STAKEHOLDER WORKSHOP ON
THE PROCUREMENT AND SUPPLY OF PESTICIDES FOR LOCUST CONTROL

FAO Headquarters, Rome
Philippine Room (Building C, 2nd floor, room C277)
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(AGENDA ITEM 4. PRODUCT ISSUES)

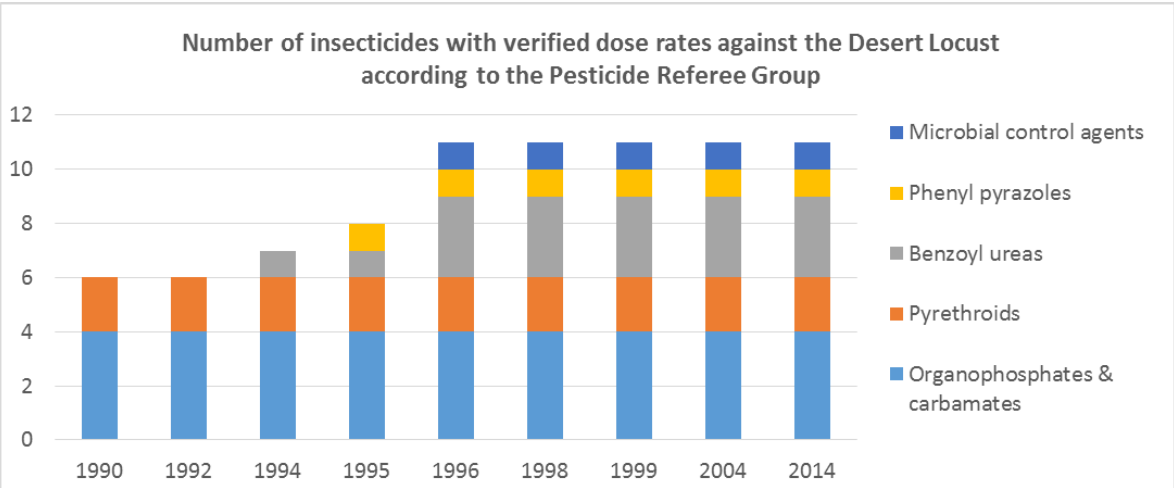
INSECTICIDES FOR LOCUST CONTROL

Introduction

After the 1985-1989 Desert Locust plague, FAO invited pesticide industry and research institutions to conduct field trials with new insecticides for locust control. The intention was to replace dieldrin for barrier treatment of hopper bands, broaden the range of contact pesticides for control of swarms and late instar hopper bands in particular in crop situations, and find low risk (biological) control agents to reduce environmental and health risks.

A large number of field efficacy trials were subsequently conducted in the early 1990s, which led to the inclusion of several benzoyl urea insect growth regulators and fipronil as barrier treatment insecticides, and *Metarhizium acridum* as a locust-specific, low risk, biocontrol agent. Since then, control of locust swarms and populations in cropping areas, which require rapid knockdown and mortality, has been limited to three organophosphate insecticides, one carbamate and two pyrethroids. After 1996, no new insecticides have been tested to a sufficient extent to establish a verified dose rate.

The actual list of insecticides with verified dose rates against the Desert Locust, and those with suggested dose rates against other locust species, is provided in Annex 1.

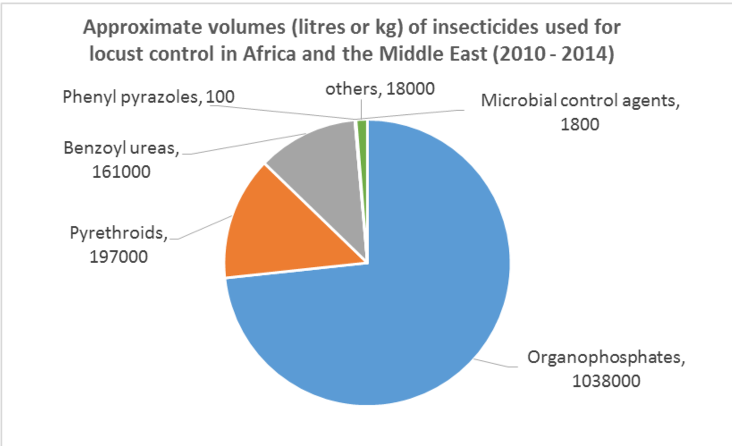


FAO promotes a preventive control strategy, which focusses on timely detection of seasonal breeding with the aim to reduce the risk of future outbreaks and upsurges. The implementation of such a strategy aims to minimize crop and pasture losses, and considerably limits control costs by intervening at an early stage with limited scale control operations; it also allows safer and environmentally friendlier control means. However, the possibility of upsurges and plagues cannot be excluded and, therefore, control options for large locust populations should also be available.

