the mean processing factors as follows, except that for the calculation of STMR-P of beer, a processing factor of 0.001 was used:

	Processing factor	STMR/STMR-P ¹⁾ (mg/kg)	HR/HR-P ¹⁾ (mg/kg)
Pome fruits	-	0.68	4.0
Apple juice	0.09	0.06	
Apple sauce	0.32	0.22	
Canned apple	<0.06	0.04	
Apple pomace, wet	2.7	1.8	
Apple pomace, dry	9.8	6.7	
Pear juice	0.03	0.02	
Canned pear	<0.02	0.01	
Grapes		0.75	2.0
Grape wine	1.0	0.75	

	Processing factor	STMR/STMR-P ¹⁾ (mg/kg)	HR/HR-P ¹⁾ (mg/kg)
Grape juice	<0.53	0.40	
Grape pomace, wet	16	12	
Grape pomace, dry	25	19	
Dried grape	3.2	2.3	
Currants		0.345	0.68
Black currant, washed	0.84	0.29	0.57
Black currant juice	0.26	0.09	
Black currant jelly	0.56	0.19	
Strawberry		0.84	3.0
Strawberry, washed	0.59	0.50	1.8
Strawberry jam	0.22	0.18	
Canned strawberry	0.21	0.18	
Tomato		0.39	2.2
Tomato juice	0.52	0.20	
Tomato paste	4.0	1.6	
Tomato puree	1.7	0.66	
Tomato pomace, wet	6.2	2.4	
Tomato pomace, dry	51	20	
Hops, dry		25	71
Beer	0.001	0.025	

¹⁾ sum of tolyfluanid and DMST expressed as tolyfluanid

Residues in animal commodities

Dietary burden in animals

The Meeting estimated the dietary burden of tolyfluanid residues in farm animals on the basis of the feeding stuffs listed in Appendix IX of the FAO Manual. Among processed products of commodities for which maximum residue levels were estimated, wet apple pomace is used as feed for cattle. No maximum residue levels were estimated for commodities which or the products of which can be used as feed for pigs or poultry.

Commodity	STMR-P ¹⁾ mg/kg	Group	Dry matter %	Residue on dry basis mg/kg	Percent of diet		Residue contribution, mg/kg	
					Beef cattle	Dairy cattle	Beef cattle	Dairy cattle
Apple pomace, wet	1.8	AB	40	4.5	40	20	1.8	0.9
				TOTAL			1.8	0.9

¹⁾ sum of tolyfluanid and DMST expressed as tolyfluanid

Animal feeding studies

Although no animal feeding studies were performed, a metabolism study on a lactating goat dosed daily for three days with 10 mg/kg bw of tolyfluanid which is equivalent of 250 ppm in feed, and slaughtered about one hour after the plasma peak level was reached (2 hours after the last dose) showed no tolyfluanid residue in muscle, liver, kidney or milk. Although the goat was fed

for only three days, the amount of tolylfluanid administered was far higher than the calculated animal dietary burden. Therefore, the Meeting concluded that residues of tolylfluanid were unlikely to occur in edible tissues/organs or milk of cattle when beef cattle and dairy cattle ingest tolylfluanid and DMST (expressed as tolylfluanid) at 1.8 mg/kg and 0.9 mg/kg in wet apple pomace respectively.

The liver and fat (perirenal, omental and subcutaneous fat) of the goat mentioned above contained total radioactivity of 20.58 and 0.85-2.28 mg/kg in tolylfluanid equivalents, among which 4.83% and 14.68% was identified as DMST respectively. DMST concentrations in the liver and fat tissues were calculated to be 0.613 and 0.077-0.207 mg/kg respectively after the 3 day oral administration of tolylfluanid at a level equivalent to 250 ppm in feed. It was estimated that concentrations of DMST in liver and fat would be very low when cattle ingests wet apple pomace containing 1.8 or 0.9 mg/kg of residues of tolylfluanid and DMST and unlikely to pose risk to health as the estimated dietary intake of tolylfluanid and DMST from liver containing 0.613 mg/kg of DMST (0.993 mg/kg in tolylfluanid equivalents) was less than 0.01% of the ADI, and 1% and 2% of the acute reference dose for general population and for children respectively. The concentrations of DMST in other tissues/organs were expected to be even much lower according to the metabolism study. No DMST was detected in milk in the study. Because the metabolism study was conducted using only one administration level, the Meeting was not able to estimate the concentrations of DMST in edible tissues at the calculated animal dietary burden.

DIETARY RISK ASSESSMENT

Long-term intake

The International Estimated Dietary Intakes (IEDIs) were calculated for the five GEMS/Food regional diets using STMRs for 12 commodities and STMR-P for dried grapes, tomato juice and tomato paste estimated by the current Meeting (Appendix III). A new ADI of 0-0.08 mg/kg bw was proposed by the current Meeting. The calculated IEDIs were 0-2% of the ADI. The Meeting concluded that the intake of residues of tolylfluanid and DMST resulting from the uses considered by the current JMPR was unlikely to present a public health concern.

Short-term intake

The International Estimated Short-Term Intakes (IESTI) for tolylfluanid and DMST were calculated for commodities for which STMRs and/or HRs were estimated by the current Meeting. An acute reference dose of 0.5 mg/kg bw was proposed by the current Meeting. The IESTIs for children range from 0 to 68% of the acute reference dose and those for general population range from 0 to 24% of the acute reference dose. The Meeting concluded that the short-term intake of residues of tolylfluanid and DMST from uses considered by the current JMPR was unlikely to present a public health concern.

4.26 TRIAZOPHOS (143)

TOXICOLOGY

Triazophos (*O,O*-diethyl *O*-1-phenyl-1*H*-1,2,4-triazol-3-yl phosphorothioate) is an organophosphorus pesticide, which was most recently evaluated toxicologically by the 1993 JMPR, when an ADI of 0–0.001 mg/kg bw was established. It was re-evaluated by the present Meeting within the periodic review programme of the Codex Committee on Pesticide Residues.

In studies in which a single oral dose of [¹⁴C]triazophos was administered by gavage to rats or dogs, absorption was rapid and essentially complete. Most of the radiolabel was excreted within 48–96 h, with a half-life in blood in both species of about 3.5 h. It was excreted primarily in urine. The metabolism in rats and dogs was qualitatively similar, and there did not appear to be a sex difference. Little residual radioactivity was found in the tissues that were analysed. Triazophos was metabolized to 1-phenyl-3-hydroxy-[1*H*]-1,2,4-triazole, and this compound and its glucuronide and sulfate ester conjugates were the predominant compounds in urine, representing most of the administered dose. In a 12-day study with repeated doses, triazophos showed little potential for bioaccumulation. By analogy with other phosphorothioate organophosphorus compounds, triazophos is probably metabolically activated to the oxon, which inhibits acetylcholinesterase activity.

In mice, rats and guinea-pigs, the acute oral LD₅₀ values ranged from 26 to 82 mg/kg bw, while dogs had higher values: about 500 mg/kg bw in females and > 800 mg/kg bw in males. In studies of acute dermal and inhalation exposure in rats, females were more sensitive than males; the acute dermal LD₅₀ ranged from 1000 to > 2000 mg/kg bw and the acute inhalation (4 h, nose-only) LC₅₀ ranged from 0.45 to 0.61 mg/l. Deaths occurred within minutes to several days after oral administration. The clinical signs included tremor, tonic convulsions, accelerated, laboured or jerky respiration, lachrymation, salivation, saltatory spasms, disequilibrium, hind-limb paralysis, vomiting or retching, diarrhoea and miosis, depending on the species. WHO has classified triazophos as 'highly hazardous'.

In rabbits, triazophos was not irritating to the eyes or skin; however, dermal and, to a lesser extent, ocular treatment with undiluted material caused some deaths. Triazophos was not a dermal sensitizer in guinea-pigs in either a Buehler or Magnusson and Kligman maximization test.

The most sensitive effect observed after treatment with triazophos is inhibition of erythrocyte cholinesterase activity. In both short- and long-term studies in several species treated orally, cholinesterase was preferentially inhibited peripherally and inhibition of brain cholinesterase activity occurred at doses higher than those at which clinical signs were observed. Hence, inhibition of erythrocyte cholinesterase activity was considered to be an appropriate surrogate for potential effects on the peripheral nervous system.

Systemic effects other than inhibition of cholinesterase activity, if any occurred, were observed in short-term studies in rodents only at the highest doses tested and generally consisted of slight perturbations of haematological and clinical chemical parameters. Other than one unexplained death in a 43-week study in rats, there were no deaths and no clinical signs in these studies. The NOAELs for inhibition of erythrocyte cholinesterase activity were between 1 and 20 ppm (0.08–3 mg/kg bw per day), depending on dose spacing. In a 13-week study in dogs, effects other than inhibition of erythrocyte cholinesterase activity were found only at the highest dose and included moribundity, clinical signs consistent with cholinergic toxicity (such as salivation, diarrhoea, vomiting and tremor), decreased food consumption and loss of body weight, haematological and clinical chemical changes in one or both sexes, hypertrophy of the

duodenal wall in all animals and degenerative or inflammatory lesions in the zygomatic gland in males. The NOAEL in this study was 0.3 ppm (equal to 0.01 mg/kg bw per day) on the basis of inhibition of erythrocyte cholinesterase activity.

In a 52-week study in dogs, some animals were reported to have had bronchopneumonia and other signs of illness, which may have confounded interpretation of the results. Persistent diarrhoea was seen in many animals at the highest dose and in one male at the intermediate dose; the possibility that these findings were related to treatment could not be dismissed. Decreased erythrocyte cholinesterase activity (24–32%) was found in males at the intermediate dose. The NOAEL was 0.4 ppm, equal to 0.012 mg/kg bw per day, on the basis of inhibition of erythrocyte cholinesterase activity.

No effects other than inhibition of cholinesterase activity were found in a long-term study of toxicity in mice. The NOAEL was 6 ppm, equal to 0.95 mg/kg bw per day, on the basis of inhibition of erythrocyte cholinesterase activity.

In a 2-year study of toxicity in rats, erythrocyte cholinesterase activity was significantly inhibited by > 20% at the two higher doses. Slight perturbations in haematological and clinical chemical parameters seen in one or both sexes at these doses were considered to be related to treatment but to represent only compensatory changes. An increased incidence of pancreatic acinar-cell hyperplasia in males at the two higher doses may have been related to treatment. The NOAEL was 3 ppm, equal to 0.15 mg/kg bw per day.

In long-term studies of toxicity and carcinogenicity in mice and rats, triazophos induced no significant or consistent increase in the incidence of any tumour type. The Meeting concluded that triazophos is not carcinogenic in mice or rats.

The genotoxic potential of triazophos was assessed in an adequate range of tests *in vitro* and in a test for micronucleus formation in mice *in vivo*. The Meeting concluded that triazophos is unlikely to pose a genotoxic hazard *in vivo*.

On the basis of the absence of carcinogenic effects in mice and rats and the overall weight of evidence from the genotoxicity studies, the Meeting concluded that triazophos is unlikely to pose a carcinogenic risk to humans.

In a study of reproductive toxicity in rats, effects on parental animals and pups were observed only at 240 ppm (equal to 12 mg/kg bw per day), the highest dose tested. Clinical signs of toxicity, aggressive behaviour and decreased body weight and food consumption were seen in parents of both generations, and some treatment-related deaths were found among the F₁ parents. The only effects on reproduction were some pup losses and decreases in pup body weights during the lactation period. The NOAEL for parental toxicity and reproductive toxicity was 27 ppm, equal to 1 mg/kg bw per day.

The studies of developmental toxicity in rats and rabbits were difficult to interpret owing to the choice of dose and/or the occurrence of illness unrelated to treatment. In rabbits, the combined NOAEL for maternal toxicity in a dose range-finding study and the main study was 4 mg/kg bw per day, on the basis of slight decreases in body weight and food consumption and clinical signs of toxicity at higher doses. The NOAEL for developmental toxicity was 4 mg/kg bw per day on the basis of possible effects on pregnancy outcome at higher doses. No malformations were observed at the highest dose tested in the main study, in rabbits (8 mg/kg bw per day) or in rats (22 mg/kg bw per day).

Several studies were conducted in which single doses were given by gavage to assess the potential of triazophos to induce delayed polyneuropathy in hens. Doses of triazophos of up to

12 mg/kg bw, given with pharmacological protection against cholinergic effects, and rechallenge with triazophos after 3 weeks did not result in behavioural or morphological signs of delayed polyneuropathy. At 50 mg/kg bw, there was some evidence of atypical neuropathology in the spinal cord, and delayed motor activity was observed in two animals. Brain cholinesterase activity and neuropathy target esterase activity were not affected at an oral dose of 10 mg/kg bw without antidotal protection. The potential of triazophos to induce delayed polyneuropathy after repeated oral administration was assessed in hens at a dietary concentration of 0, 50, 110 or 250 ppm. Food intake was variable because of wastage and cyclical eating habits. The results were compared with those seen with tri-*ortho*-cresyl phosphate in a separate study. At the highest dose of triazophos, delayed motor activity and atypical neuropathological findings in the spinal cord and periphery were reported. The histopathological findings were not typical of the classical Wallerian degeneration associated with organophosphorus-induced delayed polyneuropathy, nor could it be ascertained if the clinical signs were due to inhibition of cholinesterase activity. Neuropathy target esterase was not measured in the main study, but, when it was assessed in a separate 20-day feeding study, no inhibition was observed at doses up to 200 ppm (equivalent to 10 mg/kg bw per day). Although a few animals in the main study showed signs consistent with delayed polyneuropathy, these might well have been due to prolonged inhibition of cholinesterase activity and/or an increase in the frequency of spontaneous lesions in the nervous system due to weight loss or disease. The Meeting concluded that there was no concern for induction of delayed polyneuropathy by triazophos at doses that could be achieved in the human diet.

Several studies were conducted in which volunteers were given triazophos at doses of 0.0125–0.0625 mg/kg bw for up to 3 weeks. In the main study, conducted according to the standards of the time, triazophos administered for 3 weeks, 5 days per week, at a dose of 0.0125 mg/kg bw per day, had no effect on erythrocyte cholinesterase activity. Although signs and symptoms consistent with inhibition of cholinesterase activity were reported by some individuals, these were attributed to non-treatment-related causes, such as gastrointestinal viral-type infections or psychosocial interactions in the absence of inhibition of erythrocyte cholinesterase activity. The NOAEL was 0.0125 mg/kg bw per day, the only dose tested.

The major metabolite of triazophos, 1-phenyl-3-hydroxy-[1*H*]-1,2,4-triazole, was of low acute oral toxicity in rats (LD_{50} , > 5000 mg/kg bw) and was minimally irritating to the eyes of rabbits. The weight of the evidence from studies of genotoxicity suggested that this metabolite is of no genotoxic concern.

No cases of human poisoning were found in the literature, and no adverse effects were reported among workers at the sponsor's triazophos manufacturing plant.

The Meeting concluded that the existing database was adequate to characterize the potential hazard of triazophos to fetuses, infants and children.

The Meeting established an ADI of 0–0.001 mg/kg bw on the basis of the NOAEL of 0.0125 mg/kg bw per day, the only dose tested, in the 3-week study in volunteers, in which no effects on erythrocyte cholinesterase activity or clinical signs were observed, and a safety factor of 10. The data on humans were used because the relevant effects in animals were also linked to inhibition of cholinesterase activity. The duration of administration in the study in volunteers was considered to be sufficient to permit maximal inhibition of cholinesterase activity. The ADI was considered to be sufficiently protective against any neurotoxic effect of the chemical, including delayed polyneuropathy.

The Meeting established an acute RfD of 0.001 mg/kg bw on the basis of the NOAEL of 0.0125 mg/kg bw per day in the 3-week study in humans and a safety factor of 10.

A toxicological monograph was prepared, summarizing data received since the previous evaluation and including relevant data from previous monographs and monograph addenda.

TOXICOLOGICAL EVALUATION

Levels relevant to risk assessment

Species	Study	Effect	NOAEL	LOAEL
Mouse	2-year study of toxicity and carcinogenicity ^a	Inhibition of erythrocyte cholinesterase activity	6 ppm, equal to 0.95 mg/kg bw per day	30 ppm, equal to 4.9 mg/kg bw per day
		Carcinogenicity	150 ppm, equal to 20 mg/kg bw per day ^b	–
Rat	2-year study of toxicity and carcinogenicity ^a	Inhibition of erythrocyte cholinesterase activity and toxicity	3 ppm, equal to 0.15 mg/kg bw per day	27 ppm, equal to 1.3 mg/kg bw per day
		Carcinogenicity	240 ppm, equal to 12 mg/kg bw per day ^b	–
	Multigeneration study of reproductive toxicity ^a	Parental and offspring toxicity	27 ppm, equal to 1 mg/kg bw per day	243 ppm, equal to 12 mg/kg bw per day
		Maternal toxicity	250 ppm, equal to 22 mg/kg bw per day ^b	–
Developmental toxicity ^a	Embryo- and fetotoxicity	250 ppm, equal to 22 mg/kg bw per day ^b	–	
Rabbit	Developmental toxicity ^c	Maternal toxicity	4 mg/kg bw per day	8 mg/kg bw per day
		Embryo- and fetotoxicity	4 mg/kg bw per day	8 mg/kg bw per day
Dog	1-year study of toxicity ^a	Inhibition of erythrocyte cholinesterase activity and toxicity	0.4 ppm, equal to 0.012 mg/kg bw per day	4 ppm, equal to 0.13 mg/kg bw per day
Human	3-week study ^d	Inhibition of erythrocyte cholinesterase activity and toxicity	0.0125 mg/kg bw per day ^e	–

^a Dietary administration

^b Highest dose tested

^c Gavage

^d Oral administration

^e Only dose tested

Estimate of acceptable daily intake for humans

0–0.001 mg/kg bw

Estimate of acute reference dose

0.001 mg/kg bw

Studies that would provide information useful for continued evaluation of the compound

- Further observations in humans
- Evaluation of potential to cause delayed polyneuropathy at doses above those associated with human dietary intake

*List of end-points relevant for setting guidance values for dietary and non-dietary exposure**Absorption, distribution, excretion and metabolism in mammals*

Rate and extent of oral absorption	Rapid, essentially complete
Distribution	Extensive
Potential for accumulation	Little
Rate and extent of excretion	Rapid, almost complete within 48–96 h; mainly in urine; half-life in blood, 3.8 h in rats, 3.6 h in dogs
Metabolism in animals	Cleavage to 1-phenyl-3-hydroxy-[1H]-1,2,4-triazole followed by conjugation with glucuronide and sulfate
Toxicologically significant compounds	Parent and oxon

Acute toxicity

Rat, LD ₅₀ , oral	48–82 mg/kg bw
Rat, LD ₅₀ , dermal	1000 mg/kg bw
Rat, LC ₅₀ , inhalation (nose-only)	0.45–0.61 mg/l
Skin irritation	Negligible, but undiluted material caused some deaths
Eye irritation	Minimally irritating, but undiluted material caused some deaths
Skin sensitization	Negative in Buehler and in Magnusson and Kligman tests

Short-term studies of toxicity

Target/critical effect	Inhibition of erythrocyte (but not brain) cholinesterase activity and clinical signs of toxicity at higher doses in animals but not in humans
Lowest relevant oral NOAEL	0.012 mg/kg per day (1-year study in dogs); 0.0125 mg/kg bw per day (humans)

Genotoxicity

Unlikely to pose a genotoxic risk in vivo

Long-term studies of toxicity and carcinogenicity

Target/critical effect	Inhibition of erythrocyte cholinesterase activity
Lowest relevant NOAEL	0.15 mg/kg bw per day (rats)
Carcinogenicity	Not carcinogenic

Reproductive toxicity

Target/critical effect for reproductive toxicity	Reduced pup viability and weight
Lowest relevant NOAEL for reproductive toxicity	1 mg/kg bw per day
Target/critical effect for developmental toxicity	Effects on pregnancy outcome
Lowest relevant NOAEL for developmental toxicity	4 mg/kg bw per day

Neurotoxicity

Delayed neuropathy	No concern for delayed polyneuropathy at doses relevant to human dietary intake
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Medical data

No human poisoning cases found in the literature, and no adverse affects were reported at the sponsor's triazophos manufacturing plant.

Summary

	Value	Study	Safety factor
ADI	0–0.001 mg/kg bw	3-week, humans	10
Acute RfD	0.001 mg/kg bw	3-week, humans	10

DIETARY RISK ASSESSMENT

The theoretical maximum daily intake of triazophos in the five GEMS/Food regional diets, on the basis of existing MRLs, represented 30–100% of the ADI (Annex 3). The Meeting concluded that the intake of residues of triazophos resulting from uses that have been considered by the JMPR is unlikely to present a public health risk.

5. RECOMMENDATIONS

5.1 The Meeting recommended (Sec 2.1) that FAO, WHO and the Codex Alimentarius Commission prepare a strategic plan for JMPR reflecting upon the clear message from the CCPR regarding JMPR's role, the growing importance of WTO agreements, the proposals in the Consultants report and the ongoing overall FAO/WHO Codex evaluation.

5.2 The Meeting recommended (Sec 2.7):

That CCPR invite both exporting and importing Member Governments to submit their monitoring data on pesticide residues on spices. For preparing their submissions the data submitters are advised to consult the relevant parts, especially 'Estimation of extraneous maximum residue levels' in Chapter 5 of the revised FAO manual on 'Submission and evaluation of pesticide residues data for the estimation of maximum residue levels in food and feed' (FAO Plant Production and Protection Paper 170, 2002).

That CCPR provide information on the number of monitoring data and the geographical spread that could be considered acceptable by the members for estimating maximum residue levels.

That CCPR indicate if it is acceptable to use the current GEMS/Food total spice-consumption data for risk assessment of those spices not specifically listed.

5.3 The Meeting recommended (Sec. 2.9) a variability factor of 3 for calculation of acute dietary exposure to pesticide residues in head-lettuce and head-cabbage. The default variability factor will however be used for leaf-lettuce and other leafy vegetables.

5.4 The Meeting concluded (Sec 2.10) that the mixed 20% fat/ 80% muscle values for cattle and other mammalian animals and the mixed 10% fat /90% muscle values for poultry should be used for dietary intake calculations for meat in order to provide a more realistic estimation of the dietary exposure of consumers.

5.5 The Meeting requested CCPR to advise which is the preferred approach for Codex MRLs for animal commodities where residues are unlikely to occur:

- MRLs recommended at or about the LOQ; or
- no MRL recommendations.

5.6 The Meeting recommended that bentazone, dimethipin, imazalil, fenpropimorph (section 2.3) captan and folpet (section 4.14) be placed on the agendas of future Meetings for submission of appropriate data and reconsideration of acute toxicity.

6. FUTURE WORK

The items listed below should be considered by the Meeting in 2003 and 2004. The compounds listed include those recommended as priorities by the CCPR at its Thirty-fourth or earlier sessions and compounds scheduled for re-evaluation within the CCPR periodic review programme.

6.1 2003 JMPR

Toxicological evaluations

New compounds

Cyprodinil
Famoxadone
Methoxyfenozide
Pyrochlorobin

Periodic re-evaluations

Carbosulfan (145)
Cyhexatin (067)/azocyclotin (129)

Paraquat (057)
Terbufos (167) to be clarified

Evaluations

Dimethoate (027) – acute toxicity
Malathion (049) – acute toxicity
Pyrethrins (063)

Residue evaluations

New compounds

Cyprodinil
Famoxadone
Methoxyfenozide
Pyrochlorobin

Periodic re-evaluations

Acephate (095)/ Methamidophos (100)
Dodine (084)
Fenitrothion (037)
Lindane (048)
Pirimiphos-methyl (086)

Evaluations

Carbendazim (072)/thiophanate methyl
Carbosulfan (145)
Dicloran (083)
Dimethoate (027)
Pyrethrins (063)

6.2 2004 JMPR**Toxicological evaluations*****New compounds***

Fludioxinil
Trifloxystrobin

Periodic re-evaluations

Glyphosate (158)
Phorate (112)
Pirimicarb (101)
Triadimefon (133)
Triadimenol (168)

Evaluations

Guazatine 114
Fenpyroximate (193)-acute tox
Haloxfop (194)

Residue evaluations***New compounds***

Fludioxinil
Trifloxystrobin

Periodic re-evaluations

Ethoprophos (149)
Metalaxyl-M
Paraquat (057)
Prochloraz (142)
Propineb

Evaluations

Chlorpyrifos (017)
Dithiocarbamates (105)
Malathion (047)
Oxydemeton-methyl (116)
2-Phenylphenol (056)

ANNEX 1

ACUTE DIETARY INTAKES, ACUTE REFERENCE DOSES, RECOMMENDED MAXIMUM RESIDUE LIMITS, AND SUPERVISED TRIALS MEDIAN RESIDUE VALUES RECORDED BY THE 2002 MEETING

The 2002 Joint FAO/WHO Meeting on Pesticide Residues (JMPR) was held in Rome, Italy, from 16 to 25 September 2002. The following extract of the results of this meeting is provided to make them accessible to interested parties at an early date.

The Meeting evaluated 25 pesticides, including two new compounds and eleven compounds re-evaluated within the Periodic Review Program of the Codex Committee on Pesticide Residues (CCPR).

The Meeting allocated acceptable daily intakes (ADIs) and acute reference doses (acute RfDs) and estimated maximum residue levels which it recommended for use as maximum residue limits (MRLs) by the CCPR. It also estimated supervised trials median residue (STMR) and highest residue (HR) levels as a basis for the estimation of the dietary intakes of residues of the pesticides reviewed. The application of the HR levels is explained in the report of the 1999 Meeting (Section 2.4). The estimates are recorded in the table below.

Those pesticides for which estimated dietary intakes might, on the basis of the available information, exceed their ADIs are marked with footnotes as explained in detail in the report of the 1999 Meeting (Section 2.2). Footnotes are also applied to specific commodities where the available information indicates that the acute RfD of a pesticide might be exceeded by consumption of the food commodity. It should be noted that these considerations apply only to new compounds and those re-evaluated within the CCPR Periodic Review Program.

The table includes the Codex reference numbers of the compounds and the Codex Classification Numbers (CCNs) of the commodities, to facilitate reference to the Codex Maximum Limits for Pesticide Residues (*Codex Alimentarius*, Vol. 2B) and other documents and working documents of the Codex Alimentarius Commission. Commodities are listed in alphabetical order.

The abbreviations and symbols used in the table and not defined elsewhere are as follows:

* following recommended MRL	At or about the limit of quantification
* following name of pesticide	New compound
** following name of pesticide	Reviewed in CCPR Periodic Review Programme
HR-P	Highest residue in processed commodity, in mg/kg, calculated by multiplying the HR in the raw commodity by the processing factor

Po	The recommendation accommodates post-harvest treatment of the commodity
PoP following recommendation for processed foods (classes D and E in the Codex Classification)	The recommendation accommodates post-harvest treatment of the primary food commodity
STMR-P mean	An STMR value for a processed commodity calculated by applying the concentration or reduction factor for the process to the STMR value calculated for the raw agricultural commodity
W in place of a recommended MRL	The previous recommendation is withdrawn, or withdrawal of the recommended MRL or existing Codex or draft MRL is recommended

**ACCEPTABLE DAILY INTAKES (ADIs), ACUTE REFERENCE DOSES (RfD)
RECOMMENDED MRLs, SUPERVISED TRIAL MEDIAN RESIDUES (STMRs) AND
HIGHEST RESIDUES (HR)**

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg
				New	Previous		
Acephate** (95)	0-0.01	Acute RfD: 0.05 mg/kg bw					
Bitertanol (144)	0-0.01						
		FS 0240	Apricot	1	W	0.2	
		<i>Residue</i> (for compliance with MRLs) for plant and animal products : bitertanol. For estimations of dietary intake for plant products: bitertanol. for animal products: sum of bitertanol, <i>p</i> -hydroxybitertanol and the acid-hydrolysable conjugates of <i>p</i> -hydroxybitertanol Acute RfD: Unnecessary					
Carbaryl **(008)	0-0.008						
		AL 1021	Alfalfa forage (green)	W	100 T		
		AM 0660	Almond hulls	50		30	
		FP 0226	Apple	W	5 T		
		FS 0240	Apricot ¹	W	10 T		
		VS 0621	Asparagus	15	10 T	8.1	10
		FI 0327	Banana	W	5 T		
		GC 0640	Barley	W	5 PoT		
		AL 1030	Bean forage (green)	W	100 T		
		VR 0574	Beetroot	0.1	2 T	0.025	0.06
		FB 0264	Blackberries	W	10 T		
		FB 0020	Blueberries	W	7 T		

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR- P, mg/kg
				New	Previous		
		VB 0041	Cabbages, head	W	5 T		
		VR 0577	Carrot	0.5	2 T	0.02	0.31
		MM 0812	Cattle meat	W	0.2 T		
		FS 0013	Cherries ¹	20	10 T	4.3	16
		FC 0001	Citrus fruit	15	7 T		
			Citrus fruit, edible portion			0.487	1.6
		JF 0001	Citrus fruit juice	0.5		0.13	
		AB 0001	Citrus pulp, dried	4		1.0	
		AL 1023	Clover	W	100 T		
		SO 0691	Cotton seed	W	1 T		
		VP 0526	Common bean (pods and/or immature seeds)	W	5 T		
		FB 0265	Cranberry	W	7 T		
		VD 0527	Cowpea (dry)	W	1 T		
		VC 0424	Cucumber	W	3 T		
		FB 0266	Dewberries (including Boysenberry and Loganberry)	W	10 T		
		DF 0269	Dried grapes (=currants, raisins and sultanas)	50		5.9	39.6
		PE 0112	Eggs	W	0.5 T		
		VO 0440	Egg plant	1	5 T	0.18	0.49
			Fat from mammals other than marine mammals			0.003	0.062
		MM 0814	Goat meat	W	0.2 T		
		FB 0269	Grapes ¹	40	5 T	4.9	33
			Grape juice	30		3.2	
		AB 0269	Grape pomace, dry	80		9.8	
		AS 0162	Hay or fodder (dry) of grasses	W	100 T		
		MO 0098	Kidney of cattle, goats, pigs and sheep	3		0.119	1.9
		FI 0341	Kiwifruit	W	10 T		
		VL 0053	Leafy vegetables	W	10 T		
		MO 0099	Liver of cattle, goats, pigs and sheep	1		0.085	0.907
		GC 0645	Maize	0.02 (*)		0.02	0.02
		AF 0645	Maize forage, 400, dry	400, dry	100 T, fresh	20	
		AS 0645	Maize fodder	250, dry		0.85	
		OC 0645	Maize oil, crude	0.1		0.066	
		MM 0095	Meat (from mammals other than marine mammals)	0.05		0.02	
		VC 0046	Melons, except watermelon	W	3 T		
		ML 0106	Milks	0.05	0.1 (*) T	0.03	
		AO3 0001	Milk products	W	0.1 (*)T		
		AO5 1900	Nuts (whole shell)	W	10 T		
		FS 0245	Nectarine	W	10 T		
		GC 0647	Oats	W	5 PoT		
		VO 0442	Okra	W	10 T		

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR- P, mg/kg
				New	Previous		
		FT 0305	Olives	30	10 T		
		OC 0305	Olive oil, virgin	25		2.99	
			Olives, edible portion			5.1	36.4
		DM 0305	Olives, Processed	W	1 T		
		VR 0588	Parsnip	W	2 T		
		VP 0063	Peas (pods and succulent= immature seeds)	W	5 T		
		AL 0528	Pea vines (green)	W	100 T		
		SO 0703	Peanut, whole	W	2 T		
		AL 0697	Peanut fodder	W	100 T		
		FP 0230	Pear	W	5 T		
		VO 0445	Peppers, sweet	5	5 T	1.8	3.8
		FS 0014	Plums (including prunes) ¹	W	10 T		
		VR 0589	Potato	W	0.2 T		
		PM 0110	Poultry meat	W	0.5 T (1)		
		PO 0113	Poultry skin	W	5 T (1)		
		VC 0429	Pumpkins	W	3 T		
		FB 0272	Raspberries, Red, Black	W	10 T		
		GC 0649	Rice	50	5 PoT	8.4	46
		CM 1206	Rice bran	170		5.7	
			Rice hulls	50		25.7	
		CM 0649	Rice, husked	W	5 PoPT		
		AS 0649	Rice straw and fodder dry	120		25.6	
		CM1205	Rice, polished	1		0.168	0.92
		GC 0650	Rye	W	5 PoT		
		MM 0822	Sheep meat	W	0.2 T		
		GC 0651	Sorghum	W	10 PoT		
		AF 0651	Sorghum forage, green	20	100 T	1.5	
			Sorghum forage, dry	50		4.3	
		OC 0541	Soya bean oil, crude	0.2		0.045	
		VD 541	Soybean (dry)	0.2	1 T	0.05	0.15
		AL 0541	Soybean hay	15		7.5	
		AL 1265	Soyabean forage, green	30, dry	100 T, fresh	7.9	
			Soybeans, hulls	0.3		0.065	
		FS 0012	Stone fruit ¹	10		2.05	7.8
		FB 0275	Strawberry	W	7 T		
		VR 0596	Sugar beet	W	0.2 T		
		AV 0596	Sugar beet leaves or tops	W	100 T		
		OC 0702	Sunflower seed oil, crude	0.05		0	
			Sunflower forage	5		1.9	
		VR 0497	Swede	W	2 T		
		VO 0447	Sweet corn, corn on the cob	0.1	1 T	0.02	0.05
			Sweet corn cannery waste	7.4		1.48	
		VR 508	Sweet potato	0.02 (*)		0.02	0.02
		SO 0702	Sunflower seed	0.2		0.03	0.08
		VC 0431	Squash, summer	W	3 T		

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg
				New	Previous		
		VR 0494	Radish	W	2 T		
		VO 0448	Tomato	5	5 T	0.47	2.4
		JF 0448	Tomato juice	3		0.24	
			Tomato paste	10		0.94	
		TN 0085	Tree nuts	1	1 T	0.035	0.77
		VR 0506	Turnip, Garden	1		0.02	0.89
		GC 0654	Wheat	2	5 Po T	0.245	1.6
		CF 1211	Wheat flour	0.2	0.2 PoP T	0.02	
		CF 1210	Wheat germ	1		0.13	
		CM 0654	Wheat bran, unprocessed	2	20	0.17	
		VC 0433	Winter squash	W	3 T		
		AS 0654	Wheat straw	30		9.3	
		CF 1212	Wheat wholemeal	W	2 PoP T		
		<p><i>Residue</i> (For compliance with MRL and estimations of dietary intake in plant and animal commodities): carbaryl. ¹ The information provided to the JMPR precludes an estimate that the dietary intake would be below the acute reference dose. Acute RfD: 0.2 mg/kg bw</p>					
Carbofuran (096)	0-0.002						
		SO 0691	Cotton seed	0.1		0.02	0.04
		SO 0495	Rape seed	0.05*		0.05	
		CM 0649	Rice, husked	0.1	W	0.025	0.042
		AS 0649	Rice straw and fodder (dry)	1		0.10	
		VO 0447	Sweet corn (corn-on-the-cob)	0.1	W	0.03	0.1
		<p><i>Residue</i> (For compliance with MRLs and estimations of dietary intake): sum of carbofuran and 3-hydroxycarbofuran, expressed as carbofuran Acute RfD: 0.009 mg/kg bw</p>					
Deltamethrin**(135)	0-0.01	FP 0226	Apple	0.2	-	0.03	0.08
		JF 0226	Apple juice	-	-	0.0027	-
		VS 0620	Artichoke, Globe	W	0.05	-	-
		VR 0577	Carrot	0.02	-	0.01	0.02
		FC 0001	Citrus fruits	0.02	-	0.01	0.01
		FI 0327	Banana	W	0.05	-	-
		VD 0071	Beans (dry)	W	1 Po		
		VB 0040	Brassica vegetables	W	0.2	-	-
		VA 0036	Bulb vegetables, except Fennel Bulb	W	0.1	-	-
		SB 0715	Cacao beans	W	0.05	-	-
		GC 0080	Cereal grains	2 Po	1 Po	0.7	1.1
		SB 0716	Coffee beans	W	2 Po	-	-
		MO 0105	Edible offal (mammalian)	W	0.05		
		PE 0112	Eggs	0.02 (*)	0.01 (*)	0.02	0.02
		VD 0561	Field pea (dry)	W	1 Po		
		FT 0297	Fig	W	0.01 (*)	-	-
		VB 0042	Flowerhead brassicas	0.1	-	0.02	0.04

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR- P, mg/kg
				New	Previous		
		VO 0050	Fruiting vegetables other than cucurbits (except mushrooms)	W	0.2	-	-
		VC 0045	Fruiting vegetables, cucurbits	0.2	0.2	0.02	0.09
		FB 0269	Grapes	0.2	0.05	0.04	0.09
		TN 0666	Hazelnut	0.02 (*)	-	0.02	0.02
		DH 1100	Hops, Dry	W	5	-	-
		FI 0341	Kiwifruit	W	0.05	-	-
		VL 0053	Leafy vegetables ¹	2	0.5	0.125	1
		VA 0384	Leek	0.2	-	0.07	0.13
		VP 0060	Legume vegetables	0.2	0.1	0.01	0.14
		AL 0157	Legume animal feeds	W	0.5 dry wt	-	-
		VD 0533	Lentil (dry)	W	1 Po	-	-
		MO 0099	Liver of cattle, goats, pigs and sheep	0.03*	-	0.03	0.03
		MO 0098	Kidney of cattle, goats, pigs and sheep	0.03*	-	0.03	0.03
		FC 0003	Mandarins	W	0.05	-	-
		MM 0095	Meat (from mammals other than marine mammals)	0.5 (fat)	0.5 (fat)	0.155	0.186
		VC 0046	Melons, except watermelon	W	0.01 (*)	-	-
		ML 0106	Milks	0.05 F	0.02 F	0.017	0.018
		VO 0450	Mushrooms	0.05	0.01 (*)	0.02	0.03
		FS 0245	Nectarine	0.05	-	0.02	0.05
		SO 0088	Oilseed	W	0.1	-	-
		SO 0089	Oilseed, except peanut	W	0.1	-	-
		FT 0305	Olives	1	0.1	0.21	0.31
		OC 0305	Olive oil, crude	-	-	0.315	-
		OR 0305	Olive oil, refined	-	-	0.336	-
		VA 0385	Onion, Bulb	0.05	-	0.02	0.03
		FC 0004	Oranges, Sweet, Sour	W	0.05	-	-
		FS 0247	Peach	0.05	-	0.02	0.05
		SO 0697	Peanut	W	0.01 (*)	-	-
		FI 0353	Pineapple	W	0.01 (*)	-	-
		FS 0014	Plum (including Prunes)	0.05	-	0.02	0.05
		FP 0009	Pome fruit	W	0.1	-	7.3
		VR 0589	Potato	0.01 (*)	-	0.01	0.01
		PM 0110	Poultry meat	0.1 (fat)	0.01 (*)	0.038	0.09
		PO 0111	Poultry, edible offal of	0.02 (*)	0.01 (*)	0.02	0.02
		VD 0070	Pulses	1 Po	-	0.5	0.85
		VR 0494	Radish	0.01 (*)	-	0.01	0.01
		VR 0075	Root and tuber vegetables	W	0.01	-	-
		FS 0012	Stone fruits	W	0.05	-	-
		AS 0081	Straw and fodder (dry) of cereal grains	W	0.5	-	-
		FB 0275	Strawberry	0.2	0.05	0.02	0.1
		SO 0702	Sunflower seed	0.05 (*)	-	0.05	0.05
		VO 0447	Sweet corn (corn-on- the-cob)	0.02 (*)	-	0.02	0.02

