TEFLUBENZURON (190)

IDENTITY

ISO common name: teflubenzuron

Chemical name:

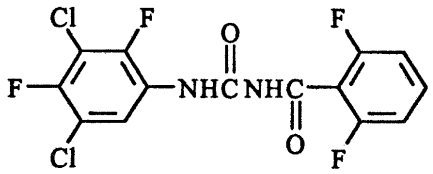
IUPAC: 1-(3,5-dichloro-2,4-difluorophenyl)-3-(2,6-difluorobenzoyl)urea

CA: *N*-[[(3,5-dichloro-2,4-difluorophenyl)amino]carbonyl]-2,6-difluorobenzamide

CAS No: 83121-18-0

Synonyms: DART; DIARACT; NEMOLT; NOMOLT; CL 291,898; SAG 134

Structural formula:



Empirical formula: $C_{14}H_6Cl_2F_4N_2O_2$

Molecular weight: 381.1

Physical and chemical properties

Technical material

Purity: 97 ± 0.72% (w/w)

State: crystalline solid

Colour: white to yellowish

Odour: practically odourless

Vapour pressure: 8×10^{-10} Pa (20°C)
3×10^{-10} Pa (40°C) (Celamerck, 1985a)
1.3×10^{-8} Pa (25°C) (Harteveld and Jager, 1988)

Melting Point: 222.5°C (Pesticide Manual, 1994)

Octanol/water partition coefficient: log P_{OW} = 4.56 (Darskus, 1982)

Solubility (g/l at 20°C):

hexane	0.05	ethanol	1.4
methanol	0.6	dichloromethane	1.8
n-octanol	0.7	acetone	10
2-propanol	0.8	dioxane	19
toluene	0.9	cyclohexanone	24
acetonitrile	1.1	dimethylformamide	170
water	2×10^{-5}		(Cardinaals, 1989; Pesticide Manual, 1994)

Hydrolytic stability: half-life at pH 5-7: 30 days (25°C), 5 days (50°C)
half-life at pH 9: 10 days (25°C), 4 h (50°C)

Photolytic stability: in aqueous solution teflubenzuron shows a half-life of approximately 10 days

Storage stability : minimum 2 years under normal conditions (Pesticide Manual, 1994)

Formulations

Teflubenzuron is available as suspension concentrates containing 150 g ai/l (NOMOLT, NEMOLT, and DART SC 15) or 50 g ai/1 (NOMOLT and DART SC 5).

METABOLISM AND ENVIRONMENTAL FATE

Animal metabolism

The biokinetics and metabolism of teflubenzuron were studied in rats, lactating goats and laying hens.

Rats. The Absorption, distribution, excretion and metabolism of teflubenzuron in the rat were studied by Schlüter (1984, 1985a, 1986a). [^{14}C]teflubenzuron labelled in the aniline ring was administered by oral gavage.

Experiments were performed at dose levels of 25 and 750 mg ai/kg body weight (Schlüter, 1984). The test substance was applied as a suspension in a 1:1 mixture of 1% Tylose C 30 (methylcellulose) and 1% Tween 80 (polyoxyethylene sorbitan mono-oleate) ensuring a high concentration and stable suspension of teflubenzuron. The low dose corresponded approximately to a no-effect level and the high dose was the highest that could be applied without gavage difficulties. The test substance was administered to 6 groups of rats. The general design of the study is shown in Table 1.

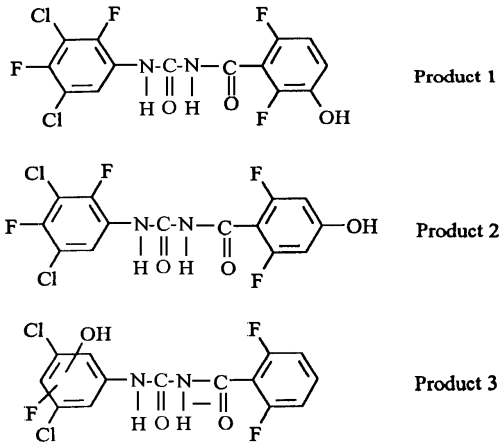
Table 1. Metabolism of teflubenzuron in rats, study design (Schlüter, 1984).

Group	Number of rats	Administration and type of study
A	1 male, 1 female	single low dose, analysis of expired air
B	5 males, 5 females	single low dose, excretion and metabolism
C	5 males, 5 females	repeated low dose, excretion and metabolism
D	5 males, 5 females	single high dose, excretion and metabolism
E	5 males, 5 females	single low dose, blood level
F	5 males, 5 females	single high dose, blood level

The results revealed that teflubenzuron was excreted completely within a short time with no differences between the sexes and no differences due to the type of exposure. The main route of elimination was in the faeces with more than 85% of the dose being eliminated within 24 h. The main component in the faeces was the unchanged parent compound (90 and 96% of the faecal residue from the low and high dose respectively), indicating low absorption by the gastrointestinal tract. Traces of metabolites (up to at least 15, mostly polar) were also found. One of them was identified as 3,5-dichloro-2,4-difluorophenylurea. The remainder of the total dose (10% and 4% of the low and high doses respectively) was absorbed and subsequently small quantities were excreted in the bile and urine. The amounts in the urine were very low: 0.5-0.9% and 0.1-0.2% of the low and high doses respectively, consisting of several polar products.

Another study (Schlüter, 1985a) revealed three metabolites in the urine. Two compounds (products 1 and 2) were structural isomers formed by hydroxylation of the benzoyl ring at positions 3 and 4 (Figure 1). The third compound was formed by replacement of one fluorine atom of the aniline ring by hydroxyl.

Figure 1. Metabolites of teflubenzuron in rat urine (Schlüter, 1985a).



The low absorption of teflubenzuron from the gastrointestinal tract of the rat was confirmed by its low levels in the plasma. The administration of 25 mg/kg body weight gave less than 0.5 µg equivalents of parent compound/ml plasma. After treatment with 750 mg/kg body weight the plasma concentrations amounted to 1-3 µg/ml (Schlüter, 1986a).

The examination of organs and tissues showed that even after 7 days administration by gavage the compound is rapidly and completely eliminated. Two days after the last treatment, no residues exceeding 0.05% of the applied radioactivity were found in any organ or tissue except the liver (0.1-0.2%). Five days after treatment the ^{14}C residues in all tissues and organs (including the gastrointestinal tract) were below 0.01 %, except in the liver which contained 0.05%.

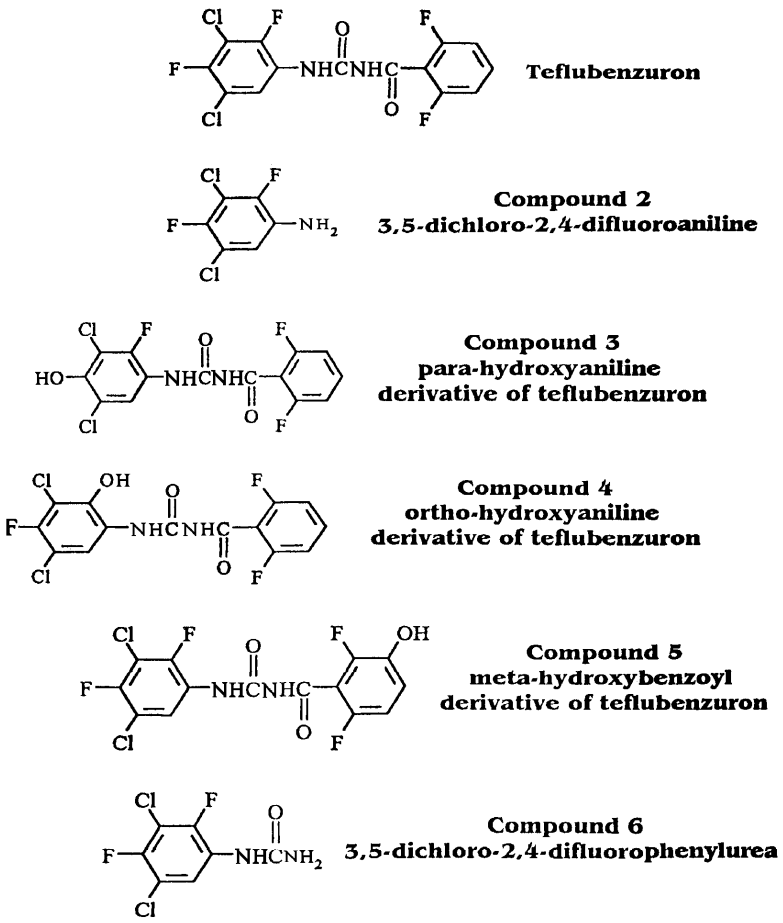
No ^{14}C was detected in expired air, indicating that the aniline ring was metabolically stable. Less than 1% of the radioactivity was detected in the carcases of the animals at the end of the study.

The metabolism and biokinetics of teflubenzuron can be characterized as showing poor absorption from the gastrointestinal tract and rapid elimination, mainly in the faeces and largely as the unchanged parent molecule with no accumulation in any organ or tissue, the sum of all metabolites accounting for less than 1% of the total radioactivity (Schlüter, 1984, 1985a, 1986a).

Nendza (1991) considered that phenylurea derivatives, including teflubenzuron, are rapidly metabolized, e.g. by demethylation and hydroxylation, and hence do not accumulate in mammalian tissues.

The biliary excretion and metabolism of aniline ring-labelled [^{14}C]teflubenzuron was studied in two groups of 6 rats (3 males and 3 females) with bile-duct canulae by Hawkins and Mayo (1988a). After the oral administration of [^{14}C]teflubenzuron at 25 mg/kg, about 16% and 1% of the dose was excreted in 48 h in the bile and urine respectively. After dosing with 750 mg/kg the corresponding figures were about 2% and 0.4%. Summation of the radioactivity in the urine, bile and liver indicated a total absorption of about 18% and 2% of the dose after administration at the 25 and 750 mg/kg levels respectively. It is evident that absorption is dose-dependent. Virtually all the absorbed teflubenzuron has been shown to be transformed. A radioactive component which yielded material which co-chromatographed with compound 5 (Figure 2) after hydrolysis indicated that one biotransformation pathway was meta-hydroxylation of the benzoyl ring and conjugation. Only very small amounts of radioactivity were co-eluted with the hydroxylated aniline derivatives of teflubenzuron (compounds 3 and 4). A radioactive component associated with 3,5-dichloro-2,4-difluorophenylurea (compound 6) confirmed that scission of the benzoyl-urea bond was an additional degradation pathway. Hydrolytic treatments of bile indicated that this phenylurea may also be present as a sulfate conjugate.

The Figure 2. Reference compounds used in the teflubenzuron bile-duct cannulation study (Hawkins and Mayo, 1988a).



biotransformation products in bile and urine included much unidentified polar material. The proportion of this material decreased only slightly after various enzyme treatments, to produce the *m*-hydroxybenzoyl derivative of teflubenzuron and the dichlorodifluorophenylurea. Acid and alkaline hydrolysis decreased the proportion of this polar material further to produce some unidentified products. There was no appreciable difference between the high-level and low-level doses in the proportions of radioactive components produced in bile or the effects of various hydrolytic treatments.

Lactating goats. Cameron *et al.*(1987a) carried out a study to determine the rates and routes of excretion of orally administered [^{14}C]teflubenzuron uniformly labelled in the aniline ring in two lactating goats and to quantify and identify the radioactive metabolites in the milk, plasma, urine, faeces, bile, organs and tissues. The nature of the radioactivity in the faeces and bile was also investigated. The goats were dosed orally twice daily for 7.5 days at a level of 7 mg/kg body weight/day.

The main route of elimination of radioactivity was in the faeces, accounting for 99% of the total administered dose (including intestinal contents at post-mortem). The major radioactive component in goat faeces had identical HPLC and TLC retention characteristics to teflubenzuron and accounted for 76.9% of the radioactivity. A minor radioactive component with similar retention characteristics to compound 5 in Figure 2 accounted for 3.6% of the radioactivity, and a second unknown minor component for 5.9%.

The levels of total radioactivity in the plasma following the first dose remained at or close to the limit of detection. During the dosing period they increased to a maximum of 8-10 ng teflubenzuron equivalent/ml by day 4.

The levels of total radioactivity in the milk were similar to those in the plasma at the same times. The highest levels were found in the day 5 evening milk (10-15 ng equivalent/ml) and represented 0.002-0.005% of the cumulative administered dose up to that time. The radioactivity in the milk accounted for 0.03% of the total administered dose. Cameron *et al.* (1989) showed that the

radioactive residues had the chromatographic characteristics of teflubenzuron.

The radioactive residues in all organs, tissues and body fluids examined post mortem were low in relation to the total dose. The highest mean levels in organs were in the liver and lung with 486 ng equivalent/g and 136 ng equivalent/g respectively, which corresponded to 0.14% and 0.02% of the total administered dose in the whole organs. Relatively high levels were also detected in bile (mean level 1306 ng equivalent/ml, 0.002% of the total administered dose). The levels of radioactivity in the liver and bile indicate biliary excretion as being important in the elimination of the absorbed fraction of an orally administered dose. The absence of similar levels in the plasma suggests that much of the absorbed radioactivity is removed by 'first-pass metabolism' in the liver.

The radioactivity in the bile was mainly in ß-glucuronide (or possibly sulfate) conjugates. When these were hydrolysed the main product had similar chromatographic characteristics to 1-(3,5-dichloro-2,4-difluorophenyl)-3-(2,6-difluoro-3-hydroxybenzoyl)urea (compound 5 in Figure 2). No unchanged teflubenzuron was found in bile either before or after enzymic hydrolysis.

The levels of radioactivity in all other organs, tissues and body fluids were generally less than 100 ng equivalent/g. Teflubenzuron was, therefore, shown to be poorly absorbed after oral administration: the absorbed fraction appears to be metabolized in the liver and conjugated before elimination, mainly in the bile.

Cameron *et al.* (1989) examined the nature of the radioactivity in extracts of the liver. The major component was a polar compound which was not identical to any of the reference compounds. Traces of material co-chromatographing with 1-(3,5-dichloro-2,4-difluorphenyl)-3-(2,6-difluoro-3-hydroxybenzoyl)urea (compound 5 in Figure 2) were also detected. The distribution of the radioactivity was unaffected by treatment with deconjugating enzymes, indicating that the polar material was not a glucuronide or sulfate conjugate.

None of the extracts contained any radioactive components with similar characteristics to either 3,5-dichloro-2,4-difluoroaniline or 3,5-dichloro-2,4-difluorophenylurea (compounds 2 and 6 in Figure 2).

Laying hens. Cameron *et al.* (1987b) investigated the disposition of teflubenzuron in laying hens and the levels and identity of the radioactive compounds in the plasma, bile, organs, tissues and eggs. [^{14}C]teflubenzuron uniformly labelled in the aniline ring was administered orally to 3 groups of 6 laying hens twice daily for 7.5 days at a level of 1.25 mg/kg/day.

The administered radioactivity was almost quantitatively recovered from the excreta (mean recovery 95.6%). The low levels of radioactivity found in plasma, eggs and post-mortem tissue samples suggest that teflubenzuron is only poorly absorbed after oral administration to hens. The absorbed radioactivity was readily eliminated from the eggs and plasma when dosing stopped (half-life of elimination 1.5-2 days).

The main radioactive component in extracts of the excreta had identical HPLC retention characteristics to teflubenzuron.

The levels of radioactivity detected in the liver and bile indicate biliary excretion as being important in the elimination of the absorbed fraction of orally administered doses. The radioactivity in the bile was again mainly in â-glucuronide (or possibly sulfate) conjugates which yielded a product with the chromatographic characteristics of 1-(3,5-dichloro-2,4-difluoropheny1)-3-(2,6-difluoro-3-

hydroxybenzoyl)urea (compound 5 in Figure 2) on hydrolysis. No unchanged teflubenzuron was found in bile either before or after enzymic deconjugation.

A radioactive component with identical retention characteristics to teflubenzuron was found in the plasma, fat, liver and egg yolk. One or possibly two very polar radioactive components were also observed in the plasma and liver which had similar retention characteristics to the main constituent of untreated bile.

In summary teflubenzuron was found to be poorly absorbed after oral administration with the absorbed fraction passing into body tissues, especially fatty tissues and egg yolk. It was readily eliminated when dosing was stopped. The absorbed fraction is apparently metabolized in the liver and conjugated before elimination, mainly in the bile. The main route of metabolism of teflubenzuron in the liver seems to be by hydroxylation of the difluorobenzoyl ring followed by conjugation of the hydroxyl group to form a â-glucuronide.

An additional study with similarly labelled teflubenzuron was carried out to identify the radioactive components in hen excreta, liver, kidney, egg yolk, and fat by HPLC and TLC (Cameron *et al*., 1988).

Liver extracts were shown to contain two components, one with characteristics identical to teflubenzuron and one very polar compound which could not be identified. No significant differences were noted following treatment with deconjugating enzymes, indicating that this polar species was not a conjugate. No compounds were found with the chromatographic characteristics of 3,5-dichloro-2,4-difluoroaniline or 3,5-dichloro-2,4-difluorphenylurea (compounds 2 and 6 in Figure 2).

Kidney extracts were shown to contain both species detected in liver extracts and also traces of material which co-chromatographed with 3,5-dichloro-2,4-difluorphenylurea.

Most of the radioactivity in yolk extracts and all of it in fat extracts co-chromatographed with teflubenzuron.

Plant metabolism

The metabolism of teflubenzuron was investigated in apples, potatoes, cotton and spinach.

Apples. Schlüter (1987a) treated selected parts of young apple trees three times with formulated [U-*aniline*-^{14}C]teflubenzuron according to the spraying schedule to be applied in agricultural practice: treatments at 3-week intervals with a 3-6 week PHI. The surfaces of the fruits and leaves were covered with droplets of the application mixture. The concentration of the active ingredient was 0.2 mg/ml (two to four times that used in agricultural practice, 0.05-0.1 mg/ml). Treated apples were sampled at intervals as well as at normal harvest, and treated and untreated leaves and untreated apples only at harvest. The radioactive residues in treated leaves and apples consisted almost exclusively of unchanged teflubenzuron: 99% and 98% respectively.

It was concluded that teflubenzuron does not penetrate into the fruits or leaves if it is sprayed on apple trees, with no systemic transport and no metabolism within the plants.

Potatoes. Schlüter (l987b) studied metabolism and kinetics of [^{14}C]teflubenzuron (uniformly labelled in the aniline ring) in potato plants. The tops of the plants as well as the soil surfaces of a potato plot were separately treated four times according to the spraying schedule to be used in agricultural

practice (treatments at about 2-week intervals, the last treatment at the beginning of flowering). Some of the plants were treated by spraying the leaves only (the soil was covered with plastic foil and cellulose tissues), and in part of the plot the application mixture was applied to the soil with no leaf treatment. The application rate of the active ingredient was 90 g ai/ha (3 times the highest rate recommended in practice of 10-30 g ai/ha). Treated and untreated tubers and tops were sampled at the growing stage and at normal harvest.

At the end of the test period (63 days after the first treatment), 99.8% of the total radioactivity was extractable from the treated leaves and could be identified as the unchanged parent compound. No significant amounts of radioactive residues were found in the tubers of leaf-treated plants, but trace amounts were detectable in the tubers sampled after soil treatment. After peeling the tubers, mean residues of 0.009 mg/kg were found in the peel, which corresponded to 0.03% of the total radioactivity applied. A total residue of 0.002 mg/kg in unpeeled tubers can be calculated.

It was concluded that teflubenzuron does not penetrate into leaves or stems if it is sprayed on to the aerial parts of potato plants. No translocation or metabolism occurs in the plants.

Cotton. Cotton plants (*Gossypium hirsutum*) were repeatedly treated with formulated teflubenzuron according to the recommendations. Six unlabelled treatments at 81 g ai/ha were followed by two applications of 156 g ai/ha of formulated [U-*aniline*-^{14}C]teflubenzuron (Schwalbe-Fehl *et al.*, 1986). Various plant parts and soil were sampled periodically until harvest. The concentrations of ^{14}C in the samples at harvest were as follows.

Soil: 0.05 µg ai equivalent/g air dried soil (0-5 cm)
Leaves: 6.4 µg ai equivalent/g fresh sample
Stems: 0.5 µg ai equivalent/g fresh sample
Capsule walls: 0.4-0.9 µg ai equivalent/g fresh sample
Seed hairs: 0.02-1.5 µg ai equivalent/g fresh sample
Seeds: 0.005-0.011 µg ai equivalent/g fresh sample

Significant residues were found only in those plant parts which were directly hit by the radiolabelled spray. The test substance was not translocated to closed cotton fruits or seeds. The radioactive residues were almost quantitatively extractable (93-98% of the total radioactivity). More than 99% of the extractable radioactivity was from the unchanged parent compound.

Spinach. Spinach plants were subjected to one run-off spray treatment with 20 ml of a 0.18% spray-wash containing 247 mg/kg [^{14}C]teflubenzuron, which corresponds to an application rate of 60 g ai/ha (Schlüter, 1985b).

The treated plants showed 6.9, 1.01, and 0.7 mg/kg total radioactive residues at 0, 8 and 15 days after treatment respectively. Almost all the residue could be removed from the plants by a surface rinse at all sampling times (at day 0 99%, day 8 99.1%, and day 15 99.2% of the corresponding total radioactive residue).

The remaining 0.8-1.0% was extractable after homogenization of the plants. TLC showed that most of the radioactive residue consisted of unchanged teflubenzuron, which amounted to 94.8% of the total radioactive residue on day 0, 91.7% on day 8 and 77.1% on day 15.

The sum of the degradation products reached 22.9% at day 15. No major product was found. The fact that the radioactivity was almost completely removed by surface rinsing indicates the

absence of metabolic degradation. It is more likely that teflubenzuron is photolytically degraded when applied to the plant surface.

