EVALUATION OF FIELD TRIALS DATA ON THE EFFICACY AND SELECTIVITY OF INSECTICIDES ON LOCUSTS AND GRASSHOPPERS

Report to FAO by the PESTICIDE REFEREE GROUP

Eighth meeting
Rome, 11 - 14 October 1999

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INTRODUCTION

1. The 8th meeting of the Pesticide Referee Group (PRG, members listed in Appendix 1) was opened by Mr. N. Van der Graaff, Chief, Plant Protection Service. He welcomed Prof. C. Coste, University of Perpignan, France, and Dr. R. Peveling, University of Basle, Switzerland, as new members of the Group. Dr. Peveling had also agreed to act as the Secretary of the Group. Mr. Munir from the Department of Plant Protection, Pakistan, joined the meeting later as a representative of a locust-affected country. Mr. Van der Graaff expressed his appreciation of the group's work. He pointed out that giving industry the opportunity to present their views on the recommendations of the Group, a procedure first adopted during the 7th meeting, had greatly improved the transparency of the process of locust pesticide review. The Desert Locust Control Committee (DLCC) meeting in May 1999 had discussed the previous report of the PRG and recommended the continuation of its financial support, as both locust-affected countries and donors had acknowledged the usefulness of the guidance provided in the report. Particular reference was made to the environmental assessments given for each of the insecticides considered efficacious for locust control.

2. The PRG wished Dr. Dick Brown a full and speedy recovery from injuries sustained in a helicopter crash in Madagascar. His extensive contribution to previous meetings had been much appreciated.

3. The PRG expressed its appreciation of having simultaneous translation in French/English to allow a full discussion of the reports among all participants of the meeting.

4. FAO pointed out that at the present time there were no major outbreaks of the Desert Locust, but in Madagascar *Locusta migratoria capito* infestations had reached full plague dimensions. Several missions had reported on the situation there and further guidance on the appropriate use of insecticides was needed. Similarly in Central Asia , large populations of locusts such as *Calliptamus italicus* and *Dociostaurus maroccanus* had caused crop losses over extensive areas. FAO recognised the difficulty in extrapolating data available for Desert Locust to other species, but hoped that the information contained in the new reports would allow initial guidance. The PRG emphasised that the behaviour of different species and ecological conditions made it extremely difficult to cross-reference dosages suitable for Desert Locust directly to other species.

5. During the first day of the meeting, the PRG received presentations from AgrEvo, Bayer, Dow AgroSciences, Novartis, Rhône-Poulenc and Uniroyal .

6. The representatives of industry welcomed the opportunity to discuss information from recent trials and comment on the report of the 7th Meeting. In particular, there was information regarding studies in Central Asia and Madagascar.

7. The PRG considered the comments made by the representatives of industry and reviewed data on efficacy and environmental impact (114 reports listed in Appendix 2). Information on one new insecticide, imidacloprid, related to trials against *Locusta migratoria capito,* has been included in Table 4. Further studies are needed against the Desert Locust before it can be included in Table 1. Dose rates are based on reported efficacy data and do not imply registration in specific countries.

8. It is recognised that industry markets their products using specific tradenames and different formulations. However, in using the common names, the Group is referring specifically to the ultra-low volume formulations considered efficacious for locust control, unless another formulation is specifically mentioned.

9. The Pesticide Referee Group is an independent body of experts that advises FAO on the efficacy and environmental impact of different pesticides for locust control. This advice is based on a critical review of reports submitted by industry, research institutes, plant protection departments, of other available literature, and on the experience of its members and of FAO experts. The resulting advice systematically lists pesticides suitable for locust control from the scientific point of view. The PRG has no legal status. All uses of pesticides discussed in this report are fully subject to national legislation, regulation and registration.

DESERT LOCUST

10. Verified dose rates, speed of action, and primary route of exposure of different control agents for the Desert Locust are given in Table 1. Only a few changes have been made compared to the previous report, because there is little new data. A major change is the reduced dose rate for fipronil. The speed of toxic action (e.g. knock-down, complete cessation of feeding) of the different compounds was assessed again and confirmed as: fast ("F" = 1-2 hours), moderate ("M" = 3-48 hours) and slow ("S" > 48 hours). Speed of action is generally determined by the class of the product, its dose rate, its inherent toxicity and its primary route of exposure.

11. Among the faster compounds listed in Table 1 are the synthetic pyrethroids and bendiocarb which produce a rapid sublethal knockdown effect, followed by a protracted paralysis after which the insect may die or recover completely depending on the dose received. Locusts that may partially recover usually die later without feeding. Some insecticides may not have such a rapid toxic effect, but still adversely affect the behaviour of the locusts. Cessation of feeding can occur very quickly even though death occurs later within the first day following treatment. Among the slower compounds listed in Table 1 are the mycoinsecticide *Metarhizium anisopliae* var. *acridum* and the benzoylureas which take a week or more (up to 21 days) to kill. To ensure that sufficient product is ingested and accumulated, the Group reaffirmed that when using the benzoylureas the early and intermediate hopper instars should be optimally targeted although later instars are also affected. Such products are more suitable for a proactive role within the confines of the locust outbreak area where barrier treatments are advisable. Between the two extremes lie most other insecticides listed in Table 1 which, depending on the dose applied, exhibit a moderate speed of kill, normally within 48 hours after treatment.

12. The Group recommends only use of products with established dose rates because of efficacy, toxicity and environmental concerns. The common names of listed insecticides, or, in the case of biologicals, the appropriate isolate, should be given in FAO publications. Different formulations of the same active ingredient can often have very different properties. Optimal reliability for locust and grasshopper control may be expected from established products provided that they meet the FAO specifications for ULV application.

APPLICATION CRITERIA

13. The PRG continues to recommend ultra-low-volume application as the standard technique to cope with the logistics of treating large areas with populations of locusts or grasshoppers, especially as these generally occur in remote areas without water. The application of one litre per hectare is preferred to ensure that sufficient droplets are applied for adequate coverage. However, when calibration is accurate and vegetation is not too dense, a lower rate of 0.5 litres per hectare is acceptable if aerially applied over large areas. Such low volumes necessitate a narrow droplet spectrum to reduce waste of insecticide in large droplets. A range of 50-100 μm VMD (Volume Median Diameter) droplet spectrum using rotary atomisers is advocated to minimise environmental pollution. Spray aircraft should be equipped with GPS guidance systems to assure correct application and to record spraying operations. GPS should also be used in ground treatments.

14. In certain areas (e.g. Central Asia) that do not have the equipment needed for ULV application, the use of emulsifiable and suspension concentrate formulations diluted in water has been advocated, especially to protect cereal crops. The use of 200 litres of water or more per hectare in ground equipment is a severe constraint on the area that can be treated, so wherever possible preference should be given to ultra-low-volume application.

se rates and speed of action of different insecticides for which verified dose rates have been established for the Desert Locust. Speed of c action (see text) was defined as: F = fast (1-2 hours), M = moderate (3-48 hours) and S = slow (> 48 hours).

	Class *	Dose (g a.i./ha)				Speed of action at verified dose rate	Primary mechanism
		overall (blanket) treatment		barrier treatment (hoppers)			
		hoppers	adults	within barrier	overall **		
	CA	100	100			F	AChE inhibition
	OP	225	225			M	AChE inhibition
	PY	12.5 [§]	12.5			F	Na channel blocking
	BU	60	n.a. [†]	100	5	S	chitin synthesis inhibition
	OP	450	450			M	AChE inhibition
	PP	4	4	12.5	0.6	M	GABA receptor blocking
	PY	20 [§]	20			F	Na channel blocking
	OP	925	925			M	AChE inhibition
ae (IMI 330189)	fungus	100	100			S	mycosis
	BU	30	n.a. [†]	n.d. [§]		S	chitin synthesis inhibition
	BU	25	n.a. [†]	75	3.7	S	chitin synthesis inhibition

carbamate, OP: organophosphate, PY: pyrethroid, PP: phenyl pyrazole; ** calculated dose rate applied over the total protected area based on an average barrier width of ıg of 1000 m (see § 17); [§] a higher rate may be required for the last instar; [†] n.a. = not applicable; [§] n.d. = not determined; [‡] where the "lambda" isomer is not registered in a ıpplied at 40 g a.i./ha.

15. In addition to overall blanket sprays, certain insecticides are also considered efficacious for barrier treatments for control of locust hoppers. Precise application recommendations that are valid under all circumstances cannot be given since they depend on local conditions. A barrier consists of a treated strip interspersed with an untreated larger area arranged so that hoppers are expected to move across and feed on treated vegetation. The width of each barrier (one or more swath widths) and distance between barriers that have to be used will depend on:

a) mobility of the hoppers
b) insecticide used (dosage, persistence)
c) the terrain/vegetation (plant density)
d) wind speed and direction during application
e) height of application

Highly mobile species may be controlled with a wide separation between barriers while a less mobile species will require closer intervals and in some cases the barriers will need to be arranged in a lattice (grid) pattern to allow for any changes in direction of hopper movement.

16. In assessing the width of the untreated area, due note must be taken of the height of release of droplets, wind speed and density of vegetation as these factors will influence the extent of drift of spray droplets downwind from the treated barrier. The pattern of spray deposition will vary significantly between different situations, so care has to be exercised in interpreting data from trials.

17. The standard dosage to be applied inside a barrier for Desert Locust control is calculated on a minimum cross wind barrier of 50 m with a 1000 m spacing between spray tracks. Thus the barrier / track spacing ratio is 1/20. It is recognised that spray drift may deposit over a wider area than the 50 m barrier, in particular when conducting aerial applications, but there will be a wide untreated area. This arrangement will insure that mobile Desert Locust hopper bands are still likely to pick up a lethal dose while crossing such a barrier. Provided that the overall dose per “protected area” is respected, operators should have some flexibility with respect to the actual barrier spacing and a.i. concentration within barriers. One model to estimate optimal separation of barriers in which a benzoylurea had been sprayed has been published (Coppen, 1999). Another model is now being developed to link behaviour characteristics of locust species, especially their movement as hoppers, with the activity of residual insecticides, to optimise the width of the treated barrier and intervening untreated area under different environmental conditions.

18. Application techniques where spray drift from one barrier reaches to or overlaps with the subsequent one are considered as irregular blanket rather than barrier treatments.

19. For ultra-low volume applications it is essential that the formulation meets the criteria for low volatility and low viscosity so that the appropriate droplet spectrum is achieved at the flow rate required to apply the recommended dosage. UL formulations need to be selected so that corrosion to application equipment is avoided. Specifications for UL formulations are being established and approved by FAO.

20. No new application equipment has been developed for locust control since the previous meeting. However, the use of several types of equipment in Central Asia was reported. In some cases insecticide was mixed with a herbicide applied to cereal crops with a tractor-mounted boom sprayer. Irrespective of the equipment used, accurate application is essential to minimise wastage and environmental pollution. The PRG again stressed the need for training all those involved in operational application. It urged the continuation of training courses under the EMPRES Programme.

21. There have been no further reports on operator exposure during the application of insecticides for locust control. In view of the concern about operator safety, further studies on exposure of operators using different equipment and the influence of opening insecticide packages of different sizes is needed. One particular problem relates to the use of dust formulations by farmers as a last resort to protect their crops. As small dust particles can be inhaled and many of the dust formulations are based on OP and carbamates, there is concern that users will be too exposed to poisoning. Use of dusts should therefore be kept to a minimum. Where the use is deemed necessary, operators and farmers need special training.

SPECIAL CONSIDERATIONS

22. The pesticides are divided into the following groups: organophosphates, pyrethroids, carbamates, benzoylureas, phenyl pyrazoles, chloronicotinyls, biological insecticides (e.g. mycoinsecticides) and botanicals. Special consideration about their suitability for control purposes and conditions of use are given.