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg
				New	Previous		
		DT 1114	Tea, Green, Black	5	10	2.2	3.1
		VO 0448	Tomatoes	0.3	-	0.02	0.2
		FT 0312	Tree Tomato	W	0.02	-	-
		TN 0678	Walnuts	0.02 (*)	-	0.02	0.02
		CM 0654	Wheat bran, unprocessed	5 PoP	5 PoP	2.31	
		CF 1211	Wheat flour	0.3 PoP	0.2 PoP	0.217	
		CF 1212	Wheat wholemeal	2 PoP	1 PoP	0.637	
		<p><i>Residue</i> (For compliance with MRL and estimations of dietary intake): sum of deltamethrin, α-R- and trans-deltamethrin ([1R-[1α(R*),3α]]-3-(2,2-dibromoethyl)-2,2-dimethyl-cyclopropanecarboxylic acid, cyano(3-phenoxyphenyl)methyl ester and [1R-[1α(S*),3β]]-3-(2,2-dibromoethyl)-2,2-dimethyl-cyclopropanecarboxylic acid, cyano(3-phenoxyphenyl)methyl ester). The residue is fat-soluble ¹ The information provided to the JMPR precludes an estimate that the dietary intake would be below the acute reference dose. Acute RfD: 0.05 mg/kg bw</p>					
Diflubenzuron ** (130)	0-0.02	FP 0226	Apple	W	1		
		JF 0226	Apple juice	-	-		0.072
		VB 0402	Brussels sprouts	W	1		
		VB 0041	Cabbages, head	W	1		
		FC 0001	Citrus fruits	0.5	1	0.26	
		SO 0691	Cotton seed	W	0.2		
		MO 0105	Edible offal (mammalian)	0.1*	0.05*	0.1	
		PE 0112	Eggs (poultry)	0.05*	0.05*	0.05	
		MM 0095	Meat (from mammals other than marine mammals)	0.1 (fat)	0.05*	0.1	
		ML 0106	Milks	0.02*F	0.05*	0.02	
		VO 0450	Mushrooms	0.3	0.1	0.075	
		FP 0230	Pear	W	1		
		FS 0014	Plums (including prunes)	W	1		
		FP 0009	Pome fruit	5	-	0.6	
		PM 0110	Poultry meat	0.05* (fat)	0.05*	0.05	
		GC 0649	Rice	0.01*	-	0.01	
		AS 0649	Rice straw and fodder, dry	0.7		0.04	
		VD 0541	Soya bean (dry)	W	0.1		
		VO 0448	Tomato	W	1		
		<p><i>Residue</i> (For compliance with MRL and for estimation of dietary intake) for plant and animal commodities: Diflubenzuron The residue is fat-soluble. Acute RfD: Unnecessary</p>					
Esfenvalerate*(204)	0-0.02				Fenvalerate (CXL)		
		SO 0691	Cotton seed	0.05	0.2	0.01	0.04
		MO 0105	Edible offal (mammalian)		0.02		
		PE 0112	Eggs	0.01*		0.01	0.01

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg	
				New	Previous			
		MM 0095	Meat (from mammals other than marine mammals)		1 (fat)			
		ML 0106	Milks		0.1F			
		PM 0110	Poultry meat	0.01* (fat)		0.01	0.01	
		PO 0111	Poultry, Edible offal of	0.01*		0.01	0.01	
		SO 0495	Rapeseed	0.01*		0.01	0.01	
		VD 0541	Soya bean (dry)	-	0.1			
		VO 0448	Tomato	0.1	1	0.02	0.04	
			Tomato paste			0.01		
			Tomato puree			0.01		
		GC 0654	Wheat	0.05		0.01	0.03	
					(fenvalerate)			
		AS 0654	Wheat straw and fodder, dry	2	2 (cereal grains)	0.47		
			<i>Residue</i> (For compliance with MRL and for estimation of dietary intake): sum of fenvalerate isomers. The residue is fat soluble. Acute RfD: 0.02 mg/kg bw					
Ethephon (106)	0-0.05		Acute RfD: 0.05 mg/kg bw					
Fenamiphos (85)	0-0.0008		Acute RfD: 0.003 mg/kg bw					
Flutolanil* (205)	0-0.09	PE 0112	Eggs	0.05*		0		
		MO 0098	Kidney of cattle, goats, pigs and sheep	0.1		0.012		
		MO 0099	Liver of cattle, goats, pigs and sheep	0.2		0.047		
		MM 0095	Meat (from mammals other than marine mammals)	0.05*		0		
		ML 0106	Milks	0.05*		0		
		PO 0111	Poultry edible offal	0.05*		0.05		
		PM 0110	Poultry meat	0.05*		0		
		CM 1206	Rice bran, unprocessed	10		1.7		
		AS 0649	Rice straw and fodder, dry	10		3.7		
		CM 0649	Rice, husked	2		0.39		
		CM 1205	Rice, polished	1		0.195		
			<i>Residue</i> (For compliance with MRL and for estimation of dietary intake): for plant commodities: flutolanil.. for animal commodities: flutolanil and transformation products containing the 2-trifluoromethyl-benzoic acid moiety, expressed as flutolanil. Acute RfD: Unnecessary					
Imidacloprid (206)	0-0.06	FP 0226	Apple	0.5		0.07	0.23	
		DF 0226	Apples, dried			0.061		
		JF 0226	Apple juice			0.046		
		AB 0226	Apple pomace, dry	5		0.364		

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR- P, mg/kg
				New	Previous		
			Apple sauce			0.053	
		FS 0240	Apricot	0.5		0.12	0.32
			Apricot jam			0.046	
			Apricot, canned			0.046	
		FI 0327	Banana	0.05		0.01	0.05
		AS 0640	Barley straw and fodder (dry) ^a	1		0.056	
		VP 0061	Beans, except broad bean and soya bean	2		0.4	0.88
			Beans, except broad bean and soya bean, cooked			0.39	
			Beans, except broad bean and soya bean, canned			0.17	
			Beer			0.0025	
		VB 0400	Broccoli	0.5		0.08	0.32
		VB 0402	Brussels sprouts	0.5		0.08	0.32
		VB 0041	Cabbages, head	0.5		0.08	0.32
		VB 0404	Cauliflower	0.5		0.08	0.32
		GC 0080	Cereals grains	0.05		0.05	0.05
		FS 0244	Cherry, sweet	0.5		0.14	0.28
			Cherry, sweet, canned			0.084	
		FC 0001	Citrus fruits	1		0.05	0.11
		JF 0001	Citrus juice			0.014	
		AB 0001	Citrus pulp, dry	10		0.374	
			Citrus marmalade (orange)			0.03	
		VC 0424	Cucumber	1		0.31	0.39
		DF 0269	Dried grapes			0.12	
		MO 0105	Edible offal (Mammalian)	0.05		0.006	0.036
		VO 0440	Egg plant	0.2		0.05	0.14
		PE 0112	Eggs	0.02*		0	0.001
		FB 0269	Grapes	1		0.11	0.61
		JF 0269	Grape juice			0.08	
		DH 1100	Hops, dry	10		0.7	
		VA 0384	Leek	0.05*		0.05	0.05
		VL 0482	Lettuce, Head	2		0.9	1.2
		AS 0645	Maize fodder ^a	0.2		0.06	
		AF 0645	Maize forage ^a	0.5		0.125	
		FI 0345	Mango	0.2		0.05	0.15
		MM 0095	Meat (from mammals other than marine mammals)	0.02*		0.001 (muscle) 0 (fat)	0.007 (muscle) 0.004(fat)
		VC 0046	Melons, except Watermelon	0.2		0.05	0.11
		ML0106	Milks	0.02*		0.0014	
		FS 0245	Nectarine	0.5		0.12	0.32
			Nectarine jam			0.046	
			Nectarine, canned			0.046	
		AF 0647	Oat forage (green) ^a	5		0.32	
		AS 0647	Oat straw and fodder, dry ^a	1		0.056	
		VA 0385	Onion, Bulb	0.1		0.05	0.06

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg
				New	Previous		
		FS 0247	Peach	0.5		0.12	0.32
			Peach jam			0.046	
			Peach, canned			0.046	
		FP 0230	Pear	1		0.38	0.71
		TN 0672	Pecan	0.05		0.05	0.05
		VO 0051	Peppers ^a	1		0.15	0.48
		FS 0014	Plums (including prunes)	0.2		0.05	0.12
		PM 0110	Poultry meat	0.02*		0(muscle) 0(fat)	0.0004 (muscle) 0 (fat)
		PO 0111	Poultry, Edible offal of	0.02*		0.0026	0.0026
		VR 0589	Potato	0.5		0.05	0.28
			Potato chips			0.068	
			Potato granules			0.046	
		SO 0495	Rape seed	0.05*		0.05	0.05
		AF 0650	Rye forage (green) ^a	5		0.32	
		AS 0650	Rye straw and fodder, dry ^a	1		0.056	
		VC 0431	Squash, Summer	1		0.31	0.39
		VO 0447	Sweet corn (corn-on-the-cob)	0.02*		0.01	0.02
		VR 0596	Sugar beet	0.05*		0.05	
		AV 0596	Sugar beet leaves or tops ^a	5		1.8	
		VO0448	Tomato	0.5		0.08	0.29
			Tomato paste			0.458	
			Tomato puree			0.184	
		JF 0448	Tomato juice			0.11	
			Tomato ketchup			0.16	
			Tomato, canned			0.073	
			Triticale forage ^a			0.32	2.4
			Triticale straw and fodder (dry) ^a	1		0.056	
		VC 0432	Watermelon	0.2		0.05	0.06
		CM 0654	Wheat bran, unprocessed	0.3		0.175	
		CF 1211	Wheat flour	0.03		0.025	
			Wheat forage ^a			0.32	2.4
		AS 0654	Wheat straw and fodder, dry ^a	1		0.056	
			Wine			0.13	
		^a Expressed on dry weight basis <i>Residue</i> (For compliance with MRLs and for estimation of dietary intake): Sum of imidacloprid and its metabolites containing the 6-chloropyridinyl moiety, expressed as imidacloprid. Acute RfD: 0.4 mg/kg bw					
Lindane** (48)	0-0.005	Acute RfD: 0.06 mg/kg bw					
Metalaxyl-M and metalaxyl** (138)	0-0.08 (group ADI)	Acute RfD: Unnecessary					
Methamidophos** (100)	0-0.004	Acute RfD: 0.01 mg/kg bw					
Oxamyl** (126)	0-0.009	FP 0226	Apple ¹	2	2	0.35	1.2
		FI 0327	Banana	W	0.2		

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR- P, mg/kg
				New	Previous		
		VP 0061	Beans, except broad bean and soya bean	W	0.2		
		VR 0577	Carrot	0.1	-	0.03	0.07
		VS 0624	Celery	W	5		
		FC 0001	Citrus fruits ¹	3	5	0.17	2
		SB 0716	Coffee beans	W	0.1		
		SO 0691	Cotton seed	0.2	0.2	0.035	0.08
		OC 0691	Cotton seed oil, crude			0.0003	
		OR 0691	Cotton seed oil, edible			0.0003	
		VC 0424	Cucumber ¹	1	2	0.37	0.54
		MO 0096	Edible offal (mammalian)	0.02 (*)	-	0	0
		PE 0112	Eggs	0.02 (*)	-	0	0
		GC 0645	Maize	W	0.05 (*)		
		MM 0095	Meat (from mammals other than marine mammals)	0.02 (*)		0	0
		VC 0046	Melons, except watermelon ¹	1	2	0.37	0.54
		ML 0106	Milks	0.02 (*)		0	
		VA 0385	Onion, Bulb	W	0.05 (*)		
			Orange oil			0.006	
		SO 0697	Peanut	0.05	0.1	0.02	0.03
		AL 0697	Peanut fodder	0.2	2	0.041	
			Peanut oil, crude			0.0034	
			Peanut oil, refined			0.0034	
		VO 0051	Peppers ¹	5	-	0.755	4.3
		VO 0445	Peppers, Sweet	W	2		
		FI 0353	Pineapple	W	1		
		VR 0589	Potato	0.1	-	0.02	0.05
		PM 0110	Poultry meat	0.02 (*)	-	0	0
		PO 0111	Poultry, Edible offal of	0.02 (*)	-	0	0
		VR 0075	Root and tuber vegetables	W	0.1		
		VD 0541	Soya bean (dry)	W	0.1		
		VC 0431	Squash, Summer	W	2		
		GS 0659	Sugar cane	W	0.05 (*)		
		VO 0448	Tomato ¹	2	2	0.58	0.99
			Tomato canned fruit			0.042	
			Tomato catsup			0.14	
		JF 0448	Tomato juice			0.07	
			Tomato paste			0.21	
			Tomato puree			0.093	
		VC 0432	Watermelon	W	2		
			<i>Residue</i> (For compliance with MRLs and for estimation of dietary intake): Sum of oxamyl and oxamyl-oxime expressed as oxamyl. ¹ The information provided to the JMPR precludes an estimate that the dietary intake would be below the acute reference dose.				
			Acute RfD: 0.009 mg/kg bw				
Oxydemeton-methyl (166)	0- 0.0003		Acute RfD: 0.002 mg/kg bw				

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg
				New	Previous		
2-phenylphenol (056)	0-0.4	FP 230	Pear	20	W	8	
			<i>Residue</i> (For compliance with MRLs and for estimation of dietary intake) for plant commodities: sum of 2-phenylphenol and sodium 2-phenylphenate, free and conjugated, expressed as 2-phenylphenol. Acute RfD: Unnecessary				
Phosmet (103)	0-0.01	FP 0226	Apple	W	10		
		FB 0020	Blueberries ¹	15	W	4.0	9.9
		FC 0001	Citrus fruits ¹	3	W	0.21	0.52
		AB 0001	Citrus pulp, dry			0.03	
		JF 0004	Orange juice			0.03	-
		FS 0245	Nectarine ¹	10	W	1.6	6.8
		FP 0230	Pome fruit ¹	10		3.3	7.3
		TN 0085	Tree nuts	0.2	W	0.05	0.09
			<i>Residue</i> (For compliance with MRL and for estimation of dietary intake): phosmet ¹ ¹ The information provided to the JMPR precludes an estimate that the dietary intake would be below the acute reference dose. Acute RfD: 0.02 mg/kg bw				
Piperonyl butoxide (062)	0-0.2	MO 1280	Cattle kidney	0.3 ^a		0.21 ^{a,b}	
		MM 0812	Cattle meat	5.0 ^a (fat)		2.6 ^{a,b}	
		ML 0812	Cattle milk	0.2 ^a F		0.14 ^{a,b}	
			Cattle muscle			0.16 ^{a,b}	
		GC 0080	Cereal grains	30 Po		11 Po	
		FC 0001	Citrus fruits	5		1.0	
		AB 0001	Citrus pulp, dry			5.7	
		JF 0001	Citrus juice	0.05		0.01	
		DM 0001	Citrus molasses			0.53	
		DF 0167	Dried fruits	0.2 Po		0.05 Po	
		PE 0112	Eggs	1 ^a		0.36 ^{a,b}	
		VC 0045	Fruiting vegetables, Cucurbits	1		0.26	
		MO 0098	Kidney of cattle, goats, pigs and sheep (except cattle)	0.2 ^c		0.034	
		VL 0483	Lettuce, Leaf	50		38	
		MO 0099	Liver of cattle, goats, pigs and sheep	1		0.094	
		OC 0645	Maize oil, crude	80 PoP		29.7	
		MM 0095	Meat fat (from mammals others than marine mammals)	2 (fat)		0.14	
			Muscle (from mammals others than marine mammals), except cattle			0.034	
		ML 0106	Milks, except cattle milk	0.05 F		0.007	
		VL 0485	Mustard greens	50		38	
		AL 0072	Pea hay or Pea fodder (dry)	200 dry wt		33.5 dry wt	
		AL 0528	Pea vine (green)	400 dry wt		108 dry wt	
		SO 0703	Peanut, whole	1 Po		0.1 Po	
		VO 0051	Peppers	2		0.675	

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg	
				New	Previous			
			Potato peel, wet			0.15		
		PO 0111	Poultry Edible offal of	10 ^a		2.0 ^{a,b}		
		PM 0110	Poultry meat	7 (fat) ^a		2.0 ^{a,b}		
			Poultry muscle			1.0 ^{a,b}		
		VD 0070	Pulses	0.2 Po		0.05 Po		
		VL 0494	Radish leaves (including Radish tops)	50		38		
		VR 0075	Root and tuber vegetables, except carrots	0.5		0.10		
		VL 0502	Spinach	50		38		
		VO 0448	Tomato	2		0.675		
		JF 0448	Tomato juice	0.3		0.10		
			Tomato purée			0.22		
		GC 0654	Wheat	30 Po	10 Po	11		
		CM 0654	Wheat bran, unprocessed	80 PoP		29.7 PoP		
		CF 1211	Wheat flour	10 PoP		3.5 PoP		
		CF 1210	Wheat germ	90 PoP		33 PoP		
		CF 1212	Wheat wholemeal	30 PoP		10.8 PoP		
			<p><i>Residue</i> (For compliance with MRLs and for estimation of dietary intake) for plant and animal commodities: piperonyl butoxide The residue is fat soluble ^a The MRL accommodates external animal treatment ^b Not STMR value but median residue concentrations in animals in a treated group ^c The MRL for cattle kidney (MO 1280) is higher than for other species of kidneys because of direct treatment of cattle. The Codex commodity MO 0098 includes cattle in its standard wording, but cattle kidney has to be excluded in this case because of the higher cattle kidney MRL Acute RfD: Unnecessary</p>					
Propargite **(113)	0-0.01							
		AL 1020	Alfalfa fodder	W	75			
		AL 1021	Alfalfa forage, (green)	W	50			
		TN 0660	Almonds	0.1	0.1 *	0.05		
		AM 0738	Almond hulls	50	-	15		
		FP 0226	Apple	3	5	0.51		
		AB 0226	Apple pomace, dry	W	80			
		JF 0226	Apple juice	0.2	-	0.03		
			Apple puree (sauce)			1.4		
		FS 0240	Apricot	W	7			
		VD 0071	Beans (dry)	W	0.2			
			Beer			0.02		
		FC 0001	Citrus fruits	3	5	0.01		
		AB 0001	Citrus pulp, dry	10	40	1.4		
		VP 0526	Common bean (pods and/or immature seeds)	W	20			
		SO0691	Cotton seed	0.1	0.1*	0.02		
		OR 0691	Cotton seed, oil, edible	0.2	-	0.02		
			Cotton seed hulls	-	-	0.06		
			Cotton seed meal	-	-	0.002		

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg
				New	Previous		
			Cotton gin byproducts	-	-	8.4	
		FB 0265	Cranberry	W	10		
		VC 0424	Cucumber	W	0.5		
		DF 0269	Dried grapes (=currants, raisins and sultanas)	12	10	0.75	
		PE 0112	Eggs	0.1 *	0.1	0	
		FT 0297	Fig	W	2		
		AB 0269	Grape pomace, dry	40	40		
		FB 0269	Grapes	7	10	0.45	
		JF 0269	Grape juice	1	-	0.05	
		DH 1100	Hops, dry	100	30	18	
		GC 0645	Maize	0.1	0.1	0.05	
		AS 0645	Maize fodder	W	10		
		AF 0645	Maize forage	W	10		
		CF 1255	Maize flour	0.2	-	0.08	
		CF 0645	Maize meal	-	-	0.06	
			Maize grits	-	-	0.05	
			Maize grain dust	-	-	1.6	
		OC 0645	Maize oil, crude	0.7	-	-	
		OR 0645	Maize oil, edible	0.5	-	0.26	
		MM 0095	Meat (from mammals other than marine mammals)	0.1 * (fat)	0.1 (fat)	0.02 (fat)	
		ML 0106	Milks	0.1 * F	0.1 F	0.001 F	
		AM 0738	Mint hay	W	50		
		FS 0245	Nectarine	W	7		
		MO0105	Offal of mammals	0.1 *	-	0.004	
		JF 0004	Orange juice	0.3	-	0.05	
		FS 0247	Peach	W	7		
		SO 0697	Peanut	0.1 *	0.1 *	0.05	
		AL 0697	Peanut fodder	W	10		
		AL 1270	Peanut forage (green)	W	10 fresh weight		
		OC 0697	Peanut oil, crude	0.3	-		
		OR 0697	Peanut oil, edible	0.3	-	0.12	
			Peanut meal	-	-	0.03	
		FP 0230	Pear	W	5		
		FD 0014	Plums (including Prunes)	W	7		
		VR 0589	Potato	W	0.1 *		
		PM 0110	Poultry meat	0.1 * (fat)	0.1 (fat)	0	
		PO 0111	Poultry, edible offal of	0.1 *	-	0	
		GC 0651	Sorghum	W	5		
		AF 0651	Sorghum forage (green)	W	10 fresh weight		
		AS 0651	Sorghum straw and fodder, dry	W	10		
		FS 0012	Stone fruit	4	-	0.87	
		FB 0275	Strawberry	W	7		
		DT 1114	Tea, Green, Black	5	10	1.0	
		VO 0448	Tomato	2	2	0.17	

Pesticide	ADI, mg/kg bw	CCN	Commodity	Recommended MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR- P, mg/kg
				New	Previous		
			Tomato puree	-	-	0.20	
		TN 0678	Walnuts	W	0.1 *		
		FB1236	Wine from grapes		-	0.01	
		<i>Residue</i> (For compliance with MRLs and for estimation of dietary intake): Propargite. The residue is fat-soluble Acute RfD: Unnecessary.					
Tolyfluanid** (162)	0-0.08	FB 0264	Blackberries	5	-	1.95	2.9
		VC 0424	Cucumber	1	-	0.37	0.96
		FB 0021	Currants, Black, Red, White	0.5	5	0.345	0.68
			Black currant, washed			0.29	0.57
		JF 1140	Black currant juice			0.09	
			Black currant jelly			0.19	
		VC 0425	Gherkin	W	2		
		FB 0269	Grapes	3	-	0.75	2.0
			Grape wine			0.75	
		JF 0269	Grape juice			0.40	
		DF 0269	Dried grapes (= Currants, Raisins and Sultanas)			2.3	
		DH 1100	Hops, dry	50	-	25	71
			Beer			0.025	
		VA 0384	Leek	2	-	0.97	1.8
		VL 0482	Lettuce, Head	0.2	1	0.05	0.17
		VO 0445	Peppers, sweet	2	-	0.67	1.6
		FP 0009	Pome fruits	5	5	0.68	4.0
		JF 0226	Apple juice			0.06	
			Apple sauce			0.22	
			Canned apple			0.04	
			Pear juice			0.02	
			Canned pear			0.01	
		FB 0272	Raspberries, Red, Black	5	-	1.95	2.9
		FB 0275	Strawberry	5	3	0.84	3.0
			Strawberry, washed			0.50	1.8
			Strawberry jam			0.18	
			Canned strawberry			0.18	
		VO 0448	Tomato	3	2	0.39	2.2
		JF 0448	Tomato juice			0.20	
			Tomato paste			1.6	
			Tomato puree			0.66	
		<i>Residue</i> (For compliance with MRLs) for plant commodities: tolylfluanid (For estimations of dietary intake) for plant commodities' sum of tolylfluanid and DMST expressed as tolylfluanid Acute RfD: 0.5 mg/kg bw					
Triazophos** (143)	0-0.001	Acute RfD: 0.001 mg/kg bw					

ANNEX 2

INDEX OF REPORTS AND EVALUATIONS OF PESTICIDES BY THE JMPR

Numbers in parentheses after the names of pesticides are Codex classification numbers. The abbreviations used are:

- T, evaluation of toxicology
- R, evaluation of residue and analytical aspects
- E, evaluation of effects on the environment

Abamectin (177)	1992 (T,R), 1994 (T,R), 1995 (T), 1997 (T,R), 2000 (R)
Acephate (095)	1976 (T,R), 1979 (R), 1981 (R), 1982 (T), 1984 (T,R), 1987 (T), 1988 (T), 1990 (T,R), 1991 (corr. to 1990 R evaluation), 1994 (R), 1996 (R), 2002 (T)
Acrylonitrile	1965 (T,R)
Aldicarb (117)	1979 (T,R), 1982 (T,R), 1985 (R), 1988 (R), 1990 (R), 1991 (corr. to 1990 evaluation), 1992 (T), 1993 (R), 1994 (R), 1996 (R), 2001 (R), 2002 (R)
Aldrin (001)	1965 (T), 1966 (T,R), 1967 (R), 1974 (R), 1975 (R), 1977 (T), 1990 (R), 1992 (R)
Allethrin	1965 (T,R)
Aminocarb (134)	1978 (T,R), 1979 (T,R)
Aminomethylphosphonic acid (AMPA, 198)	1997 (T,R)
Amitraz (122)	1980 (T,R), 1983 (R), 1984 (T,R), 1985 (R), 1986 (R), 1989 (R), 1990 (T,R), 1991 (R & corr. to 1990 R evaluation), 1998 (T)
Amitrole (079)	1974 (T,R), 1977 (T), 1993 (T,R), 1997 (T), 1998 (R)
Anilazine (163)	1989 (T,R), 1992 (R)
Azinphos-ethyl (068)	1973 (T,R), 1983 (R)
Azinphos-methyl (002)	1965 (T), 1968 (T,R), 1972 (R), 1973 (T), 1974 (R), 1991 (T,R), 1992 (corr. to 1991 report), 1993 (R), 1995 (R)
Azocyclotin (129)	1979 (R), 1981 (T), 1982 (R), 1983 (R), 1985 (R), 1989 (T,R), 1991 (R), 1994 (T)
Benalaxyl (155)	1986 (R), 1987 (T), 1988 (R), 1992 (R), 1993 (R)
Bendiocarb (137)	1982 (T,R), 1984 (T,R), 1989 (R), 1990 (R)
Benomyl (069)	1973 (T,R), 1975 (T,R), 1978 (T,R), 1983 (T,R), 1988 (R), 1990 (R), 1994 (R), 1995 (T,E), 1998 (R)

Bentazone (172)	1991 (T,R), 1992 (corr. to 1991 report, Annex I), 1994 (R), 1995 (R), 1998 (T,R), 1999 (corr. to 1998 report)
BHC (technical-grade)	1965 (T), 1968 (T,R), 1973 (T,R) (see also Lindane)
Bifenthrin (178)	1992 (T,R), 1995 (R), 1996 (R), 1997 (R)
Binapacryl (003)	1969 (T,R), 1974 (R), 1982 (T), 1984 (R), 1985 (T,R)
Bioresmethrin (093)	1975 (R), 1976 (T,R), 1991 (T,R)
Biphenyl	See Diphenyl
Bitertanol (144)	1983 (T), 1984 (R), 1986 (R), 1987 (T), 1988 (R), 1989 (R), 1991 (R), 1998 (T), 1999 (R), 2002 (R)
Bromide ion (047)	1968 (R), 1969 (T,R), 1971 (R), 1979 (R), 1981 (R), 1983 (R), 1988 (T,R), 1989 (R), 1992 (R)
Bromomethane (052)	1965 (T,R), 1966 (T,R), 1967 (R), 1968 (T,R), 1971 (R), 1979 (R), 1985 (R), 1992 (R)
Bromophos (004)	1972 (T,R), 1975 (R), 1977 (T,R), 1982 (R), 1984 (R), 1985 (R)
Bromophos-ethyl (005)	1972 (T,R), 1975 (T,R), 1977 (R)
Bromopropylate (070)	1973 (T,R), 1993 (T,R)
Butocarboxim (139)	1983 (R), 1984 (T), 1985 (T), 1986 (R)
Buprofezin (173)	1991 (T,R), 1995 (R), 1996 (corr. to 1995 report.), 1999 (R)
<i>sec</i> -Butylamine (089)	1975 (T,R), 1977 (R), 1978 (T,R), 1979 (R), 1980 (R), 1981 (T), 1984 (T,R: withdrawal of temporary ADI, but no evaluation)
Cadusafos (174)	1991 (T,R), 1992 (R), 1992 (R)
Campheclor (071)	1968 (T,R), 1973 (T,R)
Captafol (006)	1969 (T,R), 1973 (T,R), 1974 (R), 1976 (R), 1977 (T,R), 1982 (T), 1985 (T,R), 1986 (corr. to 1985 report), 1990 (R), 1999 (acute Rf D)
Captan (007)	1965 (T), 1969 (T,R), 1973 (T), 1974 (R), 1977 (T,R), 1978 (T,R), 1980 (R), 1982 (T), 1984 (T,R), 1986 (R), 1987 (R and corr. to 1986 R evaluation), 1990 (T,R), 1991 (corr. to 1990 R evaluation), 1994 (R), 1995 (T), 1997 (R), 2000 (R)
Carbaryl (008)	1965 (T), 1966 (T,R), 1967 (T,R), 1968 (R), 1969 (T,R), 1970 (R), 1973 (T,R), 1975 (R), 1976 (R), 1977 (R), 1979 (R), 1984 (R), 1996 (T), 2001 (T), 2002 (R)
Carbendazim (072)	1973 (T,R), 1976 (R), 1977 (T), 1978 (R), 1983 (T,R), 1985 (T,R), 1987 (R), 1988 (R), 1990 (R), 1994 (R), 1995 (T,E), 1998 (T,R)
Carbofuran (096)	1976 (T,R), 1979 (T,R), 1980 (T), 1982 (T), 1991 (R), 1993 (R), 1996 (T), 1997 (R), 1999 (corr. to 1997 report), 2002 T (R)
Carbon disulfide (009)	1965 (T,R), 1967 (R), 1968 (R), 1971 (R), 1985 (R)
Carbon tetrachloride (010)	1965 (T,R), 1967 (R), 1968 (T,R), 1971 (R), 1979 (R),

Carbophenothion (011)	1985 (R) 1972 (T,R), 1976 (T,R), 1977 (T,R), 1979 (T,R), 1980 (T,R), 1983 (R)
Carbosulfan (145)	1984 (T,R), 1986 (T), 1991 (R), 1992 (corr. to 1991 report), 1993 (R), 1997 (R), 1999 (R), 2002 (R)
Cartap (097)	1976 (T,R), 1978 (T,R), 1995 (T,R)
Chinomethionat (080)	1968 (T,R) (as oxythioquinox), 1974 (T,R), 1977 (T,R), 1981 (T,R), 1983 (R), 1984 (T,R), 1987 (T)
Chlorbenside	1965 (T)
Chlordane (012)	1965 (T), 1967 (T,R), 1969 (R), 1970 (T,R), 1972 (R), 1974 (R), 1977 (T,R), 1982 (T), 1984 (T,R), 1986 (T)
Chlordimeform (013)	1971 (T,R), 1975 (T,R), 1977 (T), 1978 (T,R), 1979(T), 1980(T), 1985(T), 1986 (R), 1987 (T)
Chlorfenson	1965 (T)
Chlorfenvinphos (014)	1971 (T,R), 1984 (R), 1994 (T), 1996 (R)
Chlormequat (015)	1970 (T,R), 1972 (T,R), 1976 (R), 1985 (R), 1994 (T,R), 1997 (T), 1999 (acute Rf D), 2000 (R)
Chlorobenzilate (016)	1965 (T), 1968 (T,R), 1972 (R), 1975 (R), 1977 (R), 1980 (T)
Chloropicrin	1965 (T,R)
Chloropropylate	1968 (T,R), 1972 (R)
Chlorothalonil (081)	1974 (T,R), 1977 (T,R), 1978 (R), 1979 (T,R), 1981 (T,R), 1983 (T,R), 1984 (corr. to 1983 report and T evaluation), 1985 (T,R), 1987 (T), 1988 (R), 1990 (T,R), 1991 (corr. to 1990 evaluation), 1992 (T), 1993 (R), 1997 (R)
Chlorpropham	1965 (T), 2000 (T), 2001 (R)
Chlorpyrifos (017)	1972 (T,R), 1974 (R), 1975 (R), 1977 (T,R), 1981 (R), 1982 (T,R), 1983 (R), 1989 (R), 1995 (R), 1999 (T), 2000 (R)
Chlorpyrifos-methyl (090)	1975 (T,R), 1976 (R, Annex I only), 1979 (R), 1990 (R), 1991 (T,R), 1992 (T and corr. to 1991 report), 1993 (R), 1994 (R), 2001 (T)
Chlorthion	1965 (T)
Clethodim (187)	1994 (T,R), 1997 (R), 1999 (R), 2002 (R)
Clofentezine (156)	1986 (T,R), 1987 (R), 1989 (R), 1990 (R), 1992 (R)
Coumaphos (018)	1968 (T,R), 1972 (R), 1975 (R), 1978 (R), 1980 (T,R), 1983 (R), 1987 (T), 1990 (T,R)
Crufomate (019)	1968 (T,R), 1972 (R)
Cyanophenfos (091)	1975 (T,R), 1978 (T: ADI extended, but no evaluation), 1980, (T), 1982 (R), 1983 (T)
Cycloxydim (179)	1992 (T,R), 1993 (R)

Cyfluthrin (157)	1986 (R), 1987 (T and corr. to 1986 report), 1989 (R), 1990 (R), 1992 (R)
Cyhalothrin (146)	1984 (T,R), 1986 (R), 1988 (R)
Cyhexatin (tricyclohexyltin hydroxide) (067)	1970 (T,R), 1973 (T,R), 1974 (R), 1975 (R), 1977 (T), 1978 (T,R), 1980 (T), 1981 (T), 1982 (R), 1983 (R), 1985 (R), 1988 (T), 1989 (T), 1991 (T,R), 1992 (R), 1994 (T)
Cypermethrin (118)	1979 (T,R), 1981 (T,R), 1982 (R), 1983 (R), 1984 (R), 1985 (R), 1986 (R), 1987 (corr. to 1986 evaluation), 1988 (R), 1990 (R)
Cyromazine (169)	1990 (T,R), 1991 (corr. to 1990 R evaluation), 1992 (R)
2,4-D (020)	1970 (T,R), 1971 (T,R), 1974 (T,R), 1975 (T,R), 1980 (R), 1985 (R), 1986 (R), 1987 (corr. to 1986 report, Annex I), 1996 (T), 1997 (E), 1998 (R), 2001 (R)
Daminozide (104)	1977 (T,R), 1983 (T), 1989 (T,R), 1991 (T)
DDT (021)	1965 (T), 1966 (T,R), 1967 (T,R), 1968 (T,R), 1969 (T,R), 1978 (R), 1979 (T), 1980 (T), 1983 (T), 1984 (T), 1993 (R), 1994 (R), 1996 (R)
Deltamethrin (135)	1980 (T,R), 1981 (T,R), 1982 (T,R), 1984 (R), 1985 (R), 1986 (R), 1987 (R), 1988 (R), 1990 (R), 1992 (R), 2000 (T), 2002 (R)
Demeton (092)	1965 (T), 1967 (R), 1975 (R), 1982 (T)
Demeton-S-methyl (073)	1973 (T,R), 1979 (R), 1982 (T), 1984 (T,R), 1989 (T,R), 1992 (R), 1998 (R)
Demeton-S-methylsulphon (164)	1973 (T,R), 1982 (T), 1984 (T,R), 1989 (T,R), 1992 (R)
Dialifos (098)	1976 (T,R), 1982 (T), 1985 (R)
Diazinon (022)	1965 (T), 1966 (T), 1967 (R), 1968 (T,R), 1970 (T,R), 1975 (R), 1979 (R), 1993 (T,R), 1994 (R), 1996 (R), 1999 (R), 2001 (T)
1,2-Dibromoethane (023)	1965 (T,R), 1966 (T,R), 1967 (R), 1968 (R), 1971 (R), 1979 (R), 1985 (R)
Dichlorfluamid (082)	1969 (T,R), 1974 (T,R), 1977 (T,R), 1979 (T,R), 1981 (R), 1982 (R), 1983 (T,R), 1985 (R)
1,2-Dichloroethane (024)	1965 (T,R), 1967 (R), 1971 (R), 1979 (R), 1985 (R)
Dichlorvos (025)	1965 (T,R), 1966 (T,R), 1967 (T,R), 1969 (R), 1970 (T,R), 1974 (R), 1977 (T), 1993 (T,R)
Dicloran (083)	1974 (T,R), 1977 (T,R), 1998 (T,R)
Dicofol (026)	1968 (T,R), 1970 (R), 1974 (R), 1992 (T,R), 1994 (R)
Dieldrin (001)	1965 (T), 1966 (T,R), 1967 (T,R), 1968 (R), 1969 (R), 1970 (T,R), 1974 (R), 1975 (R), 1977 (T), 1990 (R), 1992 (R)

Diflubenzuron (130)	1981 (T,R), 1983 (R), 1984 (T,R), 1985 (T,R), 1988 (R), 2001 (T), 2002 (R)
Dimethipin (151)	1985 (T,R), 1987 (T,R), 1988 (T,R), 1999 (T), 2001 (R)
Dimethoate (027)	1965 (T), 1966 (T), 1967 (T,R), 1970 (R), 1973 (R in evaluation of formothion), 1977 (R), 1978 (R), 1983 (R) 1984 (T,R) 1986 (R), 1987 (T,R), 1988 (R), 1990 (R), 1991 (corr. to 1990 evaluation), 1994 (R), 1996 (T), 1998 (R)
Dimethrin	1965 (T)
Diinocap (087)	1969 (T,R), 1974 (T,R), 1989 (T,R), 1992 (R), 1998 (R), 1999 (R), 2000 (T), 2001 (R)
Dioxathion (028)	1968 (T,R), 1972 (R)
Diphenyl (029)	1966 (T,R), 1967 (T)
Diphenylamine (030)	1969 (T,R), 1976 (T,R), 1979 (R), 1982 (T), 1984 (T,R), 1998 (T), 2001 (R)
Diquat (031)	1970 (T,R), 1972 (T,R), 1976 (R), 1977 (T,R), 1978 (R), 1994 (R)
Disulfoton (074)	1973 (T,R), 1975 (T,R), 1979 (R), 1981 (R), 1984 (R), 1991 (T,R), 1992 (corr. to 1991 report, Annex I), 1994 (R), 1996 (T), 1998 (R)
Dithianon (180)	1992 (T,R), 1995 (R), 1996 (corr. to 1995 report)
Dithiocarbamates (105)	1965 (T), 1967 (T,R), 1970 (T,R), 1983 (R propineb, thiram), 1984 (R propineb), 1985 (R), 1987 (T thiram), 1988 (R thiram), 1990 (R), 1991 (corr. to 1990 evaluation), 1992 (T thiram), 1993 (T,R), 1995 (R), 1996 (T,R ferbam, ziram, R thiram)
4,6-Dinitro- <i>ortho</i> -cresol (DNOC)	1965 (T)
Dodine (084)	1974 (T,R), 1976 (T,R), 1977 (R), 2000 (T)
Edifenphos (099)	1976 (T,R), 1979 (T,R), 1981 (T,R)
Endosulfan (032)	1965 (T), 1967 (T,R), 1968 (T,R), 1971 (R), 1974 (R), 1975 (R), 1982 (T), 1985 (T,R), 1989 (T,R), 1993 (R), 1998 (T)
Endrin (033)	1965 (T), 1970 (T,R), 1974 (R), 1975 (R), 1990 (R), 1992 (R)
Esfenvalerate (204)	2002 (T, R)
Ethephon (106)	1977 (T,R), 1978 (T,R), 1983 (R), 1985 (R), 1993 (T), 1994 (R), 1995 (T), 1997 (T), 2002 (T)
Ethiofencarb (107)	1977 (T,R), 1978 (R), 1981 (R), 1982 (T,R), 1983 (R)
Ethion (034)	1968 (T,R), 1969 (R), 1970 (R), 1972 (T,R), 1975 (R), 1982 (T), 1983 (R), 1985 (T), 1986 (T), 1989 (T), 1990 (T), 1994 (R)
Ethopropophos (149)	1983 (T), 1984 (R), 1987 (T), 1999 (R)
Ethoxyquin (035)	1969 (T,R), 1998 (T)
Ethylene dibromide	See 1,2-Dibromoethane
Ethylene dichloride	See 1,2-Dichloroethane
Ethylene oxide	1965 (T,R), 1968 (T,R), 1971 (R)

Ethylenethiourea (ETU) (108)	1974 (R), 1977 (T,R), 1986 (T,R), 1987 (R), 1988 (T,R), 1990 (R), 1993 (T,R)
Etofenprox (184)	1993 (T,R)
Etrimfos (123)	1980 (T,R), 1982 (T,R ¹), 1986 (T,R), 1987 (R), 1988 (R), 1989 (R), 1990 (R)
Fenamiphos (085)	1974 (T,R), 1977 (R), 1978 (R), 1980 (R), 1985 (T), 1987 (T), 1997 (T), 1999 (R), 2002 (T)
Fenarimol (192)	1995 (T,R,E), 1996 (R and corr. to 1995 report)
Fenbuconazole (197)	1997 (T,R)
Fenbutatin oxide (109)	1977 (T,R), 1979 (R), 1992 (T), 1993 (R)
Fenchlorfos (036)	1968 (T,R), 1972 (R), 1983 (R)
Fenitrothion (037)	1969 (T,R), 1974 (T,R), 1976 (R), 1977 (T,R), 1979 (R), 1982, (T) 1983 (R), 1984 (T,R), 1986 (T,R), 1987 (R and corr. to 1986 R evaluation), 1988 (T), 1989 (R), 2000 (T)
Fenpropathrin (185)	1993 (T,R)
Fenpropimorph (188)	1994 (T), 1995 (R), 1999 (R), 2001 (T)
Fenpyroximate (193)	1995 (T,R), 1996 (corr. to 1995 report.), 1999 (R)
Fensulfothion (038)	1972 (T,R), 1982 (T), 1983 (R)
Fenthion (039)	1971 (T,R), 1975 (T,R), 1977 (R), 1978 (T,R), 1979 (T), 1980 (T), 1983 (R), 1989 (R), 1995 (T,R,E), 1996 (corr. to 1995 report), 1997 (T), 2000 (R)
Fentin compounds (040)	1965 (T), 1970 (T,R), 1972 (R), 1986 (R), 1991 (T,R), 1993 (R), 1994 (R)
Fenvalerate (119)	1979 (T,R), 1981 (T,R), 1982 (T), 1984 (T,R), 1985 (R), 1986 (T,R), 1987 (R and corr. to 1986 report), 1988 (R), 1990 (R), 1991 (corr. to 1990 R evaluation)
Ferbam	See Dithiocarbamates, 1965 (T), 1967 (T,R), 1996 (T,R)
Fipronil	1997 (T), 2000 (T), 2001 (R)
Fipronil-desulfinyl	1997 (T)
Flucythrinate (152)	1985 (T,R), 1987 (R), 1988 (R), 1989 (R), 1990 (R), 1993 (R)
Flumethrin (195)	1996 (T,R)
Flusilazole (165)	1989 (T,R), 1990 (R), 1991 (R), 1993 (R), 1995 (T)
Flutolanil (205)	2002 (T, R)
Folpet (041)	1969 (T,R), 1973 (T), 1974 (R), 1982 (T), 1984 (T,R), 1986 (T), 1987 (R), 1990 (T,R), 1991 (corr. to 1990 R evaluation), 1993 (T,R), 1994 (R), 1995 (T), 1997 (R), 1998 (R), 1999(R)
Formothion (042)	2002 (T) 1969 (T,R), 1972 (R), 1973 (T,R), 1978 (R), 1998 (R)

