REPORT

PESTICIDE REFEREE GROUP

Rome,
Italy,
19-21
September
1994

Evaluation of field trial data on the Effectiveness of insecticides against locusts and grasshoppers

Food
and
Agriculture
Organization
of
the
United
Nations

EVALUATION OF FIELD TRIAL DATA ON THE EFFECTIVENESS OF INSECTICIDES AGAINST LOCUSTS AND GRASSHOPPERS

Report to FAO by the PESTICIDE REFEREE GROUP

Rome, 19-21 September 1994

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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INTRODUCTION

1. The Pesticide Referee Group provides FAO with independent evaluation of insecticides and recommends which can be applied to control locusts and grasshoppers. In addition to the information collected at these meetings, the Group is available for consultation by FAO in relation to advice on insecticides required for specific control programmes and trials. In particular advice may be required during emergency control operations when alternative insecticides are needed if and when those recommended are not available.

2. The 4th meeting was opened by Dr. N. van der Graaff, Chief, Plant Protection Service and Dr. A. Hafraoui, Senior Officer, Migratory Pests Group. It was attended by all members of the Group (Appendix IV). The Chairman welcomed Dr. H. Wilps as a new member to the Group. The Pesticide Referee Group during the present meeting evaluated 24 reports (Appendix I and II) in conjunction with the data examined at earlier meetings held in September 1989, November 1990 and March 1992. The Group also considered reports of large scale use of certain insecticides where relevant information supported and amplified trial data.

3. The suitability of insecticides is assessed in relation to different control strategies, namely:

1. Rapid control in emergency situations
2. Protection of crops at risk
3. Prevention of population development, for example in recession areas
4. Barrier spraying to intercept hopper bands in breeding areas
5. Combination of the above strategies

4. As indicated in previous reports, the choice of insecticide for a particular strategy depends on the characteristics of the active ingredient, thus rapid control, especially where crops are at risk, requires very effective, fast-acting, contact insecticides. Under these circumstances side-effects on non-target organisms can be accepted to a certain extent where the application is localised and deposits of these insecticides persist only for a very short duration. In contrast, slow-acting insecticides can be effective in reducing populations where they are not an immediate threat to crops. Insecticides with more selective activity against locusts and grasshoppers is a considerable advantage where several treatments may be required within a specific area to minimise the impact on non-target organisms. Increased persistence of insecticide deposits is required to treat localised barriers in the path of hopper bands. However, the environmental impact of residual deposits on non-target organisms requires very careful assessment.

5. In periods of locust recessions, data obtained from trials on grasshoppers continue to provide useful guidance in assessing different insecticides. Data from trials conducted by commercial companies, national plant protection organizations, universities and other organisations that follow the Guidelines on trials provided by FAO will continue to be reviewed and recorded on the FAO Database. It is recommended, therefore, that organisations liaise with FAO so that the aim and locality of trials is available prior to the submission of reports in an effort to avoid any duplication or other problems. The Group hope that in future evaluation of insecticides, priority will be given to development of techniques suitable for preventing hopper band populations in recession areas developing into plagues. Priority is needed to evaluate more environmentally acceptable techniques. But as promising new biological methods, such as the application of *Metarhizium flavoviride*r, require development of mass production of an acceptable product, future research is also needed with new chemicals to establish whether a more acceptable alternative to the present list of insecticides can be found.

RECOMMENDED INSECTICIDES

6. The Group confirmed the recommendations of the previous meeting and requested FAO to amend the "Desert Locust Guidelines. IV: Control" to omit insecticides such as diazinon, which are no longer regarded as suitable. The Group amended the list (Table 1) by including cyhalothrin for use in countries where the "lambda" isomer in not specifically registered. The dose for deltamethrin has been reduced in view of succesful largescale control operations.

7. The insect growth regulator diflubenzuron has been added to the list for control of locust hoppers only. Similar benzoyl urea insecticides may be effective under similar circumstances, but have not been included due to lack of trials' data submitted to FAO. Certain constraints in their potential use as a barrier treatment are indicated below.