Organophosphates, carbamates and pyrethroids

23. Organophosphates, carbamates and pyrethroids have many aspects in common. They have a broad spectrum activity, exhibit moderate (OPs) to fast (carbamates, pyrethroids) action and are therefore suitable for use in emergency situations. They work mainly by contact action and are most effective during a short period of time, 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, by contact and ingestion. The need to apply the spray directly on a target requires intensive efforts to identify and delimit appropriate targets (hopper bands and swarms). These insecticides are particularly suitable for swarm control and direct crop protection. In view of the importance of minimising environmental contamination, application accuracy is important with these compounds. Ongoing training of spray operators is therefore essential. The pesticides constitute a medium to high risk to aquatic invertebrates, especially crustaceans when pyrethroids are used, and to terrestrial non-target arthropods. Moreover, OPs may affect birds and reptiles.

Benzoylurea insect growth regulators

24. Benzoylurea IGR insecticides have been shown to be very effective against locust hoppers. Their action is slow, which makes them unsuitable for immediate crop protection. They are persistent on foliage and their fairly narrow spectrum of activity makes them attractive from an environmental point of view, but, due to adverse effects on crustaceans, spraying of surface waters must be avoided. They are most effective when applied against hoppers up to the 4th instar, but later instars can be affected. There was confirmation that although oviposition may not be influenced by treatment of adults, hatching of eggs is reduced. This results in a reduction in the initial locust population in areas treated with a benzoylurea during the previous year.

25. Benzoylureas should be used primarily as barrier treatments.

Phenyl pyrazoles

26. Many new reports were received concerning the effectiveness of fipronil, which has a contact and stomach action. These reports referred principally to species other than the Desert Locust and indicated that dosages for barrier treatments can be reduced to 1 g a.i. per protected hectare. Although the toxic effect is not so immediate as with certain other insecticides, affected locusts may cease feeding rapidly.

27. The persistence of fipronil is comparable to that of benzoylureas. However, due to its broad spectrum activity and the high risk to soil insects such as termites, fipronil is preferably applied as a barrier treatment. Separation of barriers will depend on the movement of the respective locust species. 1-2 km separation has been effective in the past when controlling Desert Locust with other persistent insecticides. Clearly, spray drift on to the inter-barrier area needs to be minimised to reduce environmental impact.

Chloronicotinyl insecticides

28. The new insecticide imidacloprid has been shown to be effective against *Locusta migratoria capito,* but insufficient data are available in relation to the Desert Locust to include it in Table 1. This insecticide has a different mode of action (blockage of postsynaptic nicotinergic acetylcholine receptors) than previously listed insecticides and is fast acting. Imidacloprid has a low persistence in the environment. Ecotoxicological field data from locust habitats have mainly been elaborated in Madagascar.

Biological insecticides

29. New data on the efficacy and environmental impact of the biopesticide *Metarhizium anisopliae* var. *acridum* isolate 330189 were provided. Large scale field trials indicated no adverse effects on non-target organisms. However, an increased risk to non-target acridid species can be anticipated, but there are at present no data available. Based on the current ecotoxicological profile, the use of *Metarhizium* in ecologically and otherwise sensitive areas should be encouraged. Nonetheless, further research on possible side-effects on non-target grasshoppers is strongly recommended.

30. Investigations are proceeding to commercialise the production of spores and provide larger quantities of the UL formulations for use in environmentally sensitive areas. The PRG expressed the hope that the research would continue to investigate the use of mycoinsecticides in recession areas to determine whether appropriately timed applications at the initiation of an upsurge of populations would prevent swarms forming and migrating to other areas.

Botanicals

31. No new data were submitted on botanical insecticides derived from *Melia volkensii* and *Azadirachta indica.*

OTHER INSECTICIDES

32. Insecticides other than those listed in Table 1 have been used against locusts and grasshoppers but insufficient data are available to determine reliable effective dose rates. FAO should continue to encourage plant protection organisations, manufacturers, and any other institutions to submit for review information on new or existing products. This should include data from laboratory studies and field trials. In particular data from operational use of insecticides should be provided to FAO. In addition to efficacy data, it is important to include as much information as possible on environmental impact studies.

33. The PRG discussed the application of mixtures of insecticides. So far data have been confined to mixtures of a pyrethroid + organophosphate or OP + carbamate. Generally, the quantity of each component in a mixture is 50% of that used if the insecticide was applied on its own which reduces the level of individual active ingredients in the environment. However, there is concern in many countries about the application of organophosphates. Extensive studies have been carried out in Mauritania to test other organophosphate/pyrethroid mixtures on Desert Locust to exploit and optimise synergistic effects of the two components, and to reduce the total amount of each insecticide significantly. Results are as yet insufficient to recommend particular mixtures. If one of the commercially available mixtures is used, it is anticipated that the mortality of locusts will be similar to that obtained if the separate components were applied at their recommended dosage, but the addition of a pyrethroid to an OP should give a more rapid knockdown. Moreover, a recent study in Madagascar showed that an OP + pyrethroid mixture was less hazardous to ground-dwelling non-target arthropods than the OP alone. These findings need further verification.

34. The PRG reconsidered the existing data concerning carbosulfan which has been used in several countries at 125 g a.i./ha, but these data lack information from field trials. Since no new field trial data were submitted, no appropriate dose rates could be verified.

35. No additional data were submitted in relation to botanical insecticides, even though commercial products are now on the market. The Group emphasises that botanicals can only be evaluated when formulated according to FAO specifications.

POSSIBLE USE PATTERNS

36. Locust control operations have to be carried out in a wide range of situations, varying from desert zones, ecologically sensitive areas to intensive farmland. In addition, locust control could be in response to emergency situations or be an attempt to carry out preventive control. The choice of a particular insecticide and type of application (blanket *vs.* barrier) will depend on the particular

circumstances and dominant features of the ecosystem. In some situations where rapid kill is not essential, lower dosages of some listed insecticides may be effective.

37. Progress towards a commercial product of a mycoinsecticide is most encouraging as it will be particularly relevant to ecologically sensitive areas such as nature reserves or agricultural areas in order to minimise pesticide residues in food. In other areas, where effects on non-target organisms or in grazing areas need to be minimised, preference will be for benzoylureas, provided the treatments avoid sensitive aquatic ecosystems.

38. The adoption of widely spaced barriers of benzoylureas or fipronil enables the dosage per protected hectare to be kept to a minimum to alleviate harmful effects to non-target organisms. Thus, for instance, fipronil applied at 12.5 g a.i./treated hectare within barriers of 50 m width with a track spacing of 1 km is approximately equivalent to 0.6 g a.i./protected hectare.

39. In agricultural areas with crops at risk, priority will be given to insecticides with a more rapid action, particularly pyrethroids.

ENVIRONMENTAL EVALUATION

40. The Group emphasises the importance of the Agenda 21 (Declaration on Environment and Development) as a general framework for environmental evaluation (UNCED, 1992). The Agenda advocates the use of target-specific and readily degradable pesticides as well as the use of biocontrol agents as alternatives to chemical pesticides to reduce environmental risks. It also calls for appropriate environmental impact assessment procedures for projects likely to have significant impacts upon biological diversity and stresses the need of national capacities in toxicity testing, exposure analysis and risk assessment. Furthermore, in ratifying the Convention on Biological Diversity (UNEP, 1992), most locust-affected countries have committed themselves to incorporating these principles in their national environmental policies.

41. Thus data on environmental hazard provided by the manufacturer must be valid for the area of application. Data on ecological key taxa (see Table 2) in locust areas are important for a proper risk assessment. The quality standards for the studies need to be the same as for efficacy tests.

42. With respect to the risk of single pesticide treatments to non-target organisms, three main groups are distinguished, viz. aquatic organisms, terrestrial vertebrates including wildlife, and terrestrial non-target arthropods. The aquatic fauna considered here are divided into fish and arthropods (crustaceans and insects). Terrestrial vertebrates include mammals, birds and reptiles, and terrestrial arthropods cover bees, natural enemies (antagonists) of locusts and other pests as well as ecologically important soil insects (ants and termites). The Group considers the classified non-target organisms as reasonably representative of the fauna exposed to pesticides in locust habitats. In some cases, however, other non-target taxa such as amphibians or butterflies may be of concern and require a specific risk assessment, as do multiple treatments within the same area and season.

43. The risk of each compound to the different groups of non-target organisms is presented in Table 2, using three classes: low, medium and high risk. The assessment is based on exposure/toxicity ratios, unless more relevant field data were available. Low risk means that no serious effects are to be expected. Medium risk means that effects of short duration are expected on a limited number of taxa. High risk means that effects of short duration are expected on many taxa, or that effects of long duration are expected on a limited number of groups. Results obtained from situations most representative of the expected field conditions are given more weight than other studies. Field studies (indicated with index [3] in Table 2) are more relevant than laboratory or semi-field studies (index [1] and [2] in Table 2). The classifications are brought in line as much as possible with accepted international classifications. Results obtained with indigenous species from locust areas in the field or in the laboratory are considered to be more relevant than results obtained with species from elsewhere. Considerable progress has been made in this respect, in particular with regard to terrestrial and aquatic non-target arthropods.

k to non-target organisms at verified dose rates against the Desert Locust (Table 1). Risk is classified as low (L), medium (M) or high (H).
: Table 3 for the classification criteria.

	Environmental risk									WHO toxicity class for active ingredient §
	Aquatic organisms		Terrestrial vertebrates			Terrestrial non-target arthropods				
	fish	arthropods	mammals	birds	reptiles	Bees	antagonists	soil insects		(human)
	M [2]	L [3]	M [1]	L [3]	-	H [1]	H [2]	M [3]		II
	M [3]	H [2]	L [3]	M [3]	M [3]	H [1]	H [3]	-		II
	L [3]	H [3]	L [1]	L [3]	L [3]	M [1]	M [3]	M [3]		II
ɜt)	L [3]	H [3]	L [1]	L [1]	-	L [1 Φ]	M [2]	M [3]		U
r) *	L	(H)	L	L	-	L [Φ]	L [3]	(M)		U
	L [3]	M [3]	L [3]	M [3]	-	H [1]	H [3]	H [3]		II
	L [2]	L [2 φ]	L [1]	L [1]	-	H [1]	H [3]	H [3]		U
	L	L	L	L	-	(H)	(H)	(H)		U
	L [1]	L [1]	L [1]	L [1]	-	H [1]	L [3]	L [3]		II)
	L [2]	H [2]	L [1]	L [1]	-	M [1]	M [3]	H [2]		II
	L [2]	M [2]	L [3]	L [3]	-	H [3]	H [3]	H [3]		III
ae (IMI 330189)	L [2]	L [2]	L [1]	L [1]	L [2]	L [3]	L [3]	L [3]		U
ɜt)	L [1]	H [2]	L [1]	L [1]	-	L [1 ‡]	M [1]	-		U
	L [1]	H [2]	L [1]	L [1]	L [3]	L [1 ‡]	L [3]	L [3]		U
	L	(H)	L	L	-	L [‡]	L	L		U

classification describes the level of availability of data: [1] classification based on laboratory and registration data with species which do not occur in locust areas; [2] laboratory data or small scale field trials with indigenous species from locust areas; [3] classification based on large scale field trials and operational data from locust areas but also Migratory and Brown Locust). The actual WHO toxicity class of the formulated insecticide may differ slightly from the one given here due to the effect of the formulation concentrations are used.

ıtments is extrapolated from blanket treatments, but is expected to be considerably lower if at least 50% of the area remains uncontaminated and if barriers are not sprayed k classes are therefore shown in brackets unless the blanket treatment was already considered to pose low risk, and no reference is made to the level of data availability. ɛded to confirm that products posing a medium or high risk as blanket sprays can be downgraded to "L" when applied as barrier sprays; [φ] see comment in paragraph 54; le from the Madagascar Migratory Locust area; [Φ] at normal use, diflubenzuron is not harmful to the brood of honey bee; [‡] benzoylureas are safe to adult worker bees but ge to the brood of exposed colonies; [§] WHO class: II = moderately hazardous, III = slightly hazardous, U = unlikely to present acute hazard in normal use; - : no data available

44. The criteria for the risk assessment applied by the PRG are given in Table 3. Existing classification criteria, e.g. widely used systems such as those agreed on by the European and Mediterranean Plant Protection Organization (EPPO) or the International Organization of Biological and Integrated Control (IOBC), are used as much as possible. Specific interpretations or modifications of certain of these schemes are discussed in the paragraphs below. Any assessments specifically designed and validated for locust areas were given priority.