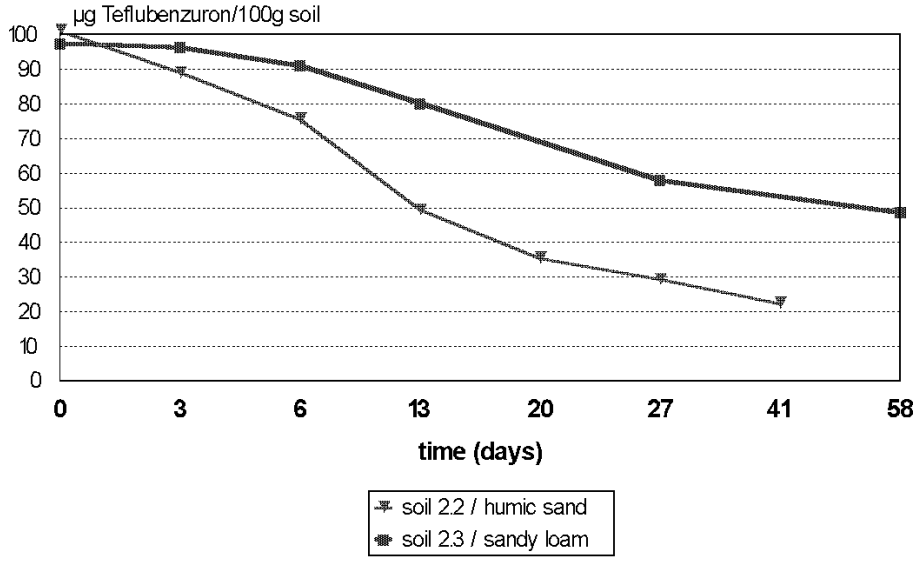
Environmental fate in soil

Laboratory studies.

Degradation. The degradation of unlabelled teflubenzuron in two different types of soil was studied by Heupt (1984). Analytical grade teflubenzuron was added at a starting concentration of 100 µg per 100 g soil (1 mg/kg).

The results showed a big difference in the rates of degradation in the different soil types. In humic soil (humic sand) degradation was more rapid than in sandy loam soil which showed less microbiological activity. The results emphasize that the microbiological factor is of primary importance. The course of the degradation curves (Figure 3) confirm this microbial metabolism. Both curves after an initial linear course show a distinct break after 3 weeks in humic soil and 4 weeks in loam soil. Thereafter they are approximately linear again with a reduced gradient. This effect is probably determined by a change of microbial activity, owing to a partial 'intoxication' of some micro-organisms involved in the degradation by the metabolites formed. The half-life of teflubenzuron in humic sand soil was 2 weeks and in sandy loam soil 6 weeks.

Figure 3. Degradation of teflubenzuron in soil (Heupt, 1984).



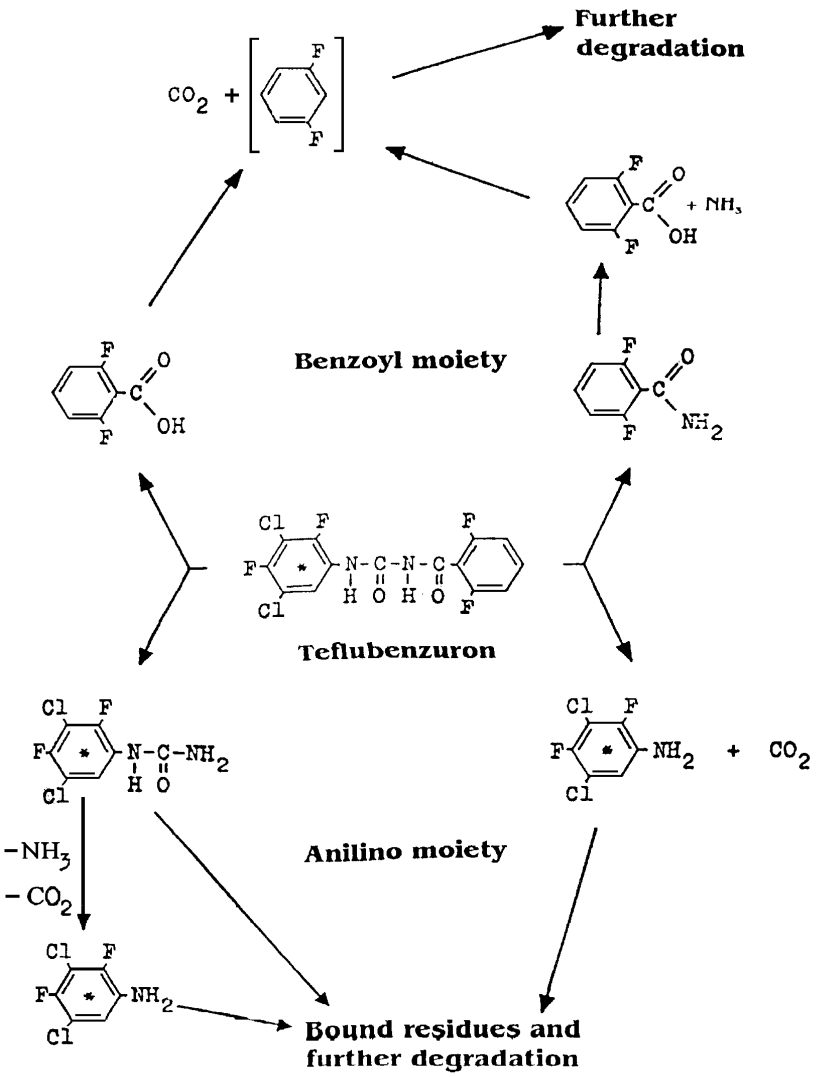
The aerobic and anaerobic degradation of teflubenzuron in a sandy loam soil (5 mg/kg) was studied by Schlüter (1985c). The compound was uniformly labelled with ^{14}C in the aniline ring. The results show that teflubenzuron is degraded in a sandy loam soil under anaerobic conditions about six

times as rapidly as under aerobic. This is confirmed by the fact that the sample taken about 1 h after treatment in the anaerobic test already showed considerable degradation (about 14%) of the parent compound whereas the aerobic test showed about 3% degradation at day 0. Under practical conditions in the field, degradation is likely to be considerably higher than under aerobic conditions in the laboratory because anaerobic degradation is involved.

There is no fundamental difference in the initial degradation pathway under anaerobic and aerobic conditions (cleavage of the parent compound and formation of unextractable residues). In both cases 3,5-dichloro-2,4-difluorophenylurea and 3,5-dichloro-2,4-difluoroaniline were found, indicating that the initial steps in the degradation route were not affected by the difference in conditions. This is consistent with the previous results which demonstrated that 3,5-dichloro-2,4-difluorophenylurea was the major product under both aerobic and anaerobic conditions.

A proposed pathway for the degradation of teflubenzuron in soil under aerobic and anaerobic conditions is shown in Figure 4.

Figure4. Proposed pathway of teflubenzuron degradation in soil under aerobic and anaerobic conditions (Schlüter, 1985c).



In an additional 150-day study the aerobic and anaerobic degradation of teflubenzuron in silty clay loam (0.5 mg/kg) was investigated by Croucher and Edwards (1990), using the benzoyl-^{14}C compound. Soil samples were incubated under aerobic conditions for 30 days, when conditions in some of the samples were made anaerobic by flooding with water and purging with nitrogen. Soils incubated in both aerobic and anaerobic conditions were analysed 60 days and 90 days after treatment.

The degradation of teflubenzuron in aerobic soil occurred at a moderately rapid rate with a half-life (DT-50) of 29 days and a DT-90 of 108 days. After the change to anaerobic conditions the rate of $^{14}CO_2$ evolution slowed considerably but the overall rate of degradation did not change, indicating that the initial steps in the degradation route were not affected by the change in conditions.

The proportions of the radioactive products recovered after 90 days from the anaerobic and aerobic soils were different. Only 3% of the applied radioactivity was evolved as $^{14}CO_2$ in the anaerobic phase of the experiment compared with 24% from the aerobic soils over the same time period. The bound residue was higher in the anaerobic than the aerobic soil.

The major extractable radioactive component at all sampling times under both aerobic and anaerobic conditions was teflubenzuron, but at least 6 other components were observed in extracts of 60-day anaerobic soil accounting for a total of 7% of the applied radioactivity. The radioactive

product expected from the initial cleavage of the [*benzoyl*-^{14}C]teflubenzuron was 2,6-difluorobenzoic acid. It was not observed under aerobic conditions, which indicated that its rate of depletion exceeded its rate of formation, but trace amounts were identified in the anaerobic soil where the rate of mineralization of the benzoyl ring was slower. Another minor degradation product identified under anaerobic conditions was formed by replacement of fluorine by hydroxyl in the 4-position of the aniline ring. This may be an aerobic transformation which was detected because of the slower rate of subsequent catabolism under anaerobic conditions. Alternatively reductive defluorination is a possible first step, followed by replacement of hydrogen by hydroxyl. Decarboxylation of 2,6-difluorobenzoic acid would also be expected. This provides good evidence for the mineralization of the bound residues under aerobic conditions.

Hawkins *et al.* (l987) studied the photodegradation of [^{14}C]teflubenzuron, uniformly labelled in the aniline ring, applied to thin layers of soil on glass plates at a rate of 30 mg/m^2 and irradiated with artificial sunlight from a xenon arc lamp for periods up to a maximum of 15 days. The compound was also applied to control plates which were maintained in the dark under similar conditions of temperature and ventilation.

On exposed plates, teflubenzuron was degraded with a half-life of about 104 days. The major degradation product was volatile and accounted for about 7.2% of the applied radioactivity after 15 days exposure; it was probably $^{14}CO_2$. Most of the radioactivity remaining in the soil was extractable into acetone and chromatographed with teflubenzuron, although after 15 days exposure 7.5-11.9% of the applied radioactivity remained bound to the soil. 3,5-Dichloro-2,4-difluorophenylurea was a minor degradation product (about 2% of the applied radioactivity) after 15 days exposure. No volatile labelled products were formed on the control plates. Apparently photodegradation has relatively little significance in the degradation of teflubenzuron in soil.

Leaching. The fate and behaviour of compounds in soil depends on the extent to which they are leached. The leaching of unlabelled teflubenzuron was studied in three types of soil: (i) sand with a low humus content, (ii) loam sand with a high humus content, and (iii) sandy loam with low humus (Celamerck, 1980). The application rate was 0.6 kg ai/ha (0.12 mg/column) and the columns were leached with a simulated rainfall of about 200 mm during two days. The leachates were extracted with benzene and analysed by HPLC. The LOD was 5 µg/l. Teflubenzuron was not detectable in the drainage water of any of the three soils.

In a more recent study (Schlüter, 1986b) a sandy loam soil was treated with [^{14}C]teflubenzuron uniformly labelled in the aniline ring at 0.5 mg/kg and aged for 30 days under aerobic conditions. After ageing 90.7% of the applied radioactivity could be extracted with solvents of increasing polarity. The radiolabelled material consisted of teflubenzuron (75.5% of the applied activity), 3,5-dichloro-2,4-difluoroaniline (2.1%), 3,5-dichloro-2,4-difluorophenylurea (5.6%), and traces of various unidentified products (7.45% in total).

Aged soil samples each equivalent to 100 g of air-dried soil were placed on top of a 30 cm segmented leaching column of untreated soil to which 11 ml distilled water was added each day for 45 days. After this simulated irrigation most of the applied radioactivity was found in the originally treated soil (80.5% of the applied activity) and the first 5 cm column segment (13.3%). In these segments teflubenzuron was still the main residue and was accompanied by the two compounds identified in the aged soil before the start of the irrigation period.

From the first 5 cm segment only 0.03% of the applied radioactivity could be found in the

aqueous effluent obtained during the 45 days period. Neither teflubenzuron nor its identified degradation products could be found in the effluent, and all three compounds show almost no tendency to migrate into deeper soil layers. The contamination of ground water by these compounds is extremely improbable in agricultural practice.

The lack of leaching is related to high adsorption of teflubenzuron by soil as is evident from the next study.

Adsorption/desorption in soil. The adsorption/desorption of teflubenzuron in soil was studied by Schlüter (1986c) in sand, sandy loam, silt loam and clay loam using a solution of the compound in 0.01 M $CaCl_2$ at a level of about one-half saturation (9.46 µg/l). After 6 hours the concentration in the supernatant solutions in contact with sand, sandy loam, silt loam and clay loam had decreased to 0.24, 0.09, 0.07, and 0.05 µg/l respectively. The concentration of the solution without soil was still 7.94 µg/l.

From these results it was calculated that the proportions of teflubenzuron adsorbed after the 6-h treatment period were 96.9% from sand, 98.8% from sandy loam, 99.1% from silt loam and 99.4% from clay loam, showing very strong adsorption of the compound to all the soils tested.

Desorption tests with the treated soil samples revealed that 6.1%, 3.7%, 1.2%, and 1.3% of the adsorbed radioactivity could be desorbed again from sand, sandy loam, silt loam and clay loam soils respectively during two desorption periods of 24 h each. It is very improbable that these trace amounts still consist only of the unchanged parent compound, since the results of the degradation studies under aerobic and anaerobic conditions indicate appreciable degradation after a corresponding period of time.

It was concluded that teflubenzuron itself shows practically no tendency to migrate once it is applied to soil. This is attributable to the very low solubility of the compound in water, and strong adsorption with very little leaching in all types of soil tested.

Rotational crops

In a study by Schlüter (1989) on rotational crops with [^{14}C]teflubenzuron uniformly labelled in the aniline ring, soil was treated with 0.5 kg ai/ha and aged under anaerobic conditions. At 30, 120 and 360 days after the soil treatment, head lettuce, carrots and wheat were planted or sown as rotational crops and grown to maturity. The ^{14}C residues, as mg/kg teflubenzuron equivalents, are shown in Table 2.

Table 2. ^{14}C levels in rotational crops after treatment with [^{14}C]teflubenzuron, expressed as mg/kg teflubenzuron equivalents (Schlüter, 1989).

Crop	^{14}C as teflubenzuron, mg/kg		
	Soil aged 30 days	Soil aged 120 days	Soil aged 360 days
head lettuce	0.007	0.006	0.002
carrots, peeled	0.013	0.006	0.002
peel	0.08	0.053	0.017
whole root	0.026	0.013	0.005
wheat straw	0.24	0.088	0.035
wheat grain	0.005	0.003	0.002

The comparatively high residue in wheat straw is partly due to the high degree of dryness of the material at harvest. Relatively high values were also found in carrots; the cause in this case is the direct contact with the treated soil. Peeled carrots, and all other fresh plant material, contained equivalents of ≤0.01 mg/kg. The results further show that, in all samples, the radioactive residues decrease significantly with increasing soil ageing periods. This decrease corresponds to the observed decrease in extractable radioactivity in soil on increasing the ageing period. Unextractable soil residues, on the other hand, increase markedly throughout the entire experimental period (up to 70% of the radioactivity originally applied). These observations indicate that the unextractable residues in soil are very probably not taken up by the rotational crops and that the radioactive residues found in the plants originate only from the extractable soil residues. Since at all times the concentration of the unchanged parent compound in the extractable soil residues is much higher than those of the individual degradation products it is probable that teflubenzuron itself is taken up by the plants.

In so far as the low residues made analysis possible, it could be shown that the plants contained numerous, mainly polar, compounds in very small amounts (≤0.05 mg/kg). Neither teflubenzuron nor its known soil degradation products (3,5-dichloro-2,4-difluorophenylurea and 3,5-dichloro-2,4-difluoroaniline) could be detected in the plants (<0.01 mg/kg).

Environmental fate in water and water/sediment systems

Laboratory studies

Hydrolysis. Teflubenzuron (unlabelled) was incubated with buffers at pH 5, 7 and 9 at room temperature. It was stable at pH 5 but was hydrolysed at pH 7 and 9 with half-lives of 8 months and 8 days respectively. In additional studies with suspensions the products identified by HPLC were 2,6-difluorobenzoic acid, 2,6-difluorobenzamide, and 3,5-dichloro-2,4-difluoroaniline, showing that all three N-CO bonds are cleaved when teflubenzuron is hydrolysed (Hawkins *et al.*, 1988b; Heupt, 1983).

Photolysis. The photodegradation of [^{14}C]teflubenzuron in aqueous solution has been investigated by Hawkins *et al.* (1988c). [^{14}C]teflubenzuron (uniformly labelled in the aniline ring) in ethanol was added to acetate buffer (0.1 M, pH 5) to a concentration 0.1 mg/l (10% ethanol) and irradiated with artificial sunlight from a xenon arc lamp for periods up 15 days. Control samples were maintained in the dark under similar conditions of temperature and ventilation.

In the exposed solutions, teflubenzuron was degraded with a half-life of about 10 days. Only one breakdown product exceeded 10% of the applied radioactivity, accounting for about 32% after 15 days, when teflubenzuron accounted for about 45%. About 5% of the applied radioactivity was recorded as volatile breakdown products. No volatile products were formed in the control incubations and after 15 days most of the applied radioactivity chromatographed with teflubenzuron.

The main product of photolysis chromatographed with the reference compound 1-(3,5-dichloro-2,4-difluorophenyl)-5-fluoro-3*H*-dihydroquinazoline-2,4-dione. The degradation product was isolated and its identification confirmed by mass spectrometry.

Sunlight has little effect on the aqueous stability of teflubenzuron. It may be adsorbed onto organic matter, thus reducing its concentration in field water. In highly polluted water, the chemical appeared to be lost because of microbial action as well as adsorption onto organic matter (Schaefer *et*

al., 1988).

Water/sediment systems. The biodegradation of [^{14}C]teflubenzuron labelled in the aniline ring was determined in two water/sediment systems in The Netherlands (Muttzall, 1987). Ditch water and one sediment sample were collected from an unpolluted ditch surrounding the premises of "TNO-Zuidpolder", Delft. A second sediment sample was collected from the river "Kromme Rijn" near Odijk (Province of Utrecht). This river has been contaminated with biocides for many years and is considered to be polluted. The concentrations of the test substance were 1 and 0.02 mg/l of labelled and unlabelled teflubenzuron.

In the "Kromme Rijn" sediment system, very little of the teflubenzuron was biodegraded to CO_2: after 12 weeks (t_{12}) only 0.9% of the initial radioactivity was detected as $^{14}CO_2$. The radioactivity in the aqueous phase increased from 12% at t_0 to 37% at t_{12} with the test concentration of 0.02 mg/l. In the test with 1 mg/l, the aqueous radioactivity reached only about 20% at the end of the test. While bound residues increased steadily from 4% at t_0 to 18% at t_{12} the radioactivity in the extracts of the solids decreased from 80% to 33%.

In the "TNO" sediment system only 0.6% of the initial ^{14}C was detected as $^{14}CO_2$ after 12 weeks. The biodegradation was similar to that in the "Kromme Rijn" system: the radioactivity in the aqueous phase rose from 8% at the beginning to 12% at the end of the test. Bound residues increased from 4% to 32% after 12 weeks, during which time the radioactivity in the extracts of the solids fell from 85% to 48%.

Analysis of the aqueous phase and the extracts of the solids by thin-layer chromatography showed that the amount of teflubenzuron decreased from 87% to 35% after 12 weeks in the Kromme Rijn sediment system: its half-life was calculated to be 6 weeks. Two major degradation products were found, one with an Rf value of 0.23, which accounted for 6% of the initial radioactivity, and one with an Rf value of 0.08, which was identified as 3,5-dichloro-2,4-difluorophenylurea. The amount of this compound increased from 3% at the beginning of the test to 14% at t_{12}.

In the TNO sediment system, the amount of teflubenzuron fell from 86% at t_0 to 40% at t_{12}, giving a half-life of 7 weeks. In this system the same 2 major products were found, 5% of the radioactivity being present as the compound with an Rf value of 0.23. The product with the Rf of 0.08 (the phenylurea) increased from 1% at t_0 to 23% at t_{12}.

METHODS OF RESIDUE ANALYSIS

Analytical methods

This type of compound is particularly suited to determination by HPLC with ultraviolet detection because of its strong absorbance near 254 mm. Teflubenzuron could not be determined by GLC on packed columns, but when GLC with capillary columns became available this procedure was also employed.

Plant material and soil. The HPLC procedure was used for alfalfa, apples, blackberries, broccoli, cabbage, citrus, cotton, cucumbers, grapes, grass, maize, mushrooms, peaches, pears, peppers, potatoes, soya beans and tomatoes, as well as for soils (Celamerk, 1982, 1985b, 1986; Cyanamid, 1995; Shell, 1988a). Teflubenzuron is extracted with acetone or from soil also with an acetone/water

mixture. Clean-up is by solvent partition followed by gel-permeation chromatography and/or silica gel column chromatography. The residue is determined by reversed-phase HPLC with ultraviolet detection at 254 nm. Recoveries determined at levels ranging from 0.01 to 2 mg/kg were 70-110%.

Some years ago, an alternative method using capillary gas chromatography was introduced and applied to cherries and plums (Shell, 1992). As in the other methods, the acetone extracts are cleaned up by solvent partition and gel-permeation chromatography. Determination is by both reversed-phase HPLC and gas chromatography with mass-selective detection. Thus GC-MS can be used as a confirmatory method. Validation was at fortification levels between 0.01 and 0.1 mg/kg. Recoveries were 85-96% and the limit of determination (LOD) was 0.01 mg/kg for both procedures.

Animal products. An HPLC method was developed for the residue determination of teflubenzuron in products of cattle and hens (Shell, 1988b). The residue is extracted with methanol or acetonitrile. In the case of high-fat material the fat is separated in a cooling bath. Further clean-up and quantification by HPLC is as in the crop method. The procedure was validated for muscle, liver, kidney, fat, skin, milk and eggs. Fortification levels were 0.01 to 0.2 mg/kg. Recoveries from the various types of sample were in the range 73-110% with an LOD of 0.01 mg/kg.