8. Continued feedback on efficacy of these insecticides from operational use is requested by the Group.

Table 1: List of acceptable insecticides with a verified dose rate for overall sprays against Desert Locusts (in alphabetical order)

INSECTICIDE	DOSE RATE	TYPE
Hoppers and swarms		
Bendiocarb	100 g ai/ha	carbamate
Chlorpyrifos	240 g ai/ha	organophosphate
Deltamethrin	12.5 g ai/ha	pyrethroid
Fenitrothion	450 g ai/ha	organophosphate
Lambdacyhalothrin*	20 g ai/ha	pyrethroid
Malathion	925 g ai/ha	organophosphate
hoppers only		
Diflubenzuron	60 g ai/ha	benzoyl urea

*: where the "lambda" isomer is not registered in a country, cyhalothrin is applied at 40 g ai/ha

OTHER INSECTICIDES

9. A number of other insecticides (Table 2) have already been used in large scale control operations against locusts. Those listed in Table 2 are not included in the main recommended list as detailed trial data has not established whether the dosages being used are optimal. The dosage for one product has been reduced since the Group's previous report on the basis of additional trial data. Since the last meeting of the Group, no new data has been submitted for some of these other insecticides. The insecticides listed in Table 2 will benefit from additional field trial data on desert locust or detailed monitoring during operational use to verify or modify the suggested dose rates.

Table 2: **List of insecticides that have been shown to be effective against grasshoppers and locusts, but additional data is needed to verify the suggested dose rates.**

INSECTICIDE	SUGGESTED DOSE RATE	TYPE
Hoppers and swarms		
Carbosulfan	240 g ai/ha	carbamate
Cypermethrin + profenofos	20 + 200 g ai/ha	pyrethr. + organoph.
Esfenvalerate + fenitrothion	5 + 245 g ai/ha	pyrethr. + organoph.
Deltamethrin + pyridafenthion	5 + 160 g ai/ha	pyrethr. + organoph.
phoxim + propoxur	258 + 42 g ai/ha	organoph. + carb.
Pyridaphenthion	400 g ai/ha	organophosphate

INSECT GROWTH REGULATORS AS BARRIER TREATMENTS

10. Several benzoyl urea insecticides listed in Table 3 have been used in trials, and due to their persistence on vegetation they have been considered for use as barrier treatments. The need to investigate their use in barrier treatments is discussed below.

Table 3: **Promising insecticides requiring additional information and/or trials for dose rate determination as barrier treatment.**

INSECTICIDE	TYPE
Hoppers only	
Diflubenzuron	Benzoyl urea
Teflubenzuron	Benzoyl urea
Triflumuron	Benzoyl urea

11. Other insecticides have been used against locusts and grasshoppers but insufficient data is available to determine reliable effective dose rates. FAO should continue to encourage manufactureres to submit for review information on new or existing products. This should include data from laboratory studies, field trials, or from operational uses on grasshoppers as well as locusts.

12. The Group recommends only use of products with established dose rates because of efficacy, toxicity and environmental concerns. Insecticides are recommended, and should be listed in FAO publications, according to the common name of the active ingredient as some of these are produced by more than one manufacturer. Different formulations of the same active ingredient can often have very different properties, so increased reliability of locust and grasshopper control may be expected from established products obtained from manufacturers who have already provided products that meet the specifications required for ULV application.

APPLICATION CRITERIA

13. The logistics of treating large populations of locusts or grasshoppers, especially in remote areas without water has necessitated ultra-low volume (ULV) as the standard application technique. A narrow droplet spectrum is essential with such a low volume to reduce wastage of insecticide in large droplets likely to fall onto bare soil or due to small droplets dispersed beyond the treated area. Environmental pollution is minimised, therefore, if the droplet size is optimised at 50 - 100 µm. However, with this narrow droplet spectrum the volume of application also needs careful consideration to ensure the probability of spray droplets impacting either directly on the insects or the vegetation on which they are resting or feeding. Inadequate control of locusts has sometimes been reported when only 0.5 litres per hectare has been applied, indicating too few droplets for adequate coverage. Thus the minimum recommended volume for locust and grasshopper control is ONE LITRE PER HECTARE. Larger volumes up to 2 or 3 litres per hectare can only be justified where there is very dense vegetation and with some types of pesticide, but generally movement of insects within the treated area will ensure contact with the spray deposit when only 1 litre is applied.

14. In recommending certain insecticides suitable for locust and grasshopper control, it is essential that the formulation meets the specifications for ultra-low volume application. In particular the volatility and the viscosity are important criteria so that the appropriate droplet size spectrum is achieved at the flow rate required to apply the recommended dosage.