Glufosinate-ammonium (175)	1991 (T,R), 1992 (corr. to 1991 report, Annex I), 1994 (R), 1998 (R), 1999 (T,R) GLYPHOSATE (158) 1986 (T,R), 1987 (R and corr. to 1986 report), 1988 (R), 1994 (R), 1997 (T,R)
Guazatine (114)	1978 (T,R), 1980 (R), 1997 (T,R)
Haloxyfop (194)	1995 (T,R), 1996 (R and corr. to 1995 report), 2001 (R)
Heptachlor (043)	1965 (T), 1966 (T,R), 1967 (R), 1968 (R), 1969 (R), 1970 (T,R), 1974 (R), 1975 (R), 1977 (R), 1987 (R), 1991 (T,R), 1992 (corr. to 1991 report, Annex I), 1993 (R), 1994 (R)
Hexachlorobenzene (044)	1969 (T,R), 1973 (T,R), 1974 (T,R), 1978(T), 1985 (R)
Hexaconazole (170)	1990 (T,R), 1991 (R and corr. to 1990 R evaluation), 1993 (R)
Hexythiazox (176)	1991 (T,R), 1994 (R), 1998 (R)
Hydrogen cyanide (045)	1965 (T,R)
Hydrogen phosphide (046)	1965 (T,R), 1966 (T,R), 1967 (R), 1969 (R), 1971 (R)
Imazalil (110)	1977 (T,R), 1980 (T,R), 1984 (T,R), 1985 (T,R), 1986 (T), 1988 (R), 1989 (R), 1991 (T), 1994 (R), 2000 (T), 2001 (T)
Imidacloprid	2001 (T), 2002 (R)
Iprodione (111)	1977 (T,R), 1980 (R), 1992 (T), 1994 (R), 1995 (T), 2001 (R)
Isofenphos (131)	1981 (T,R), 1982 (T,R), 1984 (R), 1985 (R), 1986 (T,R), 1988 (R), 1992 (R)
Kresoxim-methyl (199)	1998 (T,R), 2001 (R)
Lead arsenate	1965 (T), 1968 (T,R)
Leptophos (088)	1974 (T,R), 1975 (T,R), 1978 (T,R)
Lindane (048)	1965 (T), 1966 (T,R), 1967 (R), 1968 (R), 1969 (R), 1970 (T,R, published as Annex VI to 1971 evaluations), 1973 (T,R), 1974 (R), 1975 (R), 1977 (T,R), 1978 (R), 1979 (R), 1989 (T,R), 1997 (T), 2002 (T)
Malathion (049)	1965 (T), 1966 (T,R), 1967 (corr. to 1966 R evaluation), 1968 (R), 1969 (R), 1970 (R), 1973 (R), 1975 (R), 1977 (R), 1984 (R), 1997 (T), 1999 (R), 2000 (R)
Maleic hydrazide (102)	1976 (T,R), 1977 (T,R), 1980 (T), 1984 (T,R), 1996 (T), 1998 (R)
Mancozeb (050)	1967 (T,R), 1970 (T,R), 1974 (R), 1977 (R), 1980 (T,R), 1993 (T,R)
Maneb	See Dithiocarbamates, 1965 (T), 1967 (T,R), 1987 (T), 1993 (T,R)

Mecarbam (124)	1980 (T,R), 1983 (T,R), 1985 (T,R), 1986 (T,R), 1987 (R)
Metalaxyl (138)	1982 (T,R), 1984 (R), 1985 (R), 1986 (R), 1987 (R), 1989 (R), 1990 (R), 1992 (R), 1995 (R)
Metalaxyl-M	2002 (T)
Methacrifos (125)	1980 (T,R), 1982 (T), 1986 (T), 1988 (T), 1990 (T,R), 1992 (R)
Methamidiphos (100)	1976 (T,R), 1979 (R), 1981 (R), 1982 (T,R ²), 1984 (R), 1985 (T), 1989 (R), 1990 (T,R), 1994 (R), 1996 (R), 1997 (R), 2002 (T)
Methidathion (051)	1972 (T,R), 1975 (T,R), 1979 (R), 1992 (T,R), 1994 (R), 1997 (T)
Methiocarb (132)	1981 (T,R), 1983 (T,R), 1984 (T), 1985 (T), 1986 (R), 1987 (T,R), 1988 (R), 1998 (T), 1999 (R)
Methomyl (094)	1975 (R), 1976 (R), 1977 (R), 1978 (R), 1986 (T,R), 1987 (R), 1988 (R), 1989 (T,R), 1990 (R), 1991 (R), 2001 (T,R)
Methoprene (147)	1984 (T,R), 1986 (R), 1987 (T and corr. to 1986 report), 1988 (R), 1989 (R), 2001 (T)
Methoxychlor	1965 (T), 1977 (T)
Methyl bromide (052)	See Bromomethane
Metiram (186)	1993 (T), 1995 (R)
Mevinphos (053)	1965 (T), 1972 (T,R), 1996 (T), 1997 (E,R), 2000 (R)
MGK 264	1967 (T,R)
Monocrotophos (054)	1972 (T,R), 1975 (T,R), 1991 (T,R), 1993 (T), 1994 (R)
Myclobutanil (181)	1992 (T,R), 1997 (R), 1998 (R)
Nabam	See Dithiocarbamates, 1965 (T), 1976 (T,R)
Nitrofen (140)	1983 (T,R)
Omethoate (055)	1971 (T,R), 1975 (T,R), 1978 (T,R), 1979 (T), 1981 (T,R), 1984 (R), 1985 (T), 1986 (R), 1987 (R), 1988 (R), 1990 (R), 1998 (R)
Organomercury compounds	1965 (T), 1966 (T,R), 1967 (T,R)
Oxamyl (126)	1980 (T,R), 1983 (R), 1984 (T), 1985 (T,R), 1986 (R), 2002 (R)
Oxydemeton-methyl (166)	1965 (T, as demeton-S-methyl sulfoxide), 1967 (T), 1968 (R), 1973 (T,R), 1982 (T), 1984 (T,R), 1989 (T,R), 1992 (R), 1998 (R), 1999 (corr. to 1992 report), 2002 (T)
Oxythioquinox	See Chinomethionat
Paclobutrazol (161)	1988 (T,R), 1989 (R)
Paraquat (057)	1970 (T,R), 1972 (T,R), 1976 (T,R), 1978 (R), 1981 (R), 1982 (T), 1985 (T), 1986 (T)
Parathion (058)	1965 (T), 1967 (T,R), 1969 (R), 1970 (R), 1984 (R), 1991 (R), 1995 (T,R), 1997 (R), 2000 (R)

Parathion-methyl (059)	1965 (T), 1968 (T,R), 1972 (R), 1975 (T,R), 1978 (T,R), 1979 (T), 1980 (T), 1982 (T), 1984 (T,R), 1991 (R), 1992 (R), 1994 (R), 1995 (T), 2000 (R)
Penconazole (182)	1992 (T,R), 1995 (R)
Permethrin (120)	1979 (T,R), 1980 (R), 1981 (T,R), 1982 (R), 1983 (R), 1984 (R), 1985 (R), 1986 (T,R), 1987 (T), 1988 (R), 1989 (R), 1991 (R), 1992 (corr. to 1991 report), 1999 (T)
2-Phenylphenol (056)	1969 (T,R), 1975 (R), 1983 (T), 1985 (T,R), 1989 (T), 1990 (T,R), 1999 (T,R), 2002 (R)
Phenothrin (127)	1979 (R), 1980 (T,R), 1982 (T), 1984 (T), 1987 (R), 1988 (T,R)
Phenthoate (128)	1980 (T,R), 1981 (R), 1984 (T)
Phorate (112)	1977 (T,R), 1982 (T), 1983 (T), 1984 (R), 1985 (T), 1990 (R), 1991 (R), 1992 (R), 1993 (T), 1994 (T), 1996 (T)
Phosalone (060)	1972 (T,R), 1975 (R), 1976 (R), 1993 (T), 1994 (R), 1997 (T), 1999 (R), 2001 (T)
Phosmet (103)	1976 (R), 1977 (corr. to 1976 R evaluation), 1978 (T,R), 1979 (T,R), 1981 (R), 1984 (R), 1985 (R), 1986 (R), 1987 (R and corr. to 1986 R evaluation), 1988 (R), 1994 (T), 1997 (R), 1998 (T), 2002 (R)
Phosphine	See Hydrogen phosphide
Phosphamidon (061)	1965 (T), 1966 (T), 1968 (T,R), 1969 (R), 1972 (R), 1974 (R), 1982 (T), 1985 (T), 1986 (T)
Phoxim (141)	1982 (T), 1983 (R), 1984 (T,R), 1986 (R), 1987 (R), 1988 (R)
Piperonyl butoxide (062)	1965 (T,R), 1966 (T,R), 1967 (R), 1969 (R), 1972 (T,R), 1992 (T,R), 1995 (T), 2001 (R), 2002 (R)
Pirimicarb (101)	1976 (T,R), 1978 (T,R), 1979 (R), 1981 (T,R), 1982 (T), 1985 (R)
Pirimiphos-methyl (086)	1974 (T,R), 1976 (T,R), 1977 (R), 1979 (R), 1983 (R), 1985 (R), 1992 (T), 1994 (R)
Prochloraz (142)	1983 (T,R), 1985 (R), 1987 (R), 1988 (R), 1989 (R), 1990 (R), 1991 (corr. to 1990 report, Annex I, and R evaluation), 1992 (R), 2001 (T)
Procymidone(136)	1981 (R), 1982 (T), 1989 (T,R), 1990 (R), 1991 (corr. to 1990 Annex I), 1993 (R), 1998 (R)
Profenofos (171)	1990 (T,R), 1992 (R), 1994 (R), 1995 (R)
Propamocarb (148)	1984 (T,R), 1986 (T,R), 1987 (R)
Propargite (113)	1977 (T,R), 1978 (R), 1979 (R), 1980 (T,R), 1982 (T,R), 1999 (T), 2002 (R)
Propham (183)	1965 (T), 1992 (T,R)
Propiconazole (160)	1987 (T,R), 1991 (R), 1994 (R)
Propineb	1977 (T,R), 1980 (T), 1983 (T), 1984 (R), 1985 (T,R), 1993 (T,R)
Propoxur (075)	1973 (T,R), 1977 (R), 1981 (R), 1983 (R), 1989 (T), 1991 (R), 1996 (R)

Propylenethiourea (PTU, 150)	1993 (T,R), 1994 (R), 1999 (T)
Pyrazophos (153)	1985 (T,R), 1987 (R), 1992 (T,R), 1993 (R)
Pyrethrins (063)	1965 (T), 1966 (T,R), 1967 (R), 1968 (R), 1969 (R), 1970 (T), 1972 (T,R), 1974 (R), 1999 (T), 2000 (R)
Pyriproxyfen	1999 (R,T), 2000 (R), 2001 (T)
Quintozene (064)	1969 (T,R), 1973 (T,R), 1974 (R), 1975 (T,R), 1976 (Annex I, corr. to 1975 R evaluation), 1977 (T,R), 1995 (T,R), 1998 (R)
Spinosad	2001 (T,R)
2,4,5-T (121)	1970 (T,R), 1979 (T,R), 1981 (T)
Tebuconazole (189)	1994 (T,R), 1996 (corr. to Annex II of 1995 report), 1997 (R)
Tebufenozide (196)	1996 (T,R), 1997 (R), 1999 (R), 2001 (T,R)
Tecnazine (115)	1974 (T,R), 1978 (T,R), 1981 (R), 1983 (T), 1987 (R), 1989 (R), 1994 (T,R)
Teflubenzuron (190)	1994 (T), 1996 (R)
Terbufos (167)	1989 (T,R), 1990 (T,R)
Thianedazole (065)	1970 (T,R), 1971 (R), 1972 (R), 1975 (R), 1977 (T,R), 1979 (R), 1981 (R), 1997 (R), 2000 (R)
Thiodicarb (154)	1985 (T,R), 1986 (T), 1987 (R), 1988 (R), 2000 (T), 2001 (R)
Thiometon (076)	1969 (T,R), 1973 (T,R), 1976 (R), 1979 (T,R), 1988 (R)
Thiphanate-methyl (077)	1973 (T,R), 1975 (T,R), 1977 (T), 1978 (R), 1988 (R), 1990 (R), 1994 (R), 1995 (T,E), 1998 (T,R)
Thiram (105)	See Dithiocarbamates, 1965 (T), 1967 (T,R), 1970 (T,R), 1974 (T), 1977 (T), 1983 (R), 1984 (R), 1985 (T,R), 1987 (T), 1988 (R), 1989 (R), 1992 (T), 1996 (R)
Tolclofos-methyl (191)	1994 (T,R), 1996 (corr. to Annex II of 1995 report)
Tolyfluanid (162)	1988 (T,R), 1990 (R), 1991 (corr. to 1990 report), 2002 (R)
Toxaphene	See Camphechlor
Triadimefon (133)	1979 (R), 1981 (T,R), 1983 (T,R), 1984 (R), 1985 (T,R), 1986 (R), 1987 (R and corr. to 1986 R evaluation), 1988 (R), 1989 (R), 1992 (R), 1995 (R)
Triadimenol (168)	1989 (T,R), 1992 (R), 1995 (R)
Triazolylalanine	1989 (T,R)
Triazophos (143)	1982 (T), 1983 (R), 1984 (corr. to 1983 report, Annex I), 1986 (T,R), 1990 (R), 1991 (T and corr. to 1990 R evaluation), 1992 (R), 1993 (T,R), 2002 (T)
Trichlorfon (066)	1971 (T,R), 1975 (T,R), 1978 (T,R), 1987 (R)
Trichloronat	1971 (T,R)
Trichloroethylene	1968 (R)

Tricyclohexyltin hydroxide	See Cyhexatin
Triforine (116)	1977 (T), 1978 (T,R), 1997 (T)
Triphenyltin compounds	See Fentin compounds
Vamidothion (078)	1973 (T,R), 1982 (T), 1985 (T,R), 1987 (R), 1988 (T), 1990 (R), 1992 (R)
Vinclozolin (159)	1986 (T,R), 1987 (R and corr. to 1986 report and R evaluation), 1988 (T,R), 1989 (R), 1990 (R), 1992 (R), 1995 (T)
Zineb (105)	See Dithiocarbamates, 1965 (T), 1967 (T,R), 1993 (T)
Ziram (105)	See Dithiocarbamates, 1965 (T), 1967 (T,R), 1996 (T,R)

ANNEX 3

DIETARY INTAKE OF PESTICIDES IN RELATION TO ADIs

The following tables give details of the estimated daily intakes of the pesticides evaluated by the Meeting for the five GEMS/ Food Diets, and show the ratios of the estimated intakes to the corresponding ADIs regional.

(*) at or about the LOQ

The ranges of the intake / ADI ratios for all the compounds evaluated are tabulated in Section 3.

ACEPHATE (95)

Dietary Intake Estimate

ADI= 0.01 mg/kg body weight or 0.6 mg/person

Code	Commodity	MRL mg/kg	STMR Mg/kg	Diets: g/person/day; Intake = daily intake:µg/person									
				Mid-East		Far-East		African		Latin American		European	
				Diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
VB 0400	Broccoli	2	0.11	0.5	0.0001	1	0.0001	0	0	1.1	0.0001	2.7	0.0003
VB 0041	Cabbages. Head	2	0.33	4.5	0.0015	8.7	0.0029	0	0	9.5	0.0031	24.1	0.0079
MF 0812	Cattle fat	0.1		0.3	0	0.3	0	0.3	0	1.5	0.0002	0	0
MM 0812	Cattle meat	0.1		18.5	0.0019	3.5	0.0004	10.4	0.001	30	0.003	63.3	0.0063
VB 0404	Cauliflower	2	0.11	1.3	0.0001	1.5	0.0002	0	0	0.3	0	13	0.0014
SO 0691	Cotton seed	2		0	0	0	0	0	0	0	0	0	0
PE 0112	Eggs	0.1		14.6	0.0015	13.1	0.0013	3.7	0.0004	11.9	0.0012	37.6	0.0038
VL 0482	Lettuce. Head	5		2.3	0.0113	0	0	0	0	5.8	0.0288	22.5	0.1125
ML 0106	Milks	0.1		116.8	0.0117	32	0.0032	41.8	0.0042	160	0.016	294	0.0294
MF 0818	Pig fat	0.1		0.1	0	0.1	0	0.1	0	0.1	0	0.1	0
MM 0818	Pig meat	0.1		0	0	27.2	0.0027	2.6	0.0003	10.5	0.0011	75.8	0.0076
VR 0589	Potato	0.5		59	0.0295	19.2	0.0096	20.6	0.0103	40.8	0.0204	240.8	0.1204
PF 0111	Poultry fats	0.1		3.1	0.0003	1.3	0.0001	0.6	0.0001	2.5	0.0003	5.3	0.0005
PM 0110	Poultry meat	0.1		31	0.0031	13.2	0.0013	5.5	0.0006	25.3	0.0025	53	0.0053
VD 0541	Soya bean (dry)	0.5		4.5	0.0023	2	0.001	0.5	0.0003	0	0	0	0

VR 0596	Sugar beet	0.1		0.5	0.0001	0	0	0	0	0.3	0	2	0.0002
VO 0448	Tomato	1	0.38	81.5	0.031	7	0.0027	16.5	0.0063	25.5	0.0097	66	0.0251
					TOTAL	0.0944		0.0255		0.0235		0.0864	
					% ADI	16%		4%		4%		14%	
					Rounded % ADI =	20%		4%		4%		10%	

BITERTANOL (144)**International Estimated Daily Intake (IEDI)**

ADI = 0.01 mg/kg body weight or 600 µg for a 60 kg person ; 550 µg for a 55 kg person in Far Eastern diet

Code	Commodity	MRL mg/kg	STMR Mg/kg	Diets: g/person/day; Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				Diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
JF 0226	Apple juice		0.034	1.9	0.1	1.2	0.04	0.1	0.003	1.4	0.05	10	0.3
FS 0240	Apricot		0.2	3	0.6	0	0.0	0	0.0	0	0.0	3.5	0.7
FI 0327	Banana		0.075	8.3	0.6	26.2	2.0	21	1.6	102.3	7.7	22.8	1.7
GC 0640	Barley		0	1	0.0	3.5	0.0	1.8	0.0	6.5	0.0	19.8	0.0
FS 0013	Cherries		0.365	0	0.0	0	0.0	0	0.0	0	0.0	3	1.1
VC 0424	Cucumber		0.18	4.8	0.9	4.5	0.8	0	0.0	8.3	1.5	9	1.6
MO 0105	Edible offal (Mammalian)		0.05	4.2	0.2	1.4	0.1	2.4	0.1	6.1	0.3	12.4	0.6
PE 0112	Eggs		0	14.6	0.0	13.1	0.0	3.7	0.0	11.9	0.0	37.6	0.0
MM 0095	Meat (from mammals other than marine mammals)		0.05	37	1.9	32.8	1.6	23.8	1.2	47	2.4	155.5	7.8
ML 0106	Milks		0.05	116.8	5.8	32	1.6	41.8	2.1	160	8.0	294	14.7
FS 0245	Nectarine		0.2	1.3	0.3	0.3	0.1	0	0.0	0.4	0.1	6.3	1.3
GC 0647	Oats		0	0	0.0	0	0.0	0.2	0.0	0.8	0.0	2	0.0
FS 0247	Peach		0.2	1.3	0.3	0.3	0.1	0	0.0	0.4	0.1	6.2	1.2
FS 0014	Plums (including Prunes)		0.34	1.8	0.6	0.5	0.2	0	0.0	0	0.0	4.3	1.5
FP 0009	Pome fruits		0.24	10.8	2.6	7.5	1.8	0.3	0.1	6.5	1.6	51.3	12.3
PM 0110	Poultry meat		0	31	0.0	13.2	0.0	5.5	0.0	25.3	0.0	53	0.0

PO 0111	Poultry. Edible offal of		0	0.1	0.0	0.1	0.0	0.1	0.0	0.4	0.0	0.4	0.0
GC 0650	Rye		0	0	0.0	1	0.0	0	0.0	0	0.0	1.5	0.0
VO 0448	Tomatoes fresh		0.76	44.1	33.5	5.7	4.3	14.6	11.1	25.5	19.4	38.2	29.0
JF 0448	Tomato juice		0.1	0.3	0.0	0	0.0	0	0.0	0	0.0	2	0.2
	Tomato paste		1.6	5.8	9.3	0.2	0.3	0.3	0.5	0	0.0	4	6.4
GC 0653	Triticale		0	0	0.0	1	0.0	0	0.0	0	0.0	0	0.0
GC 0654	Wheat		0	327.3	0.0	114.8	0.0	28.3	0.0	116.8	0.0	178	0.0
			TOTAL =		57		13		17		41		80
			% ADI =		9%		2%		3%		7%		13%
			Rounded		9%		2%		3%		7%		10%

CARBARYL (008)**International Estimated Daily Intake (IEDI)**

ADI = 0.008 mg/kg bodyweight or 480 µg for a 60 kg person; 440 µg for a 55 kg person in Far Eastern diet

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				Diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
VS 0621	Asparagus		8.1	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	1.5	12.15
VR 0574	Beetroot (garden beet)		0.025	0.5	0.01	0.0	0.00	0.0	0.00	0.3	0.01	2.0	0.05
VR 0577	Carrot		0.02	2.8	0.06	2.5	0.05	0.0	0.00	6.3	0.13	22.0	0.44
FS 0013	Cherries		4.3	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	3.0	12.90
FC 0001	Citrus		0.487	54.3	26.4	6.3	3.07	5.1	2.48	54.8	26.7	49.0	23.9
	Citrus fruit juice		0.13										
JF 0004	Orange juice concentrated		0.13	7.3	0.994	0.0	0.0	0.0	0.0	0.3	0.039	0.045	0.585
JF 0002	Lemon juice single-strength		0.13	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.026	0.0	0.0
DF 0269	Dried grapes		5.9	0.3	1.48	0.0	0.00	0.0	0.00	0.3	1.48	2.3	13.28
FB 0269	Grapes		4.9	15.8	77.42	1.0	4.90	0.0	0.00	1.3	6.37	13.8	67.62
	Grape juice		3.2										
VO 0440	Egg plant		0.18	6.3	1.13	3.0	0.54	0.7	0.12	6.0	1.08	2.3	0.41
MO 0099	Kidney of cattle, goats, pigs and sheep (1)		0.119	0.1	0.01	0.0	0.00	0.1	0.01	0.2	0.02	0.2	0.02

MO 0099	Liver of cattle, goats, pigs and sheep (2)		0.085	0.2	0.02	0.0	0.00	0.1	0.01	0.3	0.03	0.4	0.03
GC 0645	Maize		0.02	48.3	0.97	31.2	0.62	106.2	2.12	41.8	0.84	8.8	0.18
OC 0645	Maize oil, crude		0.066	1.8	0.12	0.0	0.00	0.3	0.02	0.5	0.03	1.3	0.09
MM 0095	Meat (from mammals other than marine mammals)		0.02	37.0		32.8		23.8		47.0		155.5	
	Muscle (80% meat consumption)		0.02	29.6	0.59	26.2	0.52	19.0	0.38	37.6	0.75	124.4	2.49
	Fat (20% meat consumption)		0.003	7.4	0.02	6.6	0.02	4.8	0.01	9.4	0.03	31.1	0.09
ML 0106	Milks		0.030	116.8	3.50	32.0	0.96	41.8	1.25	160.0	4.80	294.0	8.82
FT 0305	Olives (3)		5.1	1.3	6.63	0.0	0.00	0.0	0.00	0.3	1.53	2.8	14.28
OC 0305	Olive oil, virgin		2.99	1.5	4.49	0.0	0.00	0.0	0.00	0.0	0.00	7.8	23.17
VO 0445	Pepper, sweet		1.8	3.3	5.94	2.0	3.60	5.3	9.54	2.3	4.14	10.3	18.54
GC 0649	Rice (see rice, polished)		8.4										
CM1205	Rice, polished		0.168	48.8	8.20	277.5	46.62	68.8	11.56	65.5	11.00	9.3	1.56
VD 541	Soya bean (dry)		0.05	4.5	0.23	2.0	0.10	0.5	0.03	0.0	0.00	0.0	0.00
OC 0541	Soybean, crude oil		0.045	1.3	0.06	1.7	0.08	3.0	0.14	14.5	0.65	4.3	0.19
FS 0012	Stone fruit		2.05	7.3	14.97	1.0	2.05	0.0	0.00	0.8	1.64	22.8	46.74
SO 0702	Sunflower seed		0.03	1.0	0.03	0.0	0.00	0.6	0.02	0.0	0.00	0.0	0.00
OC 0702	Sunflower crude oil		0	9.3	0.00	0.5	0.00	0.3	0.00	0.8	0.00	8.5	0.00
VO 0447	Sweet corn, corn on the cob		0.02	0.0	0.00	0.0	0.00	4.4	0.09	0.0	0.00	8.3	0.17
VR 0508	Sweet potato		0.02	1.5	0.03	81.3	1.63	14.3	0.29	13.8	0.28	1.3	0.03
VO 0448	Tomato fresh		0.47	44.1	20.7	5.7	2.68	14.6	6.86	25.5	11.99	38.2	17.95
VJ 0448	Tomato, juice		0.24	0.3	0.07	0.0	0.00	0.0	0.00	0.0	0.00	2.0	0.48
	Tomato paste		0.94	5.8	5.41	0.2	0.19	0.3	0.28	0.0	0.00	4.0	3.76
TN 0085	Tree nuts		0.035	1.0	0.04	13.5	0.47	3.4	0.12	17.5	0.61	3.8	0.13
VR 0506	Turnip		0.02	0.5	0.01	0.0	0.00	0.0	0.00	0.3	0.01	2.0	0.04
GC 654	Wheat		0.245	4.3	1.05	0.8	0.20	0.0	0.00	4.8	1.18	2.2	0.54
CF 1211	Wheat flour		0.02	323.0	6.46	114.0	2.28	28.3	0.57	112.0	2.24	175.8	3.52
CF 1210	Wheat germ		0.13	0.1	0.01	0.1	0.01	0.0	0.00	0.1	0.01	0.1	0.01
CF 1210	Wheat germ		0.13	0.1	0.01	0.1	0.01	0.0	0.00	0.1	0.01	0.1	0.01
			Total =		186.1		70.59		35.90		77.51		273.53

			% ADI =		39%		16%		7%		16%		57%
			Rounded % ADI =		40%		20%		10%		20%		60%

- 1) consumption data for cattle kidney
- 2) consumption data for cattle liver
- 3) STMR for olive. edible portion; consumption data for olives. Preserved

CARBOFURAN (096)

International Estimated Daily Intake (IEDI)

ADI = 0.002 mg/kg bodyweight or 120 µg for a 60 kg person; 110 µg for a 55 kg person in Far Eastern diet

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day; Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
FI 0327	Banana		0.1	8.3	0.825	26.2	2.617	21.0	2.100	102.3	10.225	22.8	2.275
VC 4199	Cantaloup		0.02	16.0	0.32	2.0	0.040	0.0	0.0	2.8	0.055	18.3	0.365
SB 0716	Coffe beans		0.1	5.3	0.53	0.4	0.040	0.0	0.0	3.6	0.360	7.9	0.790
	Coffe instant		0.005										
	Coffe roast		0.005	0.5	0.003	0.2	0.001	0.0	0.0	0.8	0.004	5.8	0.029
VC 0424	Cucumber		0.05	4.8	0.238	4.5	0.225	0.0	0.0	8.3	0.413	9.0	0.450
MO 0096	Edible offal of cattle. goates horses. pigs ans sheep		0.05	4.1	0.205	1.3	0.065	2.7	0.135	6.0	0.300	12.3	0.615
MM 0096	Meat of cattle. goats. Horses, pigs and sheep		0.05	34.0		32.0		17.5		44.3		150.3	
	Meat. fat portion (meat x 0.2)		0.05	6.8	0.340	6.4	0.320	3.5	0.175	8.9	0.443	30.1	1.503
	Meat. muscle portion (meat x 0.8)		0.05	27.2	1.36	25.6	1.280	14.0	0.700	35.4	1.770	120.2	6.010
ML 0106	Milks		0.05	116.8	5.838	32.0	1.60	41.8	2.088	160.0	8.00	294.0	14.70
FC 0004	Orange		0.1	31.5	3.15	4.0	0.40	4.8	0.483	31.0	3.10	29.8	2.975
JF 0004	Orange juice		0.001	7.3	0.007	0.0	0.0	0.0	0.0	0.3	0.0	4.5	0.005
VR 0589	Potato		0.03	59.0	1.77	19.2	0.575	20.6	0.618	40.8	1.223	240.8	7.223

SO 0495	Rape seed 1/		0.05	4.5	0.225	2.7	0.135	0.0	0.0	0.3	0.015	7.3	0.365
AS 0649	Rice, husked 2/		0.025	48.8	1.22	279.3	6.983	103.4	2.585	86.5	2.163	11.8	0.295
VC 0431	Squash, Summer		0.05	10.5	0.525	2.2	0.108	0.0	0.0	14.0	0.700	3.5	0.175
GS 0659	Sugar cane		0.1	18.5	1.85	7.3	0.733	15.9	1.592	3.5	0.350	0.0	0.0
SO 0702	Sunflower seed		0.1	1.0	0.10	0.0	0.0	0.6	0.058	0.0	0.0	0.0	0.0
VO 0447	Sweet corn (corn-on-the-cob)		0.03	0.0	0.0	0.0	0.0	4.4	0.132	0.0	0.0	8.3	0.249
				Total	18.5		15.1		10.7		29.1		38.1
			% ADI	15%		14%		9%		24%		31%	
			Rounded % ADI	20%		10%		10%		20%		30%	

1/ consumption data for rapeseed oil edible

2/ consumption data for rice

DELTA METHRIN (135)

International Estimated Daily Intakes

ADI= 0.01mg/kg bw or 600 µg/person for a 60 kg person and 550 µg/person for a 55 kg person

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day; Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
FP0226	Apple		0.03	7.5	0.2	4.7	0.1	0.3	0.0	5.5	0.2	40	1.2
JF0226	Apple juice		0.0027										
VR0577	carrot		0.01	2.8	0.0	2.5	0.0	0	0.0	6.3	0.1	22	0.2
MO1280	Cattle kidney (2)	0.05		0.1	0.0	0	0.0	0.1	0.0	0.2	0.0	0.2	0.0
MO1281	Cattle liver (2)	0.05		0.2	0.0	0	0.0	0.1	0.0	0.3	0.0	0.4	0.0
GC 0080	cereal grain (1)		0.7	56.6	39.6	49.2	34.4	160	112.0	54	37.8	38.6	27.0
FC 0001	citrus fruit		0.01	54.3	0.5	6.3	0.1	5.1	0.1	54.8	0.5	49	0.5
PE 0112	eggs (2)		0.02	14.6	0.3	13.1	0.3	3.7	0.1	11.9	0.2	37.6	0.8
	flat bread		0.35										
VB 0042	Flowerhead brassicas		0.02	1.8	0.0	2.5	0.1	0	0.0	1.4	0.0	15.7	0.3
VC 0045	fruiting vegetables, cucurbits		0.02	80.5	1.6	18.2	0.4	0	0.0	30.5	0.6	38.5	0.8
FB 0269	grapes		0.04	15.8	0.6	1	0.0	0	0.0	1.3	0.1	13.8	0.6

	steamed bread (Dumplings etc)	0.098											
FB 0275	strawberry	0.02	0	0.0	0	0.0	0	0.0	0	0.0	5.3	0.1	
SO 0702	sunflower seed	0.05	1	0.1	0	0.0	0.6	0.0	0	0.0	0	0.0	
VO 0447	sweet corn (corn-on-the-cob)	0.02	0	0.0	0	0.0	4.4	0.1	0	0.0	8.3	0.2	
DT 1114	tea, green, black (3)	0.0044	2.3	0.0	1.2	0.0	0.5	0.0	0.5	0.0	2.3	0.0	
VO 0448	tomato	0.02	44.4	0.9	5.72	0.1	14.58	0.3	25.5	0.5	40.4	0.8	
	tomato paste	0.002	5.8	0.0	0.2	0.0	0.3	0.0	0	0.0	4	0.0	
	tomato puree	0.002											
TN 0678	walnuts	0.02	0	0.0	0	0.0	0	0.0	0	0.0	0.5	0.0	
CM 0654	wheat bran, unprocessed	2.31											
CF 1211	wheat flour	0.217											
CF 1210	wheat germ	0.84	0.1	0.1	0.1	0.1	0	0.0	0.1	0.1	0.1	0.1	
CF 1212	wheat wholemeal	0.637	0.3	0.2	0	0.0	0	0.0	0	0.0	0	0.0	
CP 1211	white bread	0.098	215.3	21.1	76	7.4	18.9	1.9	37.3	3.7	117.2	11.5	
	white noodles	0.091											
CP 1212	wholemeal bread	0.294	107.7	31.7	38	11.2	9.4	2.8	74.7	22.0	58.6	17.2	
	yellow alkaline noodles	0.119											
	Total=			151		87		148		107		138	
	%ADI			25%		16%		25%		18%		23%	
	Rounded			30%		20%		30%		20%		20%	

(1) where residue information were available the consumption for the processed commodities were subtracted from the cereal grain consumption figure

(2) The 52nd JECFA recommended MRLs for cattle, sheep and chickens in fat at 0.5 mg/kg, liver and kidney at 0.05 mg/kg and muscle, eggs and milk at 0.03 mg/kg. An MRL was also recommended for salmon at 0.03 mg/kg. As the JECFA recommendations were the same or higher than here, and they comprised the major commodities consumed in the commodity groups meat mammalian, kidney and liver of cattle, goats, pigs and sheep and for poultry for which recommendations were made, the Meeting decided to utilise recommendations of the 52nd JECFA for the purposes of estimating dietary intake.

(3) The tea STMR was multiplied by the highest processing factor for tea water (brewed tea) = 2.2×0.002

DIFLUBENZURON (130)**International Estimated Daily Intakes**

ADI=0.02 mg/kg bw or 1200 ug/ person (for 60 kg)

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake:ug/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
JF 0226	Apple juice		0.072										
FC 0001	Citrus fruits		0.26	54.3	14.1	6.3	1.6	5.1	1.3	54.8	14.2	49	12.7
MO 0105	Edible offal (mammalian)		0.1	4.2	0.4	1.4	0.1	2.4	0.2	6.1	0.6	12.4	1.2
PE 0112	Eggs		0.05	14.6	0.7	13.1	0.7	3.7	0.2	11.9	0.6	37.6	1.9
MM 0095	Meat (mammalian)			37		32.8		23.8		47		155.5	
	Meat, muscle portion (meat x 0.8)		0.1	29.6	3.0	26.24	2.6	19.04	1.9	37.6	3.8	124.4	12.4
	Meat, fat portion (meat x 0.2)		0.1	7.4	0.7	6.56	0.7	4.76	0.5	9.4	0.9	31.1	3.1
ML 0106	Milks		0.02	116.8	2.3	32	0.6	41.8	0.8	160	3.2	294	5.9
VO 0450	Mushrooms		0.075	0.3	0.0	0.5	0.0	0	0.0	0	0.0	4	0.3
FP 0009	Pome fruits		0.6	10.8	6.5	7.5	4.5	0.3	0.2	6.5	3.9	51.3	30.8
PM 0110	Poultry meat			31		13.2		5.5		25.3		53	
	Poultry meat, muscle portion (meat x 0.9)		0.05	27.9	1.4	11.88	0.6	4.95	0.2	22.77	1.1	47.7	2.4
	Poultry meat, fat portion (meat x 0.1)		0.05	3.1	0.2	1.32	0.1	0.55	0.0	2.53	0.1	5.3	0.3
GC 0649	Rice		0.01	48.8	0.5	279.3	2.8	103.4	1.0	86.5	0.9	11.8	0.1
			TOTAL =		30		14		6		29		71
			% ADI =		2%		1%		1%		2%		6%
			Rounded		2%		1%		1%		2%		6%

ESFENVALERATE (204)**International Estimate of Dietary Intake**

ADI=0.02 mg/kg bw or 1200 µg/person (for 60 kg bw); 1100 µg/person (for 55 kg bw)

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
SO 0691	Cotton seed		0.01	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PE 0112	Eggs		0.01	14.6	0.1	13.1	0.1	3.7	0.0	11.9	0.1	37.6	0.4
PM 0110	Poultry meat (fat)		0.01	31		13.2		5.5		25.3		53	
	Poultry meat (fat = meat X 0.1)		0.01	3.1	0.0	1.32	0.0	0.55	0.0	2.5	0.0	5.3	0.0
	Poultry meat (muscle = meat X 0.9)		0.01	28	0.3	11.9	0.1	5.0	0.0	22.8	0.2	47.7	0.5
PO 0111	Poultry, Edible offal of		0.01	0.1	0.0	0.1	0.0	0.1	0.0	0.4	0.0	0.4	0.0
SO 0495	Rapeseed		0.01	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
VO 0448	Tomato (Note 1)		0.02	44.38	0.9	5.72	0.1	14.58	0.3	25.5	0.5	40.4	0.8
	Tomato paste		0.01	5.8	0.1	0.2	0.0	0.3	0.0	0	0.0	4	0.0
	Tomato puree		0.01										
GC 0654	Wheat (Note 2)		0.01	327.3	3.3	114.8	1.1	28.3	0.3	116.8	1.2	178	1.8
			TOTAL		5		2		1		2		3
			% ADI = Rounded		0.4%		0.1%		0.1%		0.2%		0.3%

Note 1/ Tomato is included in the esfenvalerate table because an STMR is available. Some intake from tomatoes is therefore double-counted, but the effect on the result is negligible.