Table 3. Criteria applied for the environmental risk classification used in Table 2. See text for further explanations.

A. Laboratory toxicity data					
Group	Parameter	Risk class			Reference
		low (L)	medium (M)	high (H)	
Fish	risk ratio (PEC^1/LC_{50}^2)	<1	1-10	>10	FAO/Locustox[4]
Aquatic arthropods	risk ratio (PEC/LC_{50})	<1	1-10	>10	FAO/Locustox
Reptiles, birds, mammals	risk ratio (PEC/LD_{50}^3)	<0.01	0.01-0.1	0.1	EPPO[5]
Bees	risk ratio (recommended dose rate/LD_{50})	<50	50-500	>500	PRG[6]/EPPO
Other terrestrial arthropods	acute toxicity (%) at recommended dose rate	<50%	50-99%	>99%	IOBC[7]

B. Field data (well conducted field trials and control operations)					
Group	Parameter	Risk class			Reference
		low (L)	medium (M)	high (H)	
Fish	evidence of mortality	none	incidental	massive	PRG
Aquatic arthropods	population reduction	<50%	50-90%	>90%	PRG
Reptiles, birds, mammals	evidence of mortality	none	incidental	massive	PRG
Bees	evidence of mortality	not significant	incidental	massive	EPPO
Other terrestrial arthropods	population reduction	<25%	25-75%	>75%	IOBC

[1] PEC: Predicted Environmental Concentration after treatment at the recommended dose rate; [2] LC_{50}: median lethal concentration; [3] LD_{50}: median lethal dose; [4] FAO/Locustox: FAO Locustox project in Senegal (Everts et al., 1997, 1998); [5] EPPO: European and Mediterranean Plant Protection Organization (EPPO, 1993, 1994); [6] PRG: Pesticide Referee Group; [7] International Organization for Biological and Integrated Control of Noxious Animals and Plants (Hassan, 1994). Note: As a result of a greater error associated with population estimates of terrestrial arthropods, the lower limits of the different risk classes are lower than for aquatic arthropods.

45. With respect to the risk to terrestrial vertebrates, the classifications based on laboratory data (with index [1]) are considered as resulting from direct exposure as a consequence of over-spraying. The results of this assessment were verified for some other possible routes of exposure whenever data were available. They included exposure of lizards to spray residues on the soil and exposure of mammals through ingestion of contaminated vegetation or invertebrate prey. This resulted in the same classification as given for risk of direct over-spraying as listed in Table 2.

46. For classification of risks to honey bees, the widely accepted ”hazard ratio“ is used, which is defined as the recommended dose rate (g a.i. per ha) divided by the LD50 (μg a.i. per bee). Low risk to bees corresponds to a hazard ratio <50; medium risk to a hazard ratio between 50 and 500; high risk to a hazard ratio of >500. It is acknowledged that this classification deviates from the one used by EPPO, that does not define a medium risk class. The EPPO threshold for low risk includes a safety factor of 10. This safety margin area is defined by the PRG as a medium risk. The risk discussed here refers to risk to adult worker bees only. However, risk to brood may be caused by benzoylurea IGRs when transported by the worker bees into the hives and fed to the brood.

47. Risk to non-target arthropods other than bees has been classified according to IOBC criteria, including non-target arthropods other than those covered by the IOBC.

48 . In the majority of non-target arthropods, the risk of barrier treatments is less when compared to blanket sprays because affected populations may recover through recolonisation from untreated inter-barrier areas. Therefore, from an ecotoxicological point of view, barrier treatments are preferred over blanket treatments. This implies that at least half of the inter-barrier areas should be completely uncontaminated during a control campaign if they are to function as true refugia.

49. Information summarised in Table 2 does not cover all relevant environmental effects. Long term effects and the risk of residues in livestock in treated areas are not taken into account. However, since most spraying is done on rangeland and pastures, a risk to livestock may exist. Withholding periods recommended by the manufacturer should therefore be strictly respected. The risk of bio-accumulation can be considered as low since all listed chemical pesticides are registered in OECD countries and have been classified by registration authorities as not posing a high risk of bio-accumulation. Therefore, the group did not specifically address this question.

50. The preliminary classification of imidacloprid is based on registration data and on five field studies in Madagascar. The group stresses the need for more data both from other areas (specifically from the Desert Locust zone) as well as from Madagascar.

51. Where dosages of deltamethrin higher than those considered efficacious for Desert Locust control (12.5 g a.i./ha) are used, e.g. in Malagasy Migratory Locust control (17.5 g a.i./ha), further environmental impact studies are needed.

52. Carbofuran is a toxic metabolite of carbosulfan and has been classified by WHO as highly hazardous (class Ib). No new environmental data have been provided to allow further evaluation.

53. With the exception of propoxur-phoxim, a mixture tested against a range of standard test organisms in Senegal, the database on side-effects of insecticide mixtures is limited. This has to be considerably improved if mixtures were to play a role in future locust control. At present, the PRG considers data on side-effects of mixtures at verified dose rates as insufficient for a full environmental assessment.

54. Massive kills of aquatic fauna, mainly shrimps in commercial farms, have been reported from Madagascar during Malagasy Migratory Locust control operations with chlorpyrifos and deltamethrin which are known to be highly toxic to crustaceans (see Table 2). High mortality was even reported when using fipronil which is not considered hazardous to crustaceans at verified dose rates. The incidents point to possible overdosing and underline that contamination of surface waters must be avoided. This implies that buffer zones as wide as the spray drift have to be respected and that water bodies need to be identified and registered in GPS guidance systems prior to the treatment. Furthermore, it is suggested to reassess the risk of fipronil to crustaceans, in particular to shrimps.

55. The Group is concerned that among the many reports received from Central Asia there were none on the environmental impact. Thus the particular situation in this region could not be taken into consideration.

OTHER SPECIES

56. FAO has been involved in the control of locusts in Central Asia and in Madagascar. Although dosages recommended for Desert Locust given in Table 1 may provide similar control of other locust species, reviews of trials in these regions have been made so that as much information as possible can be tabulated in a similar format. Table 4 provides a summary of the recommendations for *Calliptamus italicus, Dociostaurus maroccanus*, *Locusta migratoria capito* and *Locusta migratoria migratoria*. This information is primarily limited to those reports which were submitted to FAO during 1999, but also includes reference to relevant earlier reports. There are still insufficient data to include the Red Locust *Nomadacris septemfasciata*. Table 5 indicates which insecticides have been field tested but reports on their efficacy were either not available to the PRG or were not sufficient to obtain a verified dose rate.

57. Further experimentation has confirmed the efficacy of the benzoylurea teflubenzuron against *Locusta migratoria capito* at 50 g a.i./ha and 1 l/ha (within barriers) applied in barriers 50 m wide spaced 1000 m apart or 20 m wide and 200 m apart.

58. No further information was received concerning *Metarhizium anisopliae* isolate (SP-9), indigenous to Madagascar. In view of the importance of the availability of a biopesticide for ecologically sensitive areas, it is hoped that data will be available for review at the next PRG meeting. The Group also recognises that there are restrictions to the import of particular strains of mycoinsecticides which may limit the availability of a particular product.

Table 4. List of insecticides for which dosages can be suggested for the control of species other than the Desert Locust

Insecticide	Species	Dose (g a.i./ha)	treatment	Comments
Chlorpyrifos	LMC	240	blanket	
Chlorpyrifos + cypermethrin	LMC	120 + 14	blanket	
Deltamethrin	LMC	15	blanket *	
Diflubenzuron	CIT	7.5	blanket †	SC and OF formulations
	LMC	60	within barrier	OF formulation; no data for blanket treatment with SC formulation present
	LMM	9.6	blanket	SC formulation; no data for barrier treatment with OF formulation present
Fipronil	DMA	3	blanket	EC and UL formulations
	CIT, LMC, and LMM	4	blanket	lower dose of 2.5 g (CIT) and 2 g (LMC, LMM) a.i./ha (UL) effective as irregular blanket
	LMC	7.5	within barrier	
Imidacloprid	LMC	10	blanket	May be effective at lower doses but no data present
Profenofos + cypermethrin	LMC	200 + 20	blanket	
Teflubenzuron	LMC	50	within barrier	
Triflumuron	LMC	50	within barrier	

*17.5 g a.i./ha deltamethrin has been used in Madagascar, but initial trials indicate that a 15 g a.i./ha dosage will be effective under most conditions; † tests only done with irregular spraying (no true barriers); CIT = *Calliptamus italicus*, DMA = *Dociostaurus maroccanus*, LMC = *Locusta migratoria capito*; LMM = *Locusta migratoria migratoria*

Table 5. List of insecticides known to have been field tested against the Malagasy Migratory Locust or the Red Locust, but inadequate data presented to the PRG to include in Table 4

Insecticide	Malagasy Migratory Locust	Red Locust
Chlorpyrifos	included in Table 4	+
Carbosulfan	+	-
Cyfluthrin	+	+
Fenitrothion	+	+
Fipronil	included in Table 4	+
Metarhizium anisopliae (IMI 330189)	+	+
Metarhizium anisopliae (SP 9)	+	-
Propoxur + phoxim	+	+

+ : data available, - : no data

INSECTICIDE SELECTION

59. A major concern with locust control is that stocks of insecticides can become obsolete if stored for too long. Every effort is needed to minimise the quantities of pesticides kept for emergency use and develop a system of rapid selection and delivery of the insecticides most suitable for particular situations. To assist the discussion process, a flow chart is included that indicates factors which should be considered by decision makers when selecting insecticides (Figure 1). Where stocks of UL formulations are likely to exceed the recommended shelf life, they should where possible be reformulated for use, if appropriate, against other pests. One concern related to the application of an insecticide to settled swarms. As a rapid effect is required over a short period, there is no need for a persistent insecticide under these circumstances. An exception to this can occur when copulating swarms– especially the Malagasy Migratory Locust – stay in a particular area for a longer period of time and give rise to overlapping generations. However, the benefits of using persistent insecticides always have to be weighed against the increased environmental risk to non-target fauna.

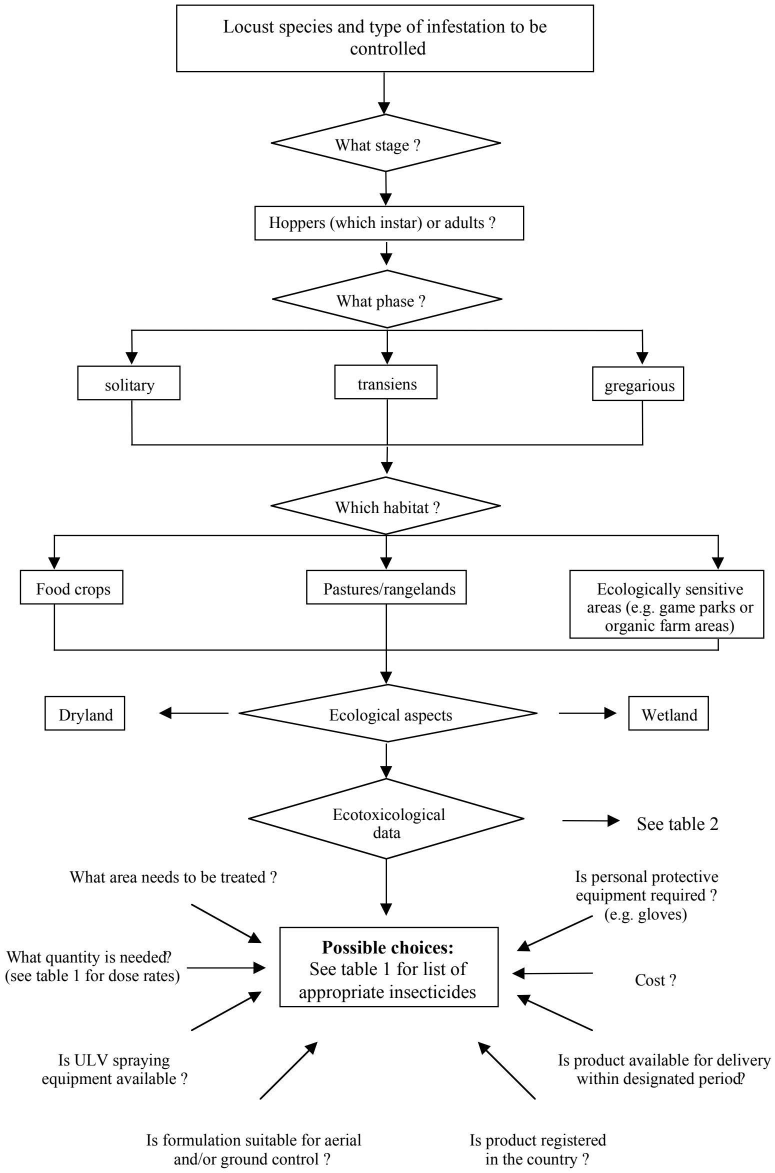

Figure 1. Factors that should be considered by decision makers when selecting insecticides for locust control.