Water. A modification of the HPLC method was developed for the determination of residues in water (Cyanamid, 1988) to meet the requirements of the EU drinking water directive. Teflubenzuron is extracted from the water sample on a C_{18} "Bondelut" solid-phase column. After elution, further clean-up on a silica gel column follows if necessary. The compound is determined by reversed-phase HPLC with UV detection at 254 nm. Analysis of water samples spiked at 0.0001 - 0.002 mg/l gave recoveries of 78-100%. The LOD was 0.0001 mg/l.

Air. Air is sucked through a Tenax or XAD column and teflubenzuron is adsorbed. The compound is then eluted and determined by reverse-phase HPLC with UV detection or by GLC with a mass-selective detector as a confirmatory method. The LOD was 56 $\mu g/m^3$ air. The method was later validated in a separate study and the LOD was lowered to 10 $\mu g/m^3$ air (Weitzel, 1995). The range of recoveries was 83-110%.

Stability of pesticide residues in stored analytical samples

The stability of teflubenzuron in various crops held under frozen conditions up to 36 months was tested by Thorstenson (1990). Untreated apple, pear, potato and cabbage samples were fortified at 0.2 mg/kg with teflubenzuron and placed in a freezer maintained at -20°C. The frozen samples were analyzed after 3, 6, 12, and 36 months of storage. The results are shown in Table 3.

Table 3. Stability of teflubenzuron in various crops stored under frozen conditions (Thorstenson, 1990).

Crop	Teflubenzuron (%)[1] remaining after			
	3 months	6 months	12 months	36 months
Apple	115.0	101.3	95.0	74.3
Pear	90.7	113.7	90.0	82.3
Potato	77.0	114.3	91.3	84.7
Cabbage	103.0	102.3	95.0	94.0

[1] Average values

After one and three years storage, 91-95% and 74-94% of the original teflubenzuron remained respectively, showing that teflubenzuron is stable in the crops investigated when stored under deep-frozen conditions.

USE PATTERN

Teflubenzuron is an insecticide which inhibits the biochemical synthesis of chitin. It controls all immature stages of the insects; the youngest larvae are the most susceptible and less teflubenzuron needs to be applied to control young larvae than older ones. The insecticidal activity of teflubenzuron results primarily from the ingestion of treated foliage; contact activity is less significant. The compound is also ovicidal by topical application.

Teflubenzuron controls a wide range of insect pests (*lepidopterous* and *coleopterous* larvae being the most sensitive), and some mites e.g. citrus rust mites - *Phyllocoptruta spp.*

The Meeting received information on GAP from the manufacturer, Germany (Anon., 1995a), Poland (Anon., 1995b), The Netherlands (Anon., 1996) and Spain (Anon., 1993). The information submitted by Spain referred to 1993 and was not taken into consideration because current Spanish GAP (March 1996) was included in the information from the manufacturer.

Table 4 shows the registered uses of teflubenzuron on all important crops and the countries where they apply.

Table 4. Registered uses of teflubenzuron.

Crop	Country	Product	Application			PHI, days
			No.	Max. rate kg ai/ha (kg ai/hl)	F/G	
Apple	Argentina	150 SC	2	0.15	F	21
	France	150 SC	1	0.05	F	14
	Greece	150 SC	2-3	0.21	F	30
	Italy	150 SC 53 SC	1-3 1-3	0.15 0.16	F F	14 14
	Jordan	150 SC	2	(0.0075)	F	15
	Netherlands	150 SC	1-3	0.11-0.16 (0.015)	F	28
	Portugal	150 SC	3	0.07	F	14
	Saudi Arabia	150 SC	2	(0.011)	F	21
	Spain	150 SC	1-2	0.09	F	28
	Switzerland	150 SC	2-3	0.3	F	21
	United Arab Emirates	150 SC	2	(0.0038)	F	7
Broccoli	Netherlands	150 SC	2-4	0.06	F	14
Brussels sprouts	Netherlands	150 SC	6-8	0.09	F	14
Head cabbages	Indonesia	50 EC		0.025	F	
	Italy	150 SC 53 SC	1 1	0.03 0.03	F F	7 7
	Jordan	150 SC	2	(0.0075)	F	14
	Poland	150 SC	1	0.03	F	14
	Switzerland	150 SC		0.045	F	14
Cabbage, Red	Germany	150 SC	1	0.06	F	14
	Netherlands	150 SC	2-4	0.06	F	14
Cabbage, Savoy	Germany	150 SC	1	0.06	F	14
	Switzerland	150 SC		0.045	F	14
Cabbage, White	Germany	150 SC	1	0.06	F	14
	Netherlands	150 SC	2-4	0.06	F	14
Cauliflower	Netherlands	150 SC	2-4	0.06	F	14
Cereals	Switzerland	150 SC		0.06	F	42
Chinese cabbage	Netherlands	150 SC	2-4	0.06	F	14
Citrus fruits	Saudi Arabia	150 SC	2	(0.011)	F	21
	South Africa	150 SC	1-2	(0.003)	F	30
	United Arab Emirates	150 SC	2	(0.0038)	F	7
Coffee	Brazil	150 SC		0.038	F	30
	Kenya	150 SC	1-2	0.11	F	30
Cotton	Argentina	150 SC	2	0.011	F	21
	Brazil	150 SC		0.0075-0.1	F	30
	Colombia	150 SC	2	0.019	F	
	Ecuador	150 SC	2	0.019-0.045	F	

	Guatemala	150 SC	2-3	0.075	F	
	Paraguay	150 SC	2-3	0.0075	F	30
Cucumber	Jordan	150 SC	2	(0.0075)	F	3
	Netherlands	150 SC	3-5	0.23 (0.015)	G	3
	Saudi Arabia	150 SC	2	(0.011)	F	
Cucurbits	Spain	150 SC	2-3	0.18	F,G	3
Egg plant	Italy	150 SC 53 SC	1-2 1-2	0.022 0.024	F F	10 10
	Jordan	150 SC	2	(0.0075)	F	
	Netherlands	150 SC	3-5	0.23 (0.015)	G	3
	Saudi Arabia	150 SC	2	(0.011)	F	
	Spain	150 SC 150 SC	2-3 2-3	0.18 0.23	F G	3 3
Gherkin	Jordan	150 SC	2	(0.0075)	F	
	Netherlands	150 SC	3-5	0.23 (0.015) 0.06 (0.0075)	G F	3 3
Grapes	Italy	150 SC 53 SC	2 2	0.09 0.096	F F	28 28
	Saudi Arabia	150 SC	2	(0.011)	F	21
	Spain	150 SC	2	0.09	F	28
	Switzerland	150 SC	2	0.09	F	21
Maize	Colombia	150 SC	2	0.045	F	
	Ecuador	150 SC	2	0.045	F	21
	Italy	150 SC 53 SC	2 2	0.15 0.16	F F	28 28
Melon	Netherlands	150 SC	3-5	0.23 (0.015)	G	3
Mushroom	Belgium	150 SC		3.0	G	14
	Italy	150 SC 53 SC	1 1	6.0 4.8	F F	45 45
Nectarine	Italy	150 SC 53 SC	1-3 1-3	0.11 0.12	F F	21 21
Nuts	France	150 SC	1	0.045	F	
Olives	Greece	150 SC	2-3	0.29	F	
Orchards and small trees	Poland	150 SC	1	0.11	F	28
Peach	Italy	150 SC 53 SC	1-3 1-3	0.11 0.12	F F	21 21
	Saudi Arabia	150 SC	2	(0.011)	F	21
Pear	France	150 SC	1	0.05	F	14
	Greece	150 SC	2-3	0.21	F	60
	Italy	53 SC	1-3	0.16	F	14
	Jordan	150 SC	2	(0.0075)	F	15
	Netherlands	150 SC	1-4	0.11-0.16 (0.011)	F	28

	Portugal	150 SC	3	0.07	F	14
	Spain	150 SC	1-2	0.06	F	28
	Switzerland	150 SC	2-3	0.3	F	21
	United Arab Emirates	150 SC	2	(0.0038)	F	7
Peppers, Sweet	Italy	150 SC 53 SC	1-2 1-2	0.075 0.08	F F	10 10
	Netherlands	150 SC	3-5	0.23 (0.015)	G	3
	Spain	150 SC 150 SC	2-3 2-3	0.18 0.23	F G	3 3
	Jordan	150 SC	2	(0.0075)	F	
	Saudi Arabia	150 SC	2	(0.011)	F	
Peppers, Chilli	Indonesia	50 SC		0.1	F	
Potato	Germany	150 SC	1	0.045	F	14
	Italy	150 SC 53 SC	1-2 1-2	0.024 0.024	F F	28 28
	Poland	150 SC	1-2	0.038	F	14
	Saudi Arabia	150 SC	2	(0.011)	F	
	Spain	150 SC	1-2	0.022	F	28
	Switzerland	150 SC		0.038	F	21
Quince	France	150 SC	1	0.05	F	14
Sorghum	Colombia	150 SC	2	0.045	F	
	Ecuador	150 SC	2	0.045	F	21
Soya bean	Brazil	150 SC		0.0075-0.023	F	30
	Paraguay	150 SC	2-3	0.0075	F	30
Squash	Saudi Arabia	150 SC	2	(0.011)	F	
Squash, Summer	Netherlands	150 SC	3-5	0.23 (0.015) 0.06 (0.0075)	G F	3 3
Stone fruits	Switzerland	150 SC	2-3	0.12	F	21
Tomato	Argentina	150 SC	3-8	0.075	F	7
	Brazil	150 SC	5-8	0.038	F	7
	Colombia	150 SC	5-8	0.03	F	
	Ecuador	150 SC	5-8	0.03	F	21
	Jordan	150 SC	2	(0.0075)	F	3
	Netherlands	150 SC	3-5	0.23 (0.015)	G	3
	Paraguay	150 SC	5-8	0.038	F	7
	Spain	150 SC 150 SC	2-3 2-3	0.18 0.23	F G	3 3
Vegetables	Saudi Arabia	150 SC	2	(0.011)	F	7
	United Arab Emirates	150 SC	2	(0.0038)	F	7
Watermelon	Jordan	150 SC	2	(0.0075)	F	

F: field, G: greenhouse.

RESIDUES RESULTING FROM SUPERVISED TRIALS

Supervised residue trials have been carried out world-wide on a wide range of crops such as citrus fruits, pome fruits, stone fruits, berries, various types of vegetables, oilseeds and fodder items. In nearly all trials teflubenzuron has been used as a 15% SC formulation (150 g/l suspension concentrate). In some trials teflubenzuron formulated as an emulsion concentrate has been applied as well (25 g/l; 33.3 g/l; 100 g/l). Trials were carried out in different climatic areas, e.g. Northern and Southern Europe, Northern and Southern America, South Africa and the Far East.

Many of the field studies cover a wide range of spray regimes for such reasons as the need to obtain data on rates of decline or to examine the effects of high application rates. In most trials the application rate was given as concentration of active ingredient in the spray solution and as kg of active ingredient per hectare if the spray volume was known. In the few trials in which different rates were used in multiple applications the individual rates are given in the Tables.

Residues have been rounded to 2 significant figures. Where replicates of the same sample have been analysed the mean has been calculated. In most of the studies carried out in the USA, replicate samples were analysed; in these cases all the results are shown. Underlined residues are from treatments according to GAP. Double-underlined residues have been used for the estimation of Supervised Trials Median Residue (STMR) levels.

Table 5. List of Tables of residues from supervised trials on crops.

Table No.	Commodity, country, year
Table 6	Grapefruit, USA (1987)
Table 7	Oranges, Brazil (1984, 1985, 1989), South Africa (1984, 1985, 1986), USA (1987)
Table 8	Apples, France (1982, 1983, 1984, 1985), Germany (1982, 1983, 1984, 1985, 1993), Italy (1984) Slovakia (1986), South Africa, UK (1985), USA (1987)
Table 9	Pears, France (1982, 1984, 1985, 1990), Germany (1993), Italy (1983, 1984)
Table 10	Cherries, Germany (1991)
Table 11	Plums, Germany (1991, 1992), Italy (1988)
Table 12	Nectarines, Italy (1988)
Table 13	Peaches, France (1982, 1983, 1984), Italy (1986)
Table 14	Grapes, France (1982, 1983, 1984), Germany (1982, 1983), Italy (1983, 1984)
Table 15	Raspberries, blackberries, blueberries, Germany (1984, 1985)
Table 16	Persimmons, Korea (1992)
Table 17	Kiwifruit, New Zealand (1986, 1987)
Table 18	Head cabbages, Brazil (1989), Germany (1982, 1983, 1984, 1985), Philippines (1985), Malaysia (1984), UK (1985), USA (1987)
Table 19	Broccoli, Germany (1984)
Table 20	Brussels sprouts, The Netherlands (1985)
Table 21	Cucumbers, Germany (1987), The Netherlands (1987)

Table No.	Commodity, country, year
Table 22	Peppers, Italy (1985, 1988), Korea (1992)
Table 23	Egg plants, Italy (1988)
Table 24	Tomatoes, Brazil (1986, 1989), Germany (1987), Italy (1987), UK (1986, 1993), USA (1987)
Table 25	Mushrooms, Germany (1984, 1985), The Netherlands (1987)
Table 26	Chinese cabbage, Philippines (1985), Malaysia (1985), The Netherlands (1986)
Table 27	Peas, France (1983)
Table 28	Soya beans, Brazil (1985, 1989), USA (1987)
Table 29	Potatoes, Brazil (1985), France (1984), Germany (1982, 1983, 1986, 1987), Italy (1985), Slovakia (1987), USA (1987)
Table 30	Maize, France (1982, 1983, 1984), Germany (1982, 1983, 1986, 1987), Italy (1984)
Table 31	Cotton, Brazil (1989), Guatemala (1984, 1985), Mexico (1984), USA (1987)
Table 32	Coffee beans, Brazil (1989)
Table 33	Alfalfa forage, green grass, Italy (1988)
Table 34	Soya bean forage and hay, USA (1987)

Citrus fruits (Tables 6-7). The use of teflubenzuron on citrus is registered in African countries, where one or two treatments with 0.003-0.011 kg ai/hl are recommended with PHIs of 7 (United Arab Emirates), 21 (Saudi Arabia) and 30 days (South Africa).

In one trial in the USA, grapefruit treated 3 times at a rate of 0.11 kg ai/ha were harvested 45 days after last treatment. In the samples taken, residues of teflubenzuron in whole fruit were <0.05 mg/kg.

Table 6. Residues of teflubenzuron in grapefruit from supervised trials, USA, 1987.

Application			PHI, days	Sample	Residues, mg/kg	Report No.
kg ai/hl	kg ai/ha	No.				
0.005	0.112	3	45	whole fruit	<0.05	HAS A025.001

Nineteen residue trials were carried out on oranges in Brazil, South Africa and the USA during 1984-1989. In one US trial teflubenzuron was applied three times at a rate of 0.11 kg ai/ha. Whole fruits analysed for teflubenzuron showed residues <0.05 mg/kg 45 or 76 days after the last treatment. Samples from trials in South Africa and Brazil were analysed to determine the distribution of residues between edible pulp and inedible peel. As expected, increasing the spray concentration or the number of applications resulted in increased residues. In nine studies in South Africa the rate of decline of residues was determined after 1 or 2 applications of 0.094-2.3 kg ai/ha. Residues in the peel decreased from 0.33-11 mg/kg at day 0 to 0.28-6.8 mg/kg at day 53 or 64, and were <0.05-0.12 mg/kg in the pulp both on days 0 and 64.

Two supervised residue trials were carried out on oranges in 1989 in Brazil. After two pre-harvest applications of 0.06 kg/ha or 0.12 kg/ha, residues after 30 days were <0.01 mg/kg in the pulp and 0.34-0.36 mg/kg in the peel.

In six further trials conducted in South Africa and Brazil samples were taken 159 and 160 days after single applications of 0.009-0.03 kg ai/hl sprays. Residues in the peel were <0.05-2.2 mg/kg, and in the pulp <0.05-0.1 mg/kg.

Table 7. Residues of teflubenzuron in oranges from supervised trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
Brazil, 1984	0.009	0.09	1	159	pulp peel	<0.05 2.2	BRA84100601
Brazil, 1985	0.009	0.09	2	68	pulp peel	<0.05 1.3	BRA85100601
Brazil, 1989	0.003	0.06	2	30	pulp peel	<0.01 0.34	SHGR.90.016
Brazil, 1989	0.06	0.12	2	30	pulp peel	<0.01 0.36	SHGR.90.016
South Africa, 1984	0.012	0.58	1	0 0 1 1 2 2 5 5 8 16 33 33 64 64	pulp peel pulp peel pulp peel pulp peel pulp pulp pulp peel pulp peel	0.08 3.0 0.16 2.7 0.11 2.9 0.09 2.5 <0.05 0.05 0.01 2.4 0.02 1.9	13406-532-2701
South Africa, 1984	0.024	1.2	1	0 0 1 1 2 2 5 5 8 16 33 33 64	pulp peel pulp peel pulp peel pulp peel pulp pulp pulp peel pulp	0.11 3.6 0.13 4.3 0.26 3.4 0.23 3.4 0.10 0.07 0.02 3.9 0.07	13406-532-2702

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
				64	peel	3.1	
South Africa, 1984	0.048	2.3	1	0	pulp	0.12	13406-532-2703
				0	peel	11	
				1	pulp	0.30	
				1	peel	10	
				2	pulp	0.33	
				2	peel	8.2	
				5	pulp	0.32	
				5	peel	8.9	
				8	pulp	0.39	
				16	pulp	0.28	
				33	pulp	0.12	
				33	peel	7.2	
				64	pulp	0.12	
				64	peel	6.8	
South Africa, 1985	0.016		1	160	pulp	<0.05	CU 85-87-A
				160	peel	<0.05	
South Africa, 1985	0.02		1	160	pulp	<0.05	CU 85-87-B
				160	peel	0.06	
South Africa, 1985	0.025		1	160	pulp	<0.05	CU 85-87-C
				160	peel	0.06	
South Africa, 1985	0.03		1	160	pulp	<0.05	CU 85-87-D
				160	peel	<0.05	
South Africa, 1986	0.004	0.094	1	0	pulp	<0.05	86/01/I/K/1A
				0	peel	0.33	
				1	pulp	<0.05	
				1	peel	0.41	
				4	pulp	<0.05	
				4	peel	0.28	
				6	pulp	<0.05	
				6	peel	0.39	
				8	pulp	<0.05	
				8	peel	0.29	
				14	pulp	<0.05	
				14	peel	0.36	
				25	pulp	<0.05	
				25	peel	0.24	
				53	pulp	<0.05	
				53	peel	0.28	
South Africa, 1986	0.008	0.19	1	0	pulp	<0.05	86/01/I/K/1B
				0	peel	0.94	
				1	pulp	0.05	
				1	peel	0.92	
				4	pulp	<0.05	
				4	peel	0.59	
				6	pulp	<0.05	
				6	peel	0.85	
				8	pulp	<0.05	
				8	peel	0.82	
				14	pulp	<0.05	

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
				14	peel	0.77	
				25	pulp	<0.05	
				25	peel	0.60	
				53	pulp	<0.05	
				53	peel	0.59	
South Africa, 1986	0.004	0.094	2	0	pulp	<0.05	86/01/I/K/1C
				0	peel	0.55	
				7	pulp	<0.05	
				7	peel	0.37	
				22	pulp	<0.05	
				22	peel	0.35	
				35	pulp	<0.05	
				35	peel	0.47	
				49	pulp	<0.05	
				49	peel	0.45	
South Africa, 1986	0.008	0.19	2	0	pulp	0.10	86/01/I/K/1D
				0	peel	1.4	
				7	pulp	<0.05	
				7	peel	1.3	
				22	pulp	<0.05	
				22	peel	0.91	
				35	pulp	<0.05	
				35	peel	0.95	
				49	pulp	0.07	
				49	peel	0.87	
South Africa, 1986	0.004		2	0	pulp	<0.05	C86-268A
				0	peel	0.73	
				7	pulp	<0.05	
				7	peel	0.36	
				14	pulp	<0.05	
				14	peel	0.65	
				34	pulp	0.10	
				34	peel	0.26	
South Africa, 1986	0.07		1	0	pulp	0.06	C86-268B
				0	peel	2.6	
				7	pulp	<0.05	
				7	peel	1.3	
				14	pulp	<0.05	
				14	peel	1.6	
				34	pulp	0.20	
				34	peel	0.43	
South Africa, 1987	0.006	0.11	3	45	whole fruit	<0.05	HAS A025.001
				45		<0.05	
				76		<0.05	
				76		<0.05	

Underlined values are from treatments according to GAP of the United Arab Emirates (PHI 7 days) or South Africa (PHI 30 days)

Pome fruits. Teflubenzuron is registered for use on apples, pears and quinces in France, apples and pears in Greece, Italy, Jordan, The Netherlands, Portugal, Spain, Switzerland and the United Arab Emirates, and apples in Argentina and Poland. One to three treatments with 0.06 (Spain) to 0.3 kg ai/ha (Switzerland) are recommended with PHIs of 7 (United Arab Emirates) to 30 (Greece, apple) and 60 days (Greece, pear).

Apples (Table 8). Supervised trials on a number of varieties of apples have been conducted in Slovakia, France, Germany, Italy, South Africa, the UK and the USA between 1982 and 1993. No GAP was available for Germany or the UK, but the trials in these countries could be related to Dutch GAP. After 1-4 treatments with 0.11-0.21 kg ai/ha (0.011 kg ai/hl) the highest residue after PHIs of 24-28 days was 0.37 mg/kg.