Note 2/ Wheat is included in the esfenvalerate table because an STMR is available. Some intake from wheat is therefore double-counted, but the effect on the result is negligible

FENVALERATE (119)**Theoretical Maximum Daily Intake (TMDI)**

ADI= 0.02 mg/kg bw or 1200 µg/person (for 60 kg bw); 1100 µg/person (for 55 kg bw)

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day; Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
VP 0061	Beans, except Broad bean and Soya bean	1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
VP 0062	Beans, shelled	0.1		0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
FB 0018	Berries and other small fruits	1		0	0.0	16	16.0	1	1.0	0	0.0	1.5	1.5
VB 0400	Broccoli	2		0.5	1.0	1	2.0	0	0.0	1.1	2.2	2.7	5.4
VB 0402	Brussels sprouts	2		0.5	1.0	1	2.0	0	0.0	1.1	2.2	2.7	5.4
VB 0041	Cabbages, Head	3		4	12.0	7.7	23.1	0	0.0	8.4	25.2	21.4	64.2
VB 0404	Cauliflower	2		1.3	2.6	1.5	3.0	0	0.0	0.3	0.6	13	26.0
VS 0624	Celery	2		0.5	1.0	0	0.0	0	0.0	0.3	0.6	2	4.0
GC 0080	Cereal grains 1/	2		106.6	213.2	338	676.0	290.1	580.2	137.7	275.4	49.3	98.6
FS 0013	Cherries	2		0	0.0	0.0	0.0	0	0.0	0	0.0	3	6.0
VL 0466	Chinese cabbage type "pak-choi"	1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
FC 0001	Citrus fruits	2		54.3	108.6	6.3	12.6	5.1	10.2	54.8	109.6	49	98.0
OR 0691	Cotton seed oil, edible	0.1		3.8	0.4	0.5	0.1	0.5	0.1	0.5	0.1	0	0.0
VC 0424	Cucumber	0.2		4.8	1.0	4.5	0.9	0	0.0	8.3	1.7	9	1.8
MO0105	Edible offal (mammalian)	0.02		4.2	0.1	1.4	0.0	2.4	0.0	6.1	0.1	12.4	0.2
VL 0480	Kale	10		0.5	5.0	0	0.0	0	0.0	0.3	3.0	2	20.0
FI 0341	Kiwifruit	5		0	0.0	0	0.0	1.9	9.5	0.1	0.5	1.5	7.5
VL 0482	Lettuce, Head	2		2.3	4.6	0	0.0	0	0.0	5.8	11.6	22.5	45.0
MM0095	Meat (from mammals other than marine mammals) (fat)	1		37		32.8		23.8		47		155.5	
	Meat (fat = meat X 0.2)	1		7.4	7.4	6.56	6.6	4.76	4.8	9.4	9.4	31.1	31.1
VC 0046	Melons, except Watermelon	0.2		16	3.2	2	0.4	0	0.0	2.8	0.6	18.3	3.7
ML0106	Milks	0.1		116.8	11.7	32	3.2	41.8	4.2	160	16.0	294	29.4
FS 0247	Peach	5		2.5	12.5	0.5	2.5	0	0.0	0.8	4.0	12.5	62.5

SO 0703	Peanut, whole	0.1	0	0.0	4	0.4	5.5	0.6	1.3	0.1	0.3	0.0
VP 0064	Peas, shelled	0.1	4	0.4	0.5	0.1	0	0.0	0.2	0.0	10.1	1.0
VO 0445	Peppers, Sweet	0.5	3.3	1.7	2	1.0	5.3	2.7	2.3	1.2	10.3	5.2
FP 0009	Pome fruits	2	10.8	21.6	7.5	15.0	0.3	0.6	6.5	13.0	51.3	102.6
VR 0075	Root and tuber vegetables	0.05	61.8	3.1	108.5	5.4	321.3	16.1	159.3	8.0	242	12.1
VD 0541	Soya bean (dry)	0.1	4.5	0.5	2	0.2	0.5	0.1	0	0.0	0	0.0
VC 0431	Squash, Summer	0.5	10.5	5.3	2.2	1.1	0	0.0	14	7.0	3.5	1.8
SO 0702	Sunflower seed	0.1	1	0.1	0	0.0	0.6	0.1	0	0.0	0	0.0
VO 0447	Sweet corn (corn-on-the-cob)	0.1	0	0.0	0	0.0	4.4	0.4	0	0.0	8.3	0.8
VO 0448	Tomato	1	81.5	81.5	7	7.0	16.5	16.5	25.5	25.5	66	66.0
TN 0085	Tree nuts	0.2	1	0.2	13.5	2.7	3.4	0.7	17.5	3.5	3.8	0.8
VC 0432	Watermelon	0.5	49.3	24.7	9.5	4.8	0	0.0	5.5	2.8	7.8	3.9
CM0654	Wheat bran, unprocessed	5	0.3	1.5	0	0.0	0	0.0	0	0.0	0	0.0
CF 1211	Wheat flour	0.2	323	64.6	114	22.8	28.3	5.7	112	22.4	175.8	35.2
CF 1212	Wheat wholemeal	2	1	2.0	0.3	0.6	0	0.0	2.8	5.6	1.3	2.6
VC 0433	Winter squash	0.5	1.5	0.8	0.3	0.2	0	0.0	2	1.0	0.5	0.3
			TOTAL	593		810		653		553		743
			% ADI	49.4%		73.6%		54.5%		46.1%		61.9%
			Rounded									
ESFENVALERATE + FENVALERATE as % of ADI				49,8%		73.7%		54.5%		46.2%		62.2%
			Rounded	50%		70%		50%		50%		60%

Note 1/ Cereal grains except wheat.

FLUTOLANIL (205)

International Estimate of Dietary Intake (IEDI)

ADI= 0.09 mg/kg bw or 5400 (for 60 kg bw); 4950 µg/person for 55 kg bw

Code	Commodity	MRL mg/kg	mg/kg	Diets: g/person/day; Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
			STMR-P mg/kg	diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
PE 0112	Eggs		0	14.6	0.0	13.1	0.0	3.7	0.0	11.9	0.0	37.6	0.0
MO 0098	Kidney of cattle, goats, pigs and sheep (Note 1)		0.012	0.1	0.0	0	0.0	0.1	0.0	0.2	0.0	0.2	0.0
	Liver of cattle, goats, pigs and sheep (Note 2)		0.047	0.2	0.0	0	0.0	0.1	0.0	0.3	0.0	0.4	0.0
	Meat (from mammals other than marine mammals)		0	37	0.0	32.8	0.0	23.8	0.0	47	0.0	155.5	0.0
	Milks		0	116.8	0.0	32	0.0	41.8	0.0	160	0.0	294	0.0
	Poultry edible offal		0.05	0.1	0.0	0.1	0.0	0.1	0.0	0.4	0.0	0.4	0.0
	Poultry meat		0	31	0.0	13.2	0.0	5.5	0.0	25.3	0.0	53	0.0
	Rice, husked		0.39	0	0.0	1.8	0.7	34.7	13.5	21	8.2	2.5	1.0
	Rice, polished		0.195	48.8	9.5	277.5	54.1	68.8	13.4	65.5	12.8	9.3	1.8
			TOTAL =		10		55		27		21		3
			% ADI =		0.2%		1.1%		0.50%		0.4%		0.1%
			Rounded		0%		1%		0%		0%		0%

Note 1/ Consumption values are for cattle kidney

Note 2/ Consumption values are for for cattle liver

IMIDACLOPRID (206)**International Estimated Daily Intake (IEDI)**

ADI= 0.06 mg/kg bw or 3600 µg/person (for 60 kg bw) 3300 µg/person (for 55kg bw)

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
FP 0226	Apple		0.07	7.5	0.5	4.7	0.3	0.3	0.0	5.5	0.4	40	2.8
JF 0226	Apple juice		0.046										
DF 0226	Apple, dried		0.061										
	Apple sauce		0.053										
FS 0240	Apricot		0.12	3.0	0.4	0	0.0	0	0.0	0	0.0	3.5	0.4
	Apricot jam		0.046										
	Apricot, canned		0.046										
FI 0327	Banana		0.01	8.3	0.1	26.2	0.3	21	0.2	102.3	1.0	22.8	0.2
GC 0640	Barley		0.05	1.0	0.1	3.5	0.2	1.8	0.1	6.5	0.3	19.8	1.0
VP 0061	Beans, except broad bean and soya bean		0.4	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
	Beans, cooked		0.39										
	Beans, canned		0.17										
	Beer		0.0025										
VB 0400	Broccoli		0.08	0.5	0.0	1.0	0.1	0	0.0	1.1	0.1	2.7	0.2
VB 0402	Brussels sprouts		0.08	0.5	0.0	1.0	0.1	0	0.0	1.1	0.1	2.7	0.2
VB 0041	Cabbages, head		0.08	5.0	0.4	9.7	0.8	0	0.0	10.5	0.8	26.8	2.1
VB 0404	Cauliflower		0.08	1.3	0.1	1.5	0.1	0	0.0	0.3	0.0	13.0	1.0
GC 0080	Cereal grains /1												
FS 0244	Cherry, sweet		0.14	0	0.0	0	0.0	0	0.0	0	0.0	2.7	0.4
	Cherry, sweet, canned		0.084										
FC 0001	Citrus fruits		0.05	54.3	2.7	6.3	0.3	5.1	0.3	54.8	2.7	49.0	2.5
JF 0001	Citrus juice		0.014										
	Citrus marmalade (orange)		0.03										
VC 0424	Cucumber		0.31	4.8	1.5	4.5	1.4	0	0.0	8.3	2.6	9.0	2.8
MO 0105	Edible offal (mammalian)		0.006	4.2	0.0	1.4	0.0	2.4	0.0	6.1	0.0	12.4	0.1
VO 0440	Egg plant		0.05	6.3	0.3	3.0	0.2	0.7	0.0	6.0	0.3	2.3	0.1
PE 0112	Eggs		0	14.5	0.0	13.0	0.0	3.6	0.0	11.8	0.0	37.5	0.0

FB 0269	Grapes		0.11	15.8	1.7	1.0	0.1	0	0.0	1.3	0.1	13.8	1.5
DF 0269	Grapes, dried		0.12	0.3	0.0	0	0.0	0	0.0	0.3	0.0	2.3	0.3
	Grape juice		0.08										
	Wine		0.13	0.5	0.1	0	0.0	0.8	0.1	19.8	2.6	97.8	12.7
DH 1100	Hops, dry		0.7	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
VA 0384	Leek		0.05	0.5	0.0	0	0.0	0	0.0	0.3	0.0	2.0	0.1
FJ 0002	Lemon juice single-strength		0.014	0	0.0	0	0.0	0.2	0.0	0	0.0	0	0.0
VL 0482	Lettuce, Head		0.9	2.3	2.1	0	0.0	0	0.0	5.8	5.2	22.5	20.3
GC 0645	Maize		0.05	48.3	2.4	31.2	1.6	106.2	5.3	41.8	2.1	8.8	0.4
FI 0345	Mango		0.05	2.3	0.1	5.3	0.3	3.4	0.2	6.3	0.3	0	0.0
MM 0095	Meat (mammals, other than marine mammals)												
	Meat x 0.2 (fat)		0	7.4	0.0	6.6	0.0	4.8	0.0	9.4	0.0	31.1	0.0
	Meat x 0.8 (muscle)		0.001	29.6	0.0	26.2	0.0	19.0	0.0	37.6	0.0	124.4	0.1
ML 0106	Milks		0.0014	116.8	0.2	32	0.0	41.8	0.1	160.0	0.2	294.0	0.4
VC 0046	Melons, except Watermelon		0.05	16.0	0.8	2	0.1	0	0.0	2.8	0.1	18.3	0.9
FS 0245	Nectarine		0.12	1.3	0.2	0.3	0.0	0	0.0	0.4	0.0	6.3	0.8
	Nectarine jam		0.046										
	Nectarine, canned		0.046										
GC 0647	Oats		0.05	0	0.0	0	0.0	0.2	0.0	0.8	0.0	2.0	0.1
JF 0004	Orange juice concentrated		0.014	7.3	0.1	0	0.0	0	0.0	0.3	0.0	4.5	0.1
VA 0385	Onion, Bulb		0.05	23	1.2	11.5	0.6	7.3	0.4	13.8	0.7	27.8	1.4
FS 0247	Peach		0.12	1.2	0.1	0.2	0.0	0	0.0	0.4	0.0	6.2	0.7
	Peach jam		0.046										
	Peach, canned		0.046										
FP 0230	Pear		0.38	3.3	1.3	2.8	1.1	0	0.0	1.0	0.4	11.3	4.3
TN 0672	Pecan		0.05	0	0.0	0	0.0	0	0.0	0	0.0	0.3	0.0
VO 0051	Peppers		0.15	3.4	0.5	2.1	0.3	5.4	0.8	2.4	0.4	10.4	1.6
FS 0014	Plums (including prunes)		0.05	1.8	0.1	0.5	0.0	0	0.0	0	0.0	4.3	0.2
PO 0110	Poultry meat		0	31.0	0.0	13.2	0.0	5.5	0.0	25.3	0.0	53.0	0.0
PO 0111	Poultry, Edible offal of		0.0026	0.1	0.0	0.1	0.0	0.1	0.0	0.4	0.0	0.4	0.0
VR 0589	Potato		0.05	59.0	3.0	19.2	1.0	20.6	1.0	40.8	2.0	240.8	12.0
	Potato chips		0.068										
	Potato granules		0.046										
SO 0495	Rape seed 3/		0.05	4.5	0.2	2.7	0.1	0	0.0	0.3	0.0	7.3	0.4
GC 0649	Rice		0.05	48.8	2.4	279.3	14.0	103.4	5.2	86.5	4.3	11.8	0.6
GC 0650	Rye		0.05	0	0.0	1.0	0.1	0	0.0	0	0.0	1.5	0.1
VC 0431	Squash, Summer		0.31	10.5	3.3	2.2	0.7	0	0.0	14.0	4.3	3.5	1.1
VO 0447	Sweet corn (corn-on-the-		0.01	0	0.0	0	0.0	4.4	0.0	0	0.0	8.3	0.1

	cob)												
VR 0596	Sugar beet	0.05	0.5	0.0	0	0.0	0	0.0	0.3	0.0	2.0	0.1	
VO 0448	Tomatoes, fresh	0.08	44.1	3.5	5.7	0.5	14.6	1.2	25.5	2.0	38.2	3.1	
JF 0448	Tomato juice	0.11	0.3	0.0	0	0.0	0	0.0	0	0.0	2.0	0.2	
	Tomato ketchup	0.16											
	Tomato paste	0.458	5.8	2.7	0.2	0.1	0.3	0.1	0	0.0	4.0	1.8	
	Tomato puree	0.184											
	Tomato, canned	0.073											
GC 0653	Triticale	0.05	0	0.0	1.0	0.1	0	0.0	0	0.0	0	0.0	
VC 0432	Watermelon	0.05	49.3	2.5	9.5	0.5	0	0.0	5.5	0.3	7.8	0.4	
GC 0654	Wheat	0.05	4.3	0.2	0.8	0.0	0	0.0	4.8	0.2	2.2	0.1	
CF 1211	Wheat flour	0.025	323.0	8.1	114.0	2.9	28.3	0.7	112.0	2.8	175.8	4.4	
			TOTAL	43		28		16		37		84	
			% ADI =	1%		1%		0%		1%		2%	
			Rounded	1%		1%		0%		1%		2%	

1/ Calculated for the individual commodities in the group (barley, maize, oats, rice, rye, triticale, wheat)

2/ calculated for JF 0004 orange juice concentrated and FJ 0002 lemon juice single-strength

3/ use rape seed oil diet data

LINDANE (048)

Theoretical Maximum Daily Intake (TMDI)

ADI = 0.005 mg/kg bw or 0.3 mg/person

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
FP 0226	Apple	0.5		7.5	0.0038	4.7	0.0023	0.3	0.0001	5.5	0.0028	40	0.02
VD 0071	Beans (dry)	1		6.8	0.0068	6.8	0.0068	0	0	13.5	0.0135	4.3	0.0043
VB 0402	Brussels sprouts	0.5		0.5	0.0003	1	0.0005	0	0	1.1	0.0005	2.7	0.0013
VB 0041	Cabbages, Head	0.5		4.5	0.0023	8.7	0.0044	0	0	9.5	0.0047	24.1	0.012
VB 0403	Cabbage, Savoy	0.5		0.1	0.0001	0.1	0.0001	0.1	0.0001	0.1	0.0001	0.1	0.0001
SB 0715	Cacao beans	1		0.5	0.0005	0	0	0	0	1.3	0.0013	3.1	0.0031
VR 0577	Carrot	0.2		2.8	0.0006	2.5	0.0005	0	0	6.3	0.0013	22	0.0044
VB 0404	Cauliflower	0.5		1.3	0.0006	1.5	0.0008	0	0	0.3	0.0001	13	0.0065
GC 0080	Cereal grains	0.5		430.8	0.2154	452.3	0.2262	318.4	0.1592	252.5	0.1262	226.3	0.1132

FS 0013	Cherries	0.5		0	0	0	0	0	0	0	0	3	0.0015
DM 1215	Cocoa butter	1		0	0	0	0	0	0	0.5	0.0005	0.4	0.0004
DM 1216	Cocoa mass	1		0	0	0	0	0	0	0.5	0.0005	0.4	0.0004
FB 0265	Cranberry	3		0	0	0	0	0	0	0	0	0.3	0.0008
FB 0279	Currant, Red, White	0.5		0	0	0	0	0	0	0	0	0.3	0.0002
PE 0112	Eggs	0.1		14.6	0.0015	13.1	0.0013	3.7	0.0004	11.9	0.0012	37.6	0.0038
VL 0476	Endive	2		0.5	0.001	0	0	0	0	0.3	0.0005	2	0.004
FB 0269	Grapes	0.5		15.8	0.0079	1	0.0005	0	0	1.3	0.0006	13.8	0.0069
VB 0405	Kohlrabi	1		0.1	0.0001	0.1	0.0001	0.1	0.0001	0.1	0.0001	0.1	0.0001
VL 0482	Lettuce, Head	2		2.3	0.0045	0	0	0	0	5.8	0.0115	22.5	0.045
MM 0097	Meat of cattle, pigs and sheep	2 (fat)		6.4	0.0128	6.2	0.0124	3	0.006	8.7	0.0174	29.9	0.0598
ML 0106	Milks	0.01 F		116.8	0.0012	32	0.0003	41.8	0.0004	160	0.0016	294	0.0029
FP 0230	Pear	0.5		3.3	0.0016	2.8	0.0014	0	0	1	0.0005	11.3	0.0056
VP 0063	Peas green	0.1		5.5	0.0006	0.7	0.0001	0	0	0.3	0	14	0.0014
FS 0014	Plums (including Prunes)	0.5		1.8	0.0009	0.5	0.0003	0	0	0	0	4.3	0.0022
VR 0589	Potato	0.05(*)		59	0.003	19.2	0.001	20.6	0.001	40.8	0.002	240.8	0.012
PM 0110	Poultry meat	0.7(fat)		3.1	0.0022	1.3	0.0009	0.6	0.0004	2.5	0.0018	5.3	0.0037
VR 0494	Radish	1		0.5	0.0005	0	0	0	0	0.3	0.0003	2	0.002
SO 0495	Rape seed	0.05		0	0	0	0	0	0	0	0	0	0
VL 0502	Spinach	2		0.5	0.001	0	0	0	0	0.3	0.0005	2	0.004
FB 0275	Strawberry	3		0	0	0	0	0	0	0	0	5.3	0.0158
VR 0596	Sugar beet	0.1		0.5	0.0001	0	0	0	0	0.3	0	2	0.0002
VO 0448	Tomato	2		81.5	0.163	7	0.014	16.5	0.033	25.5	0.051	66	0.132
				TOTAL	0,4323		0,2739		0,2007		0,2405		0,4696
				% ADI	144%		91%		67%		80%		157%
				Rounded % ADI =	140%		90%		70%		80%		160%

METALAXYL M (138)

Theoretical Maximum Daily Intake (TMDI)

ADI= 0.08 mg/kg bw or 4.8 mg/person

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
VS 0621	Asparagus	0.05 (*)		0	0	0	0	0	0	0	0	1.5	0.0001
FI 0326	Avocado	0.2		0	0	0	0	0.2	0	3.3	0.0007	1	0.0002
VB 0400	Broccoli	0.5		0.3	0.0001	0.5	0.0003	0	0	0.6	0.0003	1.4	0.0007
VB 0402	Brussels sprouts	0.2		0.3	0.0001	0.5	0.0001	0	0	0.6	0.0001	1.4	0.0003
VB 0041	Cabbages, Head	0.5		4	0.002	7.7	0.0039	0	0	8.4	0.0042	21.4	0.0107
SB 0715	Cacao beans	0.2		0.5	0.0001	0	0	0	0	1.3	0.0003	3.1	0.0006
VR 0577	Carrot	0.05 (*)		2.8	0.0001	2.5	0.0001	0	0	6.3	0.0003	22	0.0011
VB 0404	Cauliflower	0.5		1.3	0.0006	1.5	0.0008	0	0	0.3	0.0001	13	0.0065
GC 0080	Cereal grains	0.05 (*)		430.8	0.0215	452.3	0.0226	318.4	0.0159	252.5	0.0126	226.3	0.0113
FC 0001	Citrus fruits	5		54.3	0.2713	6.3	0.0317	5.1	0.0254	54.8	0.2738	49	0.245
SO 0691	Cotton seed	0.05 (*)		0	0	0	0	0	0	0	0	0	0
VC 0424	Cucumber	0.5		2.4	0.0012	2.3	0.0011	0	0	4.1	0.0021	4.5	0.0023
VC 0425	Gherkin	0.5		2.4	0.0012	2.3	0.0011	0	0	4.1	0.0021	4.5	0.0023
FB 0269	Grapes	1		15.8	0.0158	1	0.001	0	0	1.3	0.0013	13.8	0.0138
DH 1100	Hops, dry	10		0.1	0.001	0.1	0.001	0.1	0.001	0.1	0.001	0.1	0.001
VL 0482	Lettuce, Head	2		2.3	0.0045	0	0	0	0	5.8	0.0115	22.5	0.045
VC 0046	Melons, except Watermelon	0.2		16	0.0032	2	0.0004	0	0	2.8	0.0006	18.3	0.0037
VA 0385	Onion, bulb	2		23	0.046	11.5	0.023	7.3	0.0147	13.8	0.0275	27.8	0.0555
SO 0697	Peanut	0.1		0.3	0	0.2	0	2.3	0.0002	0.3	0	3	0.0003
VP 0064	Peas, shelled	0.05 (*)		4	0.0002	0.5	0	0	0	0.2	0	10.1	0.0005
VO 0051	Peppers	1		3.4	0.0034	2.1	0.0021	5.4	0.0054	2.4	0.0024	10.4	0.0104
FP 0009	Pome fruits	1		10.8	0.0108	7.5	0.0075	0.3	0.0003	6.5	0.0065	51.3	0.0513
VR 0589	Potato	0.05 (*)		59	0.003	19.2	0.001	20.6	0.001	40.8	0.002	240.8	0.012
FB 0272	Raspberries, Red, Black	0.2		0	0	0	0	0	0	0	0	0.5	0.0001
VD 0541	Soya bean (dry)	0.05		4.5	0.0002	2	0.0001	0.5	0	0	0	0	0
VL 0502	Spinach	2		0.5	0.001	0	0	0	0	0.3	0.0005	2	0.004
VC 0431	Squash, Summer	0.2		10.5	0.0021	2.2	0.0004	0	0	14	0.0028	3.5	0.0007
FB 0275	Strawberry	0.2		0	0	0	0	0	0	0	0	5.3	0.0011

VR 0596	Sugar beet	0.05 (*)		0.5	0	0	0	0	0	0.3	0	2	0.0001
SO 0702	Sunflower seed	0.05 (*)		1	0.0001	0	0	0.6	0	0	0	0	0
VO 0448	Tomato	0.5		81.5	0.0408	7	0.0035	16.5	0.0083	25.5	0.0128	66	0.033
VC 0432	Watermelon	0.2		49.3	0.0099	9.5	0.0019	0	0	5.5	0.0011	7.8	0.0016
VC 0433	Winter squash	0.2		1.5	0.0003	0.3	0.0001	0	0	2	0.0004	0.5	0.0001
				TOTAL	0.4405		0.1037		0.0722		0.367		0.5153
				% ADI	9%		2%		2%		8%		11%
				Rounded % ADI =	9%		2%		2%		8%		10%

METHAMIDOPHOS (100)**Dietary intake estimate**

ADI= 0.004 mg/kg bw or 0.24 mg/person

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				Diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
VB 0402	Brussels sprouts	1		0.5	0.0005	1	0.001	0	0	1.1	0.0011	2.7	0.0027
VB 0041	Cabbages, Head	0.5	0.01	4.5	0	8.7	0.0001	0	0	9.5	0.0001	24.1	0.0002
MF 0812	Cattle fat	0.01(*)		0.3	0	0.3	0	0.3	0	1.5	0	0	0
MM 0812	Cattle meat	0.01(*)		18.5	0.0002	3.5	0	10.4	0.0001	30	0.0003	63.3	0.0006
VB 0404	Cauliflower	0.5	0.01	1.3	0	1.5	0	0	0	0.3	0	13	0.0001
VS 0624	Celery	1		0.5	0.0005	0	0	0	0	0.3	0.0003	2	0.002
VC 0424	Cucumber	1		4.8	0.0048	4.5	0.0045	0	0	8.3	0.0083	9	0.009
MF 0814	Goat fat	0.01(*)		0.1	0	0.1	0	0.1	0	0.1	0	0.1	0
MM 0814	Goat meat	0.01(*)		2	0	0.7	0	2.3	0	0.8	0	0.3	0
DH 1100	Hops, dry	5		0.1	0.0005	0.1	0.0005	0.1	0.0005	0.1	0.0005	0.1	0.0005
VL 0482	Lettuce, Head	1		2.3	0.0023	0	0	0	0	5.8	0.0058	22.5	0.0225
ML 0106	Milks	0.01(*)		116.8	0.0012	32	0.0003	41.8	0.0004	160	0.0016	294	0.0029
FP 0009	Pome fruits	0.5	0.18	10.8	0.0019	7.5	0.0014	0.3	0	6.5	0.0012	51.3	0.0092
FS 0247	Peach	1	0.16	2.5	0.0004	0.5	0.0001	0	0	0.8	0.0001	12.5	0.002
VO 0444	Peppers, Chili	2		0.1	0.0002	0.1	0.0002	0.1	0.0002	0.1	0.0002	0.1	0.0002

VO 0445	Peppers, Sweet	1		3.3	0.0033	2	0.002	5.3	0.0053	2.3	0.0023	10.3	0.0103
VR 0589	Potato	0.05		59	0.003	19.2	0.001	20.6	0.001	40.8	0.002	240.8	0.012
MF 0822	Sheep fat	0.01(*)		0.1	0	0.1	0	0.1	0	0.1	0	0.1	0
MM 0822	Sheep meat	0.01(*)		13.5	0.0001	0.7	0	2	0	3	0	10.3	0.0001
VD 0541	Soya bean (dry)	0.05		4.5	0.0002	2	0.0001	0.5	0	0	0	0	0
VR 0596	Sugar beet	0.05		0.5	0	0	0	0	0	0.3	0	2	0.0001
VO 0448	Tomato	1	0.12	81.5	0.0098	7	0.0008	16.5	0.002	25.5	0.0031	66	0.0079
FT 0312	Tree tomato	0.01(*)		0	0	1.9	0	0.1	0	1.5	0	0.1	0
VC 0432	Watermelon	0.5		49.3	0.0246	9.5	0.0048	0	0	5.5	0.0028	7.8	0.0039
				TOTAL	0.0535		0.0168		0.0095		0.0297		0.0862
				% ADI =	22%		7%		4%		12%		36%
				Rounded % ADI =	20%		7%		4%		10%		40%

OXAMYL (126)**International Estimated Daily Intake**

ADI= 0.009 mg/kg or 540 ug/person (60 kg) 495 µg/person (55 kg)

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
FP 0226	Apple		0.35	7.5	2.6	4.7	1.6	0.3	0.1	5.5	1.9	40	14.0
VR 0577	Carrots		0.03	2.8	0.1	2.5	0.1	0	0.0	6.3	0.2	22	0.7
FC 0001	Citrus fruits		0.17	54.3	9.2	6.3	1.1	5.1	0.9	54.8	9.3	49	8.3
OC 0691	Cotton seed oil crude		0.0003	3.8	0.0	0.5	0.0	0.5	0.0	0.5	0.0	0	0.0
VC 0424	Cucumber		0.37	4.8	1.8	4.5	1.7	0	0.0	8.3	3.1	9	3.3
PE 0112	Eggs		0	14.6	0.0	13.1	0.0	3.7	0.0	11.9	0.0	37.6	0.0
MO 0105	Edible offal (mammalian)		0	4.2	0.0	1.4	0.0	2.4	0.0	6.1	0.0	12.4	0.0
MM 0095	Meat (mammals, other than marine mammals)		0	37	0.0	32.8	0.0	23.8	0.0	47	0.0	155.5	0.0
VC 0046	Melons, except watermelon		0.37	16	5.9	2	0.7	0	0.0	2.8	1.0	18.3	6.8
ML 0106	Milks		0	116.8	0.0	32	0.0	41.8	0.0	160	0.0	294	0.0
SO 0697	Peanut		0.02	0.3	0.0	0.2	0.0	2.3	0.0	0.3	0.0	3	0.1
OC 0697	Peanut oil crude		0.0034	0	0.0	1.8	0.0	3.5	0.0	0.5	0.0	1.8	0.0

VO 0051	Peppers		0.755	3.4	2.6	2.1	1.6	5.4	4.1	2.4	1.8	10.4	7.9
VR 0589	Potato		0.02	59	1.2	19.2	0.4	20.6	0.4	40.8	0.8	240.8	4.8
PM 0110	Poultry meat		0	31	0.0	13.2	0.0	5.5	0.0	25.3	0.0	53	0.0
PO 0111	Poultry, Edible offal of		0	0.1	0.0	0.1	0.0	0.1	0.0	0.4	0.0	0.4	0.0
VO 0448	Tomatoes, fresh		0.58	44.1	25.6	5.7	3.3	14.6	8.5	25.5	14.8	38.2	22.2
VJ 0448	Tomato juice		0.07	0.3	0.0	0	0.0	0	0.0	0	0.0	2	0.1
	Tomato paste		0.21	5.8	1.2	0.2	0.0	0.3	0.1	0	0.0	4	0.8
	Tomato canned fruit ^{1/}		0.042	0	0.0	0	0.0	0	0.0	0	0.0	4	0.2
	Tomato puree		0,093										
			TOTAL =		50		11		14		33		69
			% ADI =		9%		2%		3%		6%		13%
			Rounded		9%		2%		3%		6%		10%

^{1/} Use tomato peeled data

2-PHENYLPHENOL (056)

International Estimated Daily Intake

ADI= 0.4 mg/kg bw or 24000 µg/person (60kg) or 2200 µg/person (55kg)

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
FC 0001	Citrus fruits		0.2	54.3	10.9	6.3	1.3	5.1	1.0	54.8	11.0	49	9.8
JF 0004	Orange juice		0.12	7.3	0.9	0	0.0	0	0.0	0.3	0.0	4.5	0.5
FP 0230	Pear		8	3.3	26.4	2.8	22.4	0	0.0	1	8.0	11.3	90.4
					0.0		0.0		0.0		0.0		0.0

			TOTAL =		38		24		1		19		101
			% ADI =		0%		0%		0%		0%		0%
			Rounded		0%		0%		0%		0%		0%

PIPERONYL BUTOXIDE (062)**International Estimated Daily Intake (IEDI)**

ADI = 0.2 mg/kg bodyweight or 12000 µg for a 60 kg person; 11000 µg for a 55 kg person in Far Eastern diet

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
MO 1280	Cattle kidney		0.21	0.1	0.021	0.0	0.0	0.1	0.021	0.2	0.042	0.2	0.042
MM 0812	Cattle meat (fat)		2.6	18.5	48.10	3.5	9.10	10.4	27.0	30.0	78.0	63.3	164.6
ML 0812	Cattle milk		0.14	79.5	11.130	23.2	3.248	35.8	5.012	159.3	22.30	287.0	40.18
GC 0080	Cereal grains 1/		11	106.6	1172.6	338.0	3718.0	290.1	3191.1	137.7	1514.7	49.3	542.3
FC 0001	Citrus fruit		1	54.3	54.30	6.3	6.30	5.1	5.10	54.8	54.80	49.0	49.00
JF 0001	Citrus juice		0.01	7.3	0.073	0.0	0.0	0.0	0.0	0.3	0.003	4.5	0.045
DF 0167	Dried fruits		0.05	0.3	0.0	0.0	0.0	0.0	0.3	0.015	2.3	0.115	
PE 0112	Eggs		0.36	14.6	5.256	13.1	4.716	3.7	1.332	11.9	4.284	37.6	13.536
VC 0045	Fruiting vegetables, curcubits		0.26	80.5	20.93	18.2	4.73	0.0	0.00	30.5	7.93	38.5	10.01
MO 098	Kidney of cattle, goats, pigs and sheep 2/	0.034											
VL 0483	Lettuce, leaf		38	2.3	87.40	0.0	0.0	0.0	0.0	5.8	220.4	22.5	855.0
MO 0099	Liver of cattle, goats, pigs and sheep	0.09	0.2	0.019	0.0	0.0	0.1	0.009	0.2	0.019	0.2	0.019	
OC 0645	Maize oil, crude		29.7	1.8	53.46	0.0	0.0	0.3	8.910	0.5	14.850	1.3	38.610
MM 0095	Meat (from mammals others than marine mammals) 2/	0.14	18.5		29.30		13.4		17.00		92.3		
	Meat, muscle portion (meat x 0.8)		0.034	14.8	20.503	23.4	0.796	10.7	0.364	13.6	0.462	73.8	2.509

	Meat, fat portion (meat x 0.2)		0.14	3.7	0.518	5.9	0.820	2.7	0.378	3.4	0.476	18.5	2.583
	Milks 2/		0.007	37.3	0.261	8.8	0.062	6.0	0.042	0.7	0.05	7.0	0.049
VL 0485	Mustard greens		38	0.1	3.80	0.1	3.800	0.1	3.80	0.1	3.80	0.1	3.80
SO 0703	Peanut, whole		0.1	0.0	0.0	4.0	0.400	5.5	0.550	1.3	0.130	0.3	0.030
VO 0051	Pepper		0.675	3.4	2.295	2.1	1.418	5.4	3.645	2.4	1.620	10.4	7.020
PM 0110	Poultry meat, fat		7	31.0	217.00	13.2	92.40	5.5	38.50	25.3	177.10	53.0	371.00
	Poultry meat, muscle portion (meat x 0.9)		1.0	27.9	27.9	11.88	11.88	4.95	4.95	22.68	22.68	47.7	47.7
	Poultry meat, fat portion (meat x 0.1)		2.0	3.1	6.2	1.32	2.64	0.55	1.10	2.53	5.06	5.3	10.6
PO 0111	Poultry, edible offal		2	0.1	0.200	0.1	0.200	0.1	0.200	0.4	0.800	0.4	0.800
VD 0070	Pulses		0.05	24.6	1.230	19.8	0.990	17.8	0.890	23.1	1.155	12.1	0.605
VR 0075	Root and tuber vegetables, except carrots	0.1	61.8	6.180	108.5	10.85	321.3	32.130	159.3	15.93	242.0	24.20	
VL 0502	Spinach		38	0.5	19.00	0.0	0.0	0.0	0.000	0.3	11.40	2.0	76.00
VO 0448	Tomato		0.675	44.1	29.77	5.7	3.848	14.6	9.855	25.5	17.21	42.2	28.485
VJ 0448	Tomato, juice		0.1	0.3	0.030	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.200
	Tomato purée		0.22	5.8	1.265	0.2	0.044	0.3	0.066	0.0	0.0	4.0	0.880
CM 0654	Wheat bran, unprocessed		29.7	0.3	8.910	0.0	0.000	0.0	0.000	0.0	0.00	0.0	0.000
CF 1211	Wheat flour		3.5	323.0	1130.5	114.0	399.00	28.3	99.050	112.0	392.0	175.8	615.30
CF 1210	Wheat germ		33	0.1	3.300	0.1	3.300	0.0	0.000	0.1	3.300	0.1	3.300
CF 1212	Wheat wholemeal		10.8	1.0	10.80	0.3	3.240	0.0	0.000	2.8	30.24	1.3	14.040
				Total	2731		4190		3397		2423		2567
				% ADI	23%		38%		28%		20%		21%
				Rounded	20%		40%		30%		20%		20%

1/ except for wheat

2/ except from cattle

PHOSMET (103)

International Estimated Daily Intake

ADI= 0.01 mg/kg or 600 µg/person for a 60 kg person and 550 µg/person for a 55kg person

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
FS 0240	Apricot		1.6	3	4.8	0	0.0	0	0.0	0	0.0	3.5	5.6
FB 0020	blueberries		4	0	0.0	0	0.0	0	0.0	0	0.0	0.5	2.0
FC 0001	citrus fruit		0.21	8.8	1.8	0.2	0.0	0	0.0	6.3	1.3	6	1.3
SO 0691	cotton seed		0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
OR 0691	cotton seed oil. edible (1)		0	3.8	0.0	0.5	0.0	0.5	0.0	0.5	0.0	0	0.0
FB 0269	Grapes		3.1	15.8	49.0	1	3.1	0	0.0	1.3	4.0	13.8	42.8
FS 0245	Nectarine		1.6	1.25	2.0	0.25	0.4	0	0.0	0.4	0.6	6.25	10.0
JF 0004	orange juice		0.03										
FS 0247	Peach		1.6	1.25	2.0	0.25	0.4	0	0.0	0.4	0.6	6.25	10.0
FP 0009	pome fruit		3.3	10.8	35.6	7.5	24.8	0.3	1.0	6.5	21.5	51.3	169.3
VR 0587	Potato		0.05	59	3.0	19.2	1.0	20.6	1.0	40.8	2.0	240.8	12.0
TN 0085	tree nuts		0.05	1	0.1	13.5	0.7	3.4	0.2	17.5	0.9	3.8	0.2
			TOTAL=		93	30	2	31	248				
			%ADI		16%	6%	0%	5%	41%				
			Rounded		20%	5%	0%	5%	40%				

(1) utilised the cotton seed STMR of zero for cotton seed

PROPARGITE (113)**International Estimated Daily Intake**

ADI=0.01 mg/kg bw or 600 µg/person 550 µg/person Far East

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
TN 0660	almonds		0.05	0.5	0.0	0	0.0	0	0.0	0.1	0.0	1.8	0.1
FP 0226	apple		0.51	7.5	3.8	4.7	2.4	0.3	0.2	5.5	2.8	40	20.4
JF 0226	apple juice		0.03										
	apple puree (sauce)		1.4										
FS 0240	apricot (stone fruit)		0.87	3	2.6	0	0.0	0	0.0	0	0.0	3.5	3.0
	beer		0.02										
DH 1100	hops, dry		18	0.1	1.8	0.1	1.8	0.1	1.8	0.1	1.8	0.1	1.8
FC 0001	citrus fruits		0.01	54.3	0.5	6.3	0.1	5.1	0.1	54.8	0.5	49	0.5
OR 0691	cottonseed oil, edible		0.02	3.8	0.1	0.5	0.0	0.5	0.0	0.5	0.0	0	0.0
DF 0269	dried grapes		0.75	0.3	0.2	0	0.0	0	0.0	0.3	0.2	2.3	1.7
PE 0112	eggs		0	14.6	0.0	13.1	0.0	3.7	0.0	11.9	0.0	37.6	0.0
FB 0269	grapes		0.72	15.8	11.4	1	0.7	0	0.0	1.3	0.9	13.8	9.9
JF0 0269	grape juice		0.05										
	wine of grape		0.01										
GC 0645	maize (corn)		0.05	16.5	0.8	0.0	0.0	0.0	0.0	1.5	0.1	0.0	0.0
CF 1255	maize flour		0.08	31.8	2.5	31.2	2.5	106.2	8.5	40.3	3.2	8.8	0.7
	maize meal		0.06										
	maize grits		0.05										
OR 0645	maize oil, edible		0.26	1.8	0.5	0	0.0	0.3	0.1	0.5	0.1	1.3	0.3
MM 0095	meat (mammalian)			37	0.0	32.8	0.0	23.8	0.0	47	0.0	155.5	0.0
	muscle (meatX0.8)		0.002	29.6	0.1	26.24	0.1	19.04	0.0	37.6	0.1	124.4	0.2
	fat (meatX0.2)		0.02	7.4	0.1	6.56	0.1	4.76	0.1	9.4	0.2	31.1	0.6
ML 0106	milks		0.001	116.8	0.1	32	0.0	41.8	0.0	160	0.2	294	0.3
MO 0096	offals of cattle, sheep, goat..		0.004	4.1	0.0	1.3	0.0	2.7	0.0	6	0.0	12.3	0.0
JF 0004	orange juice		0.05	7.3	0.4	0	0.0	0	0.0	0.3	0.0	4.5	0.2
SO 0697	peanut		0.05										
OR 0691	peanut oil, edible		0.12										
PM 0110	poultry meat		0	31	0.0	13.2	0.0	5.5	0.0	25.3	0.0	53	0.0

PO 0111	poultry, edible offal		0	0.1	0.0	0.1	0.0	0.1	0.0	0.4	0.0	0.4	0.0
FS 0012	stone fruits (except cherries)		0.87	7.3	6.4	0.1	0.1	0	0.0	0.8	0.7	19.8	17.2
VO 0448	tomato		0.17	81.5	13.9	7	1.2	16.5	2.8	25.5	4.3	66	11.2
	tomato puree		0.2										
DT 1114	tea, green, black		1	2.3	2.3	1.2	1.2	0.5	0.5	0.5	0.5	2.3	2.3
			TOTAL=		48		10		14		16		71
			%ADI		8%		2%		2%		3%		12%
			Rounded		10%		2%		2%		3%		10%