15. In view of the concern about possible environmental effects of insecticides, the locality and extent of a treated area needs to be recorded. In particular where several sprays may be applied, for example a series of barrier treatments aimed at control of hopper bands, the position of treated areas can be demarcated by using global positioning systems (GPS) and information stored with a geographic information system (GIS). This will be particularly relevant to application of residual deposits, such a benzoyl urea insecticides in areas with temporary aquatic ecosystems to monitor any long term effects.

16. The Group were pleased that FAO had organised a meeting at which equipment manufacturers demonstrated and discussed suitability of ground ULV sprayers for locust and grasshopper control. The importance of accurate application to minimise wastage and environmental pollution in conjunction with ease of operation of the equipment cannot be overemphasised.

SPECIAL CONSIDERATIONS FOR CERTAIN INSECTICIDES

17. The pesticides are divided into the following groups: organo-phosphates, pyrethroids, carbamates, a combination of these products, insect growth regulators (IGR's), botanicals, new compounds (e.g. fipronil) and biological insecticides (e.g. myco-insecticides). Special consideration about their suitability for control purposes and conditions of use are given.

Organo-phosphates, carbamates, pyrethroids and combination products

18. Organo-phosphates, carbamates, pyrethroids and combination products have many aspects in common. They have a broad spectrum activity, act fast on the target and are therefore suitable for use in emergency situations. They work mainly by contact action and are most effective during a short period, so need to be targeted directly to the insect. Locusts exposed to treated vegetation are also affected for a limited period of time after spraying. The need to direct the spray directly to a target requires intensive efforts of identifying and delimiting suitable targets (hopper bands and swarms). These insecticides are particularly suitable for "crop protection", i.e. killing locusts menacing neighbouring crops directly.

19. Pyrethroids have a distinct knock-down effect, from which locusts sometimes may recover. A product containing a mixture of pyrethroid and organophosphate insecticides solves this problem without resorting to increased dosages.

Insect growth regulators

20. IGR's considered here all belong to the benzoyl urea group. Others (e.g. fenoxycarb) are not included for lack of efficacy to desert locust. IGR's of course are suitable only for control of hopper bands, as adult insects are hardly affected. Their slow action makes them unsuitable to protect crops at risk. Their fairly narrow spectrum of activity (=selectivity) make them attractive from an environmental point of view, but due to adverse effects to crustacea spraying surface waters must be avoided. The benzoyl urea have a long persistence on foliage which enables very efficient control operations by spraying barriers aimed to control hoppers. Barrier spraying has the advantage that only a proportion of large areas require treatment to limit survival of unidentified hopper bands. The selectivity and large untreated areas between barriers reduces impact on non-target species.

21. Control by barrier spraying is complicated as many more variables need to be optimized than in the case of overall spraying. Barrier dosage and width, interval width, barrier direction, all need to be carefully chosen and depend on vegetation type, wind direction and developmental stage. This variability makes extrapolation from one situation to another difficult, in particular when, due to lack of desert locusts, trial data has been collected on related species. Good results were obtained with barriers of diflubenzuron and triflumuron in Madagascar on *Locusta migratoria* in relatively dense vegetation. These results cannot easily be extrapolated to other conditions (e.g. *Schistocerca gregaria* in sparse vegetation), but provide a very good reference for implementing treatments by barrier spraying - for example individual barriers 50 m wide representing a single swath from an aircraft applying 100 g a.i./ha in the barrier and spaced 600 m apart with barriers perpendicular to wind direction. The Group suggests these parameters can be applied for control of desert locust in more or less comparable conditions. The results of such operations need to be monitored and reported back to the Group for developing an adequate and optimized barrier control method for desert locust.

Botanical insecticides

22. Botanical insecticides are confined to extracts from seed kernels of the trees *Azadirachta indica* and *Melia volkensii*. Repellency of spray deposits is a useful characterisation for crop protection, but variability of azadirachtin content and other active ingredients and slow action limits their usefulness in the field to small-scale use, especially as large quantities of consistent quality are not yet available.