Many residue trials were conducted in France, but they did not accord with French or other Southern European GAP.

The results of 5 Italian trials were evaluated with reference to Southern European GAP (Italy, Greece and Switzerland). Two of the trials (2 treatments with 0.24-0.27 kg ai/ha approximated both Swiss GAP (2-3 treatments, 0.3 kg ai/ha, 21-day PHI) and Greek (2-3 treatments, 0.21 kg ai/ha, 30-day PHI). The residues were 0.46 and 0.48 mg/kg at 21 days and 0.45 and 0.51 mg/kg at 28 days. Two other complied with the Italian GAP of 1-3 treatments at 0.15-0.16 kg ai/ha and a PHI of 14 days. The residues were 0.23 and 0.27 mg/kg.

No GAP was available for the USA so the results could not be evaluated.

Table 8. Residues of teflubenzuron in apples from supervised trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
France, 1982	0.008	0.098	6	28	0.25	I8264.35.02
France, 1982	0.008	0.098	6	19	0.27	I8264.35.01
France, 1983	0.009	0.098	6	21	0.34	I8364.35.01
France, 1983	0.009	0.098	6	27	0.35	I8364.35.02
France, 1984	0.005 0.005 0.005	0.05 0.05 0.05	4 4 4	42 42 42	0.1 0.06 0.04	FR84405046018B
France, 1984	0.011 0.011 0.011	0.1 0.1 0.1	4 4 4	42 42 42	0.2 0.15 0.22	FR84405046018C
France, 1984	0.015 0.015 0.015	0.15 0.15 0.15	4 4 4	42 42 42	0.37 0.18 0.27	FR84405046018D
France, 1984	0.001	0.11	8	27	0.68	I8451.3501A
France, 1984	0.01	0.15	8	27	1.2	I8451.3501B
France, 1984	0.008	0.11	9	6	0.49	I8451.3601A

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
France, 1984	0.01	0.15	9	6	0.63	I8451.3601B
France, 1985	0.005 0.009 0.014	0.14 0.27 0.41	2 2 2	100 100 100	<0.07 <0.06 0.16	16082.86A
France, 1985	0.005 0.009 0.014	0.11 0.23 0.34	2 2 2	100 100 100	<0.05 0.08 <0.07	16082.86B
France	0.005	0.05	1	118	<0.03	15734.87
France	0.017	0.05	1	107	<0.03	
France	0.005	0.05	1	136	<0.03	
France	0.005	0.05	1	126	<0.03	
France	0.01	0.05	1	121	<0.04	
France	0.005	0.05	2	83	<0.04	
France	0.005	0.05	2	81	0.03	
France	0.005	0.05	2	41	0.08	
France	0.01	0.05	2	80	<0.03	
France	0.005	0.05	3	30	0.04	
France	0.004	0.05	3	35	0.03	
France	0.005	0.05	3	82	<0.03	
France	0.005	0.05	3	28	0.06	
France	0.005	0.05	3	50	<0.03	
France	0.005	0.05	3	42	0.06	
France	0.005	0.05	3	47	0.03	
France	0.005	0.05	3	16	0.08	
France	0.005	0.05	3	47	0.07	
France	0.005	0.05	3	5	0.08	
France	0.005	0.05	3	16	0.11	
France	0.005	0.05	3	48	0.07	
France	0.005	0.05	6	38	0.09	
France	0.005	0.05	6	54	0.10	
France	0.005	0.05	6	30	0.09	
Germany, 1982	0.011	0.14	4	0 14 21	0.32 0.29 0.20	C820972

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
				28	0.23	
				35	0.20	
				42	0.26	
Germany, 1982	0.011	0.14	4	0	0.27	C821072
				14	0.17	
				21	0.19	
				28	0.19	
				35	0.15	
				42	0.13	
Germany, 1982	0.011	0.14	1	0	0.31	C827572
				14	0.15	
				28	0.09	
				42	0.07	
				56	<0.05	
				70	<0.05	
				84	<0.05	
Germany, 1983	0.011	0.16	2	0	0.23	C832872
	0.005	0.08	1	14	0.21	
				28	0.19	
				35	0.19	
				42	0.18	
Germany, 1983	0.011	0.21	2	0	0.43	C83280101
	0.005	0.10	1	14	0.23	
				28	0.24	
				35	0.22	
				42	0.17	
Germany, 1983	0.011	0.21	2	0	0.46	C83280501
	0.005	0.10	1	14	0.38	
				28	0.36	
				35	0.31	
				42	0.28	
Germany, 1983	0.011	0.21	2	0	0.13	C83280601
	0.005	0.10	1	14	0.13	
				28	0.05	
				35	0.09	
				42	0.09	
Germany, 1984	0.011	0.12	4	0	0.35	C840672
				14	0.29	
				28	0.27	
				35	0.23	
				42	0.20	
Germany, 1984	0.011	0.21	4	0	0.70	C84060101
				14	0.56	
				28	0.37	
				35	0.35	
				50	0.30	
Germany, 1984	0.011	0.21	4	0	0.39	C84060601
				14	0.23	

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
				28	0.29	
				35	0.21	
				49	0.18	
Germany, 1985	0.032	0.16	4	0	0.40	C852272
				3	0.29	
				7	0.38	
				14	0.28	
				21	0.22	
Germany, 1985	0.042	0.17	4	0	0.27	C852206
				3	0.24	
				7	0.25	
				14	0.23	
				21	0.16	
Germany, 1985	0.042	0.21	4	0	0.36	C852201
				3	0.16	
				7	0.13	
				14	0.12	
				21	0.12	
Germany, 1993	0.021	0.16	3	0	0.27	SHE-9308
				7	0.23	
				14	0.12	
				20	0.16	
Italy, 1984	0.008	0.15	1	0	0.29	I84/31/07/03
				7	0.20	
				14	0.23	
				21	0.19	
				28	0.18	
Italy, 1984	0.008	0.15	1	0	0.40	I84/31/07/04
				7	0.19	
				14	0.27	
				21	0.20	
				28	0.18	
Italy, 1984	0.014	0.24	1	0	0.86	I84/35/07/02
	0.014	0.27	1	7	0.73	
				14	0.66	
				21	0.46	
				28	0.51	
Italy, 1984	0.014	0.24	2	0	0.39	I84/35/07/03
				7	0.53	
				14	0.41	
				21	0.48	
				28	0.45	
Italy, 1984	0.014	0.24	1	0	1.3	I84/35/07/05
	0.014	0.27	3	7	0.87	
				14	0.56	
				21	0.65	
				28	0.60	

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Slovakia, 1986	0.015	0.15	4	48	0.53	CU87-389
Slovakia, 1986	0.015	0.15	4	64	0.28	CU87-388
South Africa	0.011	0.26	6	16	0.66	ZAF86I00501
UK, 1985	0.011	0.11	2	20	0.09	GBR85I00201
UK, 1985	0.011	0.11	2	24	0.11	GBR85I00202
UK, 1985	0.011	0.11	2	24	0.23	GBR85I00203
USA, 1987	0.006	0.11	4	5 5 11 11 20 20	0.25 0.12 0.26 0.12 0.17 <0.05	HAS A025.001
USA, 1987	0.024	0.11	4	7 7 15 15 30 30	0.06 <0.05 0.10 0.08 0.11 0.06	HAS A025.001
USA, 1987	0.024	0.11	4	7 7 7 7 7 7 7 7 7 7 7 15 15 15 15 15 15 30 30 30 30 30	0.10 0.07 0.12 <0.05 0.12 0.07 0.12 0.12 0.07 0.09 0.09 0.16 0.12 0.10 0.12 <0.05 0.08 0.05 0.16 0.10 0.08 0.09	HAS A025.001
USA, 1987	0.12	0.56	4	7 7 7 7 7 7 7 7	0.24 0.55 0.33 0.14 0.10 0.11 0.15 0.16	HAS A025.001

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
				15	0.13	
				15	0.07	
				15	0.10	
				15	0.07	
				15	0.57	
				30	0.21	
				30	0.26	
				30	0.51	
				30	<0.05	
				30	0.30	
				30	0.10	
				30	0.27	
USA, 1987	0.012	0.11	4	7	0.09	HAS A025.001
				7	0.07	
				15	0.14	
				15	0.13	
				30	<0.05	
				30	<0.05	
USA, 1987	0.005	0.11	4	6	0.15	HAS A025.001
				6	0.13	
				12	0.12	
				12	0.10	
				12	0.12	
				12	0.10	
				24	0.18	
				24	0.08	
				24	0.11	
				24	0.11	
USA, 1987	0.012	0.11	4	10	0.05	HAS A025.001
				10	0.06	
				20	0.07	
				20	0.08	
				40	<0.05	
				40	0.06	

Underlined residues in German and UK trials are from treatments which approximate Dutch GAP.
Double-underlined Italian residues are from treatments which approximate Italian, Greek or Swiss GAP.

Pears (Table 9). Trials on eight varieties of pears were carried out in France, Germany and Italy. As in the trials on apples the spray regimes were widely spread. When samples were taken at maturity after 3 or fewer applications of 0.023-0.3 kg ai/ha the residues of teflubenzuron were ≤0.66 mg/kg.

Most of the trials could not be evaluated. Only three Italian trials were approximately in accord with Swiss GAP. The residues at a 21-day PHI ranged from 0.43 to 0.71 mg/kg after 2 or 3 treatments at 0.27 kg ai/ha.

Table 9. Residues of teflubenzuron in pears from supervised trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
France, 1982		0.30	1	71	0.20	I82653501
France, 1984	0.003	0.028-0.033	4	27	<0.05	FR84145146018A
France, 1984	0.005	0.055-0.065	4	27	<0.05	FR84145146018B
France, 1984	0.010	0.11-0.13	4	27	0.07	FR84145146018C
France, 1984	0.015	0.17-0.20	4	27	0.16	FR84145146018D
France, 1984	0.003 0.005 0.010 0.015	0.023 0.045 0.09 0.14	1 1 1 1	67 67 67 67	<0.05 <0.05 <0.05 <0.05	FR84145146018A-D
France, 1984	0.011	0.12	1	80	<0.05	I8454.34.01A
France, 1984	0.015	0.17	1	80	<0.05	I8454.34.01B
France, 1984	0.007	0.11	1	71	<0.05	I8454.36.01A
France, 1984	0.008	0.15	1	71	0.06	I8454.36.01B
France, 1985	0.011	0.26	5	28	0.30	16082.86
France, 1985	0.014	0.34	5	28	0.25	16082.86
France, 1985	0.011	0.26	6	24	0.38	16082.86
France, 1985	0.014	0.34	6	24	0.38	16082.86
France, 1990	0.008 0.010	0.075 0.10	2 2	49 49	0.04 0.07	S/FR/E/90/117
France, 1990	0.008 0.010	0.075 0.10	2 2	56 56	0.09 0.09	S/FR/E/90/118
France, 1990	0.008 0.011	0.083 0.11	2 2	72 72	0.03 0.04	S/FR/E/90/211
France, 1990	0.008 0.011	0.075 0.10	2 2	80 80	0.02 0.07	S/FR/E/90/441
Germany, 1993	0.021	0.16	3	0 7 14 21	0.47 0.26 0.26 0.26	SHE-9308
Italy, 1983	0.014	0.34	4	54	0.58	C83220701
Italy, 1983	0.014	0.27	2	54	0.28	C83220702
Italy, 1984	0.014	0.27	4	0 7 14 21	2.1 1.4 1.5 1.3	I84/33/07/01

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
				28	1.2	
Italy, 1984	0.014	0.27	2	0 7 14 21 28	1.2 0.55 0.53 <u>0.43</u> 0.18	I84/33/07/11
Italy, 1984	0.014	0.27	3	0 7 14 21 28	1.0 0.65 0.67 <u>0.60</u> 0.66	I84/33/07/13
Italy, 1984	0.014	0.27	2	0 7 14 21 28	0.86 0.77 0.67 <u>0.71</u> 0.52	I84/33/07/02

Double-underlined residues are from treatments which approximated Swiss GAP.

Stone fruits. Teflubenzuron is registered in Switzerland for stone fruits and Italy for peaches and nectarines with 1-3 treatments of 0.12 kg ai/ha and a 21-day PHI. In Poland, one treatment of 0.11 kg ai/ha and a PHI of 28 days are recommended for orchards. In Saudi Arabia two applications of 0.011 kg ai/hl are registered for peaches with a PHI of 21 days.

Cherries (Table 10). Three trials on cherries were conducted in 1991 in Germany. Two applications were made at a rate of 0.16 kg ai/ha with an interval of 14 days. Fruit samples were taken immediately after the final application and 7, 14, 21 and 28 days later. The residues declined from 0.65-1.2 mg/kg on day 0 to 0.18- 0.21 mg/kg on day 28, calculated on the whole fruit.

Table 10. Residues of teflubenzuron in cherries from supervised trials, Germany, 1991.

Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg[1]	Report No.
	0.16	2	0 7 14 21 28	0.87 0.38 0.49 <u>0.24</u> 0.18	SHTR.93.010 -9117-01
	0.16	2	0 7 14 21 28	1.2 1.2 0.47 <u>0.24</u> 0.20	SHTR.93.010 -9117-02
	0.16	2	0 7 14	0.65 0.76 0.56	SHTR.93.010 -9117-03

Application			PHI,	Residues,	Report No.
kg ai/hl	kg ai/ha	No.	days	mg/kg[1]	
			21	0.25	
			28	0.21	

[1] Calculated as whole fruit including stone
Underlined residues are from treatments which approximate Swiss GAP.

Plums (Table 11). Data on plums are confined to trials in Germany and Italy. After two applications of either 0.12 kg ai/ha (Italy) or 0.16 kg ai/ha (Germany) the residues of teflubenzuron in samples taken at harvest were <0.01-0.08 mg/kg.

Table 11. Residues of teflubenzuron in plums from supervised trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
Germany, 1991	0.015	0.16	2	0	pulp	0.12	SHTR.93.009
				7	pulp	0.09	-0118-01
				14	pulp	0.05	
				21	fruit[1]	0.04	
				28	fruit[1]	0.01	
Germany, 1991	0.015	0.16	2	0	pulp	0.11	SHTR.93.009
				7	fruit[1]	0.04	-9118-2
				14	fruit[1]	0.05	
				21	fruit[1]	0.04	
Germany, 1991	0.015	0.16	2	0	fruit[1]	0.01	SHTR.93.009
				7		<0.01	-9118-03
				14		0.01	
				21		≤0.01	
				28		<0.01	
Germany, 1991	0.015	0.16	2	0	fruit[1]	0.03	SHTR.93.009
				7		0.01	-9118-04
				14		<0.01	
				21		≤0.01	
				28		<0.01	
Germany, 1992	0.015	0.16	2	0	fruit[1]	0.02	SHTR.93.012
				6		0.02	
				13		0.02	
				20		0.01	
				27		0.02	
Italy, 1988	0.006	0.12	2	30	fruit	0.08	I03608
Italy, 1988	0.006	0.12	2	30	fruit	0.04	I02607
Italy, 1988	0.006	0.12	2	21	fruit	0.03	I01606
Italy, 1988	0.006	0.12	2	21	fruit	0.03	SHGR.89.061
Italy, 1988	0.006	0.12	2	30	fruit	0.04	SHGR.89.061
Italy, 1988	0.006	0.12	2	30	fruit	0.08	SHGR.89.061

[1] Calculated as whole fruit including stone
[2] Double-underlined residues are from treatments which approximate Swiss GAP

Nectarines (Table 12). Two trials were carried out in Italy in 1988. After two applications of 0.12 kg ai/ha (0.006% ai in the spray solution) residues in the pulp were 0.08 mg/kg and 0.04 mg/kg at 35 days and 56 days after the last treatment respectively.

Table 12. Residues of teflubenzuron in nectarines from supervised trials, Italy, 1988.

Application			PHI,	Sample	Residues,	Report No.
kg ai/hl	kg ai/ha	No.	days		mg/kg	
0.006	0.12	2	35	pulp	0.08	I04/602
0.006	0.12	2	56	pulp	0.04	I05/603

Peaches (Table 13). In ten trials in France and Italy peaches were treated 1-6 times with the 150 SC formulation at rates of 0.1-0.19 kg ai/ha. At harvest, residues ranged from <0.05 to 0.61 mg/kg.

Table 13. Residues of teflubenzuron in peaches from supervised trials.

Country,	Application			PHI,	Residues,	Report No.
year	kg ai/hl	kg ai/ha	No.	days	mg/kg	
France, 1982	0.016 0.008	0.10 0.10	1 1	21	<u>0.13</u>	I8262.35.01
France, 1982	0.009 0.010	0.10 0.10	1 1	24	<u>0.24</u>	I8262.35.02
France, 1983	0.007	0.10	3	20	<u>0.10</u>	I8362.36.01
France, 1983	0.006	0.10	3	20	<u>0.34</u>	I8362.36.02
France, 1984	0.011	0.11	6	21	0.19	I8456.36.01A
France, 1984	0.015	0.15	6	20	<0.05	I8456.36.01B
France, 1984	0.011	0.11	6	21	0.61	I8456.36.02A
France, 1984	0.015	0.15	6	21	0.52	I8456.36.02B
Italy, 1986	0.008	0.19	1	20	0.43	I86/01/07/01
Italy, 1986	0.008	0.19	2	39	0.34	I86/01/07/02

Underlined residues are from treatments which approximate Italian and Swiss GAP

Berries and other small fruits (Tables 14-15). The only registered uses are on grapes. The treatments are 2 x 0.09-0.096 kg ai/ha in Italy and Spain with a PHI of 28 days, and in Switzerland with a PHI of 21 days. In Saudi Arabia two treatments are registered with a spray concentration of 0.011 kg ai/hl and a 21-day PHI.

Nine varieties of grape were treated in France, Germany and Italy between 1982 and 1984 1-

3 times at rates of 0.1-0.3 kg ai/ha. After one or two applications 0.15-0.23 kg ai/ha the residues of teflubenzuron in samples taken 21-28 days after the last treatment were between <0.05 and 0.72 mg/kg. The application rates in most of the trials were much higher than the rates close to 0.1 kg ai/ha permitted by GAP.

Table 14. Residues of teflubenzuron in grapes from supervised trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
France, 1982	0.27	0.30	1	66	0.86	I8260.35.01
France, 1982	0.30	0.30	1	58	3.3	I8260.35.02
France, 1983	0.27	0.30	1	58	0.58	I8361.35.01
France, 1983	0.21	0.30	1	58	0.41	I8361.35.02
France, 1984	0.10	0.11	1	70	<0.05	I8455.35.01a
France, 1984	0.14	0.15	1	70	0.17	I8455.35.01b
France, 1984	0.006	0.025	1	77	0.02	FR8480508a
France, 1984	0.013	0.05	1	77	0.03	FR8480508b
France, 1984	0.025	0.10	1	77	0.11	FR8480508c
France, 1984	0.038	0.15	1	77	0.14	FR8480508d
Germany, 1982	0.015	0.18	2	0 21 28 35 42	0.25 0.09 0.14 0.17 0.12	C821472
Germany, 1982	0.015 0.015	0.15 0.23	1 1	0 21 28 35 42	0.27 0.20 <0.05 0.17 0.21	C82140301
Germany, 1983	0.011 0.011	0.16 0.21	1 1	0 21 28 35 42	0.17 0.17 0.15 0.26 0.15	C832772
Germany, 1983	0.011 0.011	0.16 0.21	1 1	0 21 28 35 42 49 56 63	0.37 0.23 0.24 0.19 0.22 0.22 0.16 0.13	C83270301
Germany, 1983	0.011	0.16	2	0 21 28	0.13 0.08 0.07	C83270601

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
				35 42 56	0.05 0.04 0.05	
Italy, 1984	0.014	0.27	3	0 7 14 21 28	4.0 2.0 2.4 2.3 2.1	I84/36/07/01
Italy, 1984	0.014	0.27	1	0 7 14 21 28	3.1 1.8 1.1 1.0 1.0	I84/36/07/04
Italy, 1984	0.009	0.18	2	0 7 14 21 28	0.55 0.68 0.54 0.38 <0.05	I84/36/07/12
Italy, 1984	0.009	0.18	2	0 7 14 21 28	2.7 1.4 0.82 0.72 0.67	I84/36/07/13
Italy, 1984	0.014	0.27	1	0 7 14 21 28	1.7 1.4 1.1 1.0 0.94	I84/36/07/05

In Germany, teflubenzuron is registered for use in forests against larvae of *Tenthredinidae spp.* and free-eating caterpillars (1 x 0.023 kg ai/ha). As a result, wild berries and fruits are treated unintentionally. For consumer safety, eight supervised residue trials were carried out on wild raspberries, blackberries and blueberries. The worst case was simulated by application of approximately twice the registered rate. Berries were sampled at various dates after single applications of 0.045 kg ai/ha. Residues were <0.05-0.09 mg/kg in raspberries and blackberries and 0.03-0.15 mg/kg in blueberries.

Table 15. Residues of teflubenzuron in wild berries from supervised trials in Germany.

Year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Raspberries						
1984	0.004	0.045	1	0 3 7 14	0.06 <0.05 <0.05 <0.05	C84100401
1984	0.004	0.045	1	0 3 7 14	0.09 <0.05 <0.05 <0.05	C84100402
Blackberries						
1984	0.004	0.045	1	0 3 7 14	<0.05 <0.05 <0.05 <0.05	C84110401
1984	0.004	0.045	1	0 3 7 14	<0.05 <0.05 <0.05 <0.05	C84110402
1985	0.045	0.045	1	0 1 2 7 14	0.06 0.07 0.08 0.05 0.04	C851803
Blueberries						
1985	0.045	0.045	1	0 1 2 7 14	0.10 0.08 0.11 0.07 0.09	C85190501
1985	0.045	0.045	1	0 1 2 7 14	0.09 0.10 0.11 0.05 0.03	C85190502
1985	0.045	0.045	1	0 1 2 7 14	0.08 0.12 0.15 0.06 0.08	C85190503

Persimmons (Table 16). In a group of 5 trials in Korea in 1992 persimmons were treated 2-6 times with a 5% SC formulation at a rate of 0.25 kg ai/ha. Residues in samples taken 3-45 days after the

last treatment ranged between 0.02 and 0.09 mg/kg. No GAP was available to evaluate the results.