TOLYLFLUANID (162):**International estimated daily intake (IEDI).**

ADI = 0.08 mg/kg bw or 4800 µg/person or 4400 µg/person for Far-East

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
JF 0226	Apple juice		0.06										
	Apple sauce		0.22										
	Apple, Canned		0.04										
	Beer		0.025										
	Black currant jelly		0.19										
JF 1140	Black currant juice		0.09										
	Black currant, Washed		0.29										
FB 0264	Blackberries		2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
VC 0424	Cucumber		0.37	4.8	1.8	4.5	1.7	0	0.0	8.3	3.1	9	3.3
FB 0021	Currants, Black, Red, White		0.345	0	0.0	0	0.0	0	0.0	0	0.0	0.3	0.1
JF 0269	Grape juice		0.4										
	Grape wine		0.75										
FB 0269	Grapes		0.75	15.8	11.9	1	0.8	0	0.0	1.3	1.0	12.8	9.6
DF 0269	Grapes, Dried		2.3	0.3	0.7	0	0.0	0	0.0	0.3	0.7	2.3	5.3
DH 1100	Hops, dry		25	0.1	2.5	0.1	2.5	0.1	2.5	0.1	2.5	0.1	2.5
VA 0384	Leek		0.97	0.5	0.5	0	0.0	0	0.0	0.3	0.3	2	1.9
VL 0482	Lettuce, Head		0.05	2.3	0.1	0	0.0	0	0.0	5.8	0.3	22.5	1.1
	Pear juice		0.02										
	Pear, Canned		0.01										
VO 0445	Peppers, Sweet		0.67	3.3	2.2	2	1.3	5.3	3.6	2.3	1.5	10.3	6.9

FP 0009	Pome fruits (see Apple and Pear)		0.68	10.8	7.3	7.5	5.1	0.3	0.2	6.5	4.4	51.3	34.9
FB 0272	Raspberries, Red, Black		1.95	0	0.0	0	0.0	0	0.0	0	0.0	0.5	1.0
FB 0272	Strawberry		0.84	0	0.0	0	0.0	0	0.0	0	0.0	5.3	4.5
	Strawberry jam		0.18										
	Strawberry, Canned		0.18										
	Strawberry, Washed		0.5										
VO 0448	Tomato		0.39	44.1	17.2	5.7	2.2	14.6	5.7	25.5	9.9	38.2	14.9
JF 0448	Tomato juice		0.2	0.3	0.1	0	0.0	0	0.0	0	0.0	2	0.4
	Tomato paste		1.6	5.8	9.3	0.2	0.3	0.3	0.5	0	0.0	4	6.4
	Tomato puree		0.66										
			TOTAL =		54		14		12		24		93
			% ADI =		1%		0%		0%		0%		2%
			Rounded		1%		0%		0%		0%		2%

TRIAZOPHOS (143)**Theoretical maximum daily intake**

ADI= 0.001 0.06 mg/person

Code	Commodity	MRL mg/kg	STMR mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	intake	diet	intake	diet	intake	diet	intake	diet	intake
VP 0523	Broad bean, shelled (succulent)	0.02(*)		0.4	0	0.1	0	0	0	0.4	0	1.2	0
VB 0402	Brussels sprouts	0.1		0.5	0.0001	1	0.0001	0	0	1.1	0.0001	2.7	0.0003
VB 0041	Cabbages, Head	0.1		4.5	0.0005	8.7	0.0009	0	0	9.5	0.0009	24.1	0.0024
VR 0577	Carrot	0.5		2.8	0.0014	2.5	0.0013	0	0	6.3	0.0031	22	0.011
MM 0812	Cattle meat	0.01(*)		18.5	0.0002	3.5	0	10.4	0.0001	30	0.0003	63.3	0.0006
ML 0812	Cattle milk	0.01(*)		79.5	0.0008	23.2	0.0002	35.8	0.0004	159.3	0.0016	287	0.0029
VB 0404	Cauliflower	0.1		1.3	0.0001	1.5	0.0002	0	0	0.3	0	13	0.0013
GC 0080	Cereal grains	0.05(*)		430.8	0.0215	452.3	0.0226	318.4	0.0159	252.5	0.0126	226.3	0.0113
SB 0716	Coffee beans	0.05(*)		5.3	0.0003	0.4	0	0	0	3.6	0.0002	7.9	0.0004
VP 0526	Common bean (pods and/or immature seeds)	0.2		3.5	0.0007	0.8	0.0002	0	0	4	0.0008	12	0.0024
SO 0691	Cotton seed	0.1		0	0	0	0	0	0	0	0	0	0
VA 0385	Onion, bulb	0.05(*)		23	0.0012	11.5	0.0006	7.3	0.0004	13.8	0.0007	27.8	0.0014

VP 0063	Peas	0.1		0.5	0.0001	0.7	0.0001	0	0	0.3	0	14	0.0014
FP 0009	Pome fruits	0.2		10.8	0.0022	7.5	0.0015	0.3	0.0001	6.5	0.0013	51.3	0.0103
VR 0589	Potato	0.05(*)		59	0.003	19.2	0.001	20.6	0.001	40.8	0.002	240.8	0.012
VD 0541	Soya bean (dry)	0.05(*)		4.5	0.0002	2	0.0001	0.5	0	0	0	0	0
FB 0275	Strawberry	0.05(*)		0	0	0	0	0	0	0	0	5.3	0.0003
VR 0596	Sugar beet	0.05(*)		0.5	0	0	0	0	0	0.3	0	2	0.0001
			TOTAL =	0.0323		0.0288		0.0179		0.0236		0.0581	
			% ADI =	54%		48%		30%		39%		97%	
			Rounded % ADI =	50%		50%		30%		40%		100%	

	Citrus fruit juice												
DF 0269	Dried grapes		39.6	FRA	62.3	135.19					1	85.9	43
VO 0440	Egg plant		0.49	AUS	67	487.1	548	USA	444	5	2a	16.6	8
FC 203	Grapefruit		1.6	JAP	52.6	946.8	256	USA	125	5	2a	44.0	22
FB 0269	Grapes		33	AUS	67	1004	125	FRA	118	7	2a	843.2	422
	Grape juice												
MO 099	Kidney of cattle, goats, pigs and sheep		1.9	USA	65	787.8					1	23.0	12
FC 204	Lemon		1.6	FRA	62.3	115.3	108	USA	72	7	2a	14.1	7
FC 205	Lime		1.60	AUS	67	589.6	67	USA	56	7	2a	22.1	11
MO 099	Liver of cattle, goats, pigs and sheep		0.907	USA	65	379.6					1	5.3	3
FC 206	Mandarim		0.16	JAP	52.6	408.7	168	USA	124	7	2a	3.5	2
GC 0645	Maize		0.02	FRA	62.3	259.8					1	0.1	0
OC 0645	Maize oil, crude												
MM 095	Meat (mammals)		0.05	AUS	67	812.0					1	0.6	0
ML 0106	Milks	0.030		USA	65	2466					3	1.1	1
FS 245	Nectarin		7.8	USA	65	590.2	136	USA	125	7	2a	160.8	80
FT 0305	Olives		36.4	NLD	63	63					1	36.4	18
OC 0305	Olive oil												
FC 04	Oranges		1.60	USA	65	564.2	131	USA	96	7	2a	28.1	14
FS 247	Peach		7.8	JAP	52.6	625.9	98	USA	85	7	2a	168.4	84
TN 672	Pecan		0.77	AUS	67	23.45					1	0.3	0
VO 445	Pepper, sweet		3.8	FRA	62.3	207.5	119	USA	98	7	2a	48.5	24
TN 675	Pistachios		0.77	AUS	67	300.2					1	3.4	2
FS 014	Plums		7.8	USA	65	412.8	66	USA	62	7	2a	94.2	47
GC 0649	Rice (see rice, polished)		46										
CM1205	Rice, polished		0.92	JAP	52.6	401.8					1	7.0	4
VD 541	Soya bean (dry)		0.2	JAP	52.6	159.4					1	0.5	0
OC 0541	Soybean, crude oil		0.045										
FS 0012	Stone fruit (1)		7.8										
SO 0702	Sunflower seed		0.08	USA	65	193.1					1	0.2	0
OC 0702	Sunflower crude oil												
VO 1275	Sweet corn		0.05	USA	65	367.3							
VR 508	Sweet potato		0.02	USA	65	535.6	130	USA	105	7	2a	0.4	0
VO 0448	Tomato		2.4	USA	65	390.7	123	USA	123	7	2a	41.7	21

VJ 0448	Tomato, juice		0.24										
	Tomato paste		0.94										
TN 0085	Tree nuts (1)		0.77										
VR 0506	Turnip		0.89	USA	65	234.65	122	USA	105	7	2a	11.8	6
TN 678	Walnuts		0.77	FRA	62.3	135.81					1	1.7	1
GC 654	Wheat		1.6	USA	65	382.9					1	9.4	5
CM 654	Wheat bran, unprocessed	0.17		USA	65	79.95					3	0.2	0
CF 1211	Wheat flour	0.02		USA	65	365.3					3	0.1	0
CF 1210	Wheat germ	0.13		FRA	62.3	207.5					3	0.4	0

1) calculated for the individual commodities in the group

CARBARYL International Estimate of Short-term Intake (IESTI)

Acute RfD=0.2 mg/kg bw or 200 µg/kg bw

Children up to 6 years

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
TN 660	Almonds		0.77	FRA	17.8	31.33					1	1.4	1
FS 240	Apricot		7.8	AUS	19	414.4	35	USA	34	7	2a	253.9	127
VS 0621	Asparagus		10	USA	15	177	16	USA	9		1		
VR 0574	Beetroot (garden beet)		0.06	FRA	17.8	222.5	62	USA	43	7	2a	1.6	1
VR 0577	Carrot		0.31	FRA	17.8	204.7	61	USA	50	7	2a	8.8	4
FS 0013	Cherries		16	FRA	17.8	296.7	12	UK	10		1	266.7	133
FC 0001	Citrus (1)		1.6			0							
	Citrus fruit juice					0							
VO 0440	Egg plant		0.49	JA	15.9	219.3	548	USA	444	5	2a	61.5	31
FC 203	Grapefruit		1.6	FRA	17.8	381.5	256	USA	125	5	2a	79.2	40
FB 0269	Grapes		33	JAP	15.9	387	125	FRA	118	7	2a	2272.6	1136
	Grape juice												
MO 0099	Kidney of cattle, goats, pigs and sheep		1.9	USA	15	186.6					1	23.6	12
FC 204	Lemon		1.6	JP	15.9	88.40	108	USA	72	7	2a	52.4	26
FC 205	Lime		1.60	AUS	19	25.84	67	USA	56	7	2a	30.5	15
MO 0099	Liver of cattle, goats, pigs and sheep		0.907	FRA	17.8	202.7					1	10.3	5
FC 206	Mandarin		1.60	JAP	15.9	353.0	168	USA	124	7	2a	110.4	55
GC 0645	Maize		0.02	FRA	17.8	74.23					1	0.1	0

OC 0645	Maize oil, crude					0							
MM 095	Meat (mammals		0.05	AUS	19	260.5					1	0.7	0
ML 0106	Milks	0.03		USA	15	1286	136	USA	125		3	2.6	1
FS 245	Nectarin		7.8	AUS	19	302.1				7	2a	124.0	62
FT 0305	Olives		36.4	FRA	17.8	49.48					1	101.2	51
OC 0305	Olive oil					0							
FC 04	Oranges		1.60	UK	14.5	498.8	131	USA	96	7	2a	118.6	59
FS 247	Peach		7.8	AUS	19	315.6	98	USA	85	7	2a	338.9	169
TN 672	Pecan		0.77	AUS	19	22.61					1	0.9	0
VO 448	Pepper, sweet		3.8	AUS	19	60.04	119	USA	98	7	2a	129.6	65
TN 675	Pistachios		0.77	AUS	19	62.51					1	2.5	1
FS 014	Plums		7.8	FRA	17.8	254.4	66	USA	62	7	2a	274.5	137
DF 0269	Raisins		39.6	USA	15	59.25					1	156.4	78
GC 0649	Rice (see rice, polished)		46										
CM1205	Rice, polished		0.92	JAP	15.9	199					1	11.5	6
VD 541	Soya bean (dry)		0.15	JAP	15.9	88.25					1	0.8	0
OC 0541	Soybean, crude oil												
FS 0012	Stone fruit		7.8										
SO 0702	Sunflower seed		0.08	USA	15	23.85					1	0.1	0
OC 0702	Sunflower crude oil					0							
VO 1275	Sweet corn		0.05	UK	14.5	160.8							
VR 508	Sweet potato		0.02	USA	15	166.2	130	USA	105	7	2a	1.1	1
VO 0448	Tomato		2.4	USA	15	159	123	USA	123	7	2a	143.5	72
VJ 0448	Tomato, juice												
	Tomato paste												
TN 0085	Tree nuts (1)		0.77										
VR 0506	Turnip		0.89	JAP	52.6	256.2	122	USA	105	7	2a	15.0	7
TN 678	Walnuts		0.77	USA	15	5.55					1	0.3	0
GC 654	Wheat		1.6	USA	15	151.1					1	16.1	8
CM 654	Wheat bran, unprocessed	0.17		USA	15	29.7					3	0.3	0
CF 1211	Wheat flour	0.02		AUS	19	194.4					3	0.2	0
CF 1210	Wheat germ	0.13		USA	15	7.95					3	0.1	0

1) calculated for the individual commodities in the group

**International Estimate of Short-term Intake (IESTI)
General Population**

CARBOFURAN (096)

Acute RfD = 0.009 mg/kg bw or 9 µg /kg bw

Code	Commodity	STMR or	HR. or	Large portion diet			Unit weight			Variability		IESTI µg/kg bw	% acute RfD. rounded
		STMR-P. mg/kg	HP-P mg/kg	Country	Body weight, kg	Large portion, g	Country	Unit weight, g	Edible portion, g	factor	Case		
CM 0649	Rice, husked		0.042	FRA	62.5	312.5					1	0.21	2
<u>VO</u> 0447	Sweet corn (corn-on-the-cob)		0.1	USA	65	367	UK	371	215	5	2a	1.96	22

CARBOFURAN (096)

**International Estimate of Short-term Intake (IESTI)
Children up to 6 years**

Acute RfD = 0.009 mg/kg bw or 9 µg /kg bw

Code	Commodity	STMR or	HR. or	Large portion diet			Unit weight			Variability		IESTI µg/kg bw	% acute RfD. rounded
		STMR-P. mg/kg	HP-P mg/kg	Country	Body weight, kg	Large portion, g	Country	Unit weight, g	Edible portion, g	factor	Case		
CM 0649	Rice, husked		0.042	NLD	17	136.7					1	0.33	4
<u>VO</u> 0447	Sweet corn (corn-on-the-cob)		0.1	UK	14.5	161	UK	371	215	5	2b	5.5	62

DELTA METHRIN (135)

**International Estimate of Short-term Intake (IESTI)
General Population**

Acute RfD=0.05 mg/kg bw or 50 µg/kg bw

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
FP 0226	Apple		0.08	USA	65	1348	138	USA	127	7	2a	2.6	5
JF 0226	apple juice	0.0027											
GC 0640	barley	0.7		NLD	63	378					3	4.2	8
VR 0577	Carrot		0.02	NLD	63	336	100	FRA	89	7	2a	0.3	1
VB 0404	Cauliflower		0.04	UK	70.1	579	1733	UK	780	5	2b	1.7	3
GC 0080	cereal grain (1)												
VL 0466	Chinese cabbage		1.00	USA	65	377	840	USA	798	5	2b	29.0	58
FC 0001	Citrus fruit (2)												
VP 0526	Common beans (pods and or immature seeds)		0.14	NLD	63	431					1	1.0	2

VC 0424	Cucumber		0.02	NLD	65	313	301	USA	286	5	2a	0.4	1
PE 0112	Eggs		0.03	FRA	62.3	219					1	0.1	0
	flat bread	0.35											
VB 0042	Flowerhead brassicas (3)												
VC 0045	Fruiting vegetables, cucurbits (4)												
FB 0269	grapes (inc wine)		0.09	AUS	67	1004	125	FRA	118	7	2a	2.3	5
TN 0666	Hazelnut		0.02	AUS	67	70					1	0.0	0
MO 0098	kidney of cattle, goats, pigs and sheep (5)		0.05	USA	65	787.8					1	0.6	1
VL 0053	Leafy vegetables (6)												
VA 0384	Leek		0.1	FRA	62.3	374	100	FRA	50	7	2a	1.4	3
VP 0060	legume vegetables (7)												
MO 0099	liver of cattle, goats, pigs and sheep (5)		0.05	USA	65	379.6					1	0.3	1
	maize germ	0.224											
OR 0645	maize oil	12.6		NLD	63	43					3	8.6	17
MM 0095	meat (mammalian) (5)			AUS	67	521							2
	meat×0.2 (fat)		0.50	AUS	67	104					1	0.8	
	meat×0.8 (muscle)		0.03	AUS	67	417					1	0.2	
ML 0106	milks (5)	0.03		NLD	63	2515					3	1.2	2
VO 0450	Mushrooms		0.03	FRA	62.3	219					1	0.1	0
FS 0245	Nectarine		0.05	USA	65	590	136	USA	125	7	2a	1.0	2
OC 0305	olive oil, crude	0.32		FRA	62.3	57					3	0.3	1
OR 0305	olive oil, refined	0.34											
FT 0305	olives (used preserved)		0.31	NLD	63	63					1	0.3	1
VA 0385	onion, bulb		0.03	FRA	62.3	306	140	FRA	126	7	2a	0.5	1
FC 0208	oranges, sweet		0.01	USA	65	564.20	131	USA	96	7	2a	0.2	0
FS 0247	Peach		0.05	JAP	52.6	626	122	UK	110	7	2a	1.2	2
VD 0072	peas, dry												
FS 0014	plum (incl prune)		0.05	USA	65	413	66	USA	62	7	2a	0.6	1
VR 0587	Potato		0.01	NLD	63	687	122	UK	99	7	2a	0.2	0
PM 0110	Poultry meat (5)			AUS	67	431							1
	Poultry fat (meat×0.1)		0.50	AUS	67	43					1	0.3	
	Poultry muscle (meat×0.9)		0.03	AUS	67	388					1	0.2	
PO 0111	Poultry, edible offal of (5)		0.03	USA	65	248					1	0.1	0
VD 0070	Pulses (8)	0.5		FRA	62.3	445					3	3.6	7

(9) The tea STMR was multiplied by the highest processing factor for tea water (brewed tea) = 2.2×0.002

DELTA METHRIN (135)

**International Estimate of Short-term Intake (IESTI)
Children up to 6 years**

Acute RfD = 0.05 mg/kg bw or 50 µg/kg bw

Code	Name	STMR or STMR-P, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD		
			HR, mg/kg	Country	Body weight, kg	Large portion, g	Unit weight g	Country					Edible portion, g	
FP0226	Apple	0.0027	0.08	USA	15	679	138	USA	127	7	2a	7.7	15	
JF0226	Apple juice													
VD0071	Beans, dry		0.5		FRA	17.8	209					3	5.9	12
VR0577	Carrot			0.02	FRA	17.8	205	100	FRA	89	7	2a	0.8	2
VB0404	Cauliflower			0.04	NLD	17	209	1733	UK	780	5	2b	2.5	5
GC0080	cereal grain (1)													
VL0466	Chinese cabbage			1.00	JAP	15.9	183	840	USA	798	5	2b	57.5	115
FC0001	citrus fruit (2)													
VP0526	Common bean (French beans)			0.14	NLD	17	253					1	2.1	4
VC0424	Cucumber			0.02	NLD	17	162	301	USA	286	5	2b	1.0	2
PE0112	Eggs	0.03		FRA	17.8	134					3	0.2	0	
	flat bread	0.35												
VB0042	Flowerhead brassicas (3)													
VC0045	Fruiting vegetables, cucurbit (4)													
FB0269	grapes (inc wine)		0.09	JAP	15.9	388	125	FRA	118	7	2a	6.2	12	
TN0666	Hazelnut		0.02	NLD	17	11					1	0.0	0	
MO 0098	Kidney of cattle, goats, sheep and pigs (5)		0.05	USA	15	186.6					1	0.6	1	
VL0053	Leafy vegetables (6)													
VA 0384	Leek		0.1	FRA	17.8	121	100	FRA	50	7	2a	3.1	6	
VP 0060	legume vegetables (7)													
MO 0099	Liver of cattle, goats, sheep and pigs (5)		0.05	FRA	17.8	202.7					1	0.6	1	
	maize germ	0.224												
OR 0645	maize oil	12.6		FRA	17.8	21					3	14.9	30	
MM 0095	meat (mammalian) (5)			AUS	19	260							4	
	meat×0.2 (fat)		0.50	AUS	19	52					1	1.4		
	meat×0.8 (muscle)		0.03	AUS	19	208					1	0.3		
ML 0106	milks (5)	0.03		USA	15	1286					3	2.6	5	

VO 0450	mushrooms		0.03	FRA	17.8	71					1	0.1	0
FS 0245	Nectarine		0.05	AUS	19	302	136	USA	125	7	2a	2.8	6
OC 0305	olive oil, crude	0.32		FRA	17.8	63					3	1.1	2
OR 0305	olive oil, refined	0.34											
FT 0305	olives (used preserved)		0.31	FRA	17.8	49					1	0.9	2
VA 0385	onion, bulb		0.03	FRA	17.8	127	140	FRA	126	7	2a	1.5	3
FC 0208	orange, sweet		0.01	UK	14.5	495.03	229	UK	160	7	2a	1.0	2
FS 0247	Peach		0.05	AUS	19	316	122	UK	110	7	2a	2.6	5
FS 0014	plum (incl prune)		0.05	FRA	17.8	254	66	USA	62	7	2a	1.8	4
VR 0587	Potato		0.01	UK	14.5	279	122	UK	99	7	2a	0.6	1
PM 0110	Poultry meat (5)			AUS	19	224							2
	poultry fat (meat×0.1)		0.50	AUS	19	22					1	0.6	
	poultry muscle (meat×0.9)		0.03	AUS	19	201					1	0.3	
PO 0111	Poultry, edible offal of (5)		0.03	USA	15	37					1	0.1	0
VD 0070	pulses (8)												
VC 0429	Pumpkin		0.02	AUS	19	224	116	USA	81	7	2a	0.7	1
VR 0494	Radish		0.01	FRA	17.8	32					1	0.0	0
GC 0649	Rice	0.7		FRA	17.8	223					3	8.8	18
CM 1206	rice, bran (unprocessed)	1.05		USA	15	3					3	0.2	0
CM 0649	rice, husked (brown)	0.105		FRA	17.8	223					3	1.3	3
CM 1205	rice, polished	0.042		JAP	15.9	199					3	0.5	1
WD 0121	Salmon, Pacific (5)		0.03	AUS	19	234					1	0.4	1
	Sorghum flour	0.231											
	Sorghum starch	0.028											
VL 0502	spinach		1.00	NLD	17	377	111	UK	81	10	2a	65.1	130
	steamed bread (Dumplings etc)	0.098											
FB 0275	strawberry		0.10	AUS	19	176					1	0.9	2
SO 0702	sunflower seed		0.05	USA	15	24					1	0.1	0
VO 0447	sweet corn (corn-on-the-cob)		0.02	UK	14.5	161	371	UK	215	5	2b	1.1	2
DT 1114	tea, green, black (9)	0.002		JAP	15.9	10					3	0.0	0
VO 0448	Tomato		0.20	USA	15	159	123	USA	123	7	2a	12.0	24
	tomato paste	0.002											
	tomato puree	0.002											
TN 0678	Walnuts		0.02	USA	15	6					1	0.0	0
VC 0432	watermelon		0.02	AUS	19	1473	4518	USA	2078	5	2b	7.8	16
CM 0654	wheat bran, unprocessed	2.31		USA	15	30					3	4.6	9
CF 1211	wheat flour	0.217		AUS	19	194					3	2.2	4

CF 1211	Wheat flour	0.11		Aus	19	194					3	1.1	2
CF 1210	wheat germ	0.84		USA	15	8					3	0.4	1
CF 1212	wheat wholemeal	0.637		USA	15	74					3	3.1	6
CP 1211	white bread	0.098		AUS	19	192					3	1.0	2
	white noodles	0.091											
CP 1212	wholemeal bread	0.294		FRA	17.8	297					3	4.9	10
	yellow alkaline noodles	0.119											
											MAX IESTI =130		

(1) The cereal grain commodity with the highest consumption listed was for rice.

(2) Calculations were conducted for both the commodity with the highest consumption (oranges) and the commodity with the highest unit weight (grapefruit).

(3) see cauliflower

(4) Calculations were conducted for both the commodity with the highest consumption (cucumber) and the commodities with the highest unit weight (pumpkin & watermelon).

(5) The 52nd JECFA recommended MRLs for cattle, sheep and chickens in fat at 0.5 mg/kg, liver and kidney at 0.05 mg/kg and muscle, eggs and milk at 0.03 mg/kg. An MRL was also recommended for salmon at 0.03 mg/kg. As the JECFA recommendations were the same or higher than here, and they comprised the major commodities consumed in the commodity groups meat mammalian, kidney and liver of cattle, goats, pigs and sheep and for poultry for which recommendations were made, the Meeting decided to utilise recommendations of the 52nd JECFA for the purposes of estimating dietary intake.

(6) Calculations were conducted for both the commodity with the highest consumption (spinach) and the commodity with the highest unit weight (Chinese cabbage).

(7) The legume vegetable commodity with the highest consumption listed was French beans.

(8) The pulse commodity with the highest consumption listed was beans (dry).

(9) The tea STMR was multiplied by the highest processing factor for tea water (brewed tea) = 2.2×0.002

ESFENVALERATE (204)

International Estimate of Short-term Intake (IESTI) Children up to 6 years

Acute RfD= 0.02 mg/kg bw or 20 µg/kg bw

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
SO 0691	Cotton seed		0.04	USA	15	0.75					1	0.00	0
PE 0112	Eggs		0.01	France	17.8	134					1	0.08	0
PM 0110	Poultry meat (fat)		0.01	Australia	19	224					1	0.12	1
PO 0111	Poultry, Edible offal of		0.01	USA	15	37.1					1	0.02	0
VO 0448	Tomato		0.04	USA	15	159	105	FRA	102	7	2a	2.06	10
GC 0654	Wheat		0.03	USA	15	151					1	0.30	2
											MAX IESTI = 10		

ESFENVALERATE (204)

Acute RfD= 0.02 mg/kg bw or 20 µg/kg bw

International Estimate of Short-term Intake (IESTI)**General Population**

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
SO 0691	Cotton seed		0.04	USA	65	3.25					1	0.00	0
PE 0112	Eggs		0.01	France	62.3	219					1	0.04	0
PM 0110	Poultry meat (fat)		0.01	Australia	67	435					1	0.06	0
PO 0111	Poultry, Edible offal of		0.01	USA	65	248					1	0.04	0
VO 0448	Tomato		0.04	USA	65	391	105	FRA	102	7	2a	0.62	3
GC 0654	Wheat		0.03	USA	65	383					1	0.18	1
												MAX IESTI = 3	

ETHEPHON (106)

Acute RfD = 0.05 mg/kg or 50 µg/kg bw

International Estimate of Short-term Intake (IESTI)**General population**

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
VC4199	Cantaloupe		0.63	USA	65	606	552	USA	276	5	2a	16.6	33
DF0269	Dried grapes	0.84		FRA	62.3	135					3	1.8	4
FB0269	Grapes (excluding wine)		0.82	AUS	67	513	125	FRA	118	7	2a	14.9	30
VO0051	Peppers		2.40	FRA	62.3	207	172	UK	160	7	2a	45.0	90
FI0353	Pineapple		0.97	JAP	52.6	371	700	FRA	420	5	2b	34.2	68
	Pineapple juice	0.051											
	Pineapple, canned		0.27										
VO0448	Tomato		1.70	USA	65	391	123	USA	123	7	2a	29.5	59
	Tomato juice	0.14											
	Tomato paste	0.31											
	Wine	0.31		AUS	67	1131					3	5.2	10
												MAX IESTI = 90	

ETHEPHON (106)

Acute RfD=0.05 mg/kg bw or 50 µg/kg bw

International Estimate of Short-term Intake (IESTI)**Children up to 6 years**

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
VC 4199	Cantaloupe		0.63	USA	15	270	552	USA	276	5	2b	56.6	113
DF 0269	Dried grapes	0.84		USA	15	59					3	3.3	7
FB 0269	Grapes (excluding wine)		0.82	AUS	19	342	125	FRA	118	7	2a	45.3	91

VO 0051	Peppers		2.40	AUS	19	60	172	UK	160	7	2b	53.1	106
FI 0353	Pineapple		0.97	JAP	15.9	216	700	FRA	420	5	2b	66.0	132
	Pineapple juice	0.051											
	Pineapple, canned		0.27										
VO 0448	Tomato		1.70	USA	15	159	123	USA	123	7	2a	101.7	203
	Tomato juice	0.14											
	Tomato paste	0.31											
	Wine	0.31		AUS	19	4					3	0.1	0
												MAX IESTI = 203	

FENAMIPHOS (085) **International Estimate of Short-term Intake (IESTI)**
Acute RfD 0.003 mg/kg bw or 3 µg/kg bw **General Population**

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
FP 0226	Apple		0.01	USA	65	1348	138	USA	127	7	2a	0.3	11
	Apple juice	0.0078											
FI 0327	Banana		0.025	USA	65	556	118	USA	80	7	2a	0.4	13
VB 0402	Brussels sprouts		0.01	NL	63	394	7	FR			1	0.1	2
VB 0041	Cabbage, head		0.05	FR	62.3	311.5 0	771	UK	540	3	2b	0.8	25
VR 0577	Carrot		0.08	NL	63	335.2	114	UK	80	7	2a	1.0	35
OC 0691	Cotton seed oil	0.01											
MO 0105	Edible offal		0.01	FR	62.3	277					1	0.0	1
PE 0112	Eggs (1)		0.01	FR	62.3	219					1	0.0	1
FB 0269	Grapes		0.09	AUS	67	1004	125	FR	118	7	2a	2.3	77
	Grape juice	0.009											
	Raisins		0.14	FR	62.3	135					1	0.3	10
MM 095	Meat					521					1	0.1	3
	<i>Muscle (meat consumption X80%)</i>		0.01	AUS	67	417					1	0.1	
	<i>Fat (meat consumption X20%)</i>		0.01	AUS	67	104					1	0.0	
VC 0046	Melons		0.02	USA	65	655	1000	USA	630	5	2a	1.0	33
ML 0106	Milk	0		USA	65	2466					3	0.0	0
SO 0697	Peanuts		0.01	FR	62.3	161					1	0.0	1
VO 0051	Peppers (2)		0.35	FR	62.3	207	172	UK	160	7	2a	6.6	219
FI 0353	Pineapple		0.14	Japan	52.6	371	472	USA	245	5	2a	3.6	120

	Pineapple juice	0.012	0.17										
PO 0111	Poultry offal		0.01	USA	65	248					1	0.0	1
PM 0110	Poultry meat					431						0.1	2
	<i>Muscle (meat consumptionX90%)</i>		0.01	AUS	67	388					1	0.1	
	<i>Fat (meat consumptionX10%)</i>		0.01	AUS	67	43					1	0.0	
VO 0448	Tomato		0.30	USA	65	391	123	USA	123	7	2a	5.2	174
	Tomato juice	0.05											
VC 0432	Watermelon		0.02	USA	65	1939	4518	USA	2078	5	2b	3.0	99
													MAX IESTI =219

(1) large portion for chicken eggs (PE 840) was used instead of poultry eggs

(2) unit weight for pepper, sweet was used

FENAMIPHOS (085) **International Estimate of Short-term Intake (IESTI)**
Acute RfD 0.003 mg/kg bw or 3 µg/kg bw **Children up to 6 years**

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
FP 0226	Apple		0.01	USA	15	679	138	USA	127	7	2a	1.0	32
	Apple juice	0.0078											
FI 0327	Banana		0.025	Japan	15.9	312	118	USA	80	7	2a	1.2	41
VB 0402	Brussels sprouts		0.01	NL	17	213	7	FR			1	0.1	4
VB 0041	Cabbage, head		0.05	Japan	15.9	142	908	USA	717	3	2b	1.3	45
VR 0577	Carrot		0.08	FR	17.8	204.7	100	FR	89	7	2a	3.3	111
OC 0691	Cotton seed oil	0.01											
MO 0105	Edible offal		0.01	FR	17.8	203					1	0.1	4
PE 0112	Eggs (1)		0.01	FR	17.8	134					1	0.1	3
FB 0269	Grapes		0.09	Japan	15.9	388	125	FR	118	7	2a	6.2	207
	Grape juice	0.009											
DF 0269	Raisins		0.14	USA	15	59					1	0.6	18
MM 095	Meat					260						0.1	5
	<i>Muscle (meat consumptionX80%)</i>		0.01	AUS	19	208					1	0.1	
	<i>Fat (meat consumptionX20%)</i>		0.01	AUS	19	52					1	0.0	
VC 0046	Melons		0.02	AUS	19	413	1000	USA	630	5	2b	2.2	72

ML 0106	Milk	0		USA	15	1286					3	0.0	0
SO 0697	Peanuts		0.01	USA	15	78					1	0.1	2
VO 0051	Peppers (2)		0.35	AUS	19	60	172	UK	160	7	2b	7.7	258
FI 0353	Pineapple		0.14	Japan	15.9	216	472	USA	245	5	2b	9.5	318
	Pineapple juice	0.012	0.17										
PO 0111	Poultry offal		0.01	USA	15	37					1	0.0	1
PM 0110	Poultry meat					224						0.1	4
	<i>Muscle (meat consumptionX90%)</i>		0.01	AUS	19	201					1	0.1	
	<i>Fat (meat consumptionX10%)</i>		0.01	AUS	19	22					1	0.0	
VO 0448	Tomato		0.30	USA	15	159	123	USA	123	7	2a	17.9	598
	Tomato juice	0.05											
VC 0432	Watermelon		0.02	AUS	19	1473	4518	USA	2078	5	2b	7.8	258
													MAX IESTI =598

(1) large portion for chicken eggs (PE 840) was used instead of poultry eggs

(2) unit weight for pepper, sweet was used

IMIDACLOPRID (206)

International Estimate of Short-term Intake (IESTI) General Population

Acute RfD=0.4 mg/kg bw or 400 µg/kg bw

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g				Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g	Var factor			
FP 0226	Apple		0.23	USA	65	1348	110	FRA	100	7	2a	6.9	2
JF 0226	Apple juice	0.046									3		
DF 0226	Apple, dried	0.061		AUS	67	9					3	0.0	0
	Apple sauce	0.053									3		
FS 0240	Apricot		0.32	JPN	52.6	292	40	FRA	37	7	2a	3.1	1
	Apricot jam	0.046									3		
	Apricot, canned	0.046									3		
FI 0327	Banana		0.05	USA	65	556	150	FRA	102	7	2a	0.9	0
GC 0640	Barley		0.05	NLD	63	378					1	0.3	0
VP 0061	Beans, except broad bean and soya bean		0.88	FRA	62.3	312					1	4.4	1
	Beans, cooked	0.39									3		
	Beans, canned	0.17									3		
	Beer	0.0025									3		

VB 0400	Broccoli		0.32	USA	65	376	608	USA	474	5	2b	9.3	2
VB 0402	Brussels sprouts		0.32	NLD	63	394	7	FRA			1	2.0	1
VB 0041	Cabbages, Head		0.32	FRA	62.3	312	771	UNK	540	3	2b	4.8	1
VB 0404	Cauliflower		0.32	UNK	70.1	579	1733	UNK	780	5	2b	13.2	3
GC 0080	Cereal grains /1												
FS 0244	Cherry, sweet /2		0.28	FRA	62.3	375	5	FRA			1	1.7	0
	Cherry, sweet, canned	0.084									3		
FC 0001	Citrus fruits /3		0.06								1		
JF 0001	Citrus juice	0.014									3		
	Citrus marmalade (orange)	0.03									3		
VC 0424	Cucumber		0.39	NLD	63	313	400	FRA	360	5	2b	9.7	2
MO 0105	Edible offal, mammalian		0.036	FRA	62.3	277					1	0.2	0
VO 0440	Egg plant		0.14	AUS	67	487	548	USA	444	5	2a	4.7	1
PE 0112	Eggs /4		0.001	FRA	62.3	219					1	0.0	0
FB 0269	Grapes		0.61	AUS	67	1004	125	FRA	118	7	2a	15.6	4
DF 0269	Grapes, dried	0.12		NLD	63	137					3	0.3	0
JF 0269	Grape juice	0.088									3		
	Wine	0.14									3		
FC 0203	Grapefruit		0.06	JPN	52.6	947	302	UNK	160	5	2a	1.8	0
DH 1100	Hops, dry	0.7		USA	65	6					3	0.1	0
VA 0384	Leek		0.05	FRA	62.3	374	246	UNK	140	7	2a	1.0	0
FC 0204	Lemon		0.11	FRA	62.3	115	100	FRA	64	7	2a	0.9	0
VL 0482	Lettuce, Head		1.2	USA	65	213	754	UNK	558	3	2b	11.8	3
GC 0645	Maize		0.05	FRA	62.3	260					1	0.2	0
FC 0003	Mandarins		0.11	USA	65	394	100	FRA	72	7	2a	1.4	0
FI 0345	Mango		0.15	FRA	62.3	567	207	USA	139	7	2a	3.4	1
MM 0095	Meat (mammalian)					521							0
	0.004 x 0.2 (fat)		0.001	AUS	67	104					1	0.0	
	0.007 x 0.8 (muscle)		0.006	AUS	67	417					1	0.0	
VC 0046	Melons, except watermelon		0.11	USA	65	655	700	FRA	420	5	2a	4.0	0
ML 0106	Milks	0.0014		USA	65	2466					3	0.1	0
FS 0245	Nectarine		0.32	USA	65	590	110	FRA	99	7	2a	5.8	1
	Nectarine jam	0.046									3		
	Nectarine, canned	0.046									3		
GC 0647	Oats		0.05	FRA	62.3	305					1	0.2	0

IMIDACLOPRID (206)

Acute RfD=0.4 mg/kg bw or 400 µg/kg bw

International Estimate of Short-term Intake (IESTI)**Children up to 6 years**

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
FP 0226	Apple		0.23	USA	15	679	110	FRA	100	7	2a	19.6	5
JF 0226	Apple juice	0.046									3		
DF 0226	Apple, dried	0.061		AUS	19	4					3	0.0	0
	Apple sauce	0.053									3		
FS 0240	Apricot		0.32	AUS	19	414	40	FRA	37	7	2a	10.7	3
	Apricot jam	0.046									3		
	Apricot, canned	0.046									3		
FI 0327	Banana		0.05	JPN	15.9	312	150	FRA	102	7	2a	2.9	1
GC 0640	Barley		0.05	AUS	19	14					1	0.0	0
VP 0061	Beans, except broad bean and soya bean		0.88	FRA	17.8	203					1	10.0	3
	Beans, cooked	0.39									3		
	Beans, canned	0.17									3		
	Beer	0.0025									3		
VB 0400	Broccoli		0.32	USA	15	164	608	USA	474	5	2b	17.5	4
VB 0402	Brussels sprouts		0.32	NLD	17	213	7	FRA			1	4.0	1
VB 0041	Cabbages, Head		0.32	JPN	15.9	142	771	UNK	540	3	2b	8.6	2
VB 0404	Cauliflower		0.32	NLD	17	209	1733	UNK	780	5	2b	19.7	5
GC 0080	Cereal grains /1												
FS 0244	Cherry, sweet /2		0.28	FRA	17.8	297	5	FRA			1	4.7	1
	Cherry, sweet, canned	0.084									3		
FC 0001	Citrus fruits /3		0.06										
JF 0001	Citrus juice	0.014									3		
	Citrus marmalade (orange)	0.03									3		
VC 0424	Cucumber		0.39	NLD	17	162	400	FRA	360	5	2b	18.6	5
MO 0105	Edible offal, mammalian		0.036	FRA	17.8	203					1	0.4	0
VO 0440	Egg plant		0.14	JPN	15.9	219	548	USA	444	5	2b	9.6	2
PE 0112	Eggs /4		0.001	FRA	17.8	134					1		