EVALUATION AND MONITORING

60. The PRG continues to be concerned about the lack of feedback of information on operational use of insecticides against the Desert Locust. Clearly a system is needed to identify whether insecticides applied as recommended are sufficiently effective in large-scale operations. Some published reports (in Russian) referred to operational use of diflubenzuron against *Calliptamus italicus* and other species in Kazakhstan. Use of fipronil in Madagascar during 98/99 was also reported.

61. As pointed out previously, in view of the difficulty in quantifying the level of control achieved due to the mobility of locusts, attention should be given to appoint specially designated operational research teams whose task it would be to monitor control efficiency. In addition to evaluating the level of control achieved, the teams would provide data on any environmental effects observed in the locality treated. This is considered to be especially important where several sprays may be applied to the same area. The position of treated areas can be demarcated by using global positioning systems (GPS) and the information should be stored in a geographical information system. This will be particularly relevant to application of persistent pesticides, such as benzoylurea insecticides in areas with temporary aquatic ecosystems, to monitor any long term effects.

62. The increased availability of GPS linked to GIS now provides better means of maintaining exact records of areas treated so that the long-term impact of pesticides on locusts and non-target organisms could be evaluated. FAO should be encouraged to extend its "SWARMS" database (*Schistocerca* Warning Management System) to include information on the use of insecticides. Similar data will be required on the impact of mycopesticides in areas treated to assess whether the intensity of outbreaks in breeding areas can be reduced.

IMPLEMENTATION OF PREVIOUS RECOMMENDATIONS

63. Since the meeting in 1998 the following progress has been made:

⇒ Training programmes on improved pesticide application/control techniques have been carried out under the EMPRES programme; national training: Sudan (October 1998), Ethiopia (May 1999), Yemen (February 1999); regional training: Egypt – jointly with the CRC (November 1998); UK – "train of trainer" course was repeated (July 1998); Oman – another ToT course is scheduled (January 2000).

⇒ A model to optimise the use of barrier treatments is under development at NRI and is expected to be completed by late 2000.

⇒ Updated guidelines on control of locusts are expected to be circulated for comment by the end of 1999.

⇒ Ecotoxicological studies continued under the new phase of Locustox. In the EMPRES Central Region an assessment was made of the regional capacity for residue analysis.

⇒ FAO has made the work of the Pesticide Referee Group more widely known by making the Report available on the Locust Group's website.

⇒ A Regional Workshop on Biopesticides was held in Cairo in April 1999 to sensitise countries on the advantages of their use and to examine regulatory issues.

RECOMMENDATIONS

64. The PRG wished to re-emphasize the recommendations made at the previous meeting, namely:

⇒ FAO should continue to support ecotoxicological studies relevant to the locust situation. In particular data are needed further to quantify the environmental advantages of barrier treatments.

⇒ FAO should collect operational data on the area treated, the type and amount of insecticide used and the efficacy achieved during Desert Locust control operations so as to build up a centralised database.

⇒ FAO should encourage submission of pesticide efficacy and environmental data on other migratory locust and grasshopper species.

⇒ FAO should continue to make the work of the Pesticide Referee Group more widely known in the context of general crop protection.

⇒ Important contributions have come from representatives of locust affected countries, so it is suggested that FAO considers the possibility of convening one of the Group's meetings in one of these countries. This will enable the Group to discuss the latest reports with more persons directly involved in the practical aspects of locust control. Such discussions will undoubtedly benefit the host country.

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APPENDIX I

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11-14 October 1999

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APPENDIX I

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Appendix II

1999 Pesticide Referee Group Meeting – submitted efficacy (99-1 to 99-88) and environmental impact (99-A to 99-AA) reports

Control agent	***# - Submission title*** ➢ Efficacy or environmental impact report title	**Trial executor**	**Country**	Target species	**Code**
fipronil	**1. ADONIS® (fipronil): Compte rendu des travaux de développement (période 1998-1999)**	Rhône-Poulenc	Georgia, Russia, Ukraine, Kazakhstan, Madagascar, China, Zambia	*Calliptamus italicus, Dociostaurus maroccanus, Aeropus sibiricus, Chorthippus albomarginatus, Locusta migratoria migratoria*	99-1
fipronil	Appendix 1: Assessment of biological efficacy of ADONIS® 40 EC (RHÔNE-POULENC, France) in the control of *Calliptamus italicus* on the pastures	E. Abashidze, Georgian Scient. Research Institute of Plant Prot.	Georgia	*Calliptamus italicus*	99-2
fipronil	Appendix 2: Summary of a field test of ADONIS® 40 EC for control of Italian locust (*Calliptamus italicus)* in Volvograd region	O. Naoumovitch, VIZR	Russia	*Calliptamus italicus*	99-3
fipronil	Appendix 3 & 4 (French and Russian version): Rapport des essais de l'insecticide ADONIS® 40	A. Nikouline, VIZR	Russia	*Calliptamus italicus*	99-4
fipronil	Appendix 5: Results of field tests of ADONIS® 40 EC on sunflower, alfalfa and sugarbeet	A.S. Nekhai, Ukrainian Scient. Res. Institute of Plant Protection	Ukraine	*Calliptamus italicus*	99-5
fipronil	Appendix 6 & 7 (English and Russian version): Estimation of the biological efficiency of the insecticide ADONIS® 40 EC against Moroccan locust in the South of Kazakhstan and Italian locust in the North of Kazakhstan	S. Iskakov, Kazakh Scient. Res. Institute of Plant Protection	Kazakhstan	*Calliptamus italicus, Dociostaurus maroccanus*	99-6
fipronil	Appendix 8: Evaluation de l'efficacité du fipronil 4 ULV (ADONIS®) en traitement en barrières contre les bandes larvaires du Criquet marocain (*Dociostaurus maroccanus* Thunberg) *Note : This study includes an environmental impact sub-study*	A. Mouhim & J. Chihrane, Centre National de Lutte Antiacridienne	Morocco	*Dociostaurus maroccanus;* non-target arthropods: Carabidae, Tenebrionidae, Meloidae, Hymenoptera (ants), Asilidae	99-7 & 99-N
fipronil	Appendix 9: Essai d'application du fipronil 4 UL sur *Locusta migratoria capito* S. en traitement aérien avec différentes largeurs de passes	J. Rakotoarimanana & F. Ravolasahondra, Direct. Prot. des Végétaux	Madagascar	*Locusta migratoria capito*	99-8
fipronil	Appendix 10: Essai d'application du fipronil 7,5 UL en traitement aérien avec différentes largeurs de passes	M.-F. Ravolasahondra, Direct. Prot. des Végétaux	Madagascar	*Locusta migratoria capito, Nomadacris septemfasciata*	99-9

fipronil	Appendix 11: Rapport d'essai insecticide sur acridiens – Campagne 1999	M.-F. Ravolasahondra, Direct. Prot. des Végétaux	Madagascar	*Locusta migratoria capito*	99-10 = 99-56
fipronil	Appendix 12 & 13 (English and Russian version): Estimation of the biological efficiency of the insecticide ADONIS® 40 EC against Asian locust	V. Levchenko, Kazakh Scient. Res. Institute of Plant Protection	Kazakhstan	*Locusta migratoria migratoria*	99-11
fipronil	Appendix 14: Mission de suivi et d'assistance aux essais de fipronil en Chine	T. Rachadi, CIRAD-AMIS	China	*Locusta migratoria migratoria*	99-12
fipronil	Appendix 15 & 16 (English and French version): Scientific and technical assistance for a migratory locust control demonstration test conducted in Henan province (China) using fipronil	T. Rachadi, CIRAD-AMIS	China	*Locusta migratoria migratoria*	99-13
fipronil	Appendix 17: Field evaluation of fipronil (ADONIS® 6 UL) for the control of adult Red locust (*Nomadacris septemfasciata*) populations in Kafue flats outbreak area in Southern Zambia	J. W. Bahana, IRLCO-CSA	Zambia	*Nomadacris septemfasciata*	99-14
fipronil	Appendix 18: Field testing of fipronil 6.25 ULV on the Red Sea coast of Yemen *Note: Graphs and tables only*	Y. Al Gashm, Plant Protection Directorate	Yemen	*Schistocerca gregaria*	99-15
fipronil	Appendix 19 & 20 (English and Russian version): Estimation of the biological efficiency of the insecticide ADONIS® 40 EC against non-gregarious locusts in the North of Kazakhstan	I.A. Komissarova, Kazakh Scient. Res. Institute of Plant Protection	Kazakhstan	*Dociostaurus* spp. and other grasshoppers	99-16
fipronil, esfenvalerate, deltamethrin, diflubenzuron	Appendix 21: Environmental impact of acridicides in the Karoo *Note: Environmental impact study*	M.C. Van d. Westhuizen & P.W.J. Roux, Dep. Zool. & Entom., Univ. Orange Free St.	South Africa	Field study on side-effects on non-target arthropods and on indirect effects on the flora	99-A
triflumuron	**2. Rapport d'évaluation de l'efficacité biologique de l'Alsystin 050 UL** *Note: Summary tables*	R. Randrianarivo & L.R. Ratsimbazafy	Madagascar	*Locusta migratoria capito*	99-17
propoxur	**3. Rapport d'évaluation UNDENE 3 DP en lutte antiacridienne à Madagascar** *Note: Summary tables*	J. Pedras & R. Randrianarivo	Madagascar	*Locusta migratoria capito*	99-18
imidacloprid	**4. Rapport d'essai de produits acridicides** *Note: Summary tables*	D. Rakotoasombola	Madagascar	*Locusta migratoria capito*	99-19 = 99-59
	5. Overview of activities with regard to the development of diflubenzuron formulations for control of locust and grasshoppers	Uniroyal Chemical Europe	Kazakhstan	*Calliptamus italicus*, *Dociostaurus* spp., other grasshoppers	