Table 16. Residues of teflubenzuron in persimmons from supervised trials in Korea, 1992. Whole fruit analysed.

Application kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
0.25	2	45	0.02	KORE.92.002
0.25	3	3 7 15 30	0.06 0.05 0.03 0.03	KORE.92.002
0.25	4	3 7 15	0.07 0.04 0.04	KORE.92.002
0.25	5	3 7	0.09 0.06	KORE.92.002
0.25	6	3	0.09	KORE.92.002

Kiwifruit (Table 17). Four residue trials were carried out in New Zealand in 1986/87. The rates of application were 0.094, 0.19 and 0.25 kg ai/ha. Residues determined in whole fruit 16 and 99 days after the final application were 0.23-3.6 mg/kg and 0.28 mg/kg respectively. No GAP was available to evaluate the results.

Table 17. Residues of teflubenzuron in kiwifruit from supervised trials in New Zealand, 1986/7. Whole fruit analysed.

Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
0.008	0.19	7	16	1.3	CU 88554A
0.010	0.25	7	16	3.6	CU 88554B
0.010	0.094	7	16	0.23	CU 88554C
0.010	0.25	3	99	0.28	CU 88554D

Head cabbages (Table 18). Registered uses exist for red, white and Savoy cabbage in Germany (1 x 0.06 kg ai/ha, 14-day PHI), for red and white cabbage in The Netherlands (2-4 x 0.06 kg ai/ha, 14-day PHI), and for head cabbage in Indonesia (0.025 kg ai/ha, no further information), Italy (1 x 0.03 kg ai/ha, 7-day PHI), Jordan (2 x 0.0075 kg ai/hl, 14-day PHI), Poland (1 x 0.03 kg ai/ha, 14-day PHI) and Switzerland (1 x 0.045 kg ai/ha, 14-day PHI).

Ten trials on Savoy cabbage were conducted in Germany in 1982-1985. After applying 3 x 0.06 kg ai/ha, all residues of teflubenzuron were <0.05 mg/kg at the recommended PHI of 14 days. Residues in 2 UK trials on Savoy cabbage treated once with 0.06 kg ai/ha were 0.05 and 0.17 mg/kg at day 14.

Four US trials on white and red cabbage were available, each with analyses of duplicate samples with and without wrapper leaves. Residues after applying 6 x 0.045 kg ai/ha were <0.05 to 0.36 mg/kg in samples with wrapper leaves and <0.05 to 0.11 mg/kg without wrapper leaves.

In 2 trials in Brazil (1 x 0.015 kg ai/ha, 1 x 0.03 kg ai/ha) residues were <0.01 mg/kg 3 and 7 days after treatment.

One trial was carried out in Malaysia and one in the Philippines. The residues were <0.05 mg/kg 18 and 7 days, respectively, after applying 6 or 9 x 0.045 kg ai/ha.

Table 18. Residues of teflubenzuron in head cabbage from supervised trials.

Country, year	Application			PHI, days	Sample	Residues, mg/kg	Report No.
	kg ai/hl	kg ai/ha	No.				
Head cabbage							
Brazil, 1989	0.004	0.015	1	3 7	head	<0.01 <0.01	SHGR.90.015
Brazil, 1989	0.008	0.030	1	3 7	head	<0.01 <0.01	SHGR.90.015
Malaysia, 1984	0.007	0.045	6	18	head	<0.05	MYR84I01101
USA, 1987	0.014	0.045	6	0 0 3 3 7 7 14 14	head w/o head with head w/o head with head w/o head with head w/o head with	0.18, 0.37 0.09, 0.42 0.18, 0.08 0.67, 0.37 <0.05, 0.06 0.36, 0.15 0.11, 0.10 0.36, 0.26	HAS A025.001
USA, 1987	0.006	0.045	6	0 0 3 3 7 7 14 14	head w/o head with head w/o head with head w/o head with head w/o head with	<0.05, <0.05 0.26, 0.45 <0.05, <0.05 0.33, 0.31 <0.05, <0.05 0.17, 0.21 <0.05, <0.05 0.18, 0.18	HAS A025.001
USA, 1987	0.017	0.045	6	0 0 3 3 7 7 14 14	head w/o head with head w/o head with head w/o head with head w/o head with	<0.05, <0.05 0.15, 0.14 <0.05, <0.05 <0.05, 0.20 <0.05, <0.05 0.14, 0.11 <0.05, <0.05 0.09, 0.07	HAS A025. 01
USA, 1987	0.024	0.045	6	0 0 3 3 7 7	head w/o head with head w/o head with head w/o head with	<0.05, <0.05 0.10, 0.14 <0.05, <0.05 0.10, 0.10 <0.05, <0.05 0.15, <0.05	HAS A025. 01

Country, year	Application			PHI, days	Sample	Residues, mg/kg	Report No.
	kg ai/hl	kg ai/ha	No.				
				14 14	head w/o head with	<0.05, <0.05 <0.05, <0.05	
Savoy cabbage							
Germany, 1982	0.012	0.06	3	0 14 28 35 42	head	0.75 <u>≤0.05</u> <0.05 <0.05 <0.05	C821172
Germany, 1982	0.010	0.06	3	0 14 28 35 42	head	<0.05 <u>≤0.05</u> <0.05 <0.05 <0.05	C82110101
Germany, 1983	0.015	0.06	3	0 14 28 35 42	head	0.41 <u>≤0.05</u> <0.05 <0.05 <0.05	C832972
Germany, 1983	0.010	0.06	3	0 17 31 37 44	head	0.99 <u>≤0.05</u> <0.05 <0.05 <0.05	C83290101
Germany, 1983	0.015	0.06	3	0 14 21 28 34 40	head	0.25 <u>≤0.05</u> <0.05 <0.05 <0.05 <0.05	C83290601
Germany, 1984	0.010	0.06	3	0 7 14 21 28	head	0.98 <0.05 <u>≤0.05</u> <0.05 <0.05	C840872
Germany, 1984	0.008	0.06	3	0 7 15 20 27	head	<0.05 <0.05 <u>≤0.05</u> <0.05 <0.05	C84080101
Germany, 1985	0.008	0.06	3	0 3 7 10 14	head	0.10 0.05 <0.05 <0.05 <u>≤0.05</u>	C851501
Germany, 1985	0.010	0.06	3	0 3 7 10 14	head	<0.05 <0.05 <0.05 <0.05 <u>≤0.05</u>	C851505
Germany,	0.010-	0.06	3	0 3	head	0.31 0.22	C851572

Country, year	Application			PHI, days	Sample	Residues, mg/kg	Report No.
	kg ai/hl	kg ai/ha	No.				
1985	0.012			7 14 21		<0.05 <u><0.05</u> <0.05	
UK, 1985	0.02	0.06	1	13	head	<u>0.05</u>	GBR85I00101
UK, 1985	0.02	0.06	1	13	head	<u>0.17</u>	GBR85I00102
White cabbage							
Philippines, 1985	0.005	0.045	9	0 3 5 7	head	0.12 <0.05 <0.05 <0.05	PHI85I00201

w/o: without wrapper leaves
with: with wrapper leaves
Double-underlined residues were from treatments according to German GAP, but 3 treatments instead 1 were carried out

<u>Broccoli</u> (Table 19). Teflubenzuron is registered for use on broccoli in The Netherlands with 2-4 treatments at 0.06 kg ai/ha and a PHI of 14 days. In two German trials corresponding to Dutch GAP the residues were 0.13 and 0.19 mg/kg at day 14.

Table 19. Residues of teflubenzuron in broccoli from supervised trials in Germany, 1984. Whole broccoli analysed.

Application			PHI,	Residues,	Report No.
kg ai/hl	kg ai/ha	No.	days	mg/kg	
0.010-0.012	0.06	3	0 7 14 21 28	0.42 0.24 <u>0.13</u> 0.06 <0.05	C 842772
0.010-0.012	0.06	3	0 7 14 21 28	0.73 0.38 <u>0.19</u> 0.08 <0.05	C 842872

Underlined residues are from treatments according to Dutch GAP

<u>Brussels sprouts</u> (Table 20). Teflubenzuron is currently registered in The Netherlands, where 6-8 treatments at 0.09 kg ai/ha with a PHI of 14 days are recommended.

Eight residue trials were conducted in The Netherlands with 4, 5 and 6 applications at 0.06 or 0.09 kg ai/ha. The residues of teflubenzuron after 14 days were 0.1-0.28 and 0.12-0.48 mg/kg after treatment with 0.06 and 0.09 kg ai/ha respectively.

Table 20. Residues of teflubenzuron in Brussels sprouts from supervised trials in The Netherlands, 1985. Whole plants analysed.

Application			PHI,	Residues, mg/kg	Report No.
kg ai/hl	kg ai/ha	No.	days		
0.006	0.06	6	14 21	0.18 0.2	85-162A
0.006	0.06	5	14	0.15	85-163A
0.006	0.06	5	14 21	0.28 0.2	85-164A
0.006	0.06	4	14	0.1	85-165
0.009	0.09	6	14 21	0.39 0.24	85-162B
0.009	0.09	5	14	0.24	85-163B
0.009	0.09	5	14 21	0.48 0.34	85-164B
0.009	0.09	4	14	0.12	85-165

Cucumbers (Table 21). There are registered field and glasshouse uses on cucurbits in Spain (2-3 x 0.18 kg ai/ha, 3-day PHI), glasshouse uses on cucumbers and gherkins in The Netherlands (3-5 x 0.23 kg ai/ha, 3-day PHI), and field uses on cucumbers and gherkins in Jordan (0.0075 kg ai/hl, 3-day PHI). In Saudi Arabia 2 field applications with 0.011 kg ai/hl are used on cucumbers.

Three indoor trials were carried out in Germany. The residues after 3 days were 0.03 and 0.07 mg/kg from approximately 3 x 0.09 kg ai/ha, and 0.14 mg/kg from 3 x 0.18 kg. In two field trials in Italy, where 3 x 0.075 kg ai/ha were applied, the residues after 3 days were 0.02 and 0.19 mg/kg.

Table 21. Residues of teflubenzuron in cucumbers from supervised trials, 1987. Whole cucumbers analysed.

Country	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Indoors						
Germany	0.008	0.09	3	0 1 3 7 10 14	0.03 0.03 0.03 0.02 0.02 0.01	C 872722
Germany	0.007 0.008	0.067 0.009	1 2	0 1 3 5 7 10 14	0.08 0.09 0.07 0.05 0.04 0.02 0.01	C 872730
Germany		0.18	3	0 1 3 5 7 10 14	0.20 0.22 0.14 0.15 0.06 0.04 0.02	C 872720
Outdoors						
Italy	0.008	0.075	3	0 2 7 10 14 21	0.08 0.02 0.03 0.02 0.03 <0.01	I87160710
Italy	0.008	0.075	3	0 2 7 10 14 21	0.13 0.19 0.12 0.06 0.02 <0.01	I87160711

Peppers (Table 22). Teflubenzuron is registered for field use on sweet peppers in Italy (1-2 x 0.08 kg ai/ha, 10-day PHI), Jordan (2 x 0.0075 kg ai/hl), Saudi Arabia (2 x 0.011 kg ai/hl) and Spain (2-3 x 0.18 kg ai/hl, 3-day PHI), and on chilli peppers in Indonesia at 0.1 kg ai/ha. Glasshouse use on sweet peppers is registered in The Netherlands with 3-5 applications and in Spain with 2 or 3 applications of 0.23 kg ai/ha and a PHI of 3 days.

The Meeting reviewed 6 trials from Italy, 4 of them according to Italian GAP with one treatment of 0.075 kg ai/ha. The residues were 0.08-0.11 mg/kg 10 days after application.

Five trials (2-5 x 0.1 kg ai/ha) in Korea showed residues from <0.05 to 0.11 mg/kg. No GAP was available to evaluate the trials.

Table 22. Residues of teflubenzuron in peppers from supervised field trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Italy, 1985	0.0038	0.038	1	28	<0.05	I6083.86
Italy, 1985	0.008	0.075	1	28	<0.05	I6083.86
Italy,1988	0.008	0.075	1	0 0 3 3 7 7 10 14	0.16 0.09 0.09 0.07 0.15 0.08 <u>0.11</u> 0.07	ITA88001
Italy, 1988	0.008	0.075	1	0 0 3 3 7 7 10 14 14	0.11 0.12 0.12 0.14 0.10 0.11 <u>0.09</u> 0.11 0.15	ITA88002
Italy, 1988	0.008	0.075	1	0 3 7 10 14	0.13 0.08 0.12 <u>0.11</u> 0.07	SHGR.89.058
Italy, 1988	0.008	0.075	1	0 3 7 10 14	0.12 0.13 0.11 <u>0.10</u> 0.13	SHGR.89.058
Korea, 1992		0.10	2	45	<0.05	KORE.92.04
Korea, 1992		0.10	3	3 7 15 30	<0.05 <0.05 <0.05 <0.05	KORE.92.04
Korea, 1992		0.10	4	3 7 15	<0.05 <0.05 <0.05	KORE.92.04
Korea, 1992		0.10	5	3 7	0.06 <0.05	KORE.92.04
Korea, 1992		0.10	6	3	0.11	KORE.92.04

Double-underlined residues are from trials according to Italian GAP.

<u>Egg plants</u> (Table 23). Teflubenzuron is registered for field use on egg plants in Italy with 1-2 x

0.022-0.024 kg ai/ha, 10-day PHI. The GAP for field use in Jordan, Saudi Arabia and Spain, and for glasshouse use in The Netherlands and Spain, is the same as for sweet peppers.

The Meeting reviewed 6 trials from Italy, 4 of them according to Italian GAP with 1 treatment at 0.023 kg ai/ha. The residues were <0.01 mg/kg 10 days after application.

Table 23. Residues of teflubenzuron in egg plants from supervised field trials in Italy.

Year	Application			PHI,	Residues,	Report No.
	kg ai/hl	kg ai/ha	No.	days	mg/kg	
1985	0.001	0.011	1	28	<0.05	I6083.86
1985	0.002	0.023	1	28	<0.05	I6083.86
1988	0.002	0.023	1	0 0 3 3 7 7 10 14	0.02 0.02 <0.01 0.01 <0.01 <0.01 <0.01 <0.01	ITA88003
1988	0.002	0.023	1	0 0 3 3 7 7 10 14	0.02 0.02 <0.01 0.01 <0.01 <0.01 <0.01 <0.01	ITA88004
1988	0.002	0.023	1	0 3 7 10 14	0.02 0.01 <0.01 <0.01 <0.01	SHGR.89.059
1988	0.002	0.023	1	0 3 7 10 14	<0.01 <0.01 <0.01 <0.01 <0.01	SHGR.89.059

Tomatoes (Table 24). Teflubenzuron is currently registered for glasshouse use in The Netherlands (3-5 x 0.23 kg ai/ha, 3-day PHI), and for glasshouse and field use in Spain (2-3 x 0.18-0.23 kg ai/ha, 3-day PHI). Field treatments are registered in Brazil and Paraguay (5-8 x 0.038 kg ai/ha with a PHI of 7 days), Argentina (3-8 x 0.075 kg ai/ha, PHI 7 days), Columbia and Ecuador (5-8 x 0.03 kg ai/ha and in Ecuador a PHI of 21 days). In Jordan, 2 applications of 0.0075 kg ai/hl and a 3-day PHI are allowed.

Field use. Six trials were conducted in Brazil. After applying 3-5 x 0.03-0.09 kg ai/ha, residues ranged from 0.05 to 0.15 mg/kg after 6 or 7 days. Two Italian trials with 4 x 0.075 kg ai/ha resulted

in residues of 0.1 and 0.28 mg/kg 2 days after application.

Four trials were carried out in the USA. The report did not state whether the trials were outdoors or in greenhouses, but as they were in Fresno, California, it is very likely that they were outdoors. Residues from <0.05 to 0.1 mg/kg were found 3 days after treatment with 5 x 0.028-0.056 kg ai/ha.

Glasshouse use. Three trials in Germany were with 3-4 treatments at 0.09-0.17 kg ai/ha. The residues were 0.1, 0.17 and 0.47 mg/kg 3 days after the last application.

Table 24. Residues of teflubenzuron in tomatoes from supervised trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Indoors						
Germany, 1987	0.008	0.09	3	0 1 3 5 7 10 14	0.12 0.13 0.10 0.13 0.13 0.08 0.08	C 872630
Germany, 1987	0.008	0.17	4	0 1 3 5 7 10 14	0.67 0.59 0.47 0.37 0.51 0.31 0.28	C 872620
Germany, 1987	0.007 0.008	0.11 0.14	1 2	0 1 3 5 7 10 14	0.15 0.23 0.17 0.08 0.09 0.07 0.08	C 872621
UK, 1986	0.022	0.17	4	0 1 2 3	0.55 0.65 0.32 0.20	GBR86I00101
UK, 1993	0.015	0.23	5	3	0.36	CFS 1994-060
UK, 1993	0.075-0.077	1.1-1.2	5	3	1.7	CFS 1994-060

Outdoors						
Brazil, 1986	0.004	0.045	5	0 4 6 8 12 18	0.05 0.08 <u>0.05</u> 0.06 0.09 0.05	BRA86I00402
Brazil, 1986	0.007	0.09	5	0 4 6 8 12 18	0.19 0.13 0.15 0.09 0.22 0.09	BRA86I00502
Brazil, 1986	0.004	0.045	5	0 4 6 8 12 18	0.10 0.05 <u>0.06</u> <0.05 <0.05 <0.05	BRA86I00902
Brazil, 1986	0.007	0.09	5	0 4 6 8 12 18	0.14 0.09 0.08 0.05 0.04 0.03	BRA86I01002
Brazil, 1989	0.006	0.03	3	0 7 14	0.09 0.10 0.05	SHGR.90.014
Brazil, 1989	0.006	0.03	3	0 7 14	0.07 0.12 0.01	SHGR.90.014
Italy, 1987	0.008	0.075	4	0 2 7 10 14 21	0.25 0.10 0.18 0.23 0.18 0.11	I87150710
Italy, 1987	0.008	0.075	4	0 2 7 10 14 21	0.35 0.28 0.29 0.17 0.13 0.12	I87150711
USA, 1987	0.006	0.028	5	0 0 1 1 3 3 7 7	<0.05 0.07 0.09 0.09 0.06 0.09 0.08 0.08	HAS A025.001

				14	<0.05	
				14	<0.05	
USA, 1987	0.012	0.056	5	0	0.16	HAS A025.001
				0	<0.05	
				1	0.10	
				1	0.13	
				3	<0.05	
				3	0.10	
				7	0.09	
				7	0.13	
				14	0.07	
				14	0.06	
USA, 1987	0.008	0.056	5	0	0.08	HAS A025.001
				0	0.08	
				1	<0.05	
				1	<0.05	
				3	0.06	
				3	0.07	
				7	0.07	
				7	<0.05	
				14	0.09	
				14	0.09	
USA, 1987		0.056	5	0	<0.05	HAS A025.001
				0	<0.05	
				3	<0.05	
				3	<0.05	
				7	<0.05	
				7	<0.05	
				14	0.05	
				14	<0.05	

The underlined residue in the UK trial CFS 1994-060 is from a treatment which complies with Dutch GAP

Mushrooms (Table 25). Uses exist in Belgium (3 kg ai/ha, 14-day PHI) and Italy (1 x 4.8-6 kg ai/ha, 45-day PHI). In a trial with 4 replicates on cultivated mushrooms in The Netherlands the residues were all <0.05 mg/kg 25 days after applying 2 x 4.9 mg/kg.

In Germany, wild mushrooms may be treated unintentionally by the use of teflubenzuron in forests against larvae of *tenthredinidae spp.* and free-eating caterpillars at 0.023 kg ai/ha. The worst case was simulated by the application of approximately twice this rate (0.045 kg ai/ha) in 3 trials in Germany. The residues on days 0, 1 and 2 were all <0.05 mg/kg in two trials and 0.07, 0.07 and 0.05 mg/kg respectively in the third.

Table 25. Residues of teflubenzuron in mushrooms from supervised trials. Whole mushrooms analysed.

Country, year	Application			PHI,	Residues,	Report No.
	kg ai/hl	kg ai/ha	No.	days	mg/kg	
Wild mushrooms						

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Germany, 1984	0.004	0.045	1	0 1 2 7 14	0.07 0.07 0.05 <0.05 <0.05	C 84090401
Germany, 1984	0.004	0.045	1	0 1 2 7 14	<0.05 <0.05 <0.05 <0.05 <0.05	C 84090402
Germany, 1985	0.045	0.045	1	0 1 2 7 14	<0.05 <0.05 <0.05 <0.05 <0.05	C 851603
Cultivated mushrooms						
Netherlands, 1987	0.16	4.9	2	25 25 25 25	<0.05 <0.05 <0.05 <0.05	87-139

Chinese cabbage (Table 26). Teflubenzuron is currently registered only in The Netherlands. It is recommended for field use at a rate of 0.06 kg ai/ha 2-4 times a season with a PHI of 14 days.

Two trials were carried out in The Netherlands. After applying 1 x 0.06 or 0.09 kg ai/ha the residues were 0.22 and 0.31 mg/kg at day 14.