FB 0269	Grapes		0.61	JPN	15.9	388	125	FRA	118	7	2a	42.0	11
DF 0269	Grapes, dried	0.12		USA	15	59					3	0.5	0
JF 0269	Grape juice	0.088									3		
	Wine	0.14									3		
FC 0203	Grapefruit		0.06	FRA	17.8	381	302	UNK	160	5	2a	3.4	1
DH 1100	Hops, dry	0.7		JPN	15.9	0.48					3	0.0	0
VA 0384	Leek		0.05	FRA	17.8	121	246	UNK	140	7	2b	2.4	1
FC 0204	Lemon		0.11	JPN	15.9	88	100	FRA	64	7	2a	3.3	1
VL 0482	Lettuce, Head		1.2	NLD	17	84	754	UNK	558	3	2b	17.8	4
GC 0645	Maize		0.05	FRA	17.8	148					1	0.4	0
FC 0003	Mandarins		0.11	USA	15	205	100	FRA	72	7	2a	4.7	1
FI 0345	Mango		0.15	AUS	19	207	207	USA	139	7	2a	8.2	2
MM 0095	Meat (mammalian)					260							0
	Meat x 0.2 (fat)		0.004	AUS	19	52					1	0.0	
	Meat x 0.8 (muscle)		0.007	AUS	19	208					1	0.1	
VC 0046	Melons, except watermelon		0.11	AUS	19	413	700	FRA	420	5	2b	12.0	3
ML 0106	Milks	0.0014		USA	15	1286					3	0.1	0
FS 0245	Nectarine		0.32	AUS	19	302	110	FRA	99	7	2a	15.1	4
	Nectarine jam	0.046									3		
	Nectarine, canned	0.046									3		
GC 0647	Oats		0.05	USA	15	62					1	0.2	0
VA 0385	Onion, Bulb		0.06	FRA	17.8	127	164	UNK	149	7	2b	3.0	1
FC 0004	Oranges, sweet, sour		0.11	UNK	14.5	495	190	FRA	134	7	2a	9.9	2
FS 0247	Peach		0.32	AUS	19	316	110	FRA	99	7	2a	15.3	4
	Peach jam	0.046									3		
	Peach, canned	0.046									3		
FP 0230	Pear		0.71	UNK	14.5	279	166	USA	151	7	2a	58.0	15
TN 0672	Pecan		0.05	AUS	19	22					1	0.1	0
VO 0051	Peppers /5		0.48	AUS	19	60	172	UNK	160	7	2b	10.6	3
FS 0014	Plums (including prunes)		0.12	FRA	17.8	254	59	UNK	55	7	2a	3.9	1
PM 0110	Poultry meat					223							0
	Meat x 0.1 (fat)		0	AUS	19	22					1	0.0	
	Meat x 0.9 (muscle)		0.0004	AUS	19	201					1	0.0	
PO 0111	Poultry, Edible offal of		0.0026	USA	15	37					1	0.0	0

MO 0096	Edible offal (mammalian)		0	FRA	62.3	277				1	1		0
PE 0112	Eggs /2		0	FRA	62.3	219				1	1		0
FC 0203	Grapefruit		2	JPN	52.6	947	256	USA	125	5	2a	55.0	611
FC 0204	Lemon		2	FRA	62.3	115	108	USA	72	7	2a	17.6	195
FC 0003	Mandarins		2	USA	65	394	168	USA	124	7	2a	35.0	389
MM 0095	Meat (from mammals other than marine mammals)		0	AUS	67	521					1		0
VC 0046	Melons, except watermelon		0.5	USA	65	702	1000	USA	630	5	2a	26.8	297
ML 0106	Milks	0		USA	65	2466					3		0
FC 0004	Oranges, Sweet, Sour		2	USA	65	564	131	USA	96	7	2a	35.1	390
SO 0697	Peanut		0.03	FRA	62.3	161					1	0.1	1
OR 0679	Peanut oil, edible	0.0034									3		0
VO 0051	Peppers		4.3	FRA	62.3	207	119	USA	98	7	2a	54.9	610
VR 0589	Potato		0.05	NLD	63	687	122	USA	99	7	2a	1.0	11
PM 0110	Poultry meat		0	AUS	67	431				1	1		0
PO 0111	Poultry, Edible offal of		0	USA	65	248				1	1		0
VO 0448	Tomato		0.99	USA	65	391	123	USA	123	7	2a	17.2	191
													MAX IESTI = 611

1/ calculated for the individual commodities of this group

1/ based on large portion diet for PE 840, chicken eggs

OXAMYL (126)

International Estimate of Short-term Intake (IESTI)

Acute RfD= 0.009 mg/kg bw or 9 µg/kg bw

Children up to 6 years

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g				Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g	Var factor			
FP 0226	Apple		1.2	USA	15	679	138	USA	127	7	2a	115.3	1281
VR 0577	Carrots		0.07	FRA	17.8	205	61	USA	31	7	2a	1.5	17
FC 0001	Citrus fruits /1												
SO 0691	Cotton seed		0.08	USA	15	1				1	1	0.0	0
OR 0691	Cotton seed oil, edible	0,0003								1	3		
VC 0424	Cucumber		0.54	NLD	17	162	301	USA	286	7	2b	36.0	400
MO 0096	Edible offal (mammalian)		0	FRA	17.8	203				1	1		0
PE 0112	Eggs /2		0	FRA	17.8	134				1	1		0

FP 0230	Pear		7.30	USA	65	693	168	UK	153	7	2a	180.9	905
TN 0085	Tree nuts (3)												
												MAX IESTI = 1185	

(1) see apples and pears

(2) apple STMR × PF for dried apple = 3.3 × 0.09

(3) The highest consumption listed for tree nuts for the general population was for chestnuts. For case 1 IESTI calculations the commodity within a group with the highest consumption figure will result in the highest intake estimate for the group, ie the IESTI for the other tree nuts in the group will be less than chestnuts

(4) for citrus fruit, see oranges, sweet and grapefruit. These two commodities were selected as they lead to the highest IESTI values based on the largest consumption figure (oranges) and largest unit weight (grapefruit)

PHOSMET (103)

International Estimate of Short-term Intake (IESTI)

Acute RfD=0.02 mg/kg bw or 20 µg/kg bw

Children up to 6 years

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
FP 0226	Apple		7.30	USA	15	679	138	USA	127	7	2a	701.3	3506
	Apple juice	0.015											
DF0299	Apple, dried (2)	0.3		AUS	19	4					3	0.1	0
FB0204	Blueberries		9.90	FRA	17.8	138					1	76.9	385
FC0001	Citrus fruits (4)												
FC0203	Grapefruit		0.52	FRA	17.8	381	302	UK	160	5	2a	29.8	149
FS 0247	Nectarine		6.80	AUS	19	307	169	UK	150	7	2a	432.0	2160
JF0004	Orange juice	0.03											
FC0208	Oranges, sweet		0.52	USA	15	378	131	USA	96	7	2a	33.1	165
FP0230	Pear		7.30	UK	14.5	279	168	UK	153	7	2a	602.6	3013
TN0675	Pistachio		0.1	AUS	19	63					1	0.3	2
FP0009	Pome fruit (1)												
TN0085	Tree nuts (3)												
												MAX IESTI = 3506	

(1) see apples and pears

(2) apple STMR × PF for dried apple = 3.3 × 0.09

(3) The highest consumption listed for tree nuts for the children was for pistachios. For case 1 IESTI calculations the commodity within a group with the highest consumption figure will result in the highest intake estimate for the group, ie the IESTI for the other tree nuts in the group will be less than pistachios

(4) for citrus fruit, see oranges, sweet and grapefruit. These two commodities were selected as they lead to the highest IESTI values based on the largest consumption figure (oranges) and largest unit weight (grapefruit)

TOLYLFLUANID (162)

International Estimate of Short-term Intake (IESTI)

Acute RfD=0.50 mg/kg bw or 500 µg/kg bw

General Population

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
FP 0226	Apple		4	USA	65	1348	110	France	100	7	2a	119.9	24

TOLYLFLUANID (162)**International Estimate of Short-term Intake (IESTI)**

Acute RfD=0.50 mg/kg bw 500 µg/kg bw

Children up to 6 years

Code	Name	STMR or STMR-P, mg/kg	HR, mg/kg	Large portion diet			Unit weight g			Var factor	Case	IESTI, ug/kg bw/day	% acute RfD
				Country	Body weight, kg	Large portion, g	Unit weight g	Country	Edible portion, g				
	Apple		4	USA	15.0	679	110	France	100	7	2a	341.0	68
JF 0226	Apple juice	0.06									3		
	Apple sauce	0.22									3		
	Apple, Canned	0.04									3		
	Beer	0.025									3		
	Black currant jelly	0.19									3		
JF 1140	Black currant juice	0.09									3		
	Black currant, Washed		0.57								1		
FB 0264	Blackberries		2.9	France	17.8	48					1	7.7	2
VC 0424	Cucumber		0.96	NLD	17	162	400	France	360	5	2b	45.7	9
FB 0021	Currants, Black, Red, White		0.68	AUS	19.0	13					1	0.5	0
JF 0269	Grape juice	0.4									3		
	Grape wine	0.75		AUS	19	4					3	0.2	0
FB 0269	Grapes (excl. wine)		2	AUS	19	342	125	France	118	7	2a	110.5	22
DF 0269	Grapes, Dried	2.3		USA	15	59					3	9.0	2
DH 1100	Hops, dry		71	Japan	15.9	0					1	2.1	0
VA 0384	Leek		1.8	France	17.8	121	246	UK	140	7	2b	85.9	17
VL 0482	Lettuce, Head		0.17	NLD	17.0	84	754	UK	558	3	2b	2.5	1
	Pear		4	UK	14.5	279	100	France	89	7	2a	224.3	45
	Pear juice	0.02									3		
	Pear, Canned	0.01									3		
VO 0445	Peppers, Sweet		1.6	Australia	19	60	172	UK	160	7	2b	35.4	7
FP 0009	Pome fruits (see Apple and Pear)	0.68	4										
FB 0272	Raspberries, Red, Black		2.9	France	17.8	76					1	12.4	2
FB 0272	Strawberry		3	AUS	19	176					1	27.8	6
	Strawberry jam	0.18									3		
	Strawberry, Canned	0.18									3		
	Strawberry, Washed		1.8								1		
VO 0448	Tomato		2.2	USA	15	159	105	France	102	7	2a	113.1	23
JF 0448	Tomato juice	0.2									3		
	Tomato paste	1.6									3		
	Tomato puree	0.66									3		
	Tomato puree	0.66									3		
												MAX IESTI =68	

ANNEX 5

Reports and other documents resulting from previous Joint Meetings of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and WHO Expert Groups on Pesticide Residues

1. Principles governing consumer safety in relation to pesticide residues. Report of a meeting of a WHO Expert Committee on Pesticide Residues held jointly with the FAO Panel of Experts on the Use of Pesticides in Agriculture. FAO Plant Production and Protection Division Report, No. PL/1961/11; WHO Technical Report Series, No. 240, 1962.
2. Evaluation of the toxicity of pesticide residues in food. Report of a Joint Meeting of the FAO Committee on Pesticides in Agriculture and the WHO Expert Committee on Pesticide Residues. FAO Meeting Report, No. PL/1963/13; WHO/Food Add./23, 1964.
3. Evaluation of the toxicity of pesticide residues in food. Report of the Second Joint Meeting of the FAO Committee on Pesticides in Agriculture and the WHO Expert Committee on Pesticide Residues. FAO Meeting Report, No. PL/1965/10; WHO/Food Add./26.65, 1965.
4. Evaluation of the toxicity of pesticide residues in food. FAO Meeting Report, No. PL/1965/10/1; WHO/Food Add./27.65, 1965.
5. Evaluation of the hazards to consumers resulting from the use of fumigants in the protection of food. FAO Meeting Report, No. PL/1965/10/2; WHO/Food Add./28.65, 1965.
6. Pesticide residues in food. Joint report of the FAO Working Party on Pesticide Residues and the WHO Expert Committee on Pesticide Residues. FAO Agricultural Studies, No. 73; WHO Technical Report Series, No. 370, 1967.
7. Evaluation of some pesticide residues in food. FAO/PL:CP/15; WHO/Food Add./67.32, 1967.
8. Pesticide residues. Report of the 1967 Joint Meeting of the FAO Working Party and the WHO Expert Committee. FAO Meeting Report, No. PL:1967/M/11; WHO Technical Report Series, No. 391, 1968.
9. 1967 Evaluations of some pesticide residues in food. FAO/PL:1967/M/11/1; WHO/Food Add./68.30, 1968.
10. Pesticide residues in food. Report of the 1968 Joint Meeting of the FAO Working Party of Experts on Pesticide Residues and the WHO Expert Committee on Pesticide Residues. FAO Agricultural Studies, No. 78; WHO Technical Report Series, No. 417, 1968.
11. 1968 Evaluations of some pesticide residues in food. FAO/PL:1968/M/9/1; WHO/Food Add./69.35, 1969.
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13. 1969 Evaluations of some pesticide residues in food. FAO/PL:1969/M/17/1; WHO/Food Add./70.38, 1970.
14. Pesticide residues in food. Report of the 1970 Joint Meeting of the FAO Working Party of Experts on Pesticide Residues and the WHO Expert Committee on Pesticide Residues. FAO Agricultural Studies, No. 87; WHO Technical Report Series, No. 4574, 1971.
15. 1970 Evaluations of some pesticide residues in food. AGP:1970/M/12/1; WHO/Food Add./71.42, 1971.
16. Pesticide residues in food. Report of the 1971 Joint Meeting of the FAO Working Party of Experts on Pesticide Residues and the WHO Expert Committee on Pesticide Residues. FAO Agricultural Studies, No. 88; WHO Technical Report Series, No. 502, 1972.
17. 1971 Evaluations of some pesticide residues in food. AGP:1971/M/9/1; WHO Pesticide Residue Series, No. 1, 1972.
18. Pesticide residues in food. Report of the 1972 Joint Meeting of the FAO Working Party of Experts on Pesticide Residues and the WHO Expert Committee on Pesticide Residues. FAO Agricultural Studies, No. 90; WHO Technical Report Series, No. 525, 1973.
19. 1972 Evaluations of some pesticide residues in food. AGP:1972/M/9/1; WHO Pesticide Residue Series, No. 2, 1973.
20. Pesticide residues in food. Report of the 1973 Joint Meeting of the FAO Working Party of Experts on Pesticide Residues and the WHO Expert Committee on Pesticide Residues. FAO Agricultural Studies, No. 92; WHO Technical Report Series, No. 545, 1974.
21. 1973 Evaluations of some pesticide residues in food. FAO/AGP/1973/M/9/1; WHO Pesticide Residue Series, No. 3, 1974.

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23. 1974 Evaluations of some pesticide residues in food. FAO/AGP/1974/M/11; WHO Pesticide Residue Series, No. 4, 1975.
24. Pesticide residues in food. Report of the 1975 Joint Meeting of the FAO Working Party of Experts on Pesticide Residues and the WHO Expert Committee on Pesticide Residues. FAO Plant Production and Protection Series, No. 1; WHO Technical Report Series, No. 592, 1976.
25. 1975 Evaluations of some pesticide residues in food. AGP:1975/M/13; WHO Pesticide Residue Series, No. 5, 1976.
26. Pesticide residues in food. Report of the 1976 Joint Meeting of the FAO Panel of Experts on Pesticide Residues and the Environment and the WHO Expert Group on Pesticide Residues. FAO Food and Nutrition Series, No. 9; FAO Plant Production and Protection Series, No. 8; WHO Technical Report Series, No. 612, 1977.
27. 1976 Evaluations of some pesticide residues in food. AGP:1976/M/14, 1977.
28. Pesticide residues in food—1977. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues and Environment and the WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 10 Rev, 1978.
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30. Pesticide residues in food—1978. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues and Environment and the WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 15, 1979.
31. Pesticide residues in food: 1978 evaluations. FAO Plant Production and Protection Paper 15 Suppl., 1979.
32. Pesticide residues in food—1979. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 20, 1980.
33. Pesticide residues in food: 1979 evaluations. FAO Plant Production and Protection Paper 20 Suppl., 1980.
34. Pesticide residues in food—1980. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 26, 1981.
35. Pesticide residues in food: 1980 evaluations. FAO Plant Production and Protection Paper 26 Suppl., 1981.
36. Pesticide residues in food—1981. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 37, 1982.
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39. Pesticide residues in food: 1982 evaluations. FAO Plant Production and Protection Paper 49, 1983.
40. Pesticide residues in food—1983. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 56, 1985.
41. Pesticide residues in food: 1983 evaluations. FAO Plant Production and Protection Paper 61, 1985.
42. Pesticide residues in food—1984. Report of the Joint Meeting on Pesticide Residues. FAO Plant Production and Protection Paper 62, 1985.
43. Pesticide residues in food—1984 evaluations. FAO Plant Production and Protection Paper 67, 1985.
44. Pesticide residues in food—1985. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and a WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 68, 1986.
45. Pesticide residues in food—1985 evaluations. Part I. Residues. FAO Plant Production and Protection Paper 72/1, 1986.
46. Pesticide residues in food—1985 evaluations. Part II. Toxicology. FAO Plant Production and Protection Paper 72/2, 1986.

47. Pesticide residues in food—1986. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and a WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 77, 1986.
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49. Pesticide residues in food—1986 evaluations. Part II. Toxicology. FAO Plant Production and Protection Paper 78/2, 1987.
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52. Pesticide residues in food—1987 evaluations. Part II. Toxicology. FAO Plant Production and Protection Paper 86/2, 1988.
53. Pesticide residues in food—1988. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and a WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 92, 1988.
54. Pesticide residues in food—1988 evaluations. Part I. Residues. FAO Plant Production and Protection Paper 93/1, 1988.
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71. Pesticide residues in food—1994. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and a WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 127, Rome, 1995.
72. Pesticide residues in food—1994 evaluations. Part I. Residues. FAO Plant Production and Protection Paper 131/1 and 131/2 (2 volumes), Rome, 1995.
73. Pesticide residues in food—1994 evaluations. Part II. Toxicology. World Health Organization, WHO/PCS/95.2, Geneva, 1995.
74. Pesticide residues in food—1995. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the Core Assessment Group. FAO Plant Production and Protection Paper 133, Rome, 1996.
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77. Pesticide residues in food—1996. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group. FAO Plant Production and Protection Paper, 140, 1997.
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79. Pesticide residues in food—1996 evaluations. Part II. Toxicological. World Health Organization, WHO/PCS/97.1, Geneva, 1997.
80. Pesticide residues in food—1997. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group. FAO Plant Production and Protection Paper, 145, 1998.
81. Pesticide residues in food—1997 evaluations. Part I. Residues. FAO Plant Production and Protection Paper, 146, 1998.
82. Pesticide residues in food—1997 evaluations. Part II. Toxicological and Environmental. World Health Organization, WHO/PCS/98.6, Geneva, 1998.
83. Pesticide residues in food—1998. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group. FAO Plant Production and Protection Paper, 148, 1999.
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88. Pesticide residues in food—1999 evaluations. Part II. Toxicological. World Health Organization, WHO/PCS/00.4, Geneva, 2000.
89. Pesticide residues in food—2000. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group. FAO Plant Production and Protection Paper, 163, 2001.
90. Pesticide residues in food—2000 evaluations. Part I. Residues. FAO Plant Production and Protection Paper, 165, 2001.

91. Pesticide residues in food—2000 evaluations. Part II. Toxicological. World Health Organization, WHO/PCS/01.3, 2001.
92. Pesticide residues in food—2001. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group. FAO Plant Production and Protection Paper, 167, 2001.
93. Pesticide residues in food—2001 evaluations. Part I. Residues. FAO Plant Production and Protection Paper, 171, 2002.
94. Pesticide residues in food—2001 evaluations. Part II. Toxicological. World Health Organization, WHO/PCS/02.1, (2002)

ANNEX 6

CORRECTIONS TO REPORT OF 2001

Changes are shown in bold. Minor typographical errors are not included

Section 4

4.3 Chlorpropham p.38, last para, line 3.

Change “0.0002 mg/kg for cattle milk” to “0.0003 mg/kg for cattle milk”

4.8 Dimethipin p.54, para 3, line 5.

Change “(0.1 mg/kg) ...” To (0.5 mg/kg) ...

4.12 Fipronil p. 86, second para below Table, lines 2-3.

Change “0.0* for poultry meat” to “0.01 mg/kg for poultry meat”

4.17 Kresoxim-methyl p.101. Fate of residues during processing, para 3, line 2.

Change “... 0.07, 0.12 and 0.22 ...” to “... 0.07 and 0.12 ...”

4.18 Methomylp.112, para 1, last sentence.

Change to read “The Meeting estimated a maximum residue level of 1 mg/kg for tomato, **confirming the existing CXL.**”

p.117, para2, line 8.

Change “maize fodder (50 g/kg fresh weight)” to “maize fodder (50 mg/kg fresh weight)”

p.117, para 7, line 5.

Change “... 0.38 mg/kg ...” to **1.5 mg/kg ...**

p.119, para 5, line 8.

Change “<0.003-0.07 ..” to “<0.003-0.09 ...”

p.121, para 6, last sentence.

Change “The Meeting concluded ... from uses other than on the 14 commodities that have been considered ...” to “The Meeting concluded ... from uses, other than on **these** 14 commodities, that have been considered ...”

4.24 Spinosadp.167, para 8, line 7.

Change “... did not exceed the LOQ ...” to “... **was below** the LOQ ...”

p.171, second para below Table, line 1.

Change “(mean of 0.47 and 0.53 mg/kg)” to “**(the higher of the two values)**”

4.25 Tebufenozidep. 183, first Table, Rice grain, column 6.

Change “0.0114” to “**0.114**”

p.184, para 1, end of line 7.

Change “0.007” to “**0.009**”

4.26 Thiodicarb

p.195, Residues in animal commodities, para 1, last sentence.

Change “... for edible offal, meat and milk ...” to “... for edible offal, meat and **eggs**”

p.197, para 1, last line.

Change “These confirm the existing values” to “**The estimates for meat and milk** confirm the existing values”

Corrections for ANNEX 1

The relevant sections are shown below with corrections in bold. A number of minor errors, mainly in commodity names, are not listed. All corrections have been included in Annex 1 to the 2001 Evaluations.

	ADI (mg/kg bw)	CCN	Commodity Name	New MRL (mg/kg)	Previous MRL (mg/kg)	STMR, STMR-P (mg/kg)	HR HR-P (mg/kg)
Aldicarb (117)	0-0.003		Potato chips			0.0228	
Dinocap (087)		Residue for compliance with MRL and for estimation of dietary intake: sum of dinocap isomers and dinocap phenols, expressed as dinocap					
Fipronil (202)		VB 0041	Cabbages, Head	0.02	-	0.005	0.0215
		VB 0042	Flowerhead brassicas	0.02	-	0.005	0.0215
		AV 0596	Sugar beet leaves or tops	0.2 ²	-		
Haloxfop (194)		PM 0840	Chicken meat	0.01* ²	0.01*	0.002	0.003
		PO 0840	Chicken, Edible offal of	0.05	0.1	0.009	0.030
Iprodione (111)		JF 0448	Tomato juice			0.55	
Kresoxim-methyl (199)		FC 0004	Oranges, Sweet, Sour	0.5		[No entry]	
		Residue for compliance with MRLs and for estimation of the dietary intake for plant commodities: kresoxim-methyl. For compliance with MRLs and for estimation of the dietary intake for animal commodities: α -(hydroxy-tolyloxy)-tolyl(methoxyimino)acetic acid, expressed as kresoxim-methyl. Acute RfD: Unnecessary					
Methomyl** (094)		VC 0045	Fruiting vegetables, Cucurbits⁵	0.1 ¹		0.02	0.07
		MO 0105	Edible offal (from mammals other than marine mammals)	0.02* ³	0.02* [No entry]	0.00	0.00
		FB 0269	Grapes ⁴	7 ¹	5	0.86	5.2
		GC 0647	Oats	0.02* ¹	0.5	002	0.02

Insert	FP 0009	Pome fruits	W	2		
	VC 0432	Watermelon ⁴	W	0.2		
	CF 0121	Wheat flour	0.03		0.003	
Piperonyl butoxide** (062)	AB 0001	Citrus pulp , dry			5.7	
	JF 0448	Tomato juice	0.3		0.10	
	CF 1210	Wheat germ	100 PoP		30.8	
		Residue for compliance with MRLs and for estimation of the dietary intake for plant and animal commodities: piperonyl butoxide The residue is fat-soluble ¹ The MRL accommodates external animal treatment ² Not STMR but median residues from animals in a treated group ³ In muscle Acute RfD: Unnecessary				
Spinosad* (203)	JF 0004	Orange juice			0.007 2	
Tebufozide (196)	AM 0660	Almond hulls	30		15.5 15	
	MM 0812	Cattle meat (F)	0.05 (fat)		0.006	0.006
	PM 0110	Poultry meat	0.02* (fat)	-	0.02	0.02

Corrections for ANNEX 2

p.220.

Change Thianedazole to Thiabendazole and Thiophanate-methyl to Thiophanate-methyl

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ANNEX 7

RESIDUES IN UNIT CROPS

EXPLANATION

The variability factor is required for the estimation of the acute intake of pesticides. During a workshop on acute risk assessment hosted by PSD in York 1998, the need for additional data on grapes and leafy vegetables was identified. Following that workshop European Crop Protection Association (ECPA) decided to sponsor 2 studies in grapes and lettuce. The FAO/IAEA Training and Reference Centre for Food and Pesticide Control (TRC) initiated a coordinated research program including 10 commodities in 9 countries to provide residue data for estimating variability factor. The results of ECPA trials in grapes and lettuce and the first TRC trial in grapes were made available for evaluation by the 2002 JMPR.

RESIDUES RESULTING FROM SUPERVISED TRIALS

The objective of the studies was to determine the variability of residue levels of active ingredients selected from different chemical classes in/on single unit crops, and to provide experimental evidence, whether any substance class specific variability could be observed.

Grapes

The field phases of ECPA trials (G00W062R, G00W063R,) were conducted in Southern Germany (Balluff, 2001a) at two locations in Rhineland-Palatinate province, and in the Vaucluse province of Southern France (F00W041R, F00W042R) (Balluff, 2001b). The locations of sites were about 32 and 10 km, respectively.

The 011AEAH01 trial was carried out at Mád, a historical vine growing area in the Northeast part of Hungary, to determine the residues of vinclozolin, chlorpyrifos and metalaxyl in individual bunches.

The region, variety (Muscat de Hamburg in France, Kerner and Riesling in Germany and Furmint and "Hárslevelü" in Hungary), and cultivation technique were typical for grape production in those regions.

The details of the plots are summarised in Table 1.

Table 1. Plot specifications for grape trials

	Treatment	G00W062R	G00W063R	F00W039R	F00W040R	011AEAH01
Plot size [m ²]	C / T	32.4 / 88.2	43.2 / 90.0	42.9 / 218.9	55.0 / 218.9	105/525
Plants/plot	C / T	15 / 40	24 / 50	17 / 82	19 / 74	21/105
Rows/plot	C / T	1 / 1	1 / 1	1	1	1/5
Distance between rows [m]	C / T	1.8	1.8	2.20	2.20	3
Distance in rows [m]	Both	1.2	1.0	≈ 1.20	≈ 1.35	1.2
Vines/ha	Both	4630	5556	3788	3367	2739
Shortest distance between plots [m]		21.6	16.0	15.0	15.0	9

	Treatment	G00W062 R	G00W063 R	F00W039 R	F00W040 R	01IAEA H01
Shortest distance between plot and border [m]		n.a.	3.0	5.10	3.25	5

The pesticides were applied with Holder NI 1000 airblast sprayer 5/Albus yellow HK nozzles with 812 and 831 litre/ha in Germany, with Nobili airblast sprayer 2 / Albus red AMT 212 nozzles with 272 and 323 litre/ha in France, and with Haflinger sprayer (873 liter/ha) equipped with 06 multi jet nozzles in Hungary.

The active substances of the products belonged to the classes of anilinopyrimidines, triazoles, pyrethroids, organophosphates, acylalanine - phenylamides and dicarboximides and were applied once in a tank mix (Table 2).

Table2. Application dates and rates of pesticides in grape trials

Study Code	Site code	Appl. Date	Water [L/ha]	Substance class	g a.i./ha ¹
20003038/G1-FPTG Germany	G00W062 R	05 OCT 2000	812	Anilinopyrimidine Triazole Pyrethroid Organophosphate Dicarboximide	381 51 102 617 762
	G00W063 R	28 SEP 2000	831	Anilinopyrimidine Triazole Pyrethroid Organophosphate Dicarboximide	390 52 104 631 779
20003038/F1-FPTG France	F00W041R	08SEP00	273	Anilinopyrimidine Triazole Pyrethroid Organophosphate Dicarboximide	340 45 91 510 680
	F00W042R	08SEP00	323	Anilinopyrimidine Triazole Pyrethroid Organophosphate Dicarboximide	403 54 108 605 807
01IAEA H 01 Hungary	01/IAEA/H	05SEP01	973	vinclozolin metalaxyl chlorpyrifos	973 195 701

Note: 1 based on the nominal content of active ingredient (a.i.) of the commercial products

An inspection of the vines at the test plots in Germany showed that the vast majority of the grape bunches of commercial size differed in the height above ground to not more than about 50 cm. As this zone was quite narrow it was decided to take samples from two zones above and below the lowest support wire of the espalier. The education system of the grapes was of the espalier type, so there was marginal difference in the distance between the spray equipment and the grapes

during application. As the number of bunches on the plots was high, although the disease pressure especially on site “Wachenheim” was high, it was found not manageable to count the bunches and apply a randomisation scheme to identify bunches prior to sampling. Bunches were taken from both sides of the row.

On site G00W062R leaves covered grapes quite strongly. However, it was observed during the application that this was not a significant factor as the strong air stream from the axial blower equipment forced the leaves into a horizontal position during treatment. The plot G00W063R looked similar, however due to disease pressure the grapes were not that strongly covered by leaves and more grapes were in smaller distance above the soil. So on average these grapes were more exposed to sunlight than on site G00W062R.

In France, the majority of the grape bunches of commercial size differed in the height above ground to not more than about 50 cm. Few grapes were found to be covered by leaves, as according to cropping practice leaves were removed in the grape zone to get the berries fully exposed to sunlight. The education system of the grapes was of the espalier type. Grapes were classified in four clusters hanging on the vines: separately, in pairs (berry touch of two bunches), in triplets (berry touch of three bunches, all three amongst each other or 1 with 2 and 2 with 3), forming a group of four and more (berry touch of four bunches, analogous to the triplets)

After having selected 60 vines in consecutive order within a row, vines were numbered from 1 to 60 in ascending order. All grape bunches of commercial size were counted on these vines. Then the percentage of each cluster (being a single, pair etc.) was calculated. A sampling plan was prepared for each treated plot to sample according to the abundance of each cluster to yield 120 treated samples.

Samples were taken 7 days after the application in Germany and France. Only those bunches meeting commercial quality standards were taken, and the weak and unripe crops that usually would not be harvested were omitted. Samples from the control plot were taken first as entire bunches. On the treated plot, disposable gloves were worn during sampling. Samples in the treated plot were taken with the help of a PE-bag turned inside out and then cut off the main stalk. Samples were not touched with the gloves to prevent contamination of succeeding bunches. Each sample was packed in a double polyethylene bag and identified by adding one label between the bags and fixing a 2nd label outside. The sampling point and position (identification number of vine, position (upper and lower zone), leaf cover (in %)) was recorded for each sample. The samples were transported in a deep freezer car to the storage rooms in separate boxes, and stored deep-frozen until analysis. Each sample consisted of one bunch or cluster of grapes. Only one cluster of the same class was sampled per vine.

In the Hungarian trial samples were taken 7 days after application similarly as described above from both sides of the rows from randomly selected positions of the upper middle and lower part of the vines. The bunches, partly covered or not covered with leaves, were selected approximately proportionally to their abundance on the vines. The percentage coverage of the bunches was not estimated. The samples were taken by car to the laboratory within one hour after sampling, the bunches were weighted and stored in deep-freezer until analysis. The sampled zones are shown in Table 3.

Table 3. Height of sampled zones in French and Hungarian trials

	Lower zone [L]	Medium zone [M]	Upper zone [U]
F00W041R	0-70 cm	70-90 cm	> 90 cm
F00W042R	0-60 cm	60-85 cm	> 85 cm
011AEAH01	0-70 cm	70-100 cm	> 100 cm

The residue analysis for all active ingredients in samples from France and Germany was performed by using the modified DFG S-19 method, based on the extraction of 50 g portion with acetone, partition into ethyl acetate / cyclohexane (1+1), cleanup with Bio Beads S-X3 polystyrene gel and GC detection with nitrogen/phosphorus detection for the triazole and organophosphate pesticide and mass selective detection for the anilinopyrimidine, pyrethroid, and dicarboximide

pesticide. Altogether 504 samples (6 control and 120 treated samples from each site) of bunches of grapes were analyzed. No residues above the LOQ were determined in the analyzed control samples, except for two control samples in which 0.02 and 0.03 mg/kg anilinopyrimidine were found. During analysis of field samples, fortification experiments were performed at the limits of quantitation and at the expected level of residues in treated samples (Table 4).

The analytical method used in Hungary was based on blending the whole bunch in Waring blender, extraction of 30 g portion with ethyl acetate, cleanup on Bio Beads SX-3 polystyrene gel and GC detection with nitrogen/phosphorus detection. The reported LOQ and recovery values and the within laboratory reproducibility coefficient of variation, CV_R, determined from the repeated analysis of 11 analytical portions on different days, which includes the error of sample processing as well, are summarised in Table 4.

Table 4. Performance characteristics of analytical methods used for determining pesticide residues in grapes

	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide
F41-42R					
LOQ	0.02	0.05	0.02	0.02	0.02
Spike level mg/kg	0.02, 0.5	0.05, 0.1, 1.25	0.02, 0.2, 0.5	0.02, 0.4, 0.5	0.02, 0.5, 2.0
Average recovery	91	103	100	87	102
CV _A %	13.2	5.2	7.1	9.7	7.6
No of rec. tests	14	14	8	11	14
G62-63R					
Spike level mg/kg	0.04, 0.24, 1.0	0.05, 0.1, 2.5	0.04, 0.096, 1.0	0.02, 0.04, 0.5, 0.96, 1.0	0.02, 0.04, 0.5, 0.96
Average recovery	83	97	101	64	102
CV _A %	24.1	5.9	11.9	21.9	9.8
No of rec. tests	13	14	14	14	13
011AEAH01	Metalaxyl			Chlorpyrifos	Vinclozolin
LOQ [mg/kg]	0.05			0.001	0.05
Average recovery	96.1			81.6	88.13
CV _A %	12.5			16.9	9.4
No of rec. tests	10			10	10
CV _R	22.2			11.7	14.4

CV_A within laboratory reproducibility of analytical method

CV_R within laboratory reproducibility of analytical method and sample processing

The residues measured in unit samples arranged in rank order of dicarboximide pesticides and are shown in Tables 5-9.

The mean residue of the 120 samples is calculated as the weighted average:

$$\bar{R} = \frac{\sum_{i=1}^n g_i * c_i}{\sum_{i=1}^n g_i}$$

where g_i is the mass of crop unit i [g], c_i is the corresponding residue concentration [mg/kg], n is the number of data pairs used for the calculation. The residues below the LOQ values were not taken into account in calculating the weighted average, as they would bias the estimated mean value and result in smaller variability factors.

The residues in clustered bunches of grapes were evaluated with ANOVA performed for each active ingredient. The overall effect of the bunches on the residue level was significant at 0.05 level for all five classes of active ingredients indicating that the residues in the 12 clusters of four or more bunches were significantly lower at site F00W042R. However no significant difference was observed at the site F00W041R.

In the Hungarian trial 9 bunches of grape were divided into 3 equal parts along the length of the bunch. The segments were analyzed separately. The results are summarized in Table 11. ANOVA test indicated no significant difference in the mean residue concentrations of the three segments of the grapes.