To be able to control locust targets in recession/outbreak and upsurge/plague situations, different types of insecticides are required. Control of relatively small locust populations in seasonal breeding areas during a recession/outbreak is generally conducted far away from cultivated areas. Insecticides can therefore be slower acting. Typically, benzoyl-urea IGRs and the biological control agent *Metarhizium acridum* can be used; limited applications of quicker acting insecticides may be done for spot treatments. During upsurge/plague situations, on the other hand, quick acting insecticides are required to control swarms and hopper bands close to cultivated areas. IGRs may still be used against large hopper band populations outside cultivated areas, while *Metarhizium* can be applied in sensitive areas where other insecticides cannot be used.

Present use of insecticides for locust control

Almost three-quarters of the insecticides used for locust control in Africa and the Near East during the past few years (primarily against Desert Locust and Malagasy Migratory Locust) have been organophosphates – mainly chlorpyrifos and malathion – (see chart below). Pyrethroids (mainly deltamethrin and lambda-cyhalothrin) and benzoyl urea IGRs (mainly teflubenzuron) take up an additional 25% of the volume. The use of *Metarhizium* has been relatively limited, covering approximately 36 000 ha. Almost all insecticides used for locust control in Africa and the Near East are ultra low volume (ULV) formulations.



In the Caucasus and Central Asia, large areas are being treated against Moroccan Locust, Italian Locust and Migratory Locust. Average annual surface areas treated range from 3 to 7 million hectares. Pyrethroids are the insecticides of choice in this region, while lesser quantities of organophosphates, neonicotinoids and benzoyl-ureas are being applied. Historically, water-based formulations (e.g. EC, SC) are being sprayed, but lately ULV formulations are increasingly being used.

Need for new insecticides

The bulk of insecticides presently used for locust control are organophosphates and pyrethroids. These have relatively quick action and can be used against all locust targets in both recession/ outbreak and upsurge/plague situations. However, the organophosphate insecticides have globally come under heightened regulatory scrutiny because of health and environmental risks. Their use in locust control may need to be restricted in the near future.

Pyrethroids tend to cause quick knockdown of the insects, which makes them appropriate for use in cultivated areas. However, apparent recovery of locusts after initial knockdown is often observed, complicating efficacy assessment in the field, and sometimes leading to overdosing of the insecticide. Furthermore, they pose certain environmental risks, limiting their use in particular close to water bodies.

For barrier treatments, the benzoyl urea IGRs are efficacious up to mid-instar hopper bands, and have been used on a relatively large scale over the last few years. However, they are less effective against late instar hopper bands. The phenyl-pyrazole fipronil has been recommended previously for use in barrier treatments, but is effectively unavailable for locust control in Africa and the Near East due to environmental concerns. It is being used in Australia.

The entomopathogen *Metarhizium acridum* is increasingly being used in locust control although on a small scale, in particular in sensitive ecosystems and where crops are not directly threatened. Its use is limited, however, by the relatively elaborate storage, transport and application requirements when compared to conventional chemical insecticides.

Given these considerations, there is a need for new low risk insecticides having a rapid mode of action, to complement and/or replace organophosphates and pyrethroids.

The "ideal" locust control insecticide

Given the different locust targets and control situations, one ideal locust control insecticide that can be used in all situations is unlikely to exist. Depending on the target that needs to be controlled, insecticides intended for locust control ideally should have the following characteristics:

Control of recession/outbreak populations, away from cultivated areas

- High oral and/or contact toxicity to locusts (to allow low volume application rates of approximately 1.0 L/ha)
- Moderate persistence on vegetation
- Low human health risk
- Low environmental risk (particularly, but not limited to, birds, bees and aquatic organisms)

Control of swarms and hopper bands, close to or in cultivated areas

- High contact toxicity to locusts (to allow low volume application rates of approximately 1.0 L/ha)
- Low human health risk
- Low environmental risk (particularly, but not limited to, birds, bees and aquatic organisms)
- Rapid toxic action, to avoid damage to crops (i.e. knockdown of the insects within 1-2 hours after treatment, without recovery) or swarm movements
- Low to moderate persistence on vegetation