New compounds

23. Only one new compound, fipronil, a phenyl pyrazole, was evaluated. Reports from two research groups in Africa indicated that extremely low dosages are effective against certain species of locusts by contact and ingestion. Its persistence on foliage indicates that it will be suitable for barrier as well as direct treatments but further trials are needed to establish dose rates in each situation and ecotoxicological implications of this new type of active ingredient.

Biological insecticides

24. The biological insecticides considered here are myco-insecticides, i.e. preparations of spores of *Metarhizium flavoviride*. Pesticides based on *Nosema* or bacteria are not considered. Biological insecticides are slow acting. This makes field trials for efficacy evaluation very difficult. Available data concern mainly grasshoppers and some desert locusts. Verification of mortality in the field is difficult and all reliable results are from grasshoppers and locusts retained in cages after field sprays. These results are promising but need large scale verification in the field. Formulating spores of *Metarhizium flavoviride* in a oil formulation has enabled ULV sprays to be applied, and tests with this formulation have achieved promising results for control of both hoppers and adults. Exposure needs to be mainly by direct contact, although there is some evidence of secondary pick-up from vegetation. Mass production requires further development to ensure quality of the product. As the myco-insecticide is selective and slow in action, its use (at least until mass production is operational) will be confined to small scale applications in environmentally susceptible areas (presence of man, cattle, surface water) where hopper bands can be easily traced but are no immediate threat to nearby crops.

25. Table 4 summarises the suitability of the discussed groups of insecticides for different control purposes.

Table 4: Suitability of groups of insecticides for different use patterns

suitable for control of:	currently recommended		potential control agents		
	OP/ PY/ CA/ combi's	benzoyl ureas	fipronil	botanicals	myco-insecticides
hoppers	X	X	X	X	X
adults	X		X		X
crops at immediate risk	X				
crops at no immediate risk	X	X	X	X	X
vegetation barriers		X	X		

EXTRAPOLATION

26. In the recent recession period evaluation of insecticides for their suitability to control desert locusts has been difficult. Trials in different regions and on all species have not been possible. Extrapolation of data may be necessary until further test data can be collected. The Group stresses that extrapolation of data is very complex. Important variables concern 1) the target insect. 2) the environmental conditions, and 3) the application. A short inventory is given in table 5.

Table 5: Variables influencing extrapolation of test data between species and trial sites.

1) Target insect	*2) Environmental conditions*	*3) Application*
species	vegetation composition	formulation
stage of development	vegetation density	rate
conditon (physical)	geography	technique of application
density	soil	equipment
behaviour	weather (temperature,	barrier characteristics
size	humidity,	content and concentration
	wind speed	
	UV radiation, etc)	

27. This inventory is far from complete and many variables may influence the level of control. The Group always requires field trials for dose rate determination. When efficacy is shown in repeated representative trials, even with variable field conditions, the results are considered as sufficiently reliable for future practical use.

28. Results with one species cannot easily be extrapolated to other species. Laboratory data which compare the inherent toxicities to species is often helpful. Results with one compound can neither be extrapolated easiliy to the practical conditions in future situations unless a suitable reference product has been tried simultaneously. A suitable reference product should preferably be one known to be satisfactory in practice.

29. A standardised trial design improves the comparability between trials at different places and times. Trials done according to a standard guideline enable much better extrapolation to practical conditions than trials with an ad-hoc design. Therefore the Group recommends that trials are conducted according to the FAO Guidelines.

RECOMMENDATIONS

1. FAO should revise and publish the "Desert Locust Guidelines IV: Control" to include the updated list of insecticides considered suitable for desert locust control in conjunction with advice on application techniques. The common name of insecticides should be adopted to avoid advertisement of specific Trade Names. The list of insecticides should emphasise the need for the appropriate ULV formulation to provide the viscosity and reduced volatility required for locust control operations.

2. FAO should encourage feedback from control operations and further field trials to refine dosages.

3. FAO should publish the Pesticide Data Sheets for each of the recommended insecticides together with specifications of the formulations required. FAO should also revise and update the Insecticide Index.

4. FAO should encourage further development of more selective insecticides and barrier treatment techniques to minimise the environmental impact of chemical control.

5. FAO should request the Referee Group to meet annually and consult members of the Group between meetings when required for advice on choice of insecticides or trials.

6. FAO should continue to support ecotoxicological studies of different chemical groups and make optimal use of existing guidelines for risk assessment.