Table 5. Residues measured in grapes at G00W062R experimental site

GAB sample code	Vine	Bunch position	Leaf cover [%]	Weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
44	9	U	30	146	0.57	0.15	0.27	0.79	1.9
119	32	l	20	138	0.44	0.12	0.22	0.6	1.7
56	13	l	0	326	0.56	0.13	0.22	0.88	1.6
82	21	l	0	157	0.43	0.13	0.22	0.63	1.4
102	27	u	5	178	0.43	0.13	0.22	0.52	1.4
40	8	u	60	167	0.39	0.1	0.17	0.59	1.3
30	5	u	60	344	0.24	0.09	0.15	0.29	1.2
31	5	u	40	148	0.44	0.1	0.16	0.58	1.2
35	6	u	50	206	0.4	0.09	0.18	0.5	1.2
37	7	l	30	184	0.3	0.1	0.16	0.5	1.2
53	12	u	40	354	0.44	0.1	0.18	0.71	1.2
60	14	u	30	218	0.47	0.11	0.17	0.68	1.2
112	31	l	20	276	0.2	0.09	0.13	0.31	1.2
140	40	l	20	148	0.38	0.1	0.17	0.58	1.2
29	4	u	30	316	0.31	0.09	0.13	0.42	1.1
32	5	l	30	148	0.36	0.1	0.14	0.45	1.1
46	9	l	40	247	0.35	0.1	0.14	0.64	1.1
49	10	l	20	208	0.42	0.1	0.15	0.69	1.1
52	12	l	30	326	0.36	0.1	0.15	0.61	1.1
109	30	l	20	188	0.25	0.09	0.14	0.32	1.1
67	17	u	30	277	0.23	0.07	0.11	0.25	1
41	8	l	30	337	0.28	0.09	0.16	0.43	0.99
90	24	l	10	188	0.33	0.08	0.15	0.62	0.99
62	15	l	10	356	0.19	0.07	0.11	0.31	0.97
34	6	u	30	107	0.29	0.06	0.12	0.4	0.95
95	25	l	10	277	0.35	0.08	0.14	0.65	0.91
133	37	u	10	375	0.15	0.07	0.12	0.37	0.91
59	14	l	10	178	0.49	0.09	0.16	0.73	0.9
131	36	l	10	157	0.1	0.08	0.13	0.24	0.9
43	9	l	40	306	0.28	0.09	0.1	0.48	0.85
61	14	l	40	148	0.3	0.08	0.11	0.38	0.85
68	17	l	10	208	0.33	0.08	0.1	0.35	0.83

GAB sample code	Vine	Bunch position	Leaf cover [%]	Weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
73	18	u	10	237	0.21	0.07	0.11	0.47	0.82
120	32	u	20	316	0.27	0.06	0.11	0.37	0.82
65	16	l	10	217	0.25	0.07	0.12	0.45	0.81
116	31	l	0	198	0.24	0.07	0.14	0.09	0.81
48	10	u	30	276	0.31	0.06	0.11	0.55	0.8
27	3	l	30	128	0.26	0.07	0.1	0.41	0.79
104	28	l	20	197	0.24	0.07	0.12	0.32	0.77
117	32	u	30	198	0.2	0.06	0.11	0.1	0.77
54	12	l	10	257	0.31	0.07	0.11	0.45	0.76
69	17	l	5	217	0.18	0.07	0.09	0.34	0.76
110	30	u	10	137	0.22	0.05	0.09	0.27	0.75
129	35	u	30	247	0.15	0.06	0.1	0.18	0.74
33	5	l	10	185	0.3	0.06	0.1	0.33	0.73
121	33	l	10	187	0.2	0.06	0.1	0.37	0.72
24	2	l	60	267	0.24	0.06	0.09	0.33	0.7
38	7	u	50	148	0.29	0.07	0.1	0.38	0.7
36	6	l	60	306	0.25	0.07	0.1	0.33	0.69
71	18	l	20	167	0.18	0.07	0.1	0.37	0.69
91	24	l	0	227	0.26	0.06	0.1	0.46	0.69
99	26	l	40	297	0.21	0.07	0.09	0.48	0.69
58	13	l	40	286	0.3	0.06	0.1	0.45	0.68
137	38	u	30	177	0.2	0.05	0.09	0.49	0.68
51	11	l	30	276	0.25	0.06	0.09	0.48	0.67
64	16	l	20	197	0.23	0.06	0.09	0.36	0.67
100	26	l	10	246	0.21	0.07	0.12	0.51	0.67
128	35	l	10	238	0.12	0.05	0.08	0.17	0.66
63	15	u	10	206	0.2	0.06	0.1	0.14	0.65
55	13	u	10	277	0.27	0.07	0.09	0.35	0.64
76	19	l	40	167	0.26	0.07	0.1	0.43	0.64
94	25	u	40	128	0.31	0.07	0.11	0.51	0.64
122	33	u	40	267	0.21	0.05	0.09	0.4	0.64
39	8	u	30	157	0.17	0.05	0.08	0.26	0.63
111	30	l	10	147	0.11	0.06	0.09	0.23	0.63
42	8	u	20	168	0.29	0.06	0.1	0.47	0.62
50	11	u	50	157	0.23	0.05	0.07	0.3	0.62
97	26	l	10	297	0.22	0.06	0.09	0.52	0.62
70	17	u	30	197	0.21	0.07	0.09	0.29	0.61
78	20	u	30	199	0.19	0.06	0.1	0.36	0.61
135	37	u	60	167	0.09	0.05	0.09	0.22	0.58
139	39	u	40	138	0.17	0.05	0.09	0.42	0.58
66	16	u	40	186	0.25	0.05	0.08	0.38	0.57
26	3	u	60	317	0.17	0.04	0.05	0.24	0.56
96	26	u	40	178	0.2	0.06	0.08	0.43	0.56
74	19	l	0	208	0.12	0.06	0.08	0.25	0.52
57	13	u	50	138	0.22	0.05	0.05	0.37	0.51

GAB sample code	Vine	Bunch position	Leaf cover [%]	Weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
80	20	u	60	216	0.18	0.05	0.08	0.34	0.51
85	22	u	60	377	0.17	0.04	0.06	0.36	0.51
118	32	u	60	237	0.16	0.04	0.06	0.22	0.51
84	22	u	10	158	0.19	0.04	0.07	0.31	0.5
113	31	u	40	216	0.15	0.05	0.07	0.22	0.5
138	38	l	5	277	0.15	0.04	0.07	0.37	0.5
107	29	l	30	257	0.15	0.06	0.07	0.2	0.49
101	27	u	60	127	0.15	0.05	0.07	0.16	0.48
108	30	u	50	216	0.14	0.05	0.08	0.21	0.48
126	34	l	5	198	0.11	0.05	0.06	0.18	0.48
21	1	u	10	186	0.17	0.03	0.05	0.2	0.46
114	31	u	60	198	0.13	0.05	0.06	0.28	0.46
79	20	l	50	297	0.18	0.05	0.07	0.35	0.45
86	22	l	0	277	0.18	0.04	0.07	0.36	0.45
125	34	u	40	247	0.15	0.05	0.06	0.28	0.44
132	36	l	30	198	0.08	0.04	0.07	0.21	0.44
25	3	u	40	248	0.14	0.03	0.04	0.21	0.43
47	10	u	50	207	0.19	0.04	0.06	0.34	0.43
98	26	u	20	238	0.14	0.05	0.06	0.32	0.43
115	31	u	10	128	0.14	0.04	0.06	0.08	0.43
45	9	u	30	287	0.18	0.04	0.04	0.28	0.41
72	18	l	30	228	0.15	0.06	0.06	0.29	0.41
127	35	l	20	277	0.09	0.03	0.05	0.16	0.38
28	4	u	70	226	0.15	0.04	0.05	0.2	0.37
130	35	u	70	285	0.09	0.04	0.06	0.13	0.37
81	21	u	80	326	0.13	0.04	0.05	0.3	0.36
123	33	u	30	316	0.11	0.03	0.05	0.14	0.36
77	20	l	30	257	0.13	0.04	0.06	0.28	0.35
88	23	u	40	138	0.18	0.04	0.06	0.38	0.35
124	34	u	30	148	0.11	0.03	0.05	0.14	0.35
83	21	u	20	198	0.16	0.04	0.04	0.2	0.34
93	25	u	30	168	0.15	0.04	0.05	0.28	0.34
106	29	u	10	237	0.13	0.03	0.05	0.16	0.33
136	38	l	10	317	0.09	0.03	0.04	0.27	0.33
92	24	u	50	138	0.14	0.04	0.05	0.29	0.32
22	1	l	50	365	0.08	0.02	0.03	0.13	0.3
89	23	u	80	169	0.14	0.03	0.05	0.27	0.3
103	28	u	30	237	0.14	0.03	0.04	0.12	0.3
23	2	u	80	187	0.13	0.02	0.03	0.18	0.28
105	28	l	10	196	0.13	0.03	0.04	0.13	0.28
75	19	u	30	138	0.07	0.03	0.03	0.14	0.25
87	23	u	20	198	0.11	0.03	0.03	0.23	0.22
134	37	u	30	268	0.06	0.03	0.02	0.14	0.17

Table 6. Residues measured in grapes at G00W063R experimental site

GAB sample code	Vine	Bunch position	leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
84	23	u	25	168	0.36	0.08	0.16	0.29	5.4
95	27	n.a.	20	59	0.38	0.07	0.18	0.4	5.4
83	23	u	20	119	0.33	0.08	0.18	0.25	5.2
85	24	l	20	187	0.31	0.07	0.14	0.27	4.6
89	26	u	40	198	0.23	0.06	0.13	0.18	4.2
97	29	u	30	99	0.25	0.06	0.13	0.14	3.9
96	27	u	40	79	0.17	0.04	0.08	0.16	2.3
99	30	u	60	148	0.18	0.04	0.08	0.15	2.3
91	26	l	25	218	0.15	0.04	0.08	0.14	2.2
100	30	u	50	148	0.15	0.05	0.07	0.15	2.2
92	27	u	80	238	0.18	0.03	0.08	0.13	2.1
81	20	u	70	138	0.16	0.03	0.08	0.11	2
88	26	u	70	207	0.15	0.03	0.08	0.14	2
87	24	l	30	267	0.12	0.03	0.07	0.07	1.7
121	41	u	45	98	0.66	0.11	0.2	0.81	1.7
93	27	u	70	168	0.13	0.03	0.05	0.1	1.5
118	41	l	10	59	0.58	0.11	0.2	0.81	1.5
28	3	l	0	157	0.37	0.1	0.19	0.42	1.4
86	24	l	25	118	0.12	0.02	0.05	0.08	1.4
117	39	l	40	59	0.34	0.09	0.18	0.44	1.3
40	5	u	30	128	0.4	0.08	0.17	0.46	1.2
60	12	u	75	89	0.44	0.09	0.17	0.65	1.2
94	27	u	60	247	0.12	0.02	0.03	0.07	1.2
107	35	u	15	138	0.39	0.1	0.18	0.29	1.2
57	11	u	50	118	0.35	0.11	0.21	0.51	1.1
90	26	u	75	166	0.09	0.01	0.03	0.06	1.1
106	35	u	15	99	0.2	0.07	0.15	0.18	1.1
109	35	u	15	257	0.24	0.07	0.13	0.32	1.1
55	10	u	60	187	0.38	0.08	0.16	0.44	1
98	30	u	80	148	0.13	0.02	0.03	0.09	1
82	20	l	25	208	0.11	0.02	0.03	0.06	0.99
110	37	u	20	158	0.33	0.06	0.15	0.42	0.99
34	5	l	20	226	0.26	0.07	0.12	0.36	0.97
36	5	u	80	69	0.31	0.07	0.14	0.46	0.94
58	11	u	50	79	0.37	0.08	0.17	0.53	0.93
21	1	u	30	59	0.15	0.08	0.14	0.24	0.92
77	19	u	50	208	0.33	0.06	0.13	0.46	0.92
108	35	u	10	247	0.24	0.06	0.12	0.22	0.92
119	41	u	65	98	0.37	0.07	0.11	0.48	0.86
76	19	u	30	238	0.42	0.07	0.13	0.47	0.83
127	45	u	50	128	0.42	0.06	0.13	0.31	0.83
104	32	l	10	79	0.18	0.06	0.11	0.28	0.81
52	9	l	0	138	0.24	0.06	0.14	0.23	0.78
68	14	l	35	196	0.27	0.05	0.12	0.34	0.78
111	37	u	15	186	0.35	0.07	0.12	0.32	0.78

GAB sample code	Vine	Bunch position	leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
23	6	l	0	68	0.21	0.06	0.12	0.33	0.77
103	32	l	10	166	0.19	0.07	0.13	0.22	0.77
102	31	l	15	148	0.27	0.07	0.12	0.27	0.75
139	50	u	45	137	0.35	0.05	0.1	0.3	0.75
46	8	u	75	118	0.3	0.07	0.15	0.37	0.74
71	18	l	45	118	0.34	0.06	0.11	0.49	0.74
31	6	l	30	78	0.2	0.05	0.1	0.25	0.73
43	7	l	80	54	0.35	0.06	0.11	0.48	0.72
120	41	u	60	54	0.34	0.06	0.11	0.42	0.72
124	43	l	15	157	0.34	0.05	0.08	0.23	0.72
51	9	l	20	168	0.27	0.06	0.1	0.39	0.71
25	2	u	50	205	0.21	0.05	0.11	0.29	0.7
38	5	l	50	97	0.27	0.06	0.11	0.4	0.69
79	20	u	30	119	0.29	0.05	0.1	0.36	0.69
116	43	l	45	246	0.17	0.08	0.11	0.2	0.68
49	8	l	0	188	0.22	0.04	0.1	0.34	0.67
66	7	u	50	149	0.26	0.06	0.12	0.32	0.66
125	43	l	10	108	0.33	0.06	0.09	0.04	0.66
22	6	l	0	69	0.2	0.06	0.12	0.23	0.64
75	19	u	55	188	0.24	0.05	0.1	0.28	0.63
138	49	l	15	108	0.24	0.05	0.08	0.14	0.63
70	18	l	50	149	0.26	0.04	0.09	0.43	0.62
62	14	l	40	167	0.29	0.04	0.09	0.33	0.61
67	14	l	35	287	0.2	0.04	0.08	0.35	0.61
47	8	u	80	98	0.32	0.06	0.1	0.31	0.6
137	48	l	25	93	0.26	0.05	0.08	0.08	0.6
24	6	l	30	59	0.18	0.05	0.09	0.22	0.59
26	2	u	50	207	0.12	0.04	0.08	0.12	0.58
105	33	l	20	89	0.16	0.06	0.09	0.27	0.58
59	12	u	75	74	0.33	0.05	0.1	0.42	0.57
73	18	l	50	188	0.19	0.04	0.09	0.32	0.56
136	48	l	25	206	0.29	0.04	0.09	0.21	0.56
63	20	u	60	129	0.23	0.04	0.1	0.21	0.55
140	50	u	60	147	0.26	0.03	0.07	0.25	0.55
56	10	u	80	49	0.36	0.04	0.09	0.29	0.54
48	n.a.			187	0.17	0.04	0.08	0.33	0.53
32	6	l	50	237	0.2	0.05	0.09	0.19	0.52
126	44	u	40	93	0.4	0.05	0.08	0.28	0.52
129	44	u	70	88	0.3	0.05	0.07	0.23	0.51
130	45	l	15	216	0.31	0.03	0.09	0.21	0.5
112	37	l	15	217	0.19	0.05	0.07	0.26	0.49
41	6	l	50	68	0.25	0.04	0.07	0.27	0.48
54	9	U	80	158	0.21	0.03	0.07	0.35	0.48
72	18	u	60	198	0.22	0.04	0.07	0.33	0.48
122	43	l	15	277	0.3	0.04	0.09	0.35	0.48

GAB sample code	Vine	Bunch position	leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
123	43	l	20	69	0.34	0.04	0.07	0.26	0.48
133	45	l	15	89	0.24	0.07	0.08	0.18	0.48
33	5	l	20	235	0.16	0.04	0.07	0.26	0.47
134	46	u	80	92	0.3	0.04	0.09	0.2	0.46
37	5	u	60	118	0.21	0.04	0.07	0.27	0.45
61	13	u	60	128	0.2	0.03	0.06	0.17	0.42
128	44	u	70	147	0.17	0.03	0.07	0.05	0.42
64	20	u	80	168	0.17	0.03	0.06	0.09	0.41
35	5	L	20	127	0.14	0.04	0.08	0.21	0.4
42	6	l	0	48	0.18	0.03	0.05	0.19	0.37
44	7	l	80	39	0.29	0.03	0.06	0.26	0.36
80	20	u	35	89	0.23	0.02	0.05	0.21	0.35
101	30	l	20	198	0.11	0.05	0.06	0.14	0.35
131	45	l	10	287	0.14	0.03	0.05	0.12	0.35
113	37	l	25	238	0.15	0.03	0.05	0.18	0.34
27	3	u	50	187	0.1	0.02	0.05	0.1	0.33
65	20	u	70	179	0.17	0.03	0.05	0.19	0.33
53	9	l	0	129	0.12	0.04	0.05	0.18	0.31
135	46	l	15	297	0.17	0.03	0.05	0.18	0.31
50	8	l	20	177	0.12	0.03	0.04	0.13	0.29
114	44	u	50	88	0.16	0.03	0.04	0.17	0.28
132	45	l	10	267	0.12	0.03	0.04	0.1	0.26
30	4	l	50	149	0.05	0.03	0.04	0.07	0.25
69	18	l	75	98	0.17	0.03	0.04	0.2	0.25
45	8	u	60	187	0.1	0.02	0.04	0.12	0.22
78	19	l	60	267	0.1	0.02	0.03	0.13	0.22
39	5	l	50	177	0.11	0.03	0.04	0.14	0.21
115	44	u	70	129	0.08	0.05	0.03	0.08	0.18
74	19	u	50	128	0.12	0.02	0.03	0.09	0.14
29	3	l	100	116	0.06	0	0.02	0.03	0.09

Table 7. Residues measured in table grapes at F00W041R experimental site

GAB sample code	Vine	Bunch position	Leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
76	41	L	30	348	1	0.27	0.38	1.2	6.1
78	41	L	20	404	1.4	0.22	0.47	0.86	5.4
73	40	L	30	193	0.81	0.18	0.35	1	4.4
46	32	L	30	173	0.9	0.14	0.35	0.71	3.7
89	45	M	50	261	0.83	0.13	0.26	0.95	3.7
75	41	M	0	417	0.6	0.16	0.22	0.76	3.6
81	42	L	0	264	0.71	0.21	0.29	0.9	3.6
77	41	L	30	358	0.62	0.19	0.26	0.83	3.5

GAB sample code	Vine	Bunch position	Leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
84	44	M	40	254	0.72	0.13	0.24	0.78	3.5
56	35	L	30	232	0.84	0.1	0.3	0.7	3.4
74	40	L	30	302	0.69	0.15	0.28	0.86	3.4
67	37	M	30	165	0.8	0.18	0.29	1.1	3.2
115	60	M	0	332	0.79	0.13	0.3	1.1	3.2
117	62	M	0	290	0.72	0.11	0.28	0.84	3.2
85	44	L	0	411	0.72	0.14	0.22	0.65	3.1
55	35	M	0	419	0.71	0.09	0.24	0.55	3
103	49	L	40	344	0.69	0.15	0.22	0.77	3
39	27	L	0	197	0.54	0.11	0.29	0.56	2.9
62	36	M	20	420	0.65	0.13	0.27	0.81	2.9
97	52	M	50	422	0.76	0.18	0.23	0.78	2.9
72	40	L	20	329	0.66	0.11	0.23	0.63	2.8
102	49	L	40	491	0.71	0.1	0.18	0.61	2.8
104	52	L	20	388	0.6	0.14	0.18	0.62	2.8
87	46	M	0	464	0.61	0.11	0.2	0.67	2.7
109	54	M	10	356	0.57	0.13	0.23	0.73	2.7
118	63	L	0	335	0.86	0.13	0.29	0.91	2.7
26	19	L	50	190	0.54	0.09	0.23	0.41	2.6
70	38	M	30	140	0.64	0.2	0.22	0.69	2.6
80	41	L	30	397	0.7	0.15	0.21	0.54	2.6
112	57	M	0	343	0.64	0.09	0.19	0.69	2.6
57	35	L	30	254	0.75	0.1	0.25	0.65	2.5
65	37	L	10	731	0.55	0.13	0.2	0.65	2.5
68	38	L	50	536	0.52	0.11	0.19	0.66	2.5
100	50	M	10	550	0.49	0.11	0.16	0.47	2.5
21	16	M	0	427	0.54	0.08	0.21	0.43	2.4
34	24	L	15	224	0.66	0.08	0.21	0.39	2.4
37	25	L	0	200	0.51	0.11	0.24	0.63	2.4
71	39	M	30	242	0.58	0.13	0.17	0.42	2.3
92	46	M	20	723	0.53	0.12	0.16	0.53	2.3
95	52	M	50	336	0.49	0.19	0.17	0.68	2.3
98	48	M	20	522	0.56	0.09	0.16	0.33	2.3
110	55	M	0	551	0.51	0.13	0.19	0.5	2.3
47	33	L	0	217	0.58	0.09	0.22	0.45	2.2
105	53	L	0	241	0.46	0.09	0.16	0.64	2.2
125	66	M	30	272	0.63	0.11	0.22	0.52	2.2
22	17	M	0	581	0.5	0.08	0.21	0.22	2.1
33	23	M	0	740	0.42	0.08	0.17	0.41	2.1
43	29	M	10	177	0.69	0.08	0.23	0.44	2.1
59	35	L	30	330	0.59	0.06	0.2	0.41	2.1
60	35	L	30	248	0.62	0.06	0.19	0.49	2.1
69	38	M	30	329	0.58	0.11	0.19	0.57	2.1
88	45	M	50	370	0.46	0.08	0.18	0.6	2.1
122	65	L	0	257	0.57	0.38	0.19	0.6	2.1

GAB sample code	Vine	Bunch position	Leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
24	18	L	0	338	0.46	0.08	0.19	0.35	2
45	31	M	50	267	0.64	0.07	0.19	0.53	2
79	41	L	50	391	0.57	0.09	0.18	0.49	2
91	46	M	30	221	0.58	0.13	0.14	0.53	2
99	49	U	100	145	0.68	0.12	0.21	0.73	2
114	59	M	20	169	0.63	0.08	0.2	0.57	2
49	33	M	20	352	0.42	0.07	0.17	0.4	1.9
52	33	M	50	800	0.4	0.07	0.16	0.41	1.9
82	43	M	10	333	0.46	0.13	0.14	0.37	1.9
90	46	L	20	323	0.51	0.09	0.15	0.43	1.9
101	51	L	40	211	0.53	0.08	0.22	0.47	1.9
106	53	M	40	238	0.43	0.08	0.15	0.55	1.9
113	58	M	10	789	0.51	0.09	0.18	0.67	1.9
136	75	M	0	387	0.63	0.25	0.18	0.56	1.9
29	21	L	0	195	0.44	0.07	0.15	0.38	1.8
32	22	M	0	200	0.55	0.08	0.19	0.38	1.8
63	43	L	60	386	0.37	0.16	0.12	0.32	1.8
126	67	M	20	720	0.48	0.15	0.17	0.54	1.8
23	18	M	0	640	0.47	0.06	0.15	0.31	1.7
31	21	L	20	350	0.57	0.07	0.19	0.5	1.7
36	24	M	30	442	0.43	0.07	0.16	0.3	1.7
40	28	L	0	465	0.63	0.08	0.2	0.41	1.7
111	56	M	30	257	0.46	0.08	0.16	0.41	1.7
127	68	M	10	487	0.48	0.13	0.18	0.55	1.7
133	72	M	30	497	0.49	0.15	0.17	0.39	1.7
140	75	L	40	437	0.51	0.14	0.19	0.5	1.7
44	30	M	30	250	0.41	0.06	0.15	0.27	1.6
107	53	M	40	679	0.33	0.06	0.12	0.31	1.6
108	53	M	40	374	0.37	0.07	0.13	0.34	1.6
132	71	M	40	577	0.48	0.14	0.2	0.62	1.6
25	18	L	0	250	0.47	0.06	0.15	0.36	1.5
35	24	M	0	405	0.37	0.05	0.12	0.26	1.5
83	44	M	40	274	0.44	0.08	0.11	0.25	1.5
93	47	M	30	277	0.41	0.07	0.12	0.2	1.5
94	52	M	50	462	0.36	0.1	0.11	0.3	1.5
124	65	M	30	367	0.42	0.09	0.17	0.44	1.5
131	71	M	40	544	0.48	0.16	0.16	0.45	1.5
30	21	L	0	265	0.43	0.06	0.15	0.51	1.4
41	29	L	20	610	0.3	0.06	0.14	0.1	1.4
48	33	M	30	400	0.33	0.06	0.14	0.48	1.4
53	33	M	30	166	0.39	0.05	0.12	0.36	1.4
54	35	M	0	515	0.34	<0.05	0.11	0.25	1.4
64	43	L	60	360	0.32	0.1	0.1	0.31	1.4
123	65	M	30	441	0.35	0.2	0.12	0.37	1.4
28	20	M	0	584	0.38	0.06	0.13	0.43	1.3

GAB sample code	Vine	Bunch position	Leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
51	33	L	50	1060	0.3	0.06	0.12	0.34	1.3
58	35	L	30	523	0.36	<0.05	0.11	0.21	1.3
96	52	M	50	821	0.47	0.11	0.12	0.31	1.3
116	61	M	30	749	0.37	0.05	0.11	0.35	1.3
120	64	M	20	424	0.35	0.12	0.12	0.37	1.3
128	69	L	0	951	0.37	0.11	0.13	0.35	1.3
134	73	M	30	310	0.54	0.16	0.25	0.77	1.3
27	19	U	0	432	0.38	0.06	0.12	0.27	1.2
61	35	L	30	306	0.31	0.07	0.11	0.36	1.2
66	37	M	30	171	0.36	0.09	0.1	0.27	1.2
121	64	M	20	237	0.43	0.19	0.15	0.39	1.2
119	64	M	20	505	0.3	0.09	0.12	0.43	1.1
38	26	M	100	112	0.4	0.05	0.14	0.24	1
42	29	M	10	279	0.34	0.06	0.12	0.29	1
86	45	L	30	314	0.29	0.05	0.08	0.11	1
139	75	L	30	734	0.3	0.09	0.1	0.22	0.9
135	74	L	10	660	0.33	0.13	0.11	0.26	0.89
137	75	L	50	387	0.33	0.15	0.1	0.26	0.86
50	33	M	50	674	0.28	<0.05	0.08	0.24	0.8
130	71	L	20	141	0.23	0.17	0.07	0.19	0.8
138	75	L	40	1085	0.24	0.08	0.08	0.2	0.75
129	70	M	20	690	0.21	0.09	0.07	0.15	0.72

Table 8. Residues measured in grapes at F00W042R experimental site

GAB sample code	Vine	Bunch position	Leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
86	42	M	0	223	0.99	0.15	0.31	1	3.5
87	44	U	0	586	0.74	0.11	0.24	0.64	3
95	53	M	0	707	0.54	0.1	0.22	0.61	2.8
103	56	M	0	445	0.6	0.1	0.2	0.79	2.8
32	17	U	20	474	0.69	0.1	0.24	0.77	2.7
84	37	M	0	289	0.67	0.12	0.26	0.86	2.6
100	55	M	0	384	0.79	0.12	0.28	0.88	2.6
89	45	M	0	212	0.57	0.12	0.22	0.84	2.4
102	55	M	0	679	0.71	0.12	0.25	0.83	2.4
91	47	M	10	573	0.59	0.1	0.2	0.64	2.3
33	11	M	0	162	0.81	0.12	0.24	0.78	2.2
41	15	M	0	541	0.43	0.1	0.15	0.55	2.2
66	28	U	0	290	0.69	0.11	0.24	0.81	2.2
90	45	M	0	388	0.58	0.09	0.18	0.62	2.2
35	13	U	0	415	0.55	0.14	0.19	0.83	2.1
39	15	M	0	363	0.62	0.08	0.18	0.58	2.1

GAB sample code	Vine	Bunch position	Leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
49	19	U	0	816	0.63	0.11	0.2	0.57	2.1
85	40	L	0	665	0.42	0.08	0.16	0.49	2.1
92	48	M	0	453	0.55	0.08	0.17	0.55	2.1
101	55	M	0	409	0.38	0.09	0.2	0.3	2.1
131	71	L	0	432	0.34	0.08	0.14	0.41	2
140	52	M	0	670	0.42	0.08	0.2	0.55	2
30	17	U	10	344	0.48	0.08	0.19	0.38	1.9
88	44	U	0	539	0.49	0.08	0.16	0.57	1.9
93	48	M	0	709	0.52	0.07	0.16	0.48	1.9
51	21	U	0	445	0.6	0.11	0.22	0.69	1.8
59	27	M	0	660	0.49	0.07	0.15	0.62	1.8
83	37	M	0	514	0.49	0.08	0.15	0.52	1.8
94	53	M	0	518	0.31	0.08	0.15	0.32	1.8
98	55	M	0	569	0.36	0.07	0.14	0.36	1.8
125	66	L	0	311	0.32	0.07	0.11	0.44	1.8
127	68	M	0	388	0.32	0.08	0.14	0.47	1.8
22	7	M	0	537	0.47	0.11	0.16	0.52	1.7
27	10	U	0	489	0.41	0.11	0.15	0.54	1.7
34	13	M	0	615	0.44	0.15	0.16	0.5	1.7
38	14	U	0	505	0.46	0.07	0.16	0.51	1.7
44	15	M	0	866	0.51	0.07	0.14	0.6	1.7
47	18	U	10	699	0.47	0.08	0.16	0.57	1.7
52	21	U	0	941	0.5	0.1	0.17	0.57	1.7
56	23	U	0	258	0.6	0.09	0.17	0.78	1.7
68	32	M	0	578	0.41	0.07	0.13	0.42	1.7
79	35	L	0	163	0.48	0.07	0.19	0.43	1.7
121	64	M	0	751	0.23	0.07	0.15	0.31	1.7
37	14	U	10	476	0.36	0.07	0.15	0.49	1.6
45	17	M	0	348	0.45	0.14	0.16	0.52	1.6
50	28	U	20	863	0.52	0.1	0.18	0.54	1.6
58	25	U	15	172	0.66	0.07	0.19	0.62	1.6
60	27	M	0	681	0.41	0.06	0.14	0.53	1.6
64	28	U	0	326	0.47	0.08	0.16	0.67	1.6
67	31	M	0	392	0.47	0.08	0.14	0.38	1.6
97	55	M	0	1030	0.41	0.07	0.15	0.56	1.6
110	60	M	0	475	0.49	0.09	0.17	0.71	1.6
132	72	M	0	675	0.24	0.07	0.1	0.33	1.6
139	52	M	0	800	0.39	0.07	0.16	0.46	1.6
21	7	L	0	288	0.32	0.05	0.12	0.34	1.5
24	9	M	0	268	0.39	0.07	0.13	0.48	1.5
40	15	M	0	446	0.39	0.06	0.12	0.41	1.5
42	15	M	0	725	0.4	0.09	0.13	0.5	1.5
48	19	M	0	680	0.44	0.1	0.15	0.44	1.5
54	23	U	0	474	0.39	0.12	0.13	0.43	1.5
70	33	M	0	497	0.41	0.09	0.14	0.38	1.5

GAB sample code	Vine	Bunch position	Leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
72	33	M	0	903	0.4	0.06	0.12	0.32	1.5
78	35	L	0	497	0.48	0.08	0.15	0.48	1.5
80	36	M	0	463	0.44	0.08	0.14	0.38	1.5
82	37	M	0	657	0.43	0.07	0.13	0.48	1.5
96	54	L	0	519	0.26	0.06	0.1	0.41	1.5
104	57	L	0	169	0.37	0.07	0.15	0.5	1.5
23	7	U	0	311	0.37	0.11	0.13	0.56	1.4
43	15	U	0	617	0.39	0.08	0.12	0.5	1.4
65	28	U	0	316	0.46	0.07	0.15	0.62	1.4
81	36	M	0	638	0.43	0.06	0.13	0.47	1.4
105	58	M	0	571	0.34	0.08	0.13	0.4	1.4
106	59	M	0	571	0.36	0.07	0.14	0.47	1.4
118	65	M	0	619	0.34	0.07	0.14	0.55	1.4
136	45	M	0	818	0.29	0.06	0.12	0.42	1.4
25	9	M	0	476	0.43	0.06	0.12	0.6	1.3
28	10	U	0	740	0.45	0.07	0.12	0.42	1.3
36	14	M	0	796	0.33	0.07	0.1	0.29	1.3
46	18	U	0	715	0.46	0.08	0.14	0.48	1.3
55	23	M	0	352	0.42	0.08	0.14	0.47	1.3
69	32	M	0	639	0.35	0.07	0.12	0.29	1.3
71	33	U	0	521	0.35	0.06	0.11	0.19	1.3
99	55	M	0	586	0.45	0.06	0.15	0.53	1.3
119	65	M	0	585	0.34	0.06	0.12	0.42	1.3
128	68	M	0	372	0.32	0.06	0.12	0.32	1.3
133	72	M	0	221	0.28	0.05	0.1	0.33	1.3
137	52	M	0	896	0.27	0.05	0.1	0.31	1.3
138	52	M	0	710	0.22	0.06	0.1	0.37	1.3
29	10	U	0	939	0.32	0.06	0.11	0.37	1.2
63	27	L	0	975	0.31	0.07	0.09	0.37	1.2
74	33	M	0	609	0.39	0.06	0.11	0.28	1.2
76	35	L	0	632	0.35	0.06	0.11	0.37	1.2
108	60	L	0	912	0.3	0.05	0.11	0.36	1.2
109	60	M	0	847	0.27	0.05	0.08	0.32	1.2
120	64	M	0	858	0.3	0.05	0.1	0.39	1.2
122	64	M	0	1111	0.16	0.05	0.1	0.17	1.2
62	27	M	0	659	0.3	0.05	0.09	0.36	1.1
75	35	L	0	626	0.33	0.05	0.09	0.26	1.1
77	35	L	0	351	0.37	0.06	0.12	0.33	1.1
111	60	L	0	973	0.3	0.05	0.1	0.38	1.1
116	65	U	0	414	0.37	0.06	0.11	0.36	1.1
123	64	M	0	849	0.2	<0.05	0.09	0.24	1.1
124	66	L	0	319	0.24	0.05	0.1	0.35	1.1
129	68	M	0	609	0.27	<0.05	0.09	0.29	1.1
26	9	M	0	560	0.32	0.06	0.1	0.27	1
31	17	U	10	367	0.35	0.05	0.11	0.3	1

GAB sample code	Vine	Bunch position	Leaf cover [%]	weight of berries [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarb-oximide
61	27	M	10	789	0.28	0.07	0.09	0.36	1
107	60	L	0	583	0.26	0.05	0.09	0.28	1
117	65	M	0	877	0.27	0.05	0.09	0.33	1
130	69	L	0	771	0.18	<0.05	0.08	0.18	1
73	33	M	0	335	0.32	0.05	0.09	0.2	0.94
135	63	L	0	641	0.27	<0.05	0.09	0.19	0.94
113	62	L	0	434	0.18	<0.05	0.07	0.19	0.9
114	65	L	0	833	0.2	<0.05	0.07	0.19	0.87
115	65	L	0	913	0.22	<0.05	0.07	0.21	0.87
53	21	U	0	260	0.3	0.05	0.09	0.44	0.78
126	68	L	0	284	0.15	<0.05	0.06	0.12	0.68
134	63	L	0	768	0.17	<0.05	0.06	0.11	0.64
57	23	U	0	651	0.28	<0.05	0.07	0.21	0.61
112	61	L	0	365	0.09	<0.05	0.03	0.13	0.38

Table 9. Residues [mg/kg] measured in wine grape in Hungarian trial

Sample Registry No.	Code ^a	Mass	Vinchlozolin		Metalaxyl		Chlorpyrifos	
			1	2 ^b	1	2 ^b	1	2 ^b
591	1F/1	125.2g	0.651		0.143		0.271	
592	1F/2	513.5g	0.23		0.141		0.097	
593	1F/3	37.3g	0.382		0.159		0.176	
594	1T/1	22.2g	0.386		0.692		0.095	
595	1T/2	52.9g	1.494		0.306		0.238	
596	1T/3	42.7g	1.407		0.221		0.232	
597	2F/1	439.3g	1.117		0.227		0.372	
598	2F/2	346.5g	1.46		0.326		0.352	
599	2F/3	429.4g	1.189		0.25		0.569	
600	2F/4	338.4g	0.398		0.226		0.115	
601	2F/5	225.3g	1.734		0.41		0.752	
602	2F/6	157.5g	1.159		0.324		0.404	
603	2F/7	339.6g	0.487	0.623	0.227	0.18	0.168	0.186
604	2F/8	116.1g	1.647		0.428		0.705	
605	2F/9	257.2g	0.923		0.17		0.28	
606	2F/10	295.8g	0.885		0.306		0.434	
607	2F/11	303.8g	1.595		0.352		0.679	
608	2F/12	133.1g	1.812		0.42		0.836	
609	2F/13	214.4g	1.158		0.291		0.215	
610	2F/14	170.5g	0.453		0.158		0.157	
611	2F/15	272.8g	1.099		0.236		0.456	
612	2F/16	178.0g	0.916		0.3		0.528	
613	2F/17	300.1g	0.83	1.035	0.36	0.288	0.29	0.483
614	2F/18	137.9g	0.715		0.167		0.243	
615	2F/19	125.1g	1.279		0.473		0.573	
616	2F/20	147.4g	0.778		0.321		0.338	

Sample			Vinchlozolin		Metalaxyl		Chlorpyrifos	
Registry No.	Code ^a	Mass	1	2 ^b	1	2 ^b	1	2 ^b
617	2F/21	355.5g	1.024		0.269		0.404	
618	2F/22	309.7g	1.202		0.378		0.573	
619	2F/23	349.5g	1.253		0.405		0.631	
620	2F/24	209.8g	0.71		0.198		0.256	
621	2F/25	119.5g	0.609		0.325		0.103	
622	2F/26	374.8g	0.462		0.182		0.152	
623	2F/27	119.0g	0.761	0.95	0.414	0.345	0.191	0.205
624	2F/28	327.1g	1.287		0.416		0.466	
625	2F/29	176.8g	1.957		0.505		1.077	
626	2F/30	370.5g	1.07		0.299		0.514	
627	2T/1	221.9g	0.712		0.155		0.246	
628	2T/2	444.3g	0.81		0.277		0.248	
629	2T/3	463.9g	0.449		0.143		0.121	
630	2T/4	322.7g	0.63		0.205		0.309	
631	2T/5	199.8g	0.345		0.112		0.155	
632	2T/6	282.6g	0.278		0.166		0.107	
633	2T/7	314.7g	0.421	0.376	0.092	0.099	0.169	0.168
634	2T/8	209.6g	2.129		0.496		1.149	
635	2T/9	197.5g	0.351		0.098		0.161	
636	2T/10	180.0g	0.947		0.203		0.66	
637	2T/11	229.4g	0.377		<KH		0.168	
638	2T/12	305.3g	0.142		0.122		0.075	
639	3F/1	105.9g	1.238		0.275		0.32	
640	3F/2	647.7g	0.366		0.254		0.13	
641	3F/3	103.9g	0.891		0.19		0.38	
642	3F/4	232.9g	0.401		0.06		0.194	
643	3F/5	286.4g	1.703	1.542	0.272	0.244	0.563	0.524
644	3F/6	361.9g	0.745		0.261		0.384	
645	3F/7	294.0g	0.477		0.084		0.094	
646	3F/8	399.4g	0.427		0.051		0.134	
647	3F/9	138.2g	1.405		0.281		0.455	
648	3F/10	335.1g	0.77		0.157		0.222	
649	3F/11	206.6g	0.392		0.051		0.087	
650	3F/12	344.3g	1.093		0.194		0.409	
651	3F/13	195.1g	0.823		0.164		0.289	
652	3F/14	125.1g	1.145		0.272		0.403	
653	3F/15	87.6g	1.813	1.641	0.39	0.396	0.472	0.436
654	3F/16	87.0g	1.487		0.294		0.53	
655	3F/17	463.9g	1.481		0.302		0.594	
656	3F/18	370.4g	0.376		0.073		0.142	
657	3F/19	262.0g	1.132		0.32		0.544	
658	3F/20	254.5g	1.45		0.173		0.507	
659	3F/21	434.8g	1.307		0.213		0.386	
660	3F/22	353.1g	1.406		0.325		0.385	
661	3F/23	285.7g	0.798		0.066		0.204	
662	3F/24	378.1g	0.809		0.146		0.155	

Sample			Vinchlozolin		Metalaxyl		Chlorpyrifos	
Registry No.	Code ^a	Mass	1	2 ^b	1	2 ^b	1	2 ^b
663	3F/25	198.1g	0.953	1.003	0.178	0.158	0.319	0.33
664	3F/26	203.3g	1.139		0.247		0.224	
665	3F/27	239.8g	3.788		0.717		1.276	
666	3F/28	536.6g	1.997		0.291		0.651	
667	3F/29	120.0g	4.983		0.813		1.71	
668	3F/30	312.8g	0.885		0.143		0.289	
669	3F/31	222.1g	11.712		1.082		4.031	
670	3F/32	171.3g	2.491		0.465		0.97	
671	3F/33	325.4g	1.151		0.194		0.454	
672	3F/34	304.2g	1.349		0.241		0.387	
673	3F/35	164.7g	2.299	2.087	0.452	0.482	0.917	0.903
674	3F/36	222.3g	1.792		0.392		0.438	
675	3F/37	135.9g	0.848		0.234		0.328	
676	3F/38	87.3g	2.578		0.659		1.566	
677	3F/39	186.0g	2.627		0.619		0.685	
678	3F/40	351.2g	1.149		0.296		0.417	
679	3F/41	501.0g	2.627		0.575		0.902	
680	3F/42	309.6g	2.169		0.515		0.544	
681	3F/43	176.8g	4.018		1.02		2.285	
682	3F/44	129.3g	2.69		0.45		0.86	
683	3F/45	151.2g	1.658	1.617	0.433	0.401	0.507	0.519
684	3F/46	224.6g	1.298		0.542		0.364	
685	3F/47	223.3g	2.586		0.6		0.579	
686	3F/48	260.7g	1.208		0.303		0.228	
687	3F/49	127.5g	1.854		0.439		0.384	
688	3F/50	225.7g	4.298		0.133		1.575	
689	3F/51	341.1g	0.416		0.06		0.091	
690	3F/52	133.2g	2.479		0.49		1.099	
691	3F/53	149.5g	0.931		0.226		0.187	
692	3F/54	134.5g	1.39		0.208		0.406	
693	3F/55	225.4g	1.963	1.882	0.419	0.297	0.623	0.631
694	3F/56	150.3g	0.706		0.011		0.158	
695	3F/57	157.5g	5.505		0.941		1.737	
696	3F/58	152.2g	2.446		0.458		0.35	
697	3T/1	326.8g	3.171		0.673		0.896	
698	3T/2	256.8g	2.67		0.587		0.754	
699	3T/3	165.2g	3.23		0.631		0.92	
700	3T/4	123.1g	1.378		0.217		0.215	
701	3T/5	142.4g	2.564		0.484		0.718	
702	3T/6	192.6g	0.742		0.125		0.262	
703	3T/7	194.1g	0.284	0.474	0.038	0.099	0.081	0.094
704	3T/8	112.8g	0.843		0.171		0.271	
705	3T/9	112.2g	2.329		0.578		0.913	
706	3T/10	86.3g	1.795		0.35		0.473	
707	3T/11	134.0g	1.383		0.349		0.302	
708	3T/12	186.8g	3.875		0.846		1.246	

Sample			Vinchlozolin		Metalaxyl		Chlorpyrifos	
Registry No.	Code ^a	Mass	1	2 ^b	1	2 ^b	1	2 ^b
709	3T/13	125.8g	2.131		0.503		0.497	
710	3T/14	81.4g	2.774		0.523		0.526	

Notes:

a) Code for the position of the bunch:

1st character: 1 upper part; 2 middle part; 3 lower part

2nd character: F not covered bunch, T (partly) covered bunch

3rd character: number of vine on the sampled plot

b) Residues detected in a replicate analytical portion analyzed on a different day.

The coefficient of variation is calculated from the standard deviation of the residues in individual bunches and the mean residue of the grapes taken from the treated plot.

As 120 sample represents the 97.53% of the residue population with 95% probability, the variability factor was calculated from the maximum residue observed and the weighted average residue:

$$V = \frac{R_{\max}}{\bar{R}}$$

The characteristics of residue distributions are summarized in Table 10.