Further trials were conducted in Malaysia (4 x 0.045 kg ai/ha) and the Philippines (9 x 0.045 kg ai/ha). The residues were 0.16, 0.93 and 2.8 mg/kg 7 days after treatment. No GAP was available for Asian countries with which to evaluate the results.

Table 26. Residues of teflubenzuron in Chinese cabbage from supervised trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Netherlands, 1986	0.006	0.06	1	1 14 21	2 0.22 0.06	86.158A
Netherlands, 1986	0.009	0.09	1	1 14 21	3.2 0.31 0.1	86.158B
Malaysia, 1985	0.004	0.045	4	7	0.93	MYS85I01002
Malaysia, 1985	0.007	0.045	4	7	2.3	MYS85I01001
Philippines, 1985	0.005	0.045	9	0 3 5 7	1.6 0.65 0.34 0.16	PHI85I00301

Peas, immature seeds (Table 27). No information on GAP was available for peas. One trial was conducted in France. The residues were 0.19 mg/kg in green peas with pods and <0.05 mg/kg in the peas 21 days after 2 applications of 0.045 kg ai/hl (0.23 kg ai/ha).

Table 27. Residues of teflubenzuron in peas from supervised trials in France, 1983.

Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
0.045	0.22	2	21 21	peas with pod seeds	0.19 <0.05	I8353.34.01

Soya beans (Table 28). Teflubenzuron is registered for use on soya beans in Brazil (0.0075-0.023 kg ai/ha) and Paraguay (2-3 treatments of 0.0075 kg ai/ha) with a PHI of 30 days in both countries.

Six trials were carried out in Brazil, four of them according to GAP. The residues were all <0.05 mg/kg in the beans, and 0.17 and 0.29 mg/kg in two samples of hulls.

One study involving replicated trials with various application rates was carried out in the USA. Except in one trial, residues in the dried beans were below the LOD of 0.05 mg/kg after 1 or 2 treatments at 0.022-0.34 kg ai/ha 28-43 days after application. In the exceptional trial residues in the dried beans were <0.05, 0.07, 0.16, 0.28 and 0.34 mg/kg from 2 x 0.034 kg ai/ha.

Table 28. Residues of teflubenzuron in soya beans from supervised trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
Brazil, 1989	0.006	0.015	2	21	seed	<0.01	SHGR.90.017A
				30		<0.01	
	0.012	0.030	2	21	seed	<0.01	
				30		<0.01	
Brazil, 1989	0.006	0.015	2	21	seed	<0.01	SHGR.90.017B
				30		<0.01	
	0.012	0.030	2	21	seed	<0.01	
				30		<0.01	
Brazil, 1985	0.012	0.030	1	53	hull	0.17	BRA85I00801
				53	seed	<0.05	
Brazil, 1985	0.036	0.090	1	53	hull	0.29	BRA85I00901
				53	seed	<0.05	
USA, 1987	0.012	0.022	1	47	seed	<0.05	HAS A025.001
	0.012	0.022	1	47		<0.05	
	0.12	0.22	1	47		<0.05	
	0.12	0.22	1	47		<0.05	
	0.015	0.022	1	30	seed	<0.05	
	0.015	0.022	1	30		<0.05	
	0.15	0.22	1	30		<0.05	
	0.15	0.22	1	30		<0.05	
	0.024	0.022	1	43	seed	<0.05	
	0.024	0.022	1	43		<0.05	
	0.24	0.22	1	43		<0.05	
	0.24	0.22	1	43		<0.05	
	0.015	0.022	1	42	seed	<0.05	
	0.015	0.022	1	42		<0.05	
	0.15	0.22	1	42		<0.05	
	0.15	0.22	1	42		<0.05	
	0.12	0.34	1	28	seed	<0.05	
	0.12	0.34	1	28		<0.05	
	0.015	0.034	2	30	seed	0.34	
	0.015	0.034	2	30		0.28	
	0.015	0.034	2	30		0.07	
	0.015	0.034	2	30		0.16	
	0.015	0.034	2	35		<0.05	
	0.018	0.034	2	30	seed	<0.05	
	0.018	0.034	2	30		<0.05	

Potatoes (Table 29). Teflubenzuron is registered for use on potatoes in Germany (1 x 0.045 kg ai/ha),

Italy (1-2 x 0.024 kg ai/ha), Poland (1-2 x 0.038 kg ai/ha), Saudi Arabia (2 x 0.011 kg ai/hl), Spain (1-2 x 0.022 kg ai/ha) and Switzerland (0.038 kg ai/ha). The PHIs range from 14 to 28 days.

Trials on potatoes were conducted in the following countries: 2 in Brazil (4 x 0.06 or 0.12 kg ai/ha), 2 in France (1 x 0.046-0.26 kg ai/ha), 3 in Germany (2 x 0.052 kg ai/ha), 2 in Italy (1 x 0.045 kg ai/ha), 1 in Slovakia (1 x 0.022 kg ai/ha) and 1 study in the USA with replicated applications of 5 x 0.034-0.17 kg ai/ha. No residues above 0.05 mg/kg (LOD) were found in any sample at any PHI (7-79 days).

Table 29. Residues of teflubenzuron in potatoes from supervised trials. Tubers analysed.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Brazil, 1985	0.015	0.06	4	24	<0.05	BRA85I01201
Brazil, 1985	0.030	0.12	4	24	<0.05	BRA85I01501
France, 1984	0.002	0.043	1	49	<0.05	FR8413511
	0.005	0.085	1	49	<0.05	
	0.010	0.17	1	49	<0.05	
	0.015	0.23	1	49	<0.05	
France, 1984		0.03	1	7	<0.05	FR8414521
		0.06	1	7	<0.05	
		0.12	1	7	<0.05	
		0.18	1	7	<0.05	
Germany, 1982	0.01	0.052	2	0	<0.05	C821272
				64	<0.05	
Germany, 1982	0.01	0.052	2	0	<0.05	C82120101
				14	<0.05	
Germany, 1982	0.01	0.052	2	14	<0.05	C82120501
				41	<0.05	
Italy, 1985	0.01	0.045	1	21	<0.05	I84370701
Italy, 1985	0.01	0.045	1	35	<0.05	I84370703
Slovakia, 1987		0.022	1	79	<0.05	CU-88-492
USA, 1987		0.034	5	16	<0.05	HAS A025.001
		0.034	5	16	<0.05	
		0.17	5	16	<0.05	
	0.007	0.034	5	14	<0.05	
	0.007	0.034	5	14	<0.05	
	0.036	0.17	5	14	<0.05	
	0.004	0.034	5	14	<0.05	
	0.017	0.034	5	14	<0.05	
	0.017	0.034	5	14	<0.05	
	0.017	0.034	5	24	<0.05	
	0.017	0.034	5	24	<0.05	
	0.08	0.17	5	24	<0.05	

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
	0.08	0.17	5	24	<0.05	

Cereals. Teflubenzuron is registered for general use on cereals only in Switzerland, with 0.06 kg ai/ha and a PHI of 42 days, but is approved for use on maize in Columbia, Ecuador and Italy, and for sorghum in Columbia and Ecuador: supervised trials were reported only on maize.

Maize (Table 30). GAP in Columbia and Ecuador consists in 2 treatments at 0.045 kg ai/ha, with a PHI of 21 days in Ecuador, and in Italy 2 x 0.15-0.16 kg ai/ha with a PHI of 28 days.

Supervised trials were in France (6), Germany (10), Italy (2) and Slovakia (3). In the French trials (1 x 0.11-0.3 kg ai/ha) the residues were 0.16 to 6 mg/kg in the whole plant and <0.01 or <0.05 mg/kg in the grain 62-108 days after application. In Germany, 1 x 0.15 kg ai/ha gave residues of 0.41-1.9 mg/kg in the whole plant at 28 days and <0.01 or <0.05 mg/kg in the grain at 39-114 days after application. The residues found at 63-75 days in the grain in two Slovakian trials were <0.05 mg/kg. Two trials in Italy with 2 x 0.15 kg ai/ha complied with GAP. At 28 days the residues were 3.6 and 3.9 mg/kg in the whole plant and <0.05 mg/kg in the grain.

Table 30. Residues of teflubenzuron in maize from supervised trials.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
France, 1982	0.051	0.26	1	62	plant	2.0	I82.55.33.01
France, 1982	0.051	0.26	1	74 74	plant grain	3.2 <0.05	I82.55.33.02
France, 1983	0.06	0.3	1	70 84	plant grain	6.0 <0.05	I83.57.34.01
France, 1984	0.023	0.11	1	66 108	plant grain	0.48 <0.05	I84.57.34.02a
France, 1984	0.05	0.15	1	66 108	plant grain	0.51 <0.05	I84.57.34.02b
France, 1984	0.01	0.05	1	101 101	plant grain	0.16 <0.01	FR8460501
France, 1984	0.02	0.10	1	101 101	plant grain	0.53 <0.01	FR8460501
France, 1984	0.03	0.15	1	101 101	plant grain	0.54 <0.01	FR8460501
Germany, 1982	0.025	0.15	1	0 14 28 42 56	plant	3.9 2.1 1.4 1.1 0.90	C821372

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
				70		<0.05	
Germany, 1982	0.025	0.15	1	0 14 28 42 56 71	plant	2.1 1.6 0.70 1.0 0.60 <0.05	C82130501
Germany, 1983	0.015	0.15	1	0 14 28 39 39 69	plant grain	2.6 1.8 1.9 1.9 <0.05 <0.05	C833072
Germany, 1983	0.030	0.15	1	0 14 28 44 49	plant grain	1.4 2.1 1.4 1.4 <0.05	C83300301
Germany, 1983	0.038	0.15	1	0 15 31 45	plant	3.8 3.4 1.8 2.3	C83300401
Germany, 1983	0.019	0.15	1	0 14 28 44 63	plant grain	2.4 1.1 0.92 0.96 <0.05	C83300501
Germany, 1983	0.019	0.15	1	0 14 28 39 51	plant grain	1.6 1.8 1.9 0.58 <0.05	C83300601
Germany, 1986	0.038	0.15	1	0 28 56 111	plant grain	3.2 1.4 0.57 <0.05	C862272
Germany, 1986	0.038	0.15	1	0 25 56 98	plant grain	4.8 1.3 0.62 <0.05	C862205
Germany, 1987	0.038	0.15	1	0 28 56 114	plant grain	3.7 0.41 0.63 <0.01	C871772
Italy, 1984	0.025	0.15	2	0 7 14 21	plant	6.0 5.0 5.5 3.5	I84/38/07/11

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
				28		3.6	
				28	grain	<0.05	
Italy, 1984	0.025	0.15	2	0	plant	5.0	I84/38/07/12
				7		3.7	
				14		3.0	
				21		2.8	
				28		3.9	
				28	grain	<0.05	

Cotton (Table 31). Teflubenzuron is registered for use on cotton in Argentina (2 x 0.011 kg ai/ha, 21-day PHI), Brazil (0.0075-0.1 kg ai/ha, PHI 30 days), Paraguay (2-3 x 0.0075 kg ai/ha, PHI 30 days), Colombia (2 x 0.019 kg ai/ha), Ecuador (2 x 0.019-0.045 kg ai/ha) and Guatemala (2-3 x 0.075 kg ai/ha).

Residue trials were conducted in Brazil (4), Guatemala (2), Mexico (1) and the USA (one study with various rates and concentrations). The residues in the seed were <0.01 mg/kg after 31 days from 2 x 0.03 or 0.06 kg ai/ha in Brazil, and <0.05 mg/kg at 6-8 days from 14-15 x 0.039 kg ai/ha in Guatemala and 12 x 0.06-0.08 kg ai/ha at 18 days in Mexico. In the US trials the residues were <0.05, 0.07, 0.08, 0.11, 0.24 and 13 mg/kg, and 0.78, 3.1 and 4.6 mg/kg after the application of 12 x 0.045 and 12 x 0.45 kg ai/ha, respectively, at 14 or 18 days after treatment.

Table 31. Residues of teflubenzuron in cotton from supervised trials. Seed analysed.

Country, year	Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Brazil, 1989	0.012	0.03	2	31	<0.01	SHGR.90.019
Brazil, 1989	0.024	0.06	2	31	<0.01	SHGR.90.019
Brazil, 1989	0.012	0.03	2	30	<0.01	SHGR.90.019
Brazil, 1989	0.024	0.06	2	30	<0.01	SHGR.90.019
Guatemala, 1984	0.14	0.039	14	6	<0.05	GTM84I00301
Guatemala, 1985	0.14	0.039	15	8	<0.05	GTM85I00101
Mexico, 1984	0.30-0.40	0.06-0.08	12	18	<0.05	MEX84I00101
USA, 1987	0.012	0.045		14	0.11	HAS A025.001
	0.012	0.045		14	0.24	
	0.12	0.45		14	3.1	
	0.048	0.045	12	14	<0.05	
	0.048	0.045	12	14	0.08	
	0.48	0.45	12	14	0.78	
	0.019	0.045	12	18	0.07	
	0.019	0.045	12	18	13	
	0.19	0.45	12	18	4.6	

Coffee beans (Table 32). The only registered uses of teflubenzuron on coffee are in Brazil (0.038 kg ai/ha) and Kenya (1-2 x 0.11 kg ai/ha) at PHIs of 30 days in both countries. In two residue trials in Brazil, 2 applications of 0.075 or 0.15 kg ai/ha gave residues of 0.6 and 1.7 mg/kg respectively, after 35 days.

Table 32. Residues of teflubenzuron in coffee beans from supervised trials, Brazil, 1989.

Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
0.01	0.075	2	35	0.60	SHGR.90.018
0.02	0.15	2	35	1.7	SHGR.90.018

Alfalfa forage and green grass (Table 33). Two supervised trials on alfalfa and one on green grass were carried out in Italy (1 x 0.075 kg ai/ha). The residues in alfalfa forage declined from 1.4 and 2 mg/kg at day 3 to 0.18 and 1.2 mg/kg at day 28 after application, and in grass from 12 mg/kg at day 3 to 0.71 mg/kg at day 28. No information on GAP was available to evaluate the trials.

Table 33. Residues of teflubenzuron in forage (alfalfa and grass) from supervised trials in Italy, 1988. Green forage analysed.

Application kg ai/hl	kg ai/ha	No.	PHI, days	Residues, mg/kg	Report No.
Alfalfa					
0.008	0.075	1	0	4.8	SHGR.89.007
			3	2.0	
			7	1.7	
			14	2.2	
			21	0.06	
			28	0.18	
0.008	0.075	1	0	0.49	SHGR.89.007
			3	1.4	
			7	0.72	
			14	0.48	
			21	0.46	
			28	1.2	
Grass					
0.008	0.075	1	3	12	SHGR.89.008
			7	5.2	
			14	7.4	
			21	1.5	
			28	0.71	

Soya bean forage and hay (Table 34). Teflubenzuron is registered for use on soya beans in Brazil (0.0075-0.023 kg ai/ha) and in Paraguay (2-3 treatments of 0.075 kg ai/ha) with PHIs of 30 days.

Residues were determined in soya bean forage in 8 trials and in hay in 4 in the USA. After applying 1 or 2 x 0.022 kg ai/ha the residues in the forage and hay were 0.17-0.56 and 0.19-1.3 mg/kg respectively at 14 days.

Table 34. Residues of teflubenzuron in soya bean forage and hay from supervised trials in the USA, 1987.

Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
0.012	0.022	1	0	forage	0.97	HAS A025.001
			0		1.1	
			3		0.71	
			3		0.73	
			7		1.0	
			7		0.27	
			14		0.49	
			14		0.30	
0.012	0.022	2	0	forage	0.93	HAS A025.001

Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
			0		1.2	
			3		0.45	
			3		0.31	
			7		0.22	
			7		0.26	
			14		0.36	
			14		0.17	
			0	hay	2.2	
			0		1.7	
			3		1.2	
			3		0.96	
			7		<0.05	
			7		<0.05	
			14		0.08	
			14		0.19	
					0.19	
0.015	0.022	1	0	forage	0.59	HAS A025.001
			0		0.60	
			3		0.53	
			3		0.28	
			7		0.06	
			7		0.66	
			14		0.22	
			14		0.30	
0.015	0.022	2	0	forage	0.61	HAS A025.001
			0		0.66	
			3		1.1	
			3		0.66	
			7		0.50	
			7		1.0	
			14		0.54	
			14		0.51	
			0	hay	0.86	
			0		1.1	
			3		<0.05	
			3		1.8	
			7		1.9	
			7		0.80	
			14		0.91	
			14		0.26	
0.024	0.022	1	0	forage	1.3	HAS A025.001
			0		0.54	
			3		0.44	
			3		0.67	
			7		0.44	
			7		0.46	
			14		0.53	
			14		0.48	
			0	hay	1.0	
			0		2.3	
			3		2.1	
			3		0.17	
			7		1.6	

Application kg ai/hl	kg ai/ha	No.	PHI, days	Sample	Residues, mg/kg	Report No.
			7		2.4	
			14		0.60	
			14		1.3	
0.024	0.022	2	0	forage	0.58	HAS A025.001
			0		0.58	
			3		0.60	
			3		0.34	
			7		0.46	
			7		0.34	
			14		0.34	
			14		0.45	
0.015	0.022	1	0	forage	0.97	HAS A025.001
			0		0.92	
			3		0.98	
			3		0.93	
			7		0.79	
			7		0.86	
			14		0.56	
			14		0.46	
0.015	0.022	2	0	forage	0.67	HAS A025.001
			0		0.76	
			3		0.48	
			3		0.31	
			7		0.28	
			7		0.62	
			14		0.28	
			14		0.41	
			0	hay	0.57	
			0		1.3	
			3		0.77	
			3		0.88	
			7		0.65	
			7		1.6	
			14		0.62	
			14		0.77	

Animal feeding studies

The results of metabolism studies with goats and poultry indicated that teflubenzuron *per se* was the main terminal residue.

Dairy cattle (Table 35). Cameron and Puglis (1989a) fed dairy cows (4/treatment) with teflubenzuron for a period of 28 days with 10 ppm, 30 ppm or 100 ppm in the diet. Three cows in each test group were slaughtered 17-24 h after the final administration. Two additional cows fed at the highest level were maintained on the basal diet for a further 7 or 14 days after the end of dosing to provide data on depletion. Milk samples were taken from three days before administration to termination. Samples of milk and tissues (subcutaneous fat, peritoneal fat, liver, kidney, skeletal muscle) were analysed for residues of teflubenzuron. Liver samples were also analysed for the metabolite E-115, 1-(3,5-dichloro-2,4-difluorophenyl)-3-(2,6-difluoro-3-hydroxybenzoyl)urea.

The results of the analyses are given in Table 35. Low concentrations of teflubenzuron were detected in the liver and/or kidney of some animals. There was no indication of any correlation with the feeding level (or with the withdrawal time in the high-dose group); positive values were found in the liver of one control animal and the kidney of another. All residues were below 0.05 mg/kg. Residues of the metabolite E-115 in liver samples were <0.05 mg/kg (LOD).

Peritoneal fat contained only low residues of teflubenzuron (all <0.03 mg/kg). Two positive samples were from the control group. There was little evidence of any dose-related trend. Residue concentrations at or close to the LOD (0.01 mg/kg) were recorded in subcutaneous fat in the high-dose group. No residues were found in any muscle or milk samples (<0.01 mg/kg).

Table 35. Residues in dairy cattle dosed with teflubenzuron (Cameron and Puglis, 1989a).

Group	Cow	Teflubenzuron, mg/kg					
		Kidney	Liver	Muscle	Peritoneal fat	Subcutaneous fat	Milk
A (control)	1	0.015	<0.01	<0.01	0.026	<0.01	<0.01
	2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	3	<0.01	0.017	<0.01	0.024	<0.01	<0.01
B (10 ppm)	4	0.018	0.025	<0.01	0.015	<0.01	<0.01
	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	6	<0.01	<0.01	<0.01	0.028	<0.01	<0.01
C (30 ppm)	7	<0.01	<0.01	<0.01	0.015	<0.01	<0.01
	8	<0.01	<0.01	<0.01	0.017	<0.01	<0.01
	9	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
D (100 ppm)	10	<0.01	<0.01	<0.01	0.011	0.01	<0.01
	11	<0.01	<0.01	<0.01	0.015	<0.01	<0.01
	12	0.017	<0.01	<0.01	0.015	<0.01	<0.01
7 days withdrawal	13	0.041	<0.01	<0.01	0.016	<0.01	<0.01
14 days withdrawal	14	<0.01	<0.01	<0.01	0.020	0.016	<0.01

Poultry (Tables 36 and 37). Groups of ten domestic hens were fed teflubenzuron at levels of 0.5 or 1.5 ppm and a group of 30 at 5 ppm in the diet for 28 days by Cameron and Puglis (1989b). An 18-day acclimatization period was followed by a 28-day treatment period and 7- and 14-day withdrawal periods (two groups of birds treated with 5 ppm). Eggs were collected for analysis. On day 28 ten hens from each group were slaughtered and the remaining hens in the highest dose group placed on a residue-free diet and slaughtered 7 or 14 days later. Samples of eggs and tissues were analysed for teflubenzuron and liver samples also for the metabolite 1-(3,5-dichloro-2,4-difluorophenyl)-3-(2,6-difluoro-3-hydroxybenzoyl)urea (E-115).

Table 36 shows the results of the analyses of eggs. Residues of teflubenzuron were detected in all treated groups and a dose-related trend was observed. Residues above the LOD (0.01 mg/kg) were first measured at day 14 in the 0.5 and 1.5 ppm groups and at day 3 in the high-dose group. Residues in the highest dose group declined during the withdrawal period and

were below the LOD after 42 days .

Table 36. Residues of teflubenzuron in eggs (Cameron and Puglis, 1989b).