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diflubenzuron	Appendix 1 (English and Russian version): Report on the results of registration experiments of the insecticide Dimilin 48 % SC made by Uniroyal Chemical (USA) against harmful Acridoidea in 1998	N.Y. Evdokimov, Pavlodar Regional Station Plant Prot.	Kazakhstan	*Calliptamus italicus, Dociostaurus* spp., other grasshoppers	99-20
diflubenzuron	Appendix 2 (English and Russian version): Report on trials of the insecticide Dimilin (Uniroyal Chemical, USA) against a range of Acrididae grasshoppers in Akmolinski oblast	N. Samokhvalov, I. Stafeyeva, & V. Kambulin, Akmolin Oblast Plant Prot. Station	Kazakhstan	*Calliptamus italicus,* other grasshoppers	99-21
diflubenzuron	Appendix 3 (English and Russian version): Report on the results of using the pesticide Dimilin (produced by Uniroyal Chemical, USA) against harmful Acridoidea (Acrididae) in the North Kazakhstan region	I.G. Temreshev, Z.S. Suleimenova & A. Zhukashev, North Kazakhstan Regional Plant Protection Station	Kazakhstan	*Calliptamus italicus,* other grasshoppers	99-22
diflubenzuron	Appendix 4 (English and Russian version): Problems of protection of agricultural crops and lands against locust and grasshopper pests. Plant Protection in Kazakhstan 1999 (1): 21-25 *Note: published article*	N. Evdokimov, Z. Temirgaliev & M. Dublyazhova	Kazakhstan	*Calliptamus italicus, Dociostaurus maroccanus,* other grasshoppers	99-23
diflubenzuron	Appendix 5 (English and Russian version): New technology of control of locusts and grasshoppers: application experience. Plant Protection in Kazakhstan 1998 (4): 23-25 *Note: published article*	Z. Suleimenova, A. Zhukashev & P. Baginskiy	Kazakhstan	*Calliptamus italicus, Chorthippus albomarginatus, Oedaleus decorus, Dociostaurus brevicollis,* other grasshoppers	99-24
diflubenzuron	Appendix 6 (English and Russian version): About the problem of regulating locusts and grasshopper quantity in Kazakhstan. Plant Protection in Kazakhstan 1999 (1): 26-30 *Note: published article*	S. Yskak & I. Komissarova	Kazakhstan	*Locusta migratoria, Dociostaurus maroccanus Calliptamus italicus,* other grasshoppers	99-25
diflubenzuron	Appendix 7: Assessment of the side effects of Dimilin WG-80 on the honey bee (*Apis mellifera* L.) in the semi-field at two different locations *Note: Environmental impact study*	I. Tornier, AG GAB Biotechnologie und IfU Umweltanalytik	Germany	Semi field trial on side-effects on honey bees, *Apis mellifera*	99-B
diflubenzuron	Assessment of side effects of Dimilin WG-80 on the honey bee (*Apis mellifera* L.) in the field by application during bee-flight *Note: Environmental impact study*	I. Tornier, AG GAB Biotechnologie und IfU Umweltanalytik	Germany	Field trial on side-effects on honey bees, *Apis mellifera*	99-C
fipronil	**6. Evaluation de la campagne antilarvaire, orientation de la campagne anti-essaims et réhabilitation du service antiacridien dans le sud et le sud-ouest de Madagascar**	J. Andrianasolo Ravoavy	Madagascar	*Locusta migratoria capito*	99-26
triflumuron	**7. Rapport d'évaluation de l'efficacité biologique de l'Alsystin 050 UL**	R. Randrianarivo & L.R. Ratsimbazafy	Madagascar	*Locusta migratoria capito*	99-27

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deltamethrin	**8. Information on Decis 17.5 g/l ULV and other formulations**	AgrEvo	Madagascar	*Locusta migratoria capito*	99-28
fipronil	**9. Statement on World Bank Panel of Experts Report**	Rhône Poulenc	Madagascar	*Locusta migratoria capito*	99-29
fipronil	Appendix 1: Les effets de très faibles doses de fipronil sur diverses espèces de sauteriaux et d'insectes non cibles. Résultat expérimentaux obtenus par le CIRAD-GERDAT-PRIFAS au Niger *Note: summary only*	G. Balança & M.N. de Visscher	Niger	Study on effects on grasshoppers and side-effects non target insects	"
fipronil	Appendix 2: Remarques de Rhône-Poulenc Agro sur le rapport du Panel d'experts de la Banque Mondiale relatif à la lutte antiacridienne à Madagascar	Rhône-Poulenc	Madagascar	*Locusta migratoria capito*	"
	10. Nomolt® teflubenzuron 50 g/l ULV barrier trials / Madagascar	Cyanamid Int.	Madagascar	*Locusta migratoria capito*	
teflubenzuron	Appendix 1: Insecticide trial report on locusts - 1996/97 Campaign	Cyanamid Int.	Madagascar	*Locusta migratoria capito*	99-30
teflubenzuron	Appendix 2: Insecticide trial report on locusts - 1997 Campaign	Cyanamid Int.	Madagascar	*Locusta migratoria capito*	99-31
teflubenzuron	Appendix 3: Insecticide trial report on locusts - 1997/98 Campaign	Cyanamid Int.	Madagascar	*Locusta migratoria capito*	99-32
insect growth regulators	**11. A simple model to estimate the optimal separation an swath width of ULV-sprayed barriers of chitin synthesis inhibitors (CSI) to control locust hopper bands. Crop Protection 18 (1999): 151-158** *Note: published article*	G.D.A. Coppen	Locust affected countries	*Schistocerca gregaria, Locusta migratoria capito, Dociostaurus maroccanus*	99-33
phoxim/propoxur	**12. Trial report on locust control products (English and French version)**	D. Rakotoasombola	Madagascar	*Locusta migratoria capito*	99-34
carbosulfan	**13. Statement of FMC on non-approval of carbosulfan for locust control**	FMC Int.	Locust affected countries	All locusts	99-35
fipronil, fenpropathrin	**14. Field trial evaluation of fipronil for controlling rice grasshoppers (Oxya spp. Serv.) in Shaanxi Province (China)**	X. Shengquan, Z. Zhemin, W. Mingqing & D. Zhiyong	China	*Oxya chinensis, O. intricata, O. adentata, O. japonica*	99-36
fipronil, unidentified organophosphorus/pyrethroid combination	**15. Evaluation of fipronil 4 UL in the control of grasshoppers in the pastoral area of Qinghai Province, China** *Note: includes anecdotal observations on side-effects on non-target insects*	L. Zhibin, X. Shenque, W. Haichuan, W. Qingchua, L. Tao & L. Xiaojian	China	*Myrmeleotettix palpalis, Chorthippus fallax, C. brunneus, C. dubus, Angaracris rhodopa,* other grasshoppers; ground-dwelling non-target insects	99-37
chlorpyrifos	**16. Statement of Dow AgroSciences on the alleged poor performance of Dursban in Madagascar**	Dow AgroSciences	Madagascar	*Locusta migratoria capito, Nomadacris septemfasciata*	99-38

fenitrothion, chlorpyrifos, parathion, profenofos/cy-permethrin, fenitrothion/ esfenvalerate, fenitrothion/ fenvalerate, propoxur, fipronil, triflumuron, hexaflumuron, diflubenzuron	**(not considered as a submission) Aspects environnementaux de la campagne actuelle de lutte antiacridenne** *Note: Submission of document not clear*	C.C.D. Tingle	Madagascar	*Locusta migratoria capito, Nomadacris septemfasciata*	99-G
	17. Documents presumably submitted by the Ministry of Agriculture, Madagascar	Ministère de l'Agriculture	Madagascar	*Locusta migratoria capito*	
profenofos/cypermethrin	Appendix 1: Confirmation de l'efficacité d'un produit de la Société SACAO déjà homologué en lutte antiacridienne sur essaim de *Locusta migratoria capito*	Ministère de l'Agriculture	Madagascar	*Locusta migratoria capito*	99-39
profenofos/cypermethrin	Appendix 2: Confirmation de l'efficacité de la formulation Polytrine C 220 UL (APV No. 048/95 du 21 Novembre 1996) de la Société SACAO sur larves de *Locusta migratoria capito* en traitement terrestre et en couverture totale.	Ministère de l'Agriculture	Madagascar	*Locusta migratoria capito*	99-40
profenofos/cypermethrin	Appendix 3: Polytrine C - un insecticide anti-sauteriaux efficace	CIRAD	Sahel	*Oedaleus senegalensis, Hieroglyphus daganensis,* other grasshoppers	99-41
diflubenzuron	**18. Traitement en barrière avec le diflubenzuron (Dimilin 450) contre les bandes larvaires de Locusta migratoria**	M. Randriamanantsoa	Madagascar	*Locusta migratoria capito*	99-42
	19. Supervised field trials results with Dursban® and Nurelle-D® ULV insecticides against Locusta migratoria in Madagascar *Note: includes a statement on the PRG evaluation of chlorpyrifos*	Dow AgroSciences	Madagascar, Senegal, Sudan	*Locusta migratoria capito, Schistocerca gregaria, Hieroglyphus daganensis, Cataloipus* sp., *Kraussaria angulifera*	
chlorpyrifos, chlorpyrifos/cypermethrin	Appendix 1: Technical report on migratory locust field trials in Madagascar	P.A. Spurgin	Madagascar	*Locusta migratoria capito*	99-43
chlorpyrifos, chlorpyrifos/cypermethrin	Appendix 2: Comparison of the toxicity of six formulations of Dursban 240 ULV and Nurell-D 14/120 ULV on young adult desert locusts	C. K. Muinamia	Kenya	*Schistocerca gregaria*	99-44
chlorpyrifos/cypermethrin	Appendix 3: Test d'efficacité de Nurelles D 14/120 ULV de Dow AgroSciences/COMACAT sur les larves de *Locusta migratoria* en traitement terrestre et en couverture totale	Ministère de l'Agriculture	Madagascar	*Locusta migratoria capito*	99-45
chlorpyrifos/cypermethrin	Appendix 4: Test d'efficacité de Nurelle D 14/120 ULV de Dow AgroSciences/COMACAT sur essaims de *Locusta migratoria* en traitement aérien et en couverture totale	Ministère de l'Agriculture	Madagascar	*Locusta migratoria capito*	99-46

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chlorpyrifos	Appendix 5: Test d'efficacité du Dursban 240 ULV de la Société de Dow AgroSciences/COMACAT sur larves de *Locusta migratoria*	Ministère de l'Agriculture	Madagascar	*Locusta migratoria capito*	99-47
chlorpyrifos-methyl	Appendix 6: Rapport sur l'introduction du Reldan 500 ULV en milieu paysan Babak – Pout Ndof – Keur Bakary – Ndingler – Diass – Region de Thies	P. M. Tall, Inspection Reg. Prot. Végétaux	Senegal	*Hieroglyphus daganensis, Cataloipus* sp., *Kraussaria angulifera*	99-48
chlorpyrifos-methyl, cyhalothrin, bendiocarb	Appendix 7: A report on a field trial on pesticides cyhalothrin (Cypha) 4 ULV, bendiocarb (Ficam) 960 ULV and chlorpyrifos-methyl (Reldan) 500 ULV against desert locust, *Schistocerca gregaria* (Forskål)	A. O. Ahmed, Plant Protection Department, Min. of Agriculture	Sudan	*Schistocerca gregaria*	99-49
	Appendix 8: Compte-rendu du programme de stewardship réalisé à Maradi Niger – Mars 1999	Dow AgroSciences	Niger	locusts	99-50
Metarhizium (*flavoviride*) *anisopliae* var. *acridum*, IMI 330189	**20. Metarhizium anisopliae var. acridum for control of locusts and grasshoppers with minimal environmental impact – a third submission to the Desert Locust Pesticide Referee Group of the Food and Agriculture Organisation of the United Nations** *Note: update of previous submissions, including environmental impact and toxicology*	LUBILOSA Programme	West , East and South Africa	*Schistocerca gregaria, Anacridium melanorhodon, Locustana pardalina, Oeda-leus senegalensis* and other locusts and grasshoppers	
M. anisopliae, IMI 330189	Appendix 1.1: Green Muscle (IMI 330189): formulation properties	LUBILOSA Programme			99-51
M. anisopliae, IMI 330189	Appendix 1.2: Material safety data sheet	LUBILOSA Programme			99-52
M. anisopliae, IMI 330189	Appendix 1.3: Exotoxicological profile	LUBILOSA Programme	general	General toxicology and ecotoxicology	99-D
M. anisopliae, IMI 330189	Appendix 1.4: GLP reports on impact to aquatic organisms (summaries only): Zebra fish: *Brachydanio rerio* (*Danio rerio*); rainbow trout: *Oncorhynchus mykiss*; water fleas: *Daphnia magna*	LUBILOSA Programme	general	Aquatic fauna	99-E
M. anisopliae, IMI 330189	Appendix 2.1: Limits to the negative logarithmic relationship between moisture content and longevity in conidia of *Metarhizium flavoviride*. Annals of Botany 81 (1998): 625-630 *Note: published paper*	Hong et al.	general	Storage under hot conditions	99-53
M. anisopliae, IMI 330189, fenitrothion	Appendix 2.2: An assessment of the impact of biological and chemical grasshopper control agents on ground-dwelling arthropods in Niger, based on presence/absence sampling. Crop Protection 18 (1999): 323-339 *Note: published paper*	R. Peveling, S. Attignon, J. Langewald, Z. Ouambama	Niger	Assessment of impact on target grasshoppers (*Oedaleus senegalensis* and others) and ground-dwelling non-target arthropods	99-F