Table 10. Major characteristics of residue distributions in grape bunches

Pesticide/trial	Residues [mg/kg]					Variability factor
	Mean	CV _{wf}	Median	Min	Max	
ANILINO-PYRIMIDINE						
F00W041R	0.495	0.36	0.51	0.21	1.40	2.8
F00W042R	0.389	0.38	0.39	0.09	0.99	2.5
G00W062R	0.222	0.48	0.2	0.06	0.57	2.6
G00W063R	0.225	0.47	0.240	0.05	0.66	2.9
CV _{bf}	0.40					
Triazole						
F00W041R	0.105	0.49	0.1	0.05	0.38	3.6
F00W042R	0.068	0.35	0.07	0.05	0.15	2.2
G00W062R	0.062	0.41	0.06	0.02	0.15	2.4
G00W063R	0.047	0.46	0.05	0.00	0.11	2.3
CV _{bf}	0.35					
Pyrethroid						
F00W041R	0.171	0.39	0.18	0.07	0.47	2.7
F00W042R	0.134	0.36	0.14	0.03	0.31	2.3
G00W062R	0.096	0.49	0.09	0.02	0.27	2.8
G00W063R	0.090	0.48	0.095	0.02	0.21	2.3
CV _{bf}	0.31					
Organophosphate						
F00W041R	0.471	0.47	0.46	0.1	1.20	2.5
F00W042R	0.435	0.41	0.44	0.11	1.00	2.3
G00W062R	0.356	0.46	0.34	0.08	0.88	2.5

G00W063R	0.244	0.60	0.260	0.03	0.81	3.3
CV _{bf}	0.27					
Chlorpyrifos	0.47	1.06	0.39	0.08	4.03	8.5
Dicarboximide						
F00W041R	1.965	0.46	1.9	0.72	6.1	3.1
F00W042R	1.507	0.34	1.5	0.38	3.50	2.3
G00W062R	0.697	0.47	0.64	0.17	1.9	2.7
G00W063R	0.954	1.05	0.970	0.09	5.4	5.7
CV _{bf}	0.44					
Vinclozolin	1.37	1.00	1.16	0.14	11.7	8.5
Metalaxyl	0.30	0.69	0.29	0.01	1.08	3.6

CV_{wf} coefficient of variation of residues in unit crops within the experimental site

CV_{bf} coefficient of variation of average residues between the experimental sites.

Table 11. Residues measured in segments of grape bunch in 011AEAH01 trial

Segment	Parameter	Mass [g]	Chlorpyrifos	Metalaxyl	Vinclozolin
Whole bunch	Average	329	0.56	0.43	1.68
	Median	346.1	0.52	0.45	1.70
	Min	152.1	0.08	0.02	0.38
	max	591.7	2.09	1.37	4.91
	CV	0.41	0.88	0.89	0.73
	V	329	3.71	3.16	2.92
Upper		140			
	Average		0.60	0.42	1.69
	Median		0.46	0.28	1.45
	Min		0.15	0.02	0.38
	max		1.43	1.11	4.12
	CV		0.76	0.95	0.72
Middle		108			
	Average		0.53	0.41	1.59
	Median		0.57	0.48	1.77
	Min		0.08	0.10	0.41
	max		2.09	1.29	4.91
	CV		1.14	0.99	0.89
Lower		80			
	Average		0.57	0.52	1.88
	Median		0.58	0.55	1.82
	Min		0.13	0.09	0.57
	max		1.75	1.37	4.72
	CV		0.86	0.76	0.66
			3.05	2.64	2.51

Lettuce

Field trials were carried out at two sites (F00W039R, F00W040R) 5 km apart at Languedoc-Roussillon in Southern France (Balluff, 2001c), and at 2 sites (G00W060R, G00W061R) with a distance of approx. 28 km in the Rhineland-Palatinate province in Southern Germany (Balluff 2001d). Pesticides belonging to the classes of anilinopyrimidines, triazoles, pyrethroids, organophosphates, carbamates and dicarboximides were applied on locness variety using a knapsack sprayer with a lance in a tank mix in France, and on Einstein and Nadine varieties with air supported boom sprayer in Germany. The actual pressure, type of nozzles and positioning of the nozzles were taken according to local farming practice. Details of the treatments are given in Table 12.

Table 12 Details of pesticide applications in lettuce trials

	Treatment	F00W039R	F00W040R	G00W060R	G00W061R
Plot size [m ²]	C / T	30 / 45	20 / 45	20.0 / 50.0	20.0 / 50.0
Plants/plot	C / T	222 / 330	160 / 360	120 / 300	266 / 667
Rows/plot	C / T	6 / 6	4 / 6	4/4	6/6
Distance between rows [m]	both	0.50	0.50	0.35	0.30
Distance in rows [m]	both	0.27	0.25	0.30	0.25
Shortest distance between plots [m]	both	10.0	10.0	10.0	10.0
Shortest distance between plot and border [m]	both	2.0	2.0	20.0	10.0
Sprayer		Maruyama knapsack sprayer		Gloria air supported boom sprayer	
Nozzles (no./type)		1 / ATR yellow (hollow cone)		4 / XR 8002 VS	
Pressure		6.5	7	3.0	3.0
Water volume/plot		1.770	1.780	1.8	1.9
Water volume/ha		393	396	360	380
		Applied dose g a.i./ha			
Anilinopyrimidine		258	260	236	249
Triazole		148	148	135	143
Pyrethroid		39	40	36	38
Organophosphate		553	559	547	577
Dicarboximide		738	742	675	713
Carbamate		369	371	338	356

Only those heads meeting commercial quality standards were taken. According to the local practice outer leaves were discarded. On the day of sampling the samples were transported to the storage rooms. Samples were frozen within 2 hours after sampling and kept deep-frozen until arrival in the test facility 16-19 days later.

Altogether 504 samples (6 control and 120 treated samples from each site) of head lettuce were analyzed for pesticide residues. The analytical procedure was basically the same as described under grapes. The limit of quantitation (LOQ) was

0.02 mg/kg for the anilinopyrimidine, pyrethroid, organophosphate, dicarboximide, carbamate and 0.05 mg/kg for the triazole pesticide. No residues above the LOQ were determined in the control samples, except for two in which 0.02 mg/kg dicarboximide was found. The recovery of pesticides were checked in each analytical batch, and the results are summarized in Table 13.

Table 13 Average recoveries (Q) of pesticide residues from lettuce

	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
F00W039-40R						
Spike level mg/kg	0.02, 0.5, 2.5	0.05, 1.25, 2.0	0.02, 0.48, 0.5	0.02, 0.5, 2.96	0.02, 0.5, 9.6	0.02, 0.5, 1.6
Q	103	104	104	106	103	106
Sd	6.7	7.1	8.7	7.5	8.4	10
CV	0.065	0.068	0.084	0.071	0.082	0.094
No	14	14	14	14	14	14
G00W060-61R						
Spike level mg/kg	0.02, 1.0, 3.4	0.05, 0.5, 3.0	0.02, 0.28, 0.8	0.02, 1.41, 4.0	0.02, 4.4, 16	0.02, 0.36, 2.0
Q	99	106	103	113	102	104
Sd	7.2	9	11	7.5	11	12
CV	0.073	0.085	0.107	0.066	0.108	0.115
	13	13	13	13	13	13

The recoveries obtained from lettuce blank sample spiked at LOQ level ranged between 97 and 126%, while in the second sample the recoveries obtained were so high that they were considered outliers and not reported. As the residues in treated samples were $\geq 3\text{LOQ}$, the uncertain LOQ values probably did not affect the reliability of measurements.

The residues measured in individual lettuce heads are summarized in Tables 14-17.

The characteristics of residue distributions are summarized in Table 18.

Table 14. Residues [mg/kg] measured in individual lettuce heads in F 00W039R trial

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
112	290	3.6	1.9	0.76	4.4	16	1.8
111	260	3.8	2.1	0.75	4.4	15	1.8
85	190	3.9	1.9	0.69	4.5	13	1.7
49	260	2.5	1.5	0.55	3.8	12	1.1
80	200	2.7	1.5	0.63	3.7	12	1.2
108	340	2.6	1.4	0.51	3.5	12	1.1
109	310	2.4	1.4	0.54	3.6	12	1.3
113	290	2.5	1.6	0.65	3.8	12	1.3
129	250	2.7	1.6	0.64	3.8	12	1.4
40	260	2.5	1.5	0.6	3.8	11	1.2
41	340	2	1.3	0.49	3.6	11	1.1
48	230	2.5	1.4	0.52	3.4	11	1.1

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
51	280	2.3	1.3	0.44	3.4	11	1.2
63	230	2.6	1.4	0.58	3.5	11	1.1
78	350	2.1	1.4	0.48	3.7	11	1.2
101	250	2.6	1.4	0.55	3.4	11	1.2
130	180	2.6	1.4	0.63	3.6	11	1.2
22	300	1.8	1.2	0.47	3.4	10	0.95
24	440	2.2	1.5	0.48	3.7	10	1.1
29	300	2.1	1.1	0.51	3.6	10	1.1
74	210	2.2	1.4	0.48	3.3	10	0.96
90	170	3.2	1.7	0.64	3.7	10	1.5
95	170	2.2	1.5	0.52	3.3	10	1.1
110	320	2.4	1.4	0.48	3.4	10	1.2
23	470	1.7	1.2	0.47	3.4	9.8	1
114	270	2.1	1.3	0.49	3.4	9.7	0.97
115	220	2.1	1.2	0.47	3	9.7	1
39	210	2.5	1.4	0.53	3.6	9.6	1.3
43	280	2.2	1.3	0.5	3.3	9.6	0.93
92	190	2.9	1.4	0.55	3.4	9.6	1.3
87	260	2.1	1.2	0.5	3.4	9.5	0.99
88	220	2.3	1.3	0.48	3.4	9.5	1
105	240	2.4	1.3	0.46	3.2	9.4	1.1
127	260	2.5	1.2	0.52	3.3	9.4	1.1
103	270	1.9	1.1	0.46	3	9.3	1
56	380	2.1	1.4	0.41	3.5	9.1	0.99
66	240	2.2	1.2	0.45	3.1	9.1	1
79	330	1.7	1.1	0.38	2.9	9.1	0.79
91	230	2	1.2	0.47	3.4	9.1	1.1
104	180	2.4	1.2	0.55	2.9	9.1	1.2
77	330	1.6	1.1	0.37	2.9	9	0.81
55	300	2.1	1.2	0.42	3.2	8.9	0.8
50	280	2	1.2	0.46	3.2	8.8	0.89
54	260	2.3	1.3	0.45	3.2	8.6	0.86
102	290	1.9	1	0.47	3	8.6	1
126	300	1.4	0.95	0.35	2.6	8.5	0.64
96	120	2.4	1.2	0.47	2.9	8.4	0.96
45	290	2.1	1.1	0.41	3.1	8.3	0.87
65	290	1.7	0.93	0.42	2.8	8.1	0.9
106	350	1.8	0.95	0.39	2.8	8.1	0.83
37	310	2	1.2	0.41	3.1	8	1.1
61	260	1.8	1.1	0.42	2.8	8	0.73
57	250	1.8	1	0.36	2.9	7.9	0.84
124	180	2.1	1.1	0.42	2.8	7.9	0.92
125	250	1.6	1	0.36	2.8	7.9	0.81
47	330	1.7	1	0.37	2.8	7.8	0.72
84	340	1.6	0.97	0.39	2.9	7.8	0.8

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
120	290	1.9	0.96	0.38	2.8	7.8	0.85
71	300	1.6	1	0.38	2.7	7.7	0.84
36	250	1.8	1.1	0.4	2.9	7.5	0.98
52	400	1.8	1	0.32	2.9	7.5	0.88
58	250	2.4	0.93	0.32	2.6	7.5	0.77
60	390	1.7	0.96	0.38	2.8	7.5	0.81
70	340	1.4	0.86	0.34	2.7	7.5	0.78
83	220	1.8	1.1	0.42	2.9	7.5	0.94
107	340	1.8	1	0.39	2.9	7.5	0.93
30	230	1.6	0.91	0.39	2.3	7.4	0.63
117	350	1.4	0.85	0.33	2.5	7.4	0.58
135	240	2	1.1	0.41	3.1	7.4	1
33	320	1.7	0.93	0.36	2.8	7.3	0.77
21	340	1.5	0.96	0.37	2.9	7.2	0.81
89	320	1.6	1	0.43	2.9	7.2	0.84
118	220	1.7	0.98	0.35	2.8	7.2	0.62
136	240	1.8	1	0.36	2.9	7.2	0.94
137	300	1.6	1	0.36	2.9	7.2	0.78
64	230	1.9	0.95	0.35	2.6	7.1	0.87
73	280	1.1	0.81	0.32	2.5	7.1	0.59
131	340	1.8	0.95	0.28	2.7	7.1	0.86
97	320	1.9	0.99	0.35	2.5	7	0.77
86	320	1.7	0.97	0.35	2.7	6.9	0.82
116	390	1	0.67	0.27	2.3	6.9	0.51
42	430	1.3	0.73	0.29	2.3	6.8	0.69
59	100	1.9	1.1	0.4	2.9	6.8	0.86
34	240	1.5	0.91	0.33	2.5	6.7	0.59
67	240	1.9	0.96	0.38	2.5	6.7	0.84
81	280	1.9	0.92	0.36	2.5	6.7	0.84
94	310	1.5	0.92	0.35	2.3	6.7	0.66
75	310	1.4	0.78	0.33	2.4	6.6	0.66
76	290	1.3	0.81	0.29	2.4	6.6	0.66
25	450	1.3	0.83	0.31	2.6	6.5	0.62
35	380	1.3	0.85	0.32	2.8	6.5	0.67
46	320	1.4	0.8	0.31	2.5	6.5	0.76
53	360	1.4	0.85	0.3	2.5	6.5	0.61
98	220	1.8	1	0.37	2.6	6.5	0.85
72	290	1.1	0.7	0.28	2.1	6.4	0.56
38	330	1.5	0.89	0.31	2.5	6.3	0.78
93	220	1.4	0.86	0.32	2.5	6.3	0.85
134	240	1.3	0.87	0.31	2.4	6.3	0.62
133	210	1.1	0.72	0.3	2.2	6.1	0.65
121	270	1.6	0.93	0.37	2.7	6	0.64
99	240	1.7	0.88	0.29	2.4	5.9	0.62
100	310	1.4	0.84	0.31	2.3	5.7	0.6

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
26	370	1.2	0.69	0.25	2.1	5.6	0.53
44	260	1.4	0.78	0.28	2.4	5.6	0.59
122	230	1.3	0.8	0.31	2.3	5.6	0.68
123	250	1.3	0.74	0.29	2.2	5.6	0.55
140	140	1.5	0.82	0.31	2.3	5.6	0.68
31	310	1.4	0.68	0.28	2	5.5	0.65
82	230	1.6	0.86	0.29	2.4	5.4	0.68
119	310	1.2	0.64	0.24	2	5.3	0.55
32	380	1.1	0.58	0.21	1.8	5.1	0.5
62	320	0.92	0.57	0.28	1.8	5.1	0.43
128	310	1.2	1.1	0.25	2.1	5.1	0.55
28	370	1	0.66	0.24	1.9	5	0.5
68	280	1.4	0.72	0.25	1.9	4.9	0.55
69	330	0.91	0.53	0.23	1.8	4.9	0.45
132	310	1.1	0.64	0.21	1.9	4.9	0.52
138	300	1.3	0.76	0.25	2.3	4.9	0.57
139	300	1	0.59	0.22	1.9	4.2	0.52
27	420	0.8	0.47	0.17	1.5	3.8	0.35

Table 15. Residues [mg/kg] measured in individual lettuce heads in F 00W040R trial

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
91	240	4.6	2.9	0.67	6.2	22	2.3
27	290	2.8	2.3	0.56	5.2	14	2.1
128	280	4.4	2.7	0.67	6.6	18	2.1
28	270	2.4	2.1	0.46	5	12	1.9
85	280	4.1	2.7	0.62	5.9	19	1.9
114	300	3.9	2.8	0.66	6.1	20	1.8
84	220	5.6	3	0.68	6.3	22	1.7
135	370	2.4	1.8	0.38	4.9	10	1.7
139	390	2.8	2	0.44	5.1	12	1.7
116	210	3.9	2.9	0.66	6.4	20	1.6
38	350	2.1	1.4	0.32	4.5	9.6	1.5
78	280	2.1	1.8	0.37	5	12	1.5
87	270	4	2.3	0.53	5.8	17	1.5
100	260	3	2.2	0.48	5.6	17	1.5
123	410	3.2	2.1	0.5	5.7	13	1.5
127	330	3.3	2.4	0.56	6.2	18	1.5
21	290	3.4	1.9	0.42	5.3	15	1.4
37	300	3.6	2	0.47	5.1	13	1.4
77	270	3.2	2.1	0.52	5.4	14	1.4
81	230	2.8	2.1	0.5	5.3	14	1.4
93	220	4.7	2.9	0.74	6.4	20	1.4

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
99	230	2.8	2	0.47	5.5	17	1.4
115	280	3.8	2.3	0.57	5.8	15	1.4
120	260	3.5	2.2	0.47	5.6	15	1.4
126	250	4	2.4	0.62	5.9	15	1.4
41	180	4.6	2.4	0.64	6	22	1.3
51	250	3.3	2.3	0.58	5.5	13	1.3
58	260	2.1	1.5	0.29	4.3	9.8	1.3
72	240	2.6	1.6	0.43	4.5	12	1.3
79	250	4.4	2.5	0.77	5.7	19	1.3
109	310	2.5	1.9	0.38	5	11	1.3
110	300	2.7	2	0.44	5.1	13	1.3
112	360	3.2	2.1	0.38	5.1	12	1.3
113	300	2.9	2.1	0.41	5.4	15	1.3
119	310	2.9	2.1	0.47	5.5	14	1.3
125	290	3.1	2	0.52	5.7	15	1.3
129	300	3.5	2.2	0.51	5.8	15	1.3
42	340	2.7	1.7	0.41	5.1	15	1.2
88	250	3.7	2.5	0.61	5.7	16	1.2
95	320	2.7	1.7	0.4	4.9	11	1.2
101	70	3.3	2.6	0.63	6.8	24	1.2
130	350	2.6	1.8	0.47	5.2	11	1.2
134	310	3.1	1.8	0.4	5	9.7	1.2
26	300	2	1.4	0.29	4.1	9.2	1.1
34	190	2.5	1.7	0.4	5.2	12	1.1
48	270	2.9	1.8	0.46	5.2	13	1.1
52	260	2.7	1.8	0.45	5.3	15	1.1
54	190	2.5	1.7	0.39	5.1	14	1.1
56	200	3	2.2	0.48	5.8	17	1.1
57	230	2.5	1.4	0.33	4.4	11	1.1
75	210	2.6	1.9	0.49	5.2	14	1.1
86	280	2.4	1.7	0.41	4.7	12	1.1
90	220	3	2.2	0.57	6	18	1.1
92	190	3.3	2	0.51	5.5	20	1.1
94	190	4.1	2.6	0.58	5.9	20	1.1
102	310	1.9	1.6	0.33	4.7	11	1.1
106	330	1.4	1.3	0.25	4.1	8.3	1.1
30	280	3	1.9	0.39	4.9	13	1
31	290	2.3	1.4	0.31	4.4	9.8	1
39	280	2.3	1.6	0.4	4.9	12	1
43	220	3.4	2.2	0.53	6	19	1
44	220	2.5	1.8	0.42	5.6	17	1
45	190	3.2	2.4	0.55	6.2	20	1
55	190	2.4	2	0.42	5.2	13	1
60	260	2.4	1.7	0.42	5	13	1
64	260	3.3	1.9	0.5	4.9	13	1

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
74	220	2.5	1.5	0.44	4.8	14	1
111	320	3.6	2.3	0.53	5.8	17	1
122	360	2.8	1.9	0.49	5.6	14	1
124	320	2.5	2	0.47	5.5	14	1
29	310	2.2	1.6	0.34	4.7	11	0.98
137	360	1.7	1.5	0.3	4.5	11	0.97
22	250	2.3	1.5	0.34	4.7	11	0.95
23	320	2.3	1.7	0.4	4.8	11	0.95
47	210	3.7	2.4	0.59	6	15	0.95
80	240	2.7	1.7	0.49	5.1	14	0.95
32	250	3.1	1.5	0.34	4.8	13	0.94
67	220	3.1	1.9	0.54	5	14	0.94
46	190	2.6	1.7	0.37	5.1	15	0.93
53	220	2.9	1.9	0.38	5	14	0.92
24	290	1.7	1.1	0.25	3.8	6.7	0.91
82	230	2.9	1.8	0.46	4.9	13	0.91
76	230	2.9	2.2	0.58	5.3	15	0.9
140	350	2.5	1.7	0.31	4.7	9.8	0.9
25	230	1.8	1.3	0.31	4.5	11	0.88
73	210	2.4	1.7	0.46	4.8	12	0.88
121	340	3.3	2.2	0.53	5.8	15	0.88
66	250	2.2	1.4	0.37	4.2	12	0.87
69	280	1.9	1.4	0.33	4.3	9.5	0.87
71	230	2.6	1.6	0.4	4.5	12	0.87
97	210	2.4	1.6	0.37	4.9	12	0.79
65	320	2.5	1.4	0.37	4.4	13	0.78
40	250	2.2	1.7	0.39	5.1	11	0.77
136	370	2.1	1.3	0.26	4.1	6.9	0.77
35	310	2.7	1.7	0.4	4.9	11	0.76
68	280	2.2	1.4	0.36	4.5	12	0.76
83	190	3	1.9	0.49	5.4	16	0.76
138	320	2.3	1.7	0.38	4.8	11	0.76
59	180	1.5	1.2	0.27	3.9	9.5	0.75
33	250	2.1	1.4	0.3	4.3	8.4	0.74
70	270	1.9	1.3	0.28	4.2	9.7	0.74
89	190	3.3	2.3	0.58	5.9	16	0.74
108	240	2.2	1.7	0.41	5	12	0.74
133	260	2.2	1.4	0.29	4.2	8	0.73
36	280	2	1.4	0.36	4.6	11	0.71
49	230	2.3	1.6	0.38	4.9	11	0.7
105	250	1.7	1.3	0.28	4.1	8.5	0.69
96	180	2.1	1.4	0.33	4.3	8.4	0.68
61	290	2.2	1.4	0.39	4.1	9.3	0.65
131	390	1.9	1.4	0.3	4.4	10	0.65
50	300	2.3	1.7	0.4	5	12	0.64

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
117	310	1.9	1.6	0.35	4.7	12	0.63
98	180	1.7	1.5	0.35	4.5	11	0.62
103	230	1.5	1.2	0.25	4	9	0.61
107	330	1.4	1.2	0.23	3.9	7.8	0.6
104	250	1.5	1.3	0.27	4.2	9.5	0.59
63	130	2.7	1.5	0.47	4.7	15	0.56
118	140	1.5	1.2	0.31	4.5	12	0.5
62	230	1.7	1.1	0.32	3.6	7.5	0.45
132	340	1.7	1.2	0.24	4	6.6	0.43

Table 16. Residues [mg/kg] measured in individual lettuce heads in G00W060R trial

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
27	350	1.8	0.76	0.51	3.5	10	0.48
28	460	1.6	0.72	0.42	2.9	9.7	0.47
29	480	1.3	0.53	0.36	2.2	7	0.4
31	360	1.5	0.63	0.38	2.2	6.6	0.44
23	380	1.1	0.6	0.3	1.7	6.4	0.35
132	320	1.3	0.64	0.37	1.6	6.1	0.57
54	350	1.3	0.67	0.35	1.8	6	0.51
38	560	1	0.49	0.31	1.6	5.8	0.35
127	430	1.2	0.64	0.35	1.6	5.8	0.55
124	380	1.1	0.59	0.33	1.5	5.7	0.48
121	340	1.1	0.59	0.29	1.6	5.6	0.58
37	420	0.95	0.5	0.3	1.7	5.5	0.38
34	430	1.1	0.51	0.3	2	5.3	0.39
35	340	1	0.5	0.3	1.4	5.3	0.44
72	520	0.82	0.43	0.26	1.2	5.3	0.29
117	550	1.2	0.6	0.29	1.6	5.3	0.4
123	380	1.1	0.58	0.3	1.5	5.3	0.47
139	460	0.87	0.46	0.27	1.4	5.3	0.34
21	300	0.75	0.45	0.29	1.8	5.2	0.09
82	590	1.3	0.67	0.3	1.7	5.1	0.56
45	380	0.96	0.55	0.27	1.3	5	0.34
46	470	0.89	0.5	0.25	1.3	5	0.32
58	420	1	0.49	0.26	1.4	5	0.4
85	580	0.76	0.46	0.25	1.3	5	0.3
22	400	1.1	0.54	0.3	1.3	4.9	0.24
48	530	0.91	0.51	0.29	1.3	4.9	0.43
50	430	0.93	0.52	0.26	1.5	4.9	0.34
130	510	0.94	0.48	0.25	1.3	4.8	0.35
136	520	0.97	0.47	0.28	1.3	4.8	0.36

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
30	280	0.87	0.45	0.23	1.2	4.7	0.34
66	430	1.1	0.51	0.28	1.4	4.7	0.41
67	500	1.2	0.53	0.26	1.4	4.7	0.44
126	470	0.98	0.49	0.28	1.3	4.7	0.43
69	600	0.71	0.41	0.26	1.1	4.6	0.28
110	530	0.98	0.48	0.23	1.4	4.6	0.37
138	450	0.85	0.41	0.22	1.2	4.6	0.32
42	320	0.97	0.45	0.24	1.1	4.5	0.33
65	410	0.99	0.53	0.25	1.4	4.5	0.39
26	460	1.1	0.5	0.28	1.2	4.4	0.42
43	470	0.73	0.41	0.22	1.1	4.4	0.32
75	510	0.96	0.49	0.24	1.4	4.4	0.37
92	500	0.85	0.46	0.23	1.3	4.4	0.31
107	490	1.1	0.54	0.26	1.5	4.4	0.42
40	470	0.83	0.44	0.23	1.3	4.3	0.36
115	550	0.85	0.44	0.22	1.2	4.3	0.37
140	530	0.93	0.43	0.26	1.1	4.3	0.37
32	540	0.94	0.45	0.25	1.2	4.2	0.42
33	410	0.91	0.43	0.26	1.1	4.2	0.38
44	470	0.82	0.49	0.24	1.4	4.2	0.35
74	600	0.77	0.43	0.23	1.3	4.1	0.34
93	540	0.9	0.45	0.25	1.3	4.1	0.37
120	600	0.78	0.43	0.22	1.1	4.1	0.35
41	570	0.76	0.42	0.23	1.1	4	0.22
83	460	1.1	0.5	0.22	1.3	4	0.41
84	450	0.93	0.43	0.23	1.2	4	0.33
86	620	0.64	0.45	0.22	1.2	4	0.27
89	490	0.8	0.47	0.24	1.4	4	0.36
49	460	0.76	0.42	0.22	1.1	3.9	0.34
57	400	0.86	0.42	0.21	1.2	3.9	0.34
77	510	0.71	0.37	0.19	1.1	3.9	0.35
101	560	0.77	0.45	0.23	1.1	3.9	0.33
24	350	0.95	0.47	0.24	1.2	3.8	0.31
70	580	0.7	0.37	0.21	1.1	3.8	0.28
91	510	0.76	0.36	0.2	1.1	3.8	0.28
109	590	0.79	0.4	0.22	1.1	3.8	0.3
111	590	0.78	0.39	0.22	1.1	3.8	0.33
116	640	0.71	0.39	0.21	1.2	3.8	0.32
125	550	0.82	0.4	0.22	1.1	3.8	0.33
137	450	0.8	0.4	0.21	1.2	3.8	0.32
51	520	0.65	0.38	0.21	1	3.7	0.3
97	560	0.74	0.38	0.19	1.1	3.7	0.26
134	530	0.75	0.38	0.21	1.1	3.7	0.31
25	420	0.81	0.39	0.2	0.88	3.6	0.31
59	430	0.72	0.39	0.21	1	3.6	0.31

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
98	570	0.78	0.43	0.22	1.2	3.6	0.34
135	440	0.74	0.4	0.19	1	3.6	0.33
36	460	0.65	0.38	0.21	1	3.5	0.31
47	510	0.57	0.33	0.18	0.92	3.5	0.21
60	380	0.62	0.34	0.19	1.1	3.5	0.3
81	650	0.71	0.42	0.2	1.3	3.5	0.29
100	540	0.74	0.38	0.21	1.1	3.5	0.28
102	550	0.62	0.35	0.18	1	3.5	0.29
104	420	0.92	0.43	0.19	1.2	3.5	0.39
113	540	0.69	0.39	0.19	1.1	3.5	0.3
119	520	0.64	0.34	0.19	1	3.5	0.24
133	370	0.89	0.49	0.21	1.3	3.5	0.39
68	640	0.55	0.32	0.17	0.86	3.4	0.22
73	460	0.55	0.33	0.17	1.1	3.4	0.2
78	580	0.6	0.33	0.17	1.2	3.4	0.28
87	380	0.9	0.42	0.23	1.1	3.4	0.36
106	410	0.67	0.38	0.19	1.1	3.4	0.3
79	560	0.73	0.35	0.18	1	3.3	0.31
94	580	0.67	0.36	0.18	1	3.3	0.28
105	590	0.63	0.35	0.18	1	3.3	0.29
62	660	0.56	0.31	0.16	0.95	3.2	0.23
96	460	0.86	0.43	0.21	1.2	3.2	0.32
99	520	0.67	0.38	0.18	1.1	3.2	0.28
103	430	0.71	0.36	0.17	1	3.2	0.36
118	560	0.77	0.35	0.19	1	3.2	0.36
112	520	0.62	0.3	0.17	0.85	3.1	0.25
39	460	0.75	0.38	0.18	1	3	0.31
55	560	0.68	0.34	0.17	0.88	3	0.29
63	550	0.58	0.32	0.18	0.81	3	0.23
64	570	0.52	0.29	0.15	0.88	3	0.22
95	450	0.62	0.35	0.16	0.97	3	0.28
131	510	0.64	0.36	0.19	1	3	0.25
80	690	0.68	0.36	0.16	1	2.9	0.32
53	430	0.66	0.34	0.16	0.97	2.8	0.27
88	590	0.77	0.36	0.19	0.96	2.8	0.29
56	510	0.78	0.36	0.19	0.96	2.7	0.3
61	640	0.45	0.28	0.15	0.79	2.7	0.19
128	410	0.68	0.35	0.18	1	2.7	0.31
129	420	0.61	0.3	0.15	0.84	2.7	0.25
76	570	0.48	0.26	0.15	0.72	2.6	0.25
114	410	0.53	0.31	0.14	0.87	2.6	0.23
90	490	0.71	0.36	0.14	0.99	2.5	0.29
108	440	0.58	0.29	0.13	0.85	2.5	0.26
122	470	0.62	0.3	0.14	0.96	2.5	0.23
52	440	0.5	0.3	0.14	0.89	2.4	0.26

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
71	590	0.26	0.15	0.06	0.44	1.3	0.11

Table 17. Residues [mg/kg] measured in individual lettuce heads in G00W061R trial

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
21	270	3.9	3.4	0.84	7.6	19	1.4
22	300	2.9	2.6	0.61	6	14	1.2
23	270	3.2	2.9	0.72	6.9	17	1
24	200	3.2	2.8	0.67	6.5	17	1.3
25	220	3	3.1	0.72	7	18	1.1
26	290	2.3	2.2	0.51	5.4	14	1.1
27	270	3.2	2.3	0.54	5.7	13	1.1
28	200	3.5	3.1	0.74	7.2	18	1.2
29	260	3.3	2.9	0.69	6.6	16	1.2
30	170	3.9	3	0.73	7	18	1.7
31	230	3.4	3	0.74	7	16	1.5
32	310	2.7	2.1	0.5	5.2	11	0.98
33	250	2.4	2	0.45	5	9.8	0.92
34	260	4	3.1	0.77	7.4	18	1.3
35	220	3.4	3.5	0.74	7.9	16	1.6
36	240	3.4	2.8	0.68	6.8	15	1.1
37	260	3.8	3.6	0.72	7.8	17	1.8
38	220	2.7	2.6	0.55	6.2	13	1.2
39	270	3.7	3	0.72	7.4	17	1.4
40	220	3.6	2.8	0.65	6.7	15	1.3
41	210	2.9	2.4	0.5	5.7	12	1.5
42	250	3.1	2.5	0.47	5.9	13	1.3
43	220	2.8	2.5	0.56	5.8	12	1.4
44	190	3.5	3.1	0.76	7.1	18	1.3
45	240	3	2.4	0.53	5.7	13	1.1
46	240	3.2	2.5	0.53	6.2	13	1.2
47	270	2.3	1.7	0.49	4.8	11	1
48	220	3.4	3	0.66	6.9	14	1.2
49	370	3.9	3.5	0.82	8	19	1.5
50	250	3.4	2.6	0.66	6.4	14	1.3
51	230	3	2.4	0.56	5.9	12	1.3
52	250	2.3	2	0.51	5.2	11	0.86
53	270	3	2.7	0.61	6.2	14	1.4
54	270	2.6	2.1	0.49	5.2	11	1.1
55	240	3.4	3.3	0.68	7.2	16	1.3
56	240	3	2.6	0.56	6	15	0.99
57	230	2.9	2.5	0.51	5.8	12	1.2
58	300	2.5	2.1	0.46	5.3	11	1

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
59	300	2.2	2.2	0.5	5.4	11	0.75
60	270	2.5	2.5	0.56	6.3	13	1.2
61	270	2.9	2.6	0.56	6.2	13	1.2
62	170	3.3	3	0.65	6.6	15	1
63	180	4	3.4	0.72	7.6	16	1.5
64	210	3	2.8	0.64	6.9	15	1.2
65	220	3.8	3.4	0.8	7.9	18	1.5
66	250	3.6	3.3	0.74	7.4	16	1.4
67	250	2.9	2.8	0.67	7	16	1.2
68	260	3.2	2.8	0.59	6.6	15	1.3
69	240	3	2.5	0.56	6	12	1.1
70	230	2.8	2.5	0.52	5.8	13	0.97
71	180	2.2	2.3	0.49	5.6	11	1
72	300	2.3	2.4	0.6	6	13	0.81
73	190	3.1	2.8	0.59	7.1	13	1.2
74	280	2.9	2.6	0.62	6.3	14	0.99
75	210	2.8	2.7	0.63	6.4	13	1.4
76	250	3.1	2.9	0.68	6.8	15	1.1
77	210	3.3	2.7	0.6	6.3	14	1.2
78	290	2.9	2.7	0.6	6.2	15	1.1
79	250	3	2.5	0.61	6	14	0.98
80	210	3.1	3	0.8	7.2	17	1
81	220	3.6	3.7	0.76	7.8	17	1.6
82	250	3.4	3.2	0.71	7.7	15	1.5
83	210	3.2	3	0.72	7.2	15	1.2
84	220	3.3	3.2	0.68	7.5	16	1.3
85	260	2.8	2.8	0.62	6.7	15	1.2
86	180	3.4	3.1	0.73	7.2	15	1.3
87	240	2.9	3.1	0.75	7.4	16	1.2
88	280	3.2	3.2	0.7	7.4	16	1.5
89	270	3.1	3.1	0.69	7	15	1.3
90	200	2.6	2.7	0.64	6.6	14	0.94
91	270	2.9	2.6	0.6	6.5	14	1.2
92	230	2.8	2.6	0.58	6.3	14	1.6
93	220	2.9	2.5	0.58	5.9	13	1.3
94	240	3	2.6	0.58	6.4	14	1.2
95	260	2.7	2.5	0.58	6	13	1.2
96	230	3.6	3	0.66	7	15	1.7
97	230	3	3.3	0.76	7.9	16	1
98	250	2.6	2.8	0.65	6.9	15	0.96
99	250	3.7	3.2	0.78	7.6	17	1.5
100	260	3.2	2.6	0.61	6.4	13	1.2
101	210	2.7	2.5	0.59	5.9	12	1.2
102	190	3	3	0.64	6.7	13	1.2
103	190	3.7	3.5	0.78	8.2	21	1.3

GAB sample code	weight of heads [g]	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide	Carbamate
104	250	3.8	3.2	0.72	7.2	16	1.3
105	240	3	2.8	0.7	6.7	15	1.1
106	220	3.1	2.7	0.62	6.5	13	1.3
107	250	3	3	0.69	7.2	16	1.1
108	200	3.5	3.1	0.79	7.5	17	1.4
109	210	2.9	2.9	0.66	6.9	15	1.1
110	200	2.9	3.1	0.71	7.1	15	1.1
111	220	3.5	3.3	0.72	7.4	15	1.7
112	290	2.6	2.2	0.53	5.7	12	1.2
113	280	2.4	2.6	0.6	5.9	12	1.2
114	220	3.2	3.6	0.81	8	19	1.3
115	250	2.6	2.4	0.56	5.7	11	1.1
116	220	3.2	2.8	0.65	6.5	13	1.6
117	230	3.1	2.6	0.64	6.3	13	1.3
118	210	3.3	2.9	0.65	6.7	13	1.5
119	210	3.9	3.3	0.8	8	19	1.7
120	250	3.4	3.1	0.72	7.2	16	1.3
121	240	2.9	2.5	0.62	6.3	13	1.3
122	260	3.1	2.9	0.67	6.7	14	1.4
123	230	3.1	3.1	0.71	7.5	16	1.2
124	250	2.6	2.2	0.47	5.3	10	1
125	260	2.9	2.3	0.59	6.3	14	1.1
126	210	3.5	3.2	0.74	7.4	17	1
127	260	2.6	2.5	0.54	6.1	13	1.1
128	230	2.1	1.8	0.41	4.7	11	0.75
129	220	2.6	2.4	0.57	6.1	14	1.1
130	200	2.9	2.7	0.68	6.5	16	1.2
131	220	3.1	2.8	0.65	6.8	16	1.1
132	270	2.5	2	0.53	5.5	13	0.99
133	210	3.1	2.7	0.59	6.3	14	1.2
134	250	2.1	2.2	0.46	5.1	12	1
135	250	2.6	2.5	0.6	6.3	15	0.82
136	270	3.1	3	0.76	7.8	17	1.3
137	220	2.3	2	0.47	5.4	12	0.79
138	290	3	2.8	0.65	7	15	1.2
139	250	2.8	2.3	0.56	5.8	13	1.2
140	240	2.9	2.2	0.55	5.8	12	1.2

Table 18. Major characteristics of residue distributions in lettuce heads

Pesticide/trial	Residues [mg/kg]					Variability factor
	Mean	CV _{wf}	Median	Min	Max	
Anilino-pyrimidine						
F00W039R	1.89	0.31	1.8	0.8	3.9	2.1
F00W040R	2.71	0.29	2.6	1.4	5.6	2.1

Pesticide/trial	Residues [mg/kg]					Variability factor
	Mean	CV _{wf}	Median	Min	Max	
G00W060R	0.819	0.28	0.78	0.26	1.8	2.2
G00W061R	3.04	0.14	3	2.1	4	1.3
CV _{bf}	0.47					
Triazole						
F00W039R	1.04	0.28	1	0.47	2.1	2.0
F00W040R	1.84	0.24	1.8	1.1	3	1.6
G00W060R	0.424	0.23	0.42	0.15	0.76	1.8
G00W061R	2.74	0.15	2.8	1.7	3.7	1.4
CV _{bf}	0.66					
Pyrethroid						
F00W039R	0.39	0.29	0.38	0.17	0.76	1.9
F00W040R	0.43	0.27	0.415	0.23	0.77	1.8
G00W060R	0.224	0.28	0.22	0.06	0.51	2.2
G00W061R	0.63	0.15	0.64	0.41	0.84	1.3
CV _{bf}	0.40					
Organophosphate						
F00W039R	2.84	0.20	2.85	1.5	4.5	1.6
F00W040R	5.04	0.13	5	3.6	6.8	1.3
G00W060R	1.208	0.31	1.15	0.44	3.5	2.8
G00W061R	6.54	0.12	6.55	4.7	8.2	1.3
CV _{bf}	0.60					
Dicarboximide						
F00W039R	7.97	0.28	7.5	3.8	16	2.0
F00W040R	13.00	0.27	13	6.6	24	1.8
G00W060R	4.040	0.30	3.9	1.3	10	2.4
G00W061R	14.41	0.15	14	9.8	21	1.5
CV _{bf}	0.48					
Carbamate						
F00W039R	0.85	0.31	0.84	0.35	1.8	2.1
F00W040R	1.10	0.33	1	0.43	2.3	2.1
G00W060R	0.327	0.25	0.32	0.09	0.58	1.7
G00W061R	1.21	0.17	1.2	0.75	1.8	1.5
CV _{bf}	0.45					

CV_{wf} coefficient of variation of residues in unit crops within the experimental site

CV_{bf} coefficient of variation of average residues between the experimental sites.

The applicability of the Maximum Likelihood Imputation Procedure (Holden 2000) allowing the calculation of the distribution of single unit residue population from the residue distribution in composite samples, was tested with the residues found in crop units. The average percentages of the imputed percentile expressed as % of the highest single unit sample are shown in Table 19.

Table 19. Average percentages of the imputed percentile expressed as % of the highest single unit sample

	Anilino-pyrimidine	Triazole	Pyrethroid	Organo-phosphate	Dicarboximide
Grapes					

F00W041R	67	71	78	93	67
F00W042R	76	90	94	84	91
G00W062R	85	78	80	81	71
G00W063R	66	88	98	84	78
Lettuce					
F00W039R	85	85	100	95	86
F00W040R	84	105	107	112	99
G00W060R	83	103	105	61	65
G00W061R	117	116	120	123	110

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