Day	Teflubenzuron, mg/kg			
	Dose group A (control)	Dose group B (0.5 ppm)	Dose group C (1.5 ppm)	Dose group D (5 ppm)
-1	<0.01	<0.01	<0.01	<0.01
3	-	-	-	0.03
5	-	-	-	0.11
7	<0.01	<0.01	<0.01	0.14
10	-	-	-	0.16
14	<0.01	0.04	0.06	0.28
17	-	-	-	0.29
21	<0.01	0.03	0.08	0.20
24	-	-	-	0.29
26	-	-	-	0.30
28	<0.01	0.03	0.08	0.22
30	-	-	-	0.17
35	-	-	-	0.08
42	-	-	-	<0.01

The results of the tissue analyses are given in Table 37. Teflubenzuron was found in all types of tissue analysed, at levels which increased with the dose. The highest concentrations occurred in abdominal fat (0.7 mg/kg in the highest dose group).

The results indicated that residues of teflubenzuron in the liver persisted after 7 or 14 days withdrawal, although it should be noted that high residues were found in the livers of control birds as well. In other tissues residues of teflubenzuron declined when treatment was stopped. Residues of the metabolite E-115 in liver samples were below the LOD (<0.05 mg/kg).

Table 37. Residues in hens dosed with teflubenzuron (Cameron and Puglis, 1989b).

Group	Teflubenzuron, mg/kg, mean				
	Kidney	Liver	Muscle	Abdominal fat	Subcutaneous fat (skin + underlying fat)
A (control)	-	0.37	<0.01	<0.01	<0.01
B (0.5 ppm)	0.015	0.041	<0.01	0.077	0.028
C (1.5 ppm)	0.016	0.043	0.014	0.23	0.081
D (5 ppm)	0.036	0.081	0.038	0.70	0.32
7 days withdrawal	<0.01	0.086	<0.01	0.016	<0.01
14 days withdrawal	0.014	0.092	<0.01	<0.01	<0.01

FATE OF RESIDUES IN STORAGE AND PROCESSING

In processing

The results of processing studies are summarized in Table 38.

Apples. Processing studies were carried out in the USA and Germany. In one of the two US trials residues were found in whole fruit and wet pomace, and were concentrated in dry pomace; residues in juice were <0.05 mg/kg. At a fivefold application rate residues of 0.06-0.07 mg/kg were found in juice. In Germany residues were found in the whole fruit and washed whole fruit, and were concentrated in pomace and further concentrated in dried apples. Residues were lowered in apple sauce and below the LOD (<0.01 mg/kg) in juice.

Plums and cherries. Plums were processed to jam and dried prunes in a study in Germany. Residues were <0.01 mg/kg in destoned fruit and jam, and low (0.02 mg/kg) in prunes.

Cherries treated twice with teflubenzuron at a rate of 0.16 kg ai/ha were processed into preserve, jam and juice. Residues in these commodities were respectively 0.4, 0.3 and 0.7 times those in the unprocessed fruit and ranged from 0.12 to 0.21 mg/kg.

Grapes. Grapes were used to make juice and wine in Germany. The residues in the grapes were 0.12-0.26 mg/kg, but no residues were measurable in any of the corresponding juice or wine samples where the LOD was 0.01 or 0.05 mg/kg.

Potatoes. In two studies in the USA potatoes were treated 5 times at 0.034 or 0.17 kg ai/ha and processed to chips and French fries. Residues were <0.05 mg/kg in all samples from the lower rate. After the fivefold application rate, residues were still <0.05 mg/kg in tubers and chips, and <0.05 and 0.1 mg/kg in fries.

Soya beans. A single processing study was carried out on soya beans in the USA. Beans were treated once with 0.34 kg ai/ha and sampled 28 days after treatment. The residues were <0.05 mg/kg in the unprocessed seeds, beans and hulls, and 0.08 mg/kg in the meat. After processing to the oils, the residue in crude oil was <0.05 mg/kg, in refined oil 0.06 mg/kg and in refined bleached oil <0.05 and 0.14 mg/kg.

Cotton seed. Three processing studies were conducted in Guatemala and Mexico. Cotton plants were treated 12-15 times with teflubenzuron at rates of 0.039 to 0.08 kg ai/ha. The residues of teflubenzuron in the seeds, refined oil and presscake were below the LOD (<0.01 or <0.05 mg/kg). Fibre contained residues between 0.25 and 2.1 mg/kg and residues in the raw oil were at or below the LOD of 0.1 mg/kg.

Tomatoes. A study was carried out in the USA. The residues in the raw tomatoes were not given so transfer factors could not be derived, but residues in the juice were below the LOD (0.05 mg/kg) and the concentrate and the purée contained residues between 0.07 and 0.11 mg/kg. The highest residues were in the pomace at 0.94-1.2 mg/kg.

Table 38. Residues of teflubenzuron in processed commodities.

Commodity Country	Rate, kg ai/ha	No. of applications	PHI, days	Sample	Residues, mg/kg	Report No.
Apples	0.11	4	30	fruit	0.1	HAS A025.001

Commodity Country	Rate, kg ai/ha	No. of applications	PHI, days	Sample	Residues, mg/kg	Report No.
USA				fruit wet pomace wet pomace juice juice dry pomace dry pomace	0.1 0.13 0.16 <0.05 <0.05 2.5 1.9	
Apples USA	0.56	4	30	fruit fruit wet pomace wet pomace juice juice dry pomace dry pomace	<0.05 <0.05 0.4 0.51 0.07 0.06 6.2 5.8	HAS A025.001
Apple Germany	0.16	3	14	fruit washed fruit juice pomace sauce dried apples	0.12 0.19 <0.01 0.46 0.03 1.4	SHE-9308
Plums Germany	0.16	2	21	fruit destoned jam prunes	<0.01 <0.01 0.02	SHTR.93.009
Cherries Germany	0.16	2	21	fruit destoned preserve juice jam	0.31 0.12 0.21 0.1	SHTR.93.010
Grapes Germany	0.18	2	42	fruit juice wine	0.12 <0.05 <0.05	C 82 14 72
Grapes Germany	0.16/2.0	1/1	35	fruit juice wine	0.26 <0.01 <0.01	C 83 27 72
Grapes Germany	0.16/2.0	1/1	56	fruit juice wine	0.16 <0.01 <0.01	C 83 27 03 01
Potatoes USA	0.034	5	24	tuber tuber chips chips french fries french fries	<0.05 <0.05 <0.05 <0.05 <0.05 <0.05	HAS A025.001
Potatoes USA	0.17	5	24	tuber tuber chips	<0.05 <0.05 <0.05	HAS A025.001

Commodity Country	Rate, kg ai/ha	No. of applications	PHI, days	Sample	Residues, mg/kg	Report No.
				chips french fries french fries	<0.05 0.1 <0.05	
Soya beans USA	0.34	1	28	seeds beans hulls meat crude oil refined oil refined bleached oil refined bleached oil	<0.05 <0.05 <0.05 0.08 <0.05 0.06 <0.05 0.14	HAS A025.001
Cotton Guatemala	0.039	14	6	seeds raw oil refined oil presscake fibre	<0.05 <0.1 <0.1 <0.05 0.93	GTM84100301
Cotton Guatemala	0.039	15	8	seeds raw oil refined oil presscake fibre	<0.05 <0.1 <0.1 <0.05 2.1	GTM85100101
Cotton Mexico	0.06-0.08	12	18	seeds raw oil refined oil presscake fibre	<0.05 0.1 <0.1 <0.05 0.25	MEX84100101
Tomatoes USA	0.056	5	0	concentrate concentrate pomace pomace juice juice puree puree	0.1 0.11 1.2 0.94 <0.05 <0.05 0.07 0.08	HAS A025.001

RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

No information was available.

NATIONAL MAXIMUM RESIDUE LIMITS

The following national MRLs were reported to the Meeting.

Residue definition: teflubenzuron.

Country	Commodity	MRL, mg/kg
Belgium	Mushrooms	0.05
Brazil	Coffee beans	0.5
	Cotton	0.01
	Soya bean	0.01
	Tomato	0.1
France	Apple	0.5
	Pear	0.5
	Quince	0.5
Germany	Berries (wild)	0.2
	Mushrooms (wild)	0.2
	Orange	0.5
	Other plant commodities	0.05
	Pome fruits	1
Italy	Apple	1
	Cabbage	0.5
	Egg plant	0.5
	Grapes (wine)	1 (0.01)
	Maize (grain)	0.1
	Mushrooms	0.2
	Nectarine	1
	Peach	1
	Pear	1
	Peppers	0.5
	Potato	0.1
Kenya	Coffee beans	0.5
Netherlands	Apple	0.5
	Broccoli	0.05
	Brussels sprouts	0.5
	Cabbage, Red	0.05
	Cabbage, White	0.05

Country	Commodity	MRL, mg/kg
	Chinese cabbage	0.5
	Cauliflower	0.05
	Cucumber	0.2
	Cucurbits	0.2
	Egg plant	0.5
	Gherkin	0.2
	Melon	0.2
	Pear	0.5
	Peppers	0.5
	Squash, Summer	0.2
	Tomato	0.5
Spain	Apple	0.5
	Cucumber	0.2
	Cucurbits	0.2
	Egg plant	0.5
	Grapes	0.5
	Pear	0.5
	Peppers	0.5
	Potato	0.05
	Tomato	0.5
Switzerland	Apple	0.3
	Cabbage	0.05
	Cabbage, Savoy	0.05
	Cereal grains	0.05
	Grapes	0.3
	Pear	0.3
	Potato	0.05
	Stone fruits	0.3
South Africa	Citrus fruits	0.5
	Lychee	0.5

APPRAISAL

Teflubenzuron is an acylurea insecticide whose major use is for the control of a wide range of insect pests (*lepidopterous* and *coleopterous* larvae being most sensitive) and some mites in fruits, vegetables, cereals, nuts and seeds. At the request of the manufacturer, the compound was removed from the review schedule of the FAO Panel of the 1994 JMPR and its residue aspects were reviewed for the first time by the present Meeting.

Teflubenzuron is formulated as suspension concentrates containing 50 or 150 g ai/l. The active ingredient is a crystalline solid, virtually insoluble in water, soluble in medium-polarity solvents, not hydrolysed at pH 5 but hydrolysed at room temperature and pH 7 and 9 with half-lives of 8 months and 8 days respectively.

The fate of residues has been studied in animals, plants and soil.

Studies on rats, lactating goats and laying hens showed poor absorption from the gastrointestinal tract, rapid elimination mainly in the faeces or excreta, excretion largely as the unchanged parent compound, and in the case of goats no accumulation in any organ or tissue, or milk.

In goats and hens, 96-99% of administered doses were eliminated in the faeces or excreta and most of the radioactivity was associated with the parent compound. That portion of a dose which is absorbed appears to be metabolized in the liver and conjugated before elimination, mainly in the bile. In hens only, the absorbed fraction appears to be passed into body tissues, especially fatty tissues and egg yolk. The major part of the residue in fat and egg yolk was identified as teflubenzuron. The elimination of radioactivity in the milk of goats accounted for 0.03% of the total administered dose.

Studies of plant metabolism with foliar applications of teflubenzuron to apple trees, potato plants and cotton plants have shown that the insecticide does not penetrate into leaves, fruit or potato tubers. More than 98% of the extractable radioactivity was in the unchanged compound and was situated on the surface of the treated plant part. It was concluded that there is no systemic transport and no metabolism.

In a study on spinach, the residue was also almost all (99%) on the surface. The parent compound amounted to 95% of the total radioactive residue at day 0 and 77% at day 15. The fact that the radioactivity was almost completely removed by surface extraction indicates that any significant degradation is photolytic rather than metabolic.

Investigation of the degradation of teflubenzuron in soil showed that microbiological activity is of primary importance. In very humic soil degradation was more rapid than in sandy loam, with a half-life of two weeks in humic sand and six weeks in sandy loam soil. In sandy loam, teflubenzuron was degraded about six times as rapidly under anaerobic as under aerobic conditions.

Under both aerobic and anaerobic conditions, 3,5-dichloro-2,4-difluorophenylurea and 3,5-dichloro-2,4-difluoroaniline were the major products.

The adsorption and desorption of teflubenzuron was studied in four different types of soil. It was found that sand adsorbed 96.9%, sandy loam 98.8%, silt loam 99.1%, and clay loam 99.4% of the amount dissolved in the aqueous control sample after a 6-h contact period, and 6.1%, 3.7%, 1.3%

and 1.3% of the adsorbed radioactivity respectively could be desorbed again during two desorption periods of 24 h each.

Teflubenzuron itself shows practically no tendency to migrate once it is applied to soil. This is attributable to the very low solubility of the compound in water, very slight leaching and high adsorption to all types of soil tested.

Residues were not significant in rotational crops. After applying [^{14}C]teflubenzuron (0.5 kg ai/ha) and ageing the soil for 30, 120 or 360 days, the total radioactive residues expressed as teflubenzuron equivalents were 0.007, 0.006 and 0.002 mg/kg in head lettuce, 0.005, 0.003 and 0.002 mg/kg in wheat grain, 0.24, 0.088 and 0.035 mg/kg in wheat straw, and 0.026, 0.013 and 0.005 mg/kg in carrots. The results show that rotational crops, with the exception of cereal straw, will not contain residues above 0.05 mg/kg.

The biodegradation of [^{14}C]teflubenzuron was determined in two water/sediment systems. The half-life was 6-7 weeks. Two major degradation products were found; one was identified as 3,5-dichloro-2,4-difluorophenylurea.

Analytical methods are available for the determination of teflubenzuron residues in plant and animal materials, soil, water and air. Teflubenzuron is extracted from plants with acetone, from soil with an acetone/water mixture and from animal products such as muscle, liver, kidney, fat, skin, milk and eggs with acetonitrile or methanol. It is extracted from water on a C_{18}-"Bondelut" solid-phase column. Clean-up is carried out by solvent partition followed by gel-permeation chromatography and/or silica gel column chromatography. The residue is determined by reversed-phase HPLC with ultraviolet detection at 254 nm or by capillary gas chromatography with mass-selective detection. The limits of determination were 0.01 mg/kg in plants, soil and animal products and 0.0001 mg/l in water. In some supervised trials (e.g. on potatoes), an analytical method with an LOD of 0.05 mg/kg was used. For the analysis of air, the air is sucked through a Tenax or XAD column and the adsorbed teflubenzuron is eluted and determined by reversed-phase HPLC with UV detection or by GLC with a mass-selective detector as a confirmatory method. The LOD was 10 µg/m^3. The stability of stored analytical samples of teflubenzuron in apples, pears, potatoes and cabbage was investigated over a 3-year period. Losses of the insecticide were from about 6% from cabbage to 25% from apples.

Because the residues in plants and animal products are generally mostly the parent compound, the Meeting concluded that for both regulatory and risk assessment purposes the residue should be defined as teflubenzuron. The log P_{OW} of 4.56 and the results of a feeding study on laying hens, with residues in eggs and fat, indicate the fat-soluble nature of teflubenzuron. In contrast to the results with hens, a feeding study on dairy cattle showed little or no transfer of the pesticide from animal feed in milk, fat and tissues.

Definition of the residue for compliance with MRLs and for estimation of dietary intake: teflubenzuron

The residue is fat-soluble.

Supervised residue trials gave the following results.

Citrus fruits. The use of teflubenzuron is registered in the United Arab Emirates and South Africa, where 1-2 treatments with a spray concentration of 0.0038 or 0.003 kg ai/hl and PHIs of 7 or 30 days are recommended respectively. In Saudi Arabian GAP the spray concentration is 0.011 kg ai/hl with

a 21-day PHI. In total, 20 supervised trials were carried out in Brazil, South Africa and the USA.

The whole fruit was analysed only in three US trials (one on grapefruit, two on oranges) but there is no registered use in the USA. No residue was found in the whole fruit (<0.05 mg/kg), 45 and 76 days after three spray treatments (0.005-0.006 kg ai/hl, 0.11 kg ai/ha).

One trial in Brazil and three in South Africa approximated South African GAP. The residues were <0.01, <0.05 (2) and 0.1 mg/kg in the pulp and 0.24, 0.26, 0.34 and 0.47 mg/kg in the peel at PHIs of 25-35 days. In three trials, samples were also analysed after 6 or 7 days, the PHI in the United Arab Emirates. The residues were all <0.05 mg/kg in the pulp and 0.36, 0.37 and 0.39 mg/kg in the peel. Calculation of the residues in the whole fruit was not possible because no further data were reported.

The Meeting concluded that no acceptable residue data on a whole fruit basis had been submitted and could not estimate a maximum residue level for teflubenzuron in citrus fruits.

Pome fruits. Teflubenzuron is registered for use on apples and pears in Europe (France, Greece, Italy, The Netherlands, Poland, Portugal, Spain, Switzerland), Africa (Jordan, The United Arab Emirates) and Argentina (apples only).

The residue data after 1-4 treatments of apples with 0.11-0.21 kg ai/ha (0.011 kg ai/hl) at PHIs of 24-28 days in Germany and the UK could be related to Dutch GAP (1-3 x 0.11-0.16 kg ai/ha, 0.011 kg ai/hl, 28-day PHI). The residues in ten German and two UK trials were 0.05, 0.09, 0.11, 0.19 (2), 0.23 (2), 0.24, 0.27, 0.29, 0.36 and 0.37 mg/kg.

The Italian trials on apples were evaluated with reference to the Southern European GAP (Italy, Greece and Switzerland). Two trials approximated Italian GAP with 1-3 treatments of 0.15-0.16 kg ai/ha and a PHI of 14 days. The residues were 0.23 and 0.27 mg/kg. Two other trials with 2 treatments at 0.24-0.27 kg ai/ha were close to Greek GAP (2-3 treatments, 0.21 kg ai/ha, 30-day PHI) and resulted in residues of 0.45 and 0.51 mg/kg after 28 days.

Swiss GAP (2-3 treatments, 0.3 kg ai/ha, 21-day PHI) was approximated by one Italian trial on apples and three on pears (2-3 treatments with 0.24-0.27 kg ai/ha, 21-day PHI). The residues were 0.65 mg/kg in apples, and 0.43, 0.6 and 0.71 mg/kg in pears.

Many residue trials on apples and pears were conducted in France, but they did not accord with French or other European GAP. No GAP was available for the USA so the results could not be evaluated.

The Meeting estimated a maximum residue level of 1 mg/kg for teflubenzuron in pome fruits.

The teflubenzuron residues in apples in rank order in the German and UK trials were 0.05, 0.09, 0.11, 0.19 (2), 0.23 (2), 0.24, 0.27, 0.29, 0.36 and 0.37 mg/kg. The residues from trials on apples and pears in Southern Europe belonged to another population: 0.23, 0.27, 0.43, 0.45, 0.51, 0.6, 0.65 and 0.71 mg/kg. The Meeting therefore estimated an STMR level of 0.48 mg/kg for teflubenzuron in pome fruits.

Stone fruits. Teflubenzuron is registered in Switzerland for stone fruits, in Italy for peaches and nectarines, and in Saudi Arabia for peaches with 1-3 treatments of 0.11-0.12 kg ai/ha and a 21-day PHI. In Poland, one treatment of 0.11 kg ai/ha and a PHI of 28 days are recommended for orchards.

Three German trials on cherries with 2 x 0.16 kg ai/ha, approximately Swiss GAP, resulted in residues of 0.24 (2) and 0.25 mg/kg.

The Meeting concluded that there were not enough data to estimate a maximum residue level for teflubenzuron in cherries.

Trials on plums which approximated Swiss GAP were available from Germany (5) and Italy (6). After two applications of 0.16 kg ai/ha in Germany residues of teflubenzuron in samples taken at day 21 were <0.01 (2), 0.01 and 0.04 (2) mg/kg. After two applications of 0.12 kg ai/ha in Italy the residues at 21-30 days were 0.03 (2), 0.04 (2) and 0.08 (2) mg/kg.

The Meeting estimated a maximum residue level of 0.1 mg/kg for teflubenzuron in plums.

The residues from all the relevant trials in rank order were <0.01 (2), 0.01, 0.03 (2), 0.04 (4) and 0.08 (2) mg/kg, with a median value of 0.04 mg/kg. The Meeting estimated an STMR level of 0.04 mg/kg for teflubenzuron in plums.

Two trials on nectarines were carried out in Italy. After two applications of 0.12 kg ai/ha the residues in the fruits were 0.08 mg/kg and 0.04 mg/kg at 35 and 56 days after the last treatment respectively. No information on residues at the approved PHI of 21 days was available.

In eight trials in France and two in Italy peaches were treated 1-6 times with 0.1-0.19 kg ai/ha. Four trials with 2-3 x 0.1 kg ai/ha approximated Italian and Swiss GAP and resulted in residues of 0.1, 0.13, 0.24 and 0.34 mg/kg at 20-24 days.

The Meeting could not estimate a maximum residue level for teflubenzuron in nectarines and peaches because there were insufficient data from trials according to GAP.

Berries and other small fruits. The only registered uses of teflubenzuron on berries are on grapes with 2 x 0.09-0.096 kg ai/ha in Italy, Spain (both PHIs 28 days) and Switzerland (PHI 21 days), and 2 x 0.011 kg ai/hl and a 21-day PHI in Saudi Arabia.

Trials on grapes were conducted in France, Germany and Italy between 1982 and 1984. In the 10 French trials, grapes were treated once at rates of 0.1-0.3 kg ai/ha. Residues of teflubenzuron 58-77 days after treatment ranged from <0.05 to 0.86 mg/kg. In the 5 German trials, two treatments of 0.15-0.23 kg ai/ha gave residues 21 days after the last treatment between 0.08 and 0.23 mg/kg. Residues in 5 Italian trials with 1-3 treatments of 0.18-0.27 kg ai/ha were <0.05-2.1 mg/kg at 28 days. Generally the application rates in the trials were much higher than the rates close to 0.1 kg ai/ha permitted by GAP, or the PHI was excessive.