M. anisopliae, IMI 330189, fenitrothion	Appendix 2.3: Comparison of an organophosphate insecticide with a mycoinsecticide for the control of *Oedaleus senegalensis* and other Sahelian grasshoppers at an operational scale. Biocontrol Science ad Technology 9 (1999): 199-214 *Note: published paper*	J. Langewald, Z. Ouambama, A. Mamadou, R. Peveling, I. Stolz, R. Bateman,S. Attignon, S. Blanford, S. Arthurs, C. Lomer	Niger	*Oedaleus senegalensis, Acrotylus blondeli, Pyrgomorpha cognata,* Sahelian grasshopper complex	99-54
fipronil	**21. Etude de l'effet initial de la persistance du fipronil en lutte antiacridienne contre Locusta migratoria**	J. Rakotoarimanana, D. Rabakoarijao, M.F. Ravolasahondra, J. Andrianarivelo, Dir. Prot. Végétaux	Madagascar	*Locusta migratoria capito*	99-55
fipronil	Appendix 1: Vérification de l'effet initial et de la persistance d'ADONIS 4 UL de la Société Rhône Poulenc en traitement aérien contre les essaims de *Locusta migratoria capito*	Direction Prot. Végétaux, Division Experimentation	Madagascar	*Locusta migratoria capito*	99-56 = 99-10
fipronil	Appendix 2: Contrôle de l'effet initial et de la persistance d'ADONIS 4 UL de la Société Rhône Poulenc Delta Madagascar en traitement aérien avec une passe irrégulière de 200 m tout en gardant les paramètres initiaux de traitement contre les essaims de *Locusta migratoria capito*	Direction Prot. Végétaux, Division Experimentation	Madagascar	*Locusta migratoria capito*	99-57
imidacloprid	**22. Confidor 010 UL – To meet the Locust control Demands of the FAO /AGPP and PRG Members** **Note: all documents on CD, Adobe Reader**	Bayer	Madagascar, Tashkent, USA, Uzbekistan	*Locusta migratoria capito*	
imidacloprid	Appendix 1.1: Evaluation of imidacloprid UL for the operational control of migratory locusts swarms in Madagascar	R.E. Price, Locust Research Unit (ARC-PPRI, S.A:) J.Pedras (Bayer), R. Randiananarivo	Madagascar	*Locusta migratoria capito*	99-58
imidacloprid	Appendix 1.2: Rapport d'essai de produits acridicides – Mission du 20 au 27.6.1999	D. Rakotohasimbola, Direction Protection Végétaux,	Madagascar	*Locusta migratoria capito*	99-59 = 99-19
imidacloprid	Appendix 1.3: (French and English Version): Essais d'Imidaclopride en lutte anti-acridienne à Madagascar	M. Randriamanantsoa, Direction Prot. Végétaux / GTZ	Madagascar	*Locusta migratoria capito*	99-60
imidacloprid	Appendix 1.4: Rapport d'essai de produits acridicides – Mission du 04 au 22.12.1998	M. Randriamanantsoa, Direction Protection Végétaux / GTZ	Madagascar	*Locusta migratoria capito*	99-61
imidacloprid	Appendix 1.5 (in German): Untersuchung zur Wirksamkeit von Confidor UL 010 und Confidor SL 200 gegen Wanderheuschrecken (Locusta migratoria).	Schnorbach H.J., Bayer	general		99-62

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imidacloprid, deltamethrin	Appendix 1.6 (in German): Untersuchung zur Wirksamkeit von Confidor SL 200 gegen Heuschrecken in Usbekistan. *Note: short summary and tables*	Brüggen, K.U., Bayer	Uzbekistan	*Dociostaurus maroccanus, D. nigrogeniculatus, Calliptamus turanicus*	99-63
triflumuron, imidacloprid, deltamethrin	Appendix 1.7 (in German): Laborversuche zu der Wirkung von Confidor 200 SL auf die Wüstenheuschrecke *Schistocerca gregaria* (Forsk.) im Vergleich mit Alsystin (39.7% a.i.) und Decis 025 EC	S. Assembe Tsoungui, University of Hannover (Zoology), Germany	Madagascar	*Schistocerca gregaria*	99-64
imidacloprid, permethrin	Appendix 1.8: Evaluation of Provado for grasshopper control, Rangeland, Idaho, 1996 *Note: Docu-form Bayer: summary and tables*	J.W. Warren, Bayer	USA	*Melanoplus* sp.	99-65
imidacloprid, permethrin	Appendix 1.9: Evaluation of Provado for grasshopper control, Rangeland, Idaho, 1999 *Note: Docu-form Bayer: summary and tables*	J. W. Warren, Bayer	USA	*Melanoplus* sp.	99-66
imidacloprid	Appendix 1.10: Determine efficacy of foliar NTN 33893 on soyabean pests. *Note : Docu-form Bayer: summary and tables*	S. M. Schmiel, Bayer	USA	*Melanoplus* sp. and other grasshoppers	99-67
imidacloprid	Appendix 1.11: Results of Confidor 20% EC and Enduro 28.5 EC against different insects on agriculture crops and pastures	Khodja-Ahmedov, UzPP Institute, Tashkent	Tashkent	*Dociostaurus maroccanus* and other grasshopppers	99-68
imidacloprid	Appendix 1.12 (in German) Wirkung von Imidacloprid auf Heuschrecken (*Schistocerca gregaria*)	Dr. Tietjen, Bayer	laboratory	*Schistocerca gregaria*	99-69
imidacloprid	Appendix 2.1: Imidacloprid : Summary on ecobiology	R. Grau, Bayer	laboratory	General toxicology and ecotoxicology	99-H
imidacloprid, fipronil, deltamethrin	Appendix 2.2: Effets à court terme des acridicides, Fipronil, Decis, Confidor sur les termites	S. Rafanomezana, Projet DPV/GTZ	Madagascar	Non-target arthropods (Termites): *Coarctotermes clepsydra* and *C. pauliani*	99-I
imidacloprid, fipronil, deltamethrin	Appendix 2.3: Les effets de trois insecticides (Fipronil, Deltaméthrine, Imidaclopride) sur les arthropodes non cibles épigés, en lutte antiacridienne	A. Raveloson, Projet DPV/GTZ	Madagascar	Non-target arthropods: *Glyptophrynus tenuesculptus* (Tenebrionidae); *Chlaenius obscuricollis* (Carabidae); ants; spiders	99-J
imidacloprid, fipronil, deltamethrin	Appendix 2.4: Evaluation comparative des effets à court terme de trois acricides : fipronil (Adonis 4), deltaméthrine (Decis 17.5) et imidacloprid (Confidor 10) sur les reptiles dans la région d'Ankazoabo	H. Rakotondramasy, Projet DPV/GTZ	Madagascar	Reptiles (skinks): *Mabuya elegans*	99-K

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imidacloprid, fipronil, deltamethrin	Appendix 2.5: Evaluation comparative des effets à court terme de trois acricides : fipronil (Adonis 4), deltaméthrine (Decis 17.5) et imidacloprid (Confidor 10) sur les micromammifères dans la région d'Ankazoabo	H. Rakotondramasy, Projet DPV/GTZ	Madagascar	Mammals (Insectivora): *Echinops telfairi; Suncus madagascariensis*	99-L
imidacloprid, fipronil, deltamethrin	Appendix 2.6: Impact à court terme de trois acridicides sur les arthropodes	J.-J. Rafanomezantsoa, Projet DPV/GTZ	Madagascar	Non-target arthropods: Araneae (Theridiidae, Philodromidae, Araneidae), Acrididae, Formicidae, Pipunculidae	99-M
propoxur, propoxur/phoxim	**23. Non-target toxicity tests with propoxur and propoxur-phoxim**	FAO Locustox,	Senegal	Aquatic and terrestrial non-target test species from locust and grasshopper habitats	
propoxur	Test LCTX 9803: La toxicité topicale aiguë de propoxur sur *Trachyderma hispida* (Coleoptera, Tenebrionidae)	FAO Locustox, Volet Entomologie	Senegal	Toxicity test according to standard testing procedure: *Trachyderma hispida*	99-N1
propoxur	Test LCTX 9804: La toxicité par ingestion de propoxur 75 WP sur *Trachyderma hispida* (Coleoptera, Tenebrionidae)	FAO Locustox, Volet Entomologie	Senegal	Toxicity test according to standard testing procedure: *Trachyderma hispida*	99-N
propoxur	Test LCTX 9805: La toxicité par ingestion de propoxur 2% DP sur *Pimelia senegalensis* (Coleoptera, Tenebrionidae)	FAO Locustox, Volet Entomologie	Senegal	Toxicity test according to standard testing procedure: *Pimelia senegalensis*	99-O
propoxur/phoxim	Test LCTX 9806: La toxicité topicale aiguë de propoxur-phoxim sur *Trachyderma hispida* (Coleoptera, Tenebrionidae)	FAO Locustox, Volet Entomologie	Senegal	Toxicity test according to standard testing procedure: *Trachyderma hispida*	99-P
propoxur	Test LCTX 9807: La toxicité par ingestion de propoxur 2% DP sur *Trachyderma hispida* (Coleoptera, Tenebrionidae)	FAO Locustox, Volet Entomologie	Senegal	Toxicity test according to standard testing procedure: *Trachyderma hispida*	99-Q
propoxur/phoxim	Test LCTX 9808: La toxicité par ingestion de propoxur-phoxim sur *Trachyderma hispida* (Coleoptera, Tenebrionidae)	FAO Locustox, Volet Entomologie	Senegal	Toxicity test according to standard testing procedure: *Trachyderma hispida*	99-R
propoxur/phoxim	Test LCTX 9809: La toxicité topicale aiguë de propoxur-phoxim sur *Pimelia senegalensis* (Coleoptera, Tenebrionidae)	FAO Locustox, Volet Entomologie	Senegal	Toxicity test according to standard testing procedure: *Pimelia senegalensis*	99-S
propoxur	Test LCTX 9811: La toxicité par ingestion de propoxur 75 WP sur *Pimelia senegalensis* (Coleoptera, Tenebrionidae)	FAO Locustox, Volet Entomologie	Senegal	Toxicity test according to standard testing procedure: *Pimelia senegalensis*	99-S2