7. FAO should publish the existing Guidelines on trials and collaborate with other organisations such as EPPO on any future revision of guidelines for efficacy trials.

APPENDIX I

Insecticide trial reports reviewed by the Pesticide Referee Group in September 1994

NO	TITLE	EXECUTOR	COUNTRY	PESTICIDES	REMARKS
87.15	Field trials with penncap M for the control of grasshopper (Schistocerca piceifrons piceifrons)	J. Acevado	Costa Rica	methyl-parathion (ME)	summary of aerial trial; inadequate reporting.
89.18	Efficacy trials with some pyrethroid formulations against the brown locust (Locustana pardulaina (Wlk.))	Brown et al.	South Africa	deltamethrin esfenvalerate esfenvalerate + fenitrothion deltamethrin + fenitrothion	supportive data on locusts
91.13	Rapport des essais d'un binaire Polytrine C sur deux sites au Sénégal	DPV	Sénégal	profenofos + cypermethrin	grasshopper data only; proper study; data on species susceptibility
91.14	Effects of treatment with oil from the neem tree (Azadirachta indica Juss.) compared to the insect growth regulator fenoxycarb on two grasshopper species in Northern Mali	J. Langewald	Mali	neem fenoxycarb	small plots; no replicates
92.1	Rapport d'essais de lutte chimique contre les sautériaux . Applications ULV terrestres avec Sumicombi-alpha et fénitrothion	SPV	Mali	fenitrothion fenitrothion + esfenvalerate	good report; grasshoppers only
92.2	Barrier spray treatment with diflubenzuron (ULV) against gregarious hopper bands of the Moroccan locust Dociostaurus maroccanus (Thunberg)(Orthoptera:Acrididae) in N.E. Morocco	Bouachi et al.	Morocco	diflubenzuron	good report; barrier treatment

NO	TITLE	EXECUTOR	COUNTRY	PESTICIDES	REMARKS
92.3	*Comparison of diflubenzuron and malathion as blanket* sprays against sedentary populations of locusts and grasshoppers in Moroccan grassland	*Bouachi et al.*	*Morocco*	*diflubenzuron* malathion	good report; IGR as blanket spray
92.4	Studies on the migration behaviour of Krausella amabile treated with Metarhizium flavoviride over stripes of vegetation sprayed with crude neem oil	Langewald et al.	Mali	neem	no replicates; no evidence of reduced activity due to neem.
92.5	Effects of treatment with two different formulations from the neem tree (Azadirachta indica Juss.) compared to the insect growth regulator Dimilin on two grasshopper species in Northern Mali	Langewald	Mali	neem diflubenzuron	field applications and caged mortality evaluation; small plots
92.6	Efficacy of lambdacyhalothrin ULV against fifth instar hoppers of the brown locust (Locustana pardalina Walk.)	Brown	South Africa	lambdacyhalothrin fenitrothion	good supportive data on locusts
92.7	Efficacy of deltamthrin + fenitrothion ULV combinations and RU's ISO-50B ULV against fifth instar hoppers of the brown locust (Locustana pardalina Walk.) in South Africa	Brown	South Africa	fenitrothion + deltamethrin fenitrothion ISO-50B	good supportive data on locusts
93.1	Test d'efficacité d'Ofunack 400 contre les larves IV, V et adultes du criquet pelèrin S. gregaria	INRAT	Tunisia	pyridaphenthion	field-cage trials; no information on application parameters; laboratory insects
93.2	Barrier treatment with a benzoyl urea insect growth regulator against Locusta migratoria capito (Sauss) hopper bands in Madagascar	Scherer et al.	Madagascar	triflumuron	good study on barrier treatment
93.3	Fields trials of Reldan 170 ULV (EF1214), Reldan 500 ULV (EF1242) and Dursban 240 ULV (M3469) against Locusta migratoria capito.	Villeneuve	Madagascar	chlorpyrifos chlorpyrifos-methyl	supportive data on locusts