The Meeting concluded that since no data were provided from trials according to GAP it could not estimate a maximum residue level for teflubenzuron in grapes.

Uses on other berries are not registered but eight German trials on wild raspberries, blackberries and blueberries were reported. In Germany, teflubenzuron is registered for use in the forest against larvae of *Tenthredinidae spp.* and free-eating caterpillars (1 x 0.023 kg ai/ha). As result of this, wild berries and fruits are treated unintentionally. The worst case was simulated by application of approximately twice the approved rate (0.045 kg ai/ha). In raspberries and

blackberries, the residues were <0.05 (2), 0.06 (2) and 0.09 mg/kg, ≤0.05 (4) and 0.08 mg/kg, and ≤0.05 (4) and 0.05 mg/kg at 0, 2 or 3, and 7 days respectively. The residues in blueberries in three trials, which appeared to be from a different population, were 0.08, 0.09 and 0.1 mg/kg, 0.11 (2) and 0.12 mg/kg, and 0.05, 0.06 and 0.07 mg/kg at 0, 2 and 7 days.

The Meeting accepted that there was an indirect use on wild berries, but because the data were limited and the commodities are not in international trade it did not estimate maximum residue levels for teflubenzuron on wild raspberries, blackberries or blueberries.

Persimmons. Data were available from a group of 5 trials in Korea. Persimmons were treated 2-6 times with 0.25 kg ai/ha. Residues in samples taken 3-45 days after the last treatment were 0.02-0.09 mg/kg. No GAP was available to evaluate the trials.

Kiwifruit. Four residue trials were carried out in New Zealand. The application rates were 0.094, 0.19 and 0.25 kg ai/ha. Residues determined in whole fruit 16 and 99 days after the final application were 0.23-3.6 mg/kg and 0.28 mg/kg respectively. No GAP was available to evaluate the trials.

Head cabbages. There are registered uses on red, white and Savoy cabbage in Germany (1 x 0.06 kg ai/ha, 14-day PHI), on red and white cabbage in The Netherlands (2-4 x 0.06 kg ai/ha, 14-day PHI), and on head cabbages in Indonesia (0.025 kg ai/ha, no further information), Italy (1 x 0.03 kg ai/ha, 7-day PHI), Jordan (2 x 0.0075 kg ai/hl, 14-day PHI), Poland (1 x 0.03 kg ai/ha, 14-day PHI) and Switzerland (1 x 0.045 kg ai/ha, 14-day PHI).

Four US trials on white and red cabbage, each with analyses of duplicate samples with and without wrapper leaves, were reported. Residues after applying 6 x 0.045 kg ai/ha were <0.05-0.36 mg/kg in samples with wrapper leaves and <0.05-0.11 mg/kg without wrapper leaves 14 days after treatment. One trial was carried out in Malaysia and one in the Philippines. After applying 6 or 9 x 0.045 kg ai/ha, residues were <0.05 mg/kg after 18 and 7 days respectively. In two trials in Brazil (1 x 0.015 kg ai/ha, 1 x 0.03 kg ai/ha) residues were <0.01 mg/kg 3 or 7 days after treatment. No information on GAP was available for the USA, Brazil, Malaysia or the Philippines with which to evaluate the data from the trials in these countries.

Ten trials on Savoy cabbage were conducted in Germany, 1982-1985. After applying 3 x 0.06 kg ai/ha, all residues were <0.05 mg/kg at the recommended PHI of 14 days. Residues in two UK trials on Savoy cabbage treated once according to German GAP with 0.06 kg ai/ha were 0.05 and 0.17 mg/kg at 14 days.

The Meeting estimated a maximum residue level of 0.2 mg/kg for teflubenzuron in head cabbages.

The teflubenzuron residues in the ten German and two UK trials in rank order were <0.05 (10), 0.05 and 0.17 mg/kg. The median residue was below the LOD (0.05 mg/kg). The Meeting estimated an STMR level of 0.05 mg/kg.

Broccoli. Teflubenzuron is registered for use on broccoli in The Netherlands with 2-4 treatments of 0.06 kg ai/ha and a PHI of 14 days.

Two German trials according to Dutch GAP were reported. The residues were 0.13 and 0.19 mg/kg at day 14.

The Meeting concluded that insufficient data were available to estimate a maximum residue level for teflubenzuron in broccoli.

Brussels sprouts. Teflubenzuron is registered in The Netherlands, where 6-8 treatments of 0.09 kg ai/ha with a PHI of 14 days are recommended.

Eight residue trials were conducted in The Netherlands with 4, 5 or 6 applications, four at 0.06 and four at 0.09 kg ai/ha. After treatment with 0.09 kg ai/ha, the residues were 0.12 to 0.48 mg/kg at 14 days. The residues after 14 days in the 4 trials with 0.06 kg ai/ha were of the same order, 0.1-0.28 mg/kg, and support the conclusion that a maximum residue level of 0.5 mg/kg is appropriate. The residues in rank order were 0.1, 0.12, 0.15, 0.18, 0.24, 0.28, 0.39 and 0.48 mg/kg, giving a median of 0.21 mg/kg.

The Meeting estimated an STMR level of 0.21 mg/kg and a maximum residue level of 0.5 mg/kg for Brussels sprouts.

Cucumbers. Teflubenzuron is registered for field and glasshouse uses on cucurbits in Spain (2-3 x 0.18 kg ai/ha, 3-day PHI), for glasshouse use on cucumbers and gherkins in The Netherlands (3-5 x 0.23 kg ai/ha, 3-day PHI), for field treatments of cucumbers and gherkins (2 x 0.0075 kg ai/hl, 3-day PHI) in Jordan, and for field use on cucumbers with 2 x 0.011 kg ai/hl in Saudi Arabia.

Three indoor trials were carried out in Germany. The residues after 3 days were 0.03 and 0.07 mg/kg from approximately 3 x 0.09 kg ai/ha, and 0.14 mg/kg from 3 x 0.18 kg. In two field trials in Italy, where 3 x 0.075 kg ai/ha were applied, the residues after 3 days were 0.02 and 0.19 mg/kg.

The Meeting concluded that there were insufficient data from trials according to GAP to estimate a maximum residue level for teflubenzuron in cucumbers.

Peppers. Teflubenzuron is registered for field use on sweet peppers in Italy (1-2 x 0.08 kg ai/ha, 10-day PHI), Jordan (2 x 0.0075 kg ai/hl), Saudi Arabia (2 x 0.011 kg ai/hl) and Spain (2-3 x 0.18 kg ai/hl, 3-day PHI), and on chilli peppers in Indonesia at 0.1 kg ai/ha. Glasshouse use on sweet peppers is registered in The Netherlands with 3-5 applications and in Spain with 2 or 3 applications of 0.23 kg ai/ha and a PHI of 3 days.

The Meeting reviewed 6 trials from Italy, 4 of them (all in 1988) according to Italian GAP with 1 treatment of 0.075 kg ai/ha. The residues were 0.09, 0.1 and 0.11 mg/kg (2) 10 days after application.

Trials were reported from Korea but no information on GAP was available for their evaluation.

The Meeting concluded that only 4 trials according to GAP, carried out in one year, were insufficient to estimate a maximum residue level for peppers, which are a major crop.

Egg plants. Teflubenzuron is registered for field use on egg plants in Italy with 1-2 x 0.022-0.024 kg ai/ha, 10-day PHI. The GAP for field use in Jordan, Saudi Arabia and Spain, and for glasshouse use in The Netherlands and Spain, is the same as for sweet peppers.

The Meeting reviewed 6 outdoor trials from Italy. In four of them which complied with Italian GAP with 1 treatment at 0.023 kg ai/ha the residues were all <0.01 mg/kg 10 days after application. No residue data were available for glasshouse use.

The Meeting concluded that the data were insufficient to estimate a maximum residue level.

Tomatoes. Teflubenzuron is currently registered for glasshouse use in The Netherlands (3-5 x 0.23 kg ai/ha, 3-day PHI), and for glasshouse and field use in Spain (2-3 x 0.18-0.23 kg ai/ha, 3-day PHI). In Brazil and Paraguay, 5-8 field treatments at 0.038 kg ai/ha with a PHI of 7 days are recommended. Further registered field uses exist in Argentina, Colombia, Ecuador, and Jordan.

Four trials were carried out in the USA. Residues from <0.05 to 0.1 mg/kg were found 3 days after treatment with 5 x 0.028-0.056 kg ai/ha. No information on GAP was available for the USA with which to evaluate the data.

Two of 6 field trials in Brazil, with 5 x 0.045 kg ai/ha, approximated GAP and resulted in residues of 0.05 and 0.06 mg/kg 6 days after treatment, two trials at twice this rate gave residues of 0.08 and 0.15 mg/kg, and in the third pair of trials (3 x 0.03 kg ai/ha) 0.1 and 0.12 mg/kg were found at 7 days. Two Italian field trials at 4 x 0.075 kg ai/ha, with residues of 0.1 and 0.28 mg/kg at day 2, could not be evaluated against Spanish GAP because the rate was too low.

Three indoor trials with 3 or 4 treatments at 0.09-0.17 kg ai/ha were reported from Germany, but there are no registered uses there. One of them could be evaluated against Dutch GAP and showed a residue of 0.47 mg/kg 3 days after application. Two of three UK trials at 4 x 0.17 kg ai/ha, 5 x 1.14-1.17 kg ai/ha, and 5 x 0.23 kg ai/ha approximated Dutch and Spanish glasshouse uses and showed residues of 0.2 and 0.36 mg/kg 3 days after treatment.

The Meeting concluded that there were insufficient data from trials according to GAP for field and glasshouse uses to estimate a maximum residue level for teflubenzuron in tomatoes.

Mushrooms. Uses on cultivated mushrooms exist in Belgium (3 kg ai/ha, 14-day PHI) and Italy (1 x 4.8-6 kg ai/ha, 45-day PHI).

One trial with four replicated plots of cultivated mushrooms was conducted in The Netherlands. The residues were all <0.05 mg/kg 25 days after applying 2 x 4.9 kg ai/ha.

The Meeting concluded that the data from trials according to GAP were insufficient to estimate a maximum residue level for teflubenzuron in cultivated mushrooms.

In 3 trials on wild mushrooms in Germany with 1 x 0.045 kg ai/ha the residues on days 0, 1 and 2 were all <0.05 mg/kg in two trials and 0.07, 0.07 and 0.05 mg/kg respectively in the third.

The Meeting accepted that there was an indirect use on wild mushrooms from the German use of teflubenzuron in forests (1 x 0.023 kg ai/ha), but because the data were limited and wild mushrooms are not in international trade it did not estimate a maximum residue level for wild mushrooms.

Chinese cabbage. Teflubenzuron is currently registered only in The Netherlands. It is recommended for field use at a rate of 0.06 kg ai/ha 2-4 times a season with a PHI of 14 days.

Two trials were carried out in the Netherlands. After applying 1 x 0.06 or 0.09 kg ai/ha the residues were 0.22 and 0.31 mg/kg at day 14.

Trials were also conducted in Malaysia and the Philippines but no information on GAP for Asian countries was available from which to evaluate the results.

The Meeting concluded that there were insufficient data from trials according to GAP to estimate a maximum residue level.

Peas. One trial with 2 x 0.045 kg ai/hl was conducted in France. The residues were 0.19 mg/kg in peas with pods and <0.05 mg/kg in the peas after 21 days. No information on GAP was available to evaluate the trial.

Soya beans. Teflubenzuron is registered for the use on soya beans in Brazil (0.0075-0.023 kg ai/ha) and Paraguay (2-3 x 0.0075 kg ai/ha) with PHIs of 30 days.

Six trials were carried out in Brazil (1-2 x 0.015-0.09 kg ai/ha). Four of them (2 x 0.015-0.03 kg ai/ha) were within the wide range of Brazilian GAP but were at only 2 sites. The residues were <0.01 mg/kg 30 days after treatment.

One study with replicated trials at various application rates was carried out in the USA. Residues in the seeds after 2 treatments with 0.034 kg ai/ha (0.015 kg ai/hl) and a PHI of 30 days were <0.05-0.34 mg/kg. No information on relevant GAP was available.

The Meeting concluded that the data from trials according to GAP were insufficient to estimate a maximum residue level for teflubenzuron in soya beans, a major crop.

Potatoes. Teflubenzuron is registered for use on potatoes in Germany (1 x 0.045 kg ai/ha), Italy (1-2 x 0.024 kg ai/ha), Poland (1-2 x 0.038 kg ai/ha), Saudi Arabia (2 x 0.011 kg ai/hl), Spain (1-2 x 0.022 kg ai/ha) and Switzerland (0.038 kg ai/ha). The PHIs range from 14 to 28 days.

Data were available from 11 trials in Brazil, France, Germany, Italy, Slovakia and the USA, but most of them were not according to GAP or no information on relevant GAP was available. Only 2 German trials (2 x 0.052 kg ai/ha, 14-day PHI) approximated GAP. Teflubenzuron was not detected in any of the samples (<0.05 mg/kg), even from exaggerated application rates at short PHIs.

It was concluded from a study of teflubenzuron metabolism and kinetics in potato plants that teflubenzuron does not penetrate into the leaves, stems or tubers if it is sprayed on the foliage. No systemic transport or metabolism occurs in the plants.

In view of the results of the metabolism study and the absence of residues in the trials, the Meeting concluded that sufficient information was available to estimate a maximum residue level for potatoes of 0.05* mg/kg as being a practical limit of determination, and estimated an STMR level of nil for teflubenzuron in potatoes.

Maize. Uses of teflubenzuron exist in Colombia and Ecuador with 2 treatments of 0.045 kg ai/ha and in Ecuador a PHI of 21 days. The insecticide is registered in Italy for use on maize at 2 x 0.15-0.16 kg ai/ha with a PHI of 28 days, and in Switzerland for cereals at 0.06 kg ai/ha with a 42-day PHI.

Supervised trials were reported from France (6), Germany (10), Italy (2) and Slovakia (3),

but information on GAP was available only from Italy. None of the northern European trials approximated Swiss GAP nor the French trials Italian GAP (they were at exaggerated rates and/or longer PHIs). Two trials in Italy with 2 x 0.15 kg ai/ha corresponded with GAP. At day 28 the residues were 3.6 and 3.9 mg/kg in the whole plant and <0.05 mg/kg in the grain.

The data from trials according to GAP were insufficient to estimate a maximum residue level.

Cotton seed. Teflubenzuron is registered for uses on cotton in Argentina (2 x 0.011 kg ai/ha, 21-day PHI), Brazil (0.0075-0.1 kg ai/ha, 30-day PHI), Paraguay (2-3 x 0.0075 kg ai/ha, 30-day PHI), Colombia (2 x 0.019 kg ai/ha), Ecuador (2 x 0.019-0.045 kg ai/ha) and Guatemala (2-3 x 0.075 kg ai/ha).

Seven trials in Latin America were within the wide range of Brazilian GAP. No residues above the LODs of 0.01 or 0.05 mg/kg were found in 4 Brazilian trials (2 x 0.03 or 2 x 0.06 kg ai/ha, PHI 31 days), 2 trials in Guatemala (14-15 x 0.039 kg ai/ha, PHI 6-8 days), or 1 trial in Mexico (12 x 0.06-0.08 kg ai/ha, PHI 18 days). The residues in rank order were <0.01 (4), <0.05 mg/kg (3).

In 9 US trials the residues were <0.05, 0.07, 0.08, 0.11, 0.24 and 13 mg/kg from 12 x 0.045 kg ai/ha, and 0.78, 3.1 and 4.6 mg/kg from 12 x 0.45 kg ai/ha 14 or 18 days after treatment. No information on GAP was available to evaluate the trials.

The results of the 6 US trials with 12 treatments at 0.045 kg ai/ha are inconsistent with the "nil" residues in Latin America with similar application rates. For this reason and because Brazilian GAP is reported to have such a wide range of application rates, the Meeting could not estimate a maximum residue level for cotton seed.

Coffee beans. The registered uses of teflubenzuron on coffee plants are in Brazil at 0.038 kg ai/ha and in Kenya with 1 or 2 treatments at 0.11 kg ai/ha, with PHIs of 30 days in both countries.

Two residue trials were conducted in Brazil. After 2 applications of 0.075 or 0.15 kg ai/ha and a PHI of 35 days, the residues were 0.6 and 1.7 mg/kg respectively.

There were insufficient data to estimate a maximum residue level.

Alfalfa forage and green grass. Two supervised trials on alfalfa and 1 on green grass were carried out in Italy (1 x 0.075 kg ai/ha). The residues in alfalfa forage declined from 1.4 and 2 mg/kg at day 3 to 0.18 and 1.2 mg/kg at day 28 after application. The residue is grass was 0.71 mg/kg at 28 days. No information on GAP was available to evaluate the trials.

Soya bean forage and hay. Teflubenzuron is registered for use on soya beans in Brazil (0.0075-0.023 kg ai/ha) and Paraguay (2-3 x 0.0075 kg ai/ha) with PHIs of 30 days.

Eight trials were carried out in the USA with 1 or 2 x 0.022 kg ai/ha. The residues in the forage and hay were 0.17-0.56 mg/kg and 0.19-1.3 mg/kg, respectively, at day 14. No information on GAP was available to evaluate the results.

Because no residue data were submitted from South America, the Meeting could not estimate a maximum residue level for teflubenzuron in soya bean forage or hay.

Animal products. When dairy cows were fed with feed containing 10, 30 or 100 ppm teflubenzuron

for 28 days, the residues of teflubenzuron in subcutaneous fat, peritoneal fat, liver, kidney and skeletal muscle were <0.05 mg/kg. Low concentrations of teflubenzuron were detected in the liver or kidney of some animals (0.015-0.041 mg/kg). There was no indication of any correlation with the dose level, or with the withdrawal period in the high-dose group. Two apparent residues were found in the control group. Residues of the metabolite E-115, 1-(3,5-dichloro-2,4-difluorophenyl)-3-(2,6-difluoro-3-hydroxybenzoyl)urea, in liver samples were <0.05 mg/kg (the LOD).

Only low residues of teflubenzuron occurred in peritoneal fat (0.011-0.028 mg/kg). Residues at or close to the LOD (0.01 mg/kg) were recorded in subcutaneous fat in the high-dose group, but 0.016 mg/kg was found 14 days after withdrawal.

No residues were found in any muscle or milk samples (<0.01 mg/kg).

An obstacle to estimating maximum residues for meat and milk is the lack of sufficient residue data on typical feed items (green forage, fruit pomace, cereal grains, pulses, oil seed), for which no MRLs could be recommended. The Meeting concluded that in the absence of such recommendations no maximum residues for teflubenzuron in products of ruminant origin could be estimated.

Laying hens were fed teflubenzuron at levels of 0.5 ppm, 1.5 ppm and 5 ppm in the diet for 28 days. Residues were detected in the eggs of all treated groups and a dose-related trend was observed. Values above the LOD of 0.01 mg/kg were first measured at day 14 in the groups treated with 0.5 ppm (0.04 mg/kg) and 1.5 ppm (0.06 mg/kg). In the high-dose group the first measured mean residue was 0.03 mg/kg at day 3, a mean maximum of 0.30 mg/kg was reached at day 26 and the residues declined during the withdrawal period. They were below the LOD after 42 days in the highest dose group.

Residues of teflubenzuron were found in all types of tissue analysed. The highest concentrations occurred in abdominal fat (0.7 mg/kg in the highest dose group). In the 0.5 ppm group residues were <0.01 mg/kg in muscle and 0.028 mg/kg in subcutaneous fat. Residues in the liver of hens kept on a teflubenzuron-free diet after dosing persisted for 7 or 14 days after withdrawal. Residues of the metabolite E-115 in liver samples were below the LOD (<0.05 mg/kg). High positive results were found in the livers of control birds.

Again the lack of residue data on typical poultry feed items (cereals, pulses) prevented the Meeting from estimating maximum residue levels for teflubenzuron in poultry commodities.

Processing studies on apples, plums, cherries, grapes, potatoes, tomatoes, soya beans and cotton were made available to the Meeting. With most of these crops (apples, plums, tomatoes, potatoes, soya beans, cotton seed) even exaggerated application rates did not produce sufficiently high residues in the raw commodity to estimate transfer factors. The Meeting was also unable to confirm the reported results for the processed products in the absence of details of the processing procedures.

In general, residues were reduced in canning fruit and processing to juice and wine but concentrated during soya bean oil production, by drying fruits, and in producing pomace. This is to be expected because of the fat-soluble nature of the active ingredient or the reduced water content of the processed products.

The only information on residues in the edible portions of food commodities came from

separate analyses of the pulp and peel of citrus fruit. Although the data were insufficient to estimate a maximum residue level for citrus, they indicated that residues in citrus pulp are likely to be less than 10% of the residue in the peel.

No information was provided on residues in commodities in commerce or at consumption.

RECOMMENDATIONS

The Meeting estimated the maximum residue and STMR levels listed below. The maximum residue levels are recommended for use as MRLs.

Definition of the residue (for compliance with MRLs and for estimation of dietary intake): teflubenzuron.

The residue is fat-soluble.

Commodity		Recommended MRL, mg/kg	Estimated STMR, mg/kg	PHI on which estimates are based, days
CCN	Name			
VB 0402	Brussels sprouts	0.5	0.21	14
VB 0041	Cabbages, Head	0.2	0.05	14
FS 0014	Plums (including Prunes)	0.1	0.04	21
FP 0009	Pome fruits	1	0.48	14-30
VR 0589	Potatoes	0.05*	0	7-35

FURTHER WORK OR INFORMATION

Desirable

1. Physical and chemical properties of the pure active ingredient.

2. Further processing studies on apples and plums to allow the calculation of transfer factors.

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