propoxur/phoxim	Test LCTX 9812: La toxicité aiguë de propoxur/phoxim sur *Anisops sardeus* (Hemiptera, Notonectidae)	FAO Locustox, Volet Ecotoxicologie Aquatique	Senegal	Toxicity test according to standard testing procedure: *Anisops sardeus*	99-T
propoxur/phoxim	Test LCTX 9813: La toxicité aiguë de propoxur 75 WP sur *Anisops sardeus* (Hemiptera, Notonectidae)	FAO Locustox, Volet Ecotoxicologie Aquatique	Senegal	Toxicity test according to standard testing procedure: *Anisops sardeus*	99-U
propoxur/phoxim	Test LCTX 9814: La toxicité aiguë de propoxur 75 WP sur *Oreochromus niloticus* (Pisces, Cichlidae)	FAO Locustox, Volet Ecotoxicologie Aquatique	Senegal	Toxicity test according to standard testing procedure: *Oreochromus niloticus*	99-V
propoxur	Test LCTX 9815: La toxicité aiguë de propoxur 2% DP sur *Anisops sardeus* (Hemiptera, Notonectidae)	FAO Locustox, Volet Ecotoxicologie Aquatique	Senegal	Toxicity test according to standard testing procedure: *Anisops sardeus*	99-W
chlorpyrifos, fipronil	**24. Effets du chlorpyrifos et du fipronil sur les coléoptères rampants et les arthropodes du sol dans la savane semi-aride de Fete-Ole au Nord du Sénégal**	A. Danfa, A.L. Ba, H. van der Valk, C. Rouland-Lefèvre, W. Mullié, J. W. Everts; FAO Locustox	Senegal	Long term field trials with particular emphasis on ants and termites	99-X
fenitrothion, fenitrothion/ esfenvalerate, triflumuron	**25. Environmental impact of the locust control agents fenitrothion, fenitrothion-esfenvalerate and triflumuron on terrestrial arthropods in Madagascar hopper bands. Crop Protection 18 (1999) : 659-676** *Note: published article*	R. Peveling, J.-J. Rafanomezantsoa, R. Razafinirina, R. Tovonkery, G. Zafimaniry	Madagascar	Medium and large-scale field trials on side effects on non-target arthropods	99-Y
diflubenzuron, fenitrothion	**26. Evaluation des effets du fenitrothion et du diflubenzuron sur l'entomofaune auxiliaire des acridiens dans la savane sèche du Nord Sénégal**	A. Niassy, H. van der Valk; FAO Locustox	Senegal	Field trials with particular reference to beneficial arthropods	99-Z
All products	**27. Madagascar – mission de formulation d'un programme de lutte antiacridienne a court, moyen et long termes**	FAO	Madagascar		99-70
	28. Decis vs locusts and grasshoppers – New trial & control operations reports July 1999 – Summary of results	AgrEvo	Madagascar	*Locusta migratoria capito*	99-71
deltamethrin	Appendix 1: Report on trials carried out in Madagascar to further evaluate the efficacy of deltamethrin against the Madagascar migratory locust (*Locusta migratoria capito* (Saussure))	H.Greef, S.J. Ross; AgrEvo SA	Madagascar	*Locusta migratoria capito*	99-72
deltamethrin	Appendix 2: Preliminary consultant report				99-73
deltamethrin	Appendix 3: Essai de confirmation de la Deltamethrine 17.5 ULV de la Société Hoechst sur essaims de *Locusta migratoria capito*	M.-F. Ravolasahondra, Direct. Prot. des Végétaux	Madagascar	*Locusta migratoria capito*	99-74

deltamethrin	Appendix 4: DPV-Hoechst Madagascar S.A. aerial spray trial with Decis 17.5 UL against adult swarms of *Locusta migratoria capito* (Saussure), Ranohira aerea, Madagascar, 22-27 August, 1998	D. Brown, F. Andriantsihoarana; Hoechst Madagascar	Madagascar	*Locusta migratoria capito*	99-75
deltamethrin	Appendix 5: Rapport de suivi Decis 17.5 ULV appliqué sur les criquets migrateurs	A. Herindranovona; Comité National de Lutte Antiacridienne	Madagascar	*Locusta migratoria capito*	99-76
deltamethrin	Appendix 6: Essai d'efficacité de la Deltamethrine en formulation ULV de la Société Hoechst Madagascar sur les larves des criquets migrateurs	M.-F. Ravolasahondra, Direct. Prot. des Végétaux	Madagascar	*Locusta migratoria capito*	99-77
deltamethrin	Appendix 7: Tester l'efficacité de 5 formulations de la Société Hoechst sur les criquets	M.-F. Ravolasahondra, Direct. Prot. des Végétaux	Madagascar	*Locusta migratoria capito*	99-78
deltamethrin	Appendix 8: Contrôle de confirmation ou infirmation des résultats obtenus lors des précédents essais de la Deltamethrine de la Société Hoechst S.A . sur *Locusta migratoria capito* (larves et adultes)	M.-F. Ravolasahondra, Direct. Prot. des Végétaux	Madagascar	*Locusta migratoria capito*	99-79
deltamethrin	Appendix 9: Rapport d'évaluation de Decis 17.5 ULV sur *Locusta migratoria capito* dans la région du Boina – Avril 1999	M.G. Randriamaharavo; Hoechst Madagascar	Madagascar	*Locusta migratoria capito*	99-80
deltamethrin	Appendix 10: Rapport d'évaluation Decis 17.5 ULV sur *Nomadacris septemfasciata* (Audinet-Serville, 1838)	A. Herindranovona; Hoechst Madagascar	Madagascar	*Nomadacris septemfasciata*	99-81
deltamethrin	Appendix 11: Rapport d'observation Decis® contre *Locusta migratoria capito* (Saussure, 1884)	A. Herindranovona; Interkem S.A	Madagascar	*Locusta migratoria capito*	99-82
deltamethrin	Appendix 12 (English and Russian version): Report on improvement in technology of applying Decis and Decis Extra produced by AgrEvo company (Germany) against non-gregarious locusts in spring wheat crops area in North Kazakhstan	Z.D. Ismukhambetov, T.N. Nurmuratuly, I.A. Comissarova, G. Zhumagalieva; Kazakh Plant Prot. Res. Institute	Kazakhstan	*Paracyptera microptera, Chorthippus albomarginatus, Dociostaurus brevicollis* and other grasshoppers	99-83
deltamethrin	Appendix 13 (English and Russian version): Report on the outcome of testing various doses of insecticide Decis 2.5% EC (AgrEvo company, Germany) against Asian locusts (*Locusta migratoria* L.) and Italian locust in South-East and North Kazakhstan	T.N. Nurmuratuly, S. Iskakov, V.I. Levchenko, Kazakh Plant Prot. Res. Institute	Kazakhstan	*Calliptamus italicus,* *Locusta migratoria migratoria*	99-84
	29. Untitled dossier submitted by Uniroyal				
diflubenzuron	Appendix 1: Report on registration trials of Dimilin 48% SC insecticide, Uniroyal Chemical (USA), against Asian locust	Kazakh Agrarian University	Kazakhstan	*Locusta migratoria migratoria*	99-85

diflubenzuron	Appendix 2 (in English and Russian): Report on the outcomes of Dimilin-OF-6 application to control locusts and grasshoppers in the Pavlodar Oblast in 1999	Z.K. Temirgaliev, D.D. Golysh; Pavlorad Regional Plant Prot. Depart.	Kazakhstan	*Calliptamus italicus,* other grasshoppers	99-86
diflubenzuron	Appendix 3: Report on the outcomes of testing Dimilin insecticide (Uniroyal Chemical Company, USA) against locusts and grasshoppers in the Kostanai Region in 1999	S.S. Khasenov; Kostanai Regional Plant Prot. Depart.	Kazakhstan	*Calliptamus italicus, Paracyptera microptera, Dociostaurus krauss, Chorthippus albomarginatus* and other grasshoppers	99-87
diflubenzuron	Appendix 4: Report on the outcomes of the use of Dimilin SC-48 insecticide (Uniroyal Chemical Firm, USA) in the Akmola Region in 1999	I.Temreshev; Akmola Regional Plant Prot. Depart.	Kazakhstan	*Calliptamus italicus, Paracyptera microptera, Gomphocerus sibiricus, Dociostaurus krauss, Chorthippus albomarginatus* and other grasshoppers	99-88
fenitrothion/esfenvalerate, triflumuron	**25. Locust and tsetse fly control in Africa – Does wildlife pay the bill for animal health and food security? American Chemical Society Symposium Series (in press)** *Note: published article*	R. Peveling, P. Nagel; University of Basle, Switzerland	Madagascar	Large-scale field trial on side effects on the iguanid lizard *Chalarodon madagascariensis*	99-AA

Appendix III

Summary of data from efficacy trial reports

Insecticide	Application rate (g a.i./ha)	Control (%) @ ... h or d	Species	Sprayer and/or application	Vol. appl. rate (l/ha)	Plot size (ha)	Replicates	Report code	Comments
bendiocarb	480	86 @ 72 h, nymphs 75 @ 72 h, adults	SGR, L_5 – adult	ULVA Mast	0.5	50	1	99-49	Locusts exposed to spray in field cages; additional assessment with transect counts
chlorpyrifos	240	100 @ 48 h, nymphs 24-98 @ 48 h, swarms	***LMC, L_{2-3} – ad.***	Berthoud C 5; aerial, AU 5000	1	1, nymphs 120-300, ad.	4 3	99-43	Poor results of swarm control due to locusts flying into treated area
"	240	99 @ 48 h	LMC, L_3	Berthoud C 5	1	1	4	99-47	Field assessment
chlorpyrifos methyl	250	70 @ 6 h 95 @ 24 h	***mixed grasshoppers***	Berthoud C 8	0.5	1	34	99-48	91-92 data on grasshoppers; operational trials on farm level, effects on various other pests also assessed
"	250	100 @ 72 h, nymphs 82 @ 72 h, adults	SGR, L_5 – adult	ULVA Mast	0.5	50	1	99-49	Locusts exposed to spray in field cages; additional assessment with transect counts
chlorpyrifos, chlorpyrifos + cypermethrin	–	>90 @ 50 h	SGR	lab tests	–	–	–	99-44	Lab study; mixture acted faster
chlorpyrifos + cypermethrin	120 + 14	99 @ 48 h, nymphs 99 @ 48 h, swarms	***LMC, L_{2-3} – ad.***	Berthoud C 5; aerial, AU 5000	1	2, nymphs 120 +150, ad.	1 2	99-43	Similar control of nymphs achieved with mixture of profenofos and cypermethrin (reference product)
"	120 + 14	98 @ 48 h	LMC, L_{2-3}	Berthoud C 5	1	1	3	99-45	Brief report; similar control achieved with mixture of profenofos and cypermethrin (reference product)
"	120 + 14	93-100 @ 48 h	***LMC, swarms***	aerial, AU 5000	1	100 + 200	4	99-46	96-99% knockdown @ 2 h
cyhalothrin	40	97 @ 72 h, nymphs 100 @ 72 h, adults	SGR, L_5 – adult	ULVA Mast	0.5	50	–	99-49	Locusts exposed to spray in field cages; additional assessment with transect counts
deltamethrin	17.5	>90 @ 24 h	***LMC, swarms***	Helicopter, AU 5000	1	50 + 70	2	99-28	Brief report
"	15-17.5	74–100 @ 24 h (15 g) 89–100 @ 24 h (17.5 g)	LMC, L_{4-5} – ad.	ground, Solo aerial, AU 5000	0.857-1	1, nymphs 125-467, ad.	5 3	99-72	Flying swarm treatment; lower dose effective against young adults
"	17.5	***100 @ 72 h***	***LMC, swarm***	Helicopter, AU 5000	1	≈ 30	1	99-74	Similar effect achieved with fipronil at 2 g a.i./ha (reference product)
"	17.5	100 @ 72 h	LMC, swarms	Helicopter, AU 5000	1	50-70	1	99-75	Similar effect achieved with fipronil at 4 g a.i./ha (reference product)
"	16.6	58 @ 21 h	LMC, swarm	Helicopter	0.95	2,000	1	99-76	Low efficacy
"	17.5	97-99 @ 72 h	LMC, L_{4-5}	Micro ULVA	1	1	3	99-77	
"	17.5	98 @ 24 h	LMC, L_{1-5}	Micro ULVA	1	1	4	99-78	Several other products tested as well
"	17.5	39-94 @ 72 h	LMC, L_5 – ad.	Micro ULVA	1	1	3	99-79	Low mortality in nymphs; young adults more sensitive; EC formulation and fipronil also tested
"	17.5	95-100 @ 72 h	LMC, adult	aerial, AU 5000	1	450	2	99-80	
"	17.5	86-99 @ 72 h 100 @ 96 h	NSE, adult	aerial, AU 5000 and AU 7000	1	–	6	99-81	Treated area not given