NO	TITLE	EXECUTOR	COUNTRY	PESTICIDES	REMARKS
93.4	Field evaluation of carbosulfan 25% for the control of locust	Ketema et al.	Ethiopia	carbosulfan carbaryl fenitrothion	high volume EC application
94.1	Sprayed barrier of diflubenzuron (ULV) as a control technique against marching hopper bands of migratory locust Locusta migratoria capito (Thunberg)(Orthoptera:Acrididae) in Southern Madagascar	Coppen et al.	Madagascar	diflubenzuron	good study on barrier treatment
94.2	Evaluation of fipronil in the control and management of desert locust (Schistocerca gregaria Forskal) nymphs and adults	DLCO-EA	Ethiopia	fipronil	laboratory and field work on new product; more data required.
94.3	Field tests with botanicals, mycocides and chitin synthesis inhibitors	Wilps et al.	various	melia neem triflumuron teflubenzuron	review paper of various field studies
94.4	Efficacy of fipronil against nymphal bands of the brown locust in the Karoo, South Africa	Price et al.	South Africa	fipronil fenitrothion	important data on new product compared with old standard
ADDITIONAL INFORMATION EXAMINED DURING THE MEETING					
	A brief review of laboratory testing of insecticides against locusts and grasshoppers	Fenn	NRI/UK	various	useful report for comparison of susceptibility between species
	Programme lutte biologique contre les locustes et les saiteriaux. Volet DFPV. Rapport de Progres	Kooyman	Niger Mauritanie	Metarhizium flavoviride	preliminary data on biological insecticides
	Preliminary field trial on the control of Phaulacridium vittatum (Sjostetd)(Orthoptera: Acrididae) populations with Metarhizium flavoviride Gams and Rozsypal (Deuteromycotina: Hyphomycetes)	Baker et al	Australia	Metarhizium flavoviride	preliminary data on biological insecticides

NO	TITLE	EXECUTOR	COUNTRY	PESTICIDES	REMARKS
	Susceptibility of the australian plague locust, Chortoicetes terminifera, and the wingless grasshopper, Phaulacridium vittatum, to the fungi Metarhizium spp.	Milner et al.	Australia	Metarhizium flavoviride M. anisopliae	preliminary data on biological insecticides
	Controlling brown locust hopper bands in South Africa with a myco-insecticide spray	Bateman et al.	South Africa	Metarhizium flavoviride	preliminary data on biological insecticides

APPENDIX II

Summary of data from trial reports listed by insecticide as discussed in the 1994 Group meetings

INSECTICIDE	CLASS	APP. RATE (g ai/ha)	CONTROL 24 hrs (%)	SPECIES	SPRAYER	VOL RATE (l/ha)	PLOT SIZE (ha)	REPL-ICS	REPORT CODE	COMMENTS
carbaryl	CA	127.5	97	SGR	motor. knapsack	200	???	1	93.4	WP formulation
carbosulfan	CA	150	96	SGR	motor. knapsack	200	???	1	93.4	EC formulation
chlorpyrifos	OP	180	90	LMI	Micro-ULVA	0.75	1	6	93.3	
chlorpyrifos-methyl	OP	170	91	LMI	Micro-ULVA	1	1	6	93.3	
		200	90	LMI	Micro-ULVA	1.18	1	6	93.3	
		225	89	LMI	Micro-ULVA	0.45	1	6	93.3	
cypermethrin +	PY + OP	60	80 - 88	MIX	ULVA MAST	???	???	2	91.13	species response
profenofos		110	83 - 91	MIX	ULVA MAST	???	???	2	91.13	species response
diflubenzuron	IGR	60	*	DMA	Micro-ULVA	1	variable	4	92.2	*: band area declined relative to untreated; barrier treatment
		60	*	MIX	Micro-ULVA	2	1	3	92.3	*: population declined after 10 days; overall spray
		15 - 135	55 / 100	KAM/OSE	ULVA +	0.25-2	0.25	1	92.5	control after 18 days
		93.7*	**	LMI	Micro-ULVA	0.8*	20 km2	1	94.1	*: in barrier; ** declining populations over 16 days
fenitrothion	OP	250	>98	MIX	Micro-ULVA	0.5	1	3	92.1	
		1280	98	SGR	motor. knapsack	1	???	1	93.4	

INSECTICIDE	CLASS	APP. RATE (g ai/ha)	CONTROL 24 hrs (%)	SPECIES	SPRAYER	VOL RATE (l/ha)	PLOT SIZE (ha)	REPL-ICS	REPORT CODE	COMMENTS
fenitrothion + esfenvalerate	OP + PY	245 + 5 98 + 2	>99 >81	MIX MIX	Micro-ULVA Micro-ULVA	1 0.4	1 1	3 3	92.1 92.1	
fenoxycarb	IGR	200	33	KAM, ONI	ULVA -8	1	0.25	1	91.14	mortality after 24 days
fipronil	PPZ	5 -20 5 -17.5	100 >98	SGR LPA	Micro-ULVA ULVA +	1 0.8	??? variable	1 3-5	94.2 94.4	simulated field trial
malathion	OP	600	*	MIX	Micro-ULVA	2	1	3	92.3	*: rapid decline in population in 2 days
methyl-parathion	OP	???	95	SPI	Aerial (hydrol. nozzles)	???	???	1	87.15	summary sheet; incomplete data
neem	BOT	0.20% 0.20%	80 48 up to 75	KAM, ONI KAM, ONI KAM KAM/OSE	ULVA -8 ULVA -8 Mini-ULVA ULVA 8	5 10 10 0.25 - 20	0.25 0.25 0.25 0.25	1 1 1 1	91.14 91.14 92.4 92.5	mortality after 24 days mortality after 24 days migration study control after 18 days
pyridaphenthion	OP	400-500	100	SGR	???	0.8 - 1	1	3	93.1	
triflumuron	IGR	100*	up to 100	LMI	Aerial (Micronair)	---	600	1	93.2	*: dose in barrier

APPENDIX III

FAO FIELD DOSE RATE RECOMMENDATIONS OF INSECTICIDES FOR DESERT LOCUST CONTROL

Revised list: 21 September 1994

Table 1: List of acceptable insecticides with a verified dose rate for overall sprays against Desert Locusts (in alphabetical order)

INSECTICIDE	DOSE RATE	TYPE
Hoppers and swarms		
Bendiocarb	100 g ai/ha	carbamate
Chlorpyrifos	240 g ai/ha	organophosphate
Deltamethrin	12.5 g ai/ha	pyrethroid
Fenitrothion	450 g ai/ha	organophosphate
Lambdacyhalothrin*	20 g ai/ha	pyrethroid
Malathion	925 g ai/ha	organophosphate
hoppers only		
Diflubenzuron	60 g ai/ha	benzoyl urea

*: where the "lambda" isomer is not registered in a country, cyhalothrin is applied at 40 g ai/ha

Table 2: List of insecticides that have been shown to be effective against grasshoppers and locusts, but additional data is needed to verify the suggested dose rates.

INSECTICIDE	SUGGESTED DOSE RATE	TYPE
Hoppers and swarms		
Carbosulfan	240 g ai/ha	carbamate
Cypermethrin + profenofos	20 + 200 g ai/ha	pyrethr. + organoph.
Esfenvalerate + fenitrothion	5 + 245 g ai/ha	pyrethr. + organoph.
Deltamethrin + pyridafenthion	5 + 160 g ai/ha	pyrethr. + organoph.
phoxim + propoxur	258 + 42 g ai/ha	organoph. + carb.
Pyridaphenthion	400 g ai/ha	organophosphate

It is recommended that FAO replace all its previous dose recommendations by the above lists. All the insecticides should be supplied for 1 litre per hectare application.

APPENDIX IV

PARTICIPANTS IN THE MEETING OF THE PESTICIDE REFEREE GROUP; 19 - 21 SEPTEMBER 1994

MEMBERS OF THE PESTICIDE REFEREE GROUP

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APPENDIX V

TERMS OF REFERENCE FOR PESTICIDE REFEREE GROUP

1. To evaluate pesticide trial reports with reference to the following:

   a) Satisfactory trial technique (eg. number of replicates, method of measuring mortality, application technique).

   b) Credibility of the report (methods and procedures fully described).

   c) Satisfactory kill at the dosages used.

2. On the basis above, and relevant information on large scale control operations, adapt the list of pesticides and dosages suitable for operations against locusts/grasshoppers.

3. Compile a list of pesticides that warrant further evaluation and specify the trials required (laboratory, field, small scale, large scale, etc.).

4. Provide FAO with advice on pesticides when required between meetings

5. Review an updated set of draft guidelines for pesticide trials on desert locusts and on grasshoppers

6. Advise on methodologies to extrapolate trial data from grasshopper trials to Desert Locust

7. Prepare a report covering the above points.