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deltamethrin	17.5	100 @ 48 h	LMC, adult	aerial, AU 5000	1	300	1	99-82	
"	6.25-10	92-97 @ 1 d (lowest-highest dose)	CAL, DBR, PMI	ground sprayer OP 2000	200	1.5	2	99-83	High volume application; EC formulation
"	5-10	93-100 @ 12 h (LMM) 66- 77 @ 3 d (CIT) (lowest-highest dose)	LMM, L_{1-5} – adult, CIT	knapsack Agro-tope (LMM), OP 2000 (CIT)	–	0.05 (LMM) 2 (CIT)	3 (LMM) 2 (CIT)	99-84	High volume application, actual volume not given; 6 EC formulation; 7.5 g a.i./ha recommended
diflubenzuron	10-48	≤96 @ 13 d	CIT and other grasshoppers	AU 8000	1.5-2	0.5-1	4	99-20	0.02 – 0.04 l/ha 48 SC recommended for hoppers
"	9 + 15	90-95 @ 10-12 d	CIT and other grasshoppers	AU 8000, AU 8110, AU 8115	–	13,158	–	99-21	Barriers 100 m wide separated by 200 m; various trials over very large area
"	1.2 + 4.8 blanket	>90 @ 15 d	CIT and other grasshoppers	OP 2000, AU 8110	110	4.5-3,317	2	99-22	Some sprays combined with herbicide; recommends 48 SC at 0.015 to 0.03 l/ha
"	18 in barrier	92-95 (several weeks)	CIT and other grasshoppers	AU 8115 and local sprayers	various	> 10,000	–	99-23	Published paper: reports extensive areas treated with OF 6 using hang-gliders; some area treated with AU 8110 on trucks; also refers to registration trials for 48 SC – presumably overlaps with above reports
"	9 blanket 15 in barrier	94-97 @ 10 d	CIT and other grasshoppers	AU 8110	ULV and high volume	various	–	99-24	Published report on trials in N. Kazakhstan; OF 6 formulation; SC formulation mixed with herbicides
"	9 / protected ha on average	>90 @ 15 d	various, 80% CIT	AU 8115	ULV and high volume	35,000	–	99-25	Published paper discussing regulation of locusts; also refers to trials with 48 SC
"	100 in barrier 20 prot. area	80 @ 10 d 99 @ 12 d	LMC, L_{2-3}	aerial, AU 3000	1	barriers	1	99-42	Barriers treated with IGR; 500 m separation of barriers 100 m wide; hopper bands followed
"	7.2-9.6 blanket 9.6-14.4 barrier	96-97 @ 10 d blanket 86-90 @ 10 d barrier	LMM, mixed stages	Micro ULVA +	20	0.2	4	99-85	Ratio treated (barrier) : untreated (inter-barrier) = 1; 48 SC formulation
"	9-18 in barrier	>95	various	GRD 6, GRD 10, AU 8115	20	600-20,000	–	99-86	Various barrier treatments: a) barriers 50-200 m wide, barrier spacing 200-300 m; b) protective belts 500 m wide, up to 16 km long
"	9.6 blanket (SC) 18 barrier (OF)	95-100 @ 20 d (SC) 98-100 @ 20 d (OF)	CIT, PMI, CAL and others	OP 2000 (SC), AU 8115 (OF)	25-150 (SC) 0.25 (OF)	50 (SC) 13,500 (OF)	2 (SC) –	99-87	High volume application with 48 SC formulation; barrier treatment with pure 6 OF formulation; ratio treated (barrier) : untreated (inter-barrier) = 1
"	9.6 blanket 19.2-28.8 barrier	98 @ 14 d blanket 90-95 @ 14 d barrier (200-100 m spacing)	CIT, DKR, CAL and others	OP 2000	200	50	20	99-88	Blanket and barrier treatments with 48 SC formu-lations; barrier width 100 m, spacing 100-200 m
fipronil	3-5	49-100 @ 72 h	CIT, DMA	high volume	200-300	various	various	99-1	Summary of 96–98 data
"	4-5	80 @ 72 h 99 @ 10 d (both doses)	CIT, L_{2-3}	high volume	300	5	2	99-2	Lower rate slower but after 7 days 95% control

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fipronil	4-5	62-85 @ 24 h 81-96 @ 72 h (lowest-highest dose)	CIT, L_{3-5}	high volume	300	2 + 50	2	99-3	
"	4	98 @ 72 h	***CIT, L_{4-5}***	high volume	300	4	2	99-4	
"	4	90-95 @ 72 h	CIT, L_{1-3}	high volume	300	6	3	99-5	Sunflower, alfalfa + sugar beet
"	2-4	88-98 @ 72 h DMA 51-100 @ 72 h CIT (barrier-blanket)	***CIT, L_{1-2}*** ***DMA, L_{2-4}***	high volume	280	6-15	2	99-6	Full cover and barrier treatment (43 m untreated and untreated); higher mortality in CIT with full cover spray
	5.28 in barrier	80 @ 72 h	DMA, L_{4-5}	Micro ULVA	1.3	–	1	99-7	10 m barrier, 50 m separation
"	1.3-4	94 @ 8 h ≥98 @ 48 h	***LMC, adult***	Helicopter, AU 5000	1	130-240	3	99-8	Irregular application, 100, 200, 300 m; similar efficacy at all dosages
"	1.3-6	4 UL: 91 @ 48 h (4 g) 81 @ 48 h (2 g) 67 @ 48 h (1.3 g) 7.5 UL: 98 @ 48 h (6 g) 91 @ 48 h (3 g) 90 @ 48 h (2 g)	LMC and NSE, adult	Helicopter, AU 5000	0.3-1	150-300 and 80-200	1-2 and 1	99-9	Irregular application ,100, 200 and 300 m; two different concentrations tested, 4 UL and 7.5 UL; low dose (4 UL) >82% @ 96 h
"	2 + 4	27 @ 72 h (2 g) 99 @ 24 h (4 g)	***LMC, adult***	aerial, AU 5000	0.5 + 1	150 + 400	1	99-10 (99-56)	Irregular, 100 and 200 m; treatment error at 2 g a.i.
"	2	≈100 @ 24 h (both barrier and blanket treatment)	LMM, L_4	aerial, boom AMO 76-7000	6-12	200	1	99-11	Blanket + barrier, 4 g a.i. in barriers 40 m wide
"	3, 4, 6	93-96 @ 96 h (all doses)	LMM, L_{3-5}	aerial, AU 3000	–	50-100	1	99-12 (99-13)	50 m barriers for dosages 6 + 4 g a.i./ha, 100 m barriers for dosage 3 g a.i./ha
"	6	>80 @ 72 h	NSE, adult	aerial, AU 4000	1	70	2	99-14	Mortality assessed in field-caged locusts
"	3.1	100 @ 12 h	SGR, adult	ground	0.5	–	3	99-15	Chlorpyrifos gave 100% @ 12 h
"	4	92 @ 24 h	CAL and other grasshoppers	ground	high volume	12	2	99-16	
"	7.5 in barrier	90-100 @ 24 h	LMC, all stages	Helicopter, AU 5000	1 (barrier)	2.3 million	–	99-26	Evaluation of campaign between November 1998 and April 1999
"	4 + 8 in barrier 1.36 prot. area	84-87 @ 72 h 94-99 @ 21 d	*Oxya* spp.	handheld ULV	1-2	0.1 + 235	10 + 1	99-36	China, treated fields of rice (border treatment); barriers @ 4 and 8 g a.i./ha; 50 SC also effective
"	2-10	>90 @ 24 h (5-10 g) >80 @ 24 h (2-3 g) >95 @ 48 h (all doses)	*Oxya* spp.	–	0.5-2.5	–	–	99-37	Summary report; contact more effective than stomach action

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fipronil	2 + 4	50 @ 6 h 99 @ 24 h (4 g) 89 @ 24 h (2 g)	***LMC, swarms***	aerial, AU 6000	0.5 + 1	150 + 800	1	99-55	Irregular, 100 m + 200 m
"	2	90 @ 24 h 100 @ 72 h	LMC, swarm	aerial, AU 5000	0.5	800	3	99-57	Irregular, 100 m + 200 m
imidacloprid	10	99 @ 72 h	LMC, swarm	aerial, AU 5000	1	150	1	99-58	Rapid kill, suitable for operational control
"	10	see remarks	"	"	"	"	"	99-59 (99-19)	Cage samples to assess efficacy (report 99-58)
"	5-100	100 @ 48 h (all doses)	LMC, $L_{3–5}$	Micro ULVA	1	1	7	99-60	10 g a.i./ha gave 48-72 h persistence; 50-100 a.i./ha gave 7-8 days persistence
"	10-20	100 @ 48 h	LMC, $L_{3–4}$	Micro ULVA	1	1	1	99-61	Locusts exposed to spray residues at different times after treatment
"	10-30	80-100 @ 10 d	LMI, L_3	spray chamber	1-3	–	–	99-62	Lab test; assessment includes moribund locusts
"	20-40	87-91 @ 24 h (20 g) 92-96 @ 24 h (40 g)	DMA, $L_{2–4}$	high volume	300	–	3	99-63	Brief report
"	10-100 ppm	>80 (18 ppm)	SGR, L_3	laboratory	–	–	–	99-64	Laboratory study; exposure to treated wheat
"	11.2-56	>95 @ 24 h (all doses)	North Americ. grasshoppers	backpack	467	<0.01	4	99-65	Summary table; few details
"	66-300	>95 @ 24 h	DMA	high volume	500	–	3	99-68	EC formulation; few details
"	0.01-100 ppm	100 @ 2 h (100 ppm) ≤ 40 @ 4 d (≤ 10 ppm)	SGR	laboratory	–	–	–	99-69	Laboratory study; exposure to treated wheat; insufficient information
M. anisopliae IMI 330189	$5x10^{12}$ spores/ha	>90 @ 16 d	OSE, various grasshoppers	aerial + ground	0.5 + 1	800 + 50	1 + 3	99-54	
teflubenzuron	50 in barrier	97 @ 6 d	LMC, $L_{4–5}$	Micro ULVA	1	30	2 bands	99-30	No details on barrier spacing
"	50 "	100 @ 5 d	LMC, $L_{2–3}$	Micro ULVA	1	40	3 bands	99-31	Barrier width 20 m; spacing 200 m
"	50 "	100 @ 6 d	LMC, $L_{3–5}$	Micro ULVA	1	215	4 bands	99-32	Barrier width 50 m; spacing 1000 m
triflumuron	50	99 @ 15 d	LMC, $L_{3–5}$	aerial	1	100	4 bands	99-27	Barrier width 100 m; spacing 500 m
"	–	95 @ 10 d	LMC, L_3	–	–	–	–	99-17	No application details, incomplete report
phoxim + propoxur	258 + 42	100 @ 24 h	LMC, L_2	aerial, AU 5000	1	50	1	99-34	
profenofos + cypermethrin	200 + 20	86 @ 24 h 100 @ 48 h	LMC, swarm	Helicopter, AU 5000	1	100	1	99-39	
"	200 + 20	82 @ 24 h 97 @ 48 h	LMC, L_3	Berthoud C 5	1	5	1	99-40	
"	200 + 20 150 + 15	82 @ 48 h 78 @ 48 h	OSE + other grasshoppers	ULVA Mast	1-1.5	4.2	–	99-41	Old report
propoxur	27	100 @ 1.2 h	LMC, $L_{1–2}$	Solo 423	7 kg	2-3	2	99-18	Dustable powder formulation

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Appendix IV

TERMS OR REFERENCE

1. To evaluate, at least once a year, pesticide trial reports on Desert Locusts and other migratory locusts, with reference to the following:

   a) satisfactory trial technique (e.g. number of replicates, method of measuring mortality, application technique).

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

   c) effective kill at the dosages used.

   d) health and environmental implications.

2. On the basis of the above, and relevant information on large scale control operations, prepare a list of pesticides and dosages efficacious for operations against Desert Locusts and other migratory locusts, and appraise them according to their health and environmental risk.

3. Compile a list of pesticides that warrant further evaluation either from the point of view of efficacy or environmental side-effects, and specify the trials required (laboratory, field, small scale, large scale).

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

5. Prepare a report covering the above points.

Members (not more than 5), appointed on a personal basis, should be impartial and objective in their assessments and should have at least one of the following qualifications:

- should have experience of locust field work.
- should be actively involved in locust control in a locust-affected country.
- should have experience in pesticide application and evaluation.
- should have environmental/ecotoxicological experience.