Control of hopper bands by barrier treatments, close to or away from cultivated areas

- High oral toxicity to locusts (to allow low volume application rates of approximately 1.0 L/ha)

- Moderate to high persistence on vegetation, but low persistence in soil and water
- Moderate to high persistence in the insect body (depending on the mode of action), but low bioaccumulation potential in vertebrates
- Low human health risk
- Low environmental risk (particularly, but not limited to, birds, bees and aquatic organisms)

Efficacy trials for locust control

Detailed guidelines are available from FAO for the execution of field efficacy trials of insecticides on locusts and grasshoppers[1].

A minimum of two to four field trials are likely to be needed for the establishment of a reliable and robust effective dose rate.

Discussion points

The meeting may wish to consider the following points for discussion.

- Are insecticides available, with relatively new modes of action, which respond to (part of) the characteristics listed above (in particular for control of swarms and hopper bands during upsurges/plagues)?[2]
- Are new insecticides presently in advanced stages of development, which respond to (part of) the characteristics listed above?
- Have entirely new insecticidal mechanisms been tested on locusts and shown promising results (e.g. RNA interference)?
- What are constraints for pesticide industry to test new insecticides for locust control?
- What could be the role of FAO in testing new insecticides for locust control?
- What could be done to facilitate and improve storage, transport and application requirements of biological control agents such as *Metarhizium*?

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[1] http://www.fao.org/ag/locusts/en/publicat/gl/index.html

[2] Limited field trial data are available at the Pesticide Referee Group for neonicotinoids and for spinosad; so far, no data have been proposed for relatively new classes of insecticides such as (but not limited to) the diamides, other spinosyns or metaflumizone.

Annex Verified dose rates of different insecticides for control of the Desert Locust (*Schistocerca gregaria*). (Source: Pesticide Referee Group 2014[3])

Insecticide	**Class**	**Dose rate** (g a.i./ha) [1]				**Speed of action** at verified dose rate [3]	**Primary mode of action**
		Blanket treatment		**Barrier treatment** (hoppers) [2]			
		Hoppers	Adults	Intra-barrier	Overall		
Bendiocarb	CA	100	100			F	AChE inhibition
Chlorpyrifos	OP	240	240			M	AChE inhibition
Deltamethrin	PY	12.5 or 17.5 [4]	12.5 or 17.5 [4]			F	Na channel blocking
Diflubenzuron	BU	30	n.a.	100 [5]	14.3	S	Chitin synthesis inhibition
Fenitrothion	OP	400	400			M	AChE inhibition
Fipronil	PP			4.2	0.6	M	GABA receptor blocking
Lambda-cyhalothrin	PY	20	20			F	Na channel blocking
Malathion	OP	925	925			M	AChE inhibition
Metarhizium anisopliae (IMI 330189)	fungus	50	50			S	Mycosis
Teflubenzuron	BU	30	n.a.	n.d.		S	Chitin synthesis inhibition
Triflumuron	BU	25	n.a.	75 [5]	10.7	S	Chitin synthesis inhibition

Abbreviations: BU: benzoylurea, CA: carbamate, OP: organophosphate, PY: pyrethroid, PP: phenyl pyrazole; n.a. = not applicable; n.d. = not determined;

Notes: [1] Application volumes for the recommended dose rates differ depending on the formulation available.

[2] Calculated dose rate applied over the total target area based on an average barrier width of 100 m and a track spacing of 700 m.

[3] Speed of toxic action: F = fast (1-2 hours), M = moderate (3-48 hours) and S = slow (> 48 hours).

[4] The higher dose rate may be required if there is a risk of recovery of late instars or at high temperatures.

[5] Blanket spray data and observations for other locusts suggest that effective dose rates for Desert Locust barrier treatments may be further reduced;

[3] http://www.fao.org/ag/locusts/en/publicat/meeting/topic/572/index.html

Annex Suggested dose rates for the control of locust species other than the Desert Locust. (Source: Pesticide Referee Group 2014)

Insecticide	**Class**	**Species**	**Dose rate** (g a.i./ha) [1]				**Speed of action** at verified dose rate [3]	**Remarks**
			Blanket treatment		**Barrier treatment** (hoppers) [2]			
			Hoppers	Adults	Intra-barrier	Overall		
Chlorpyrifos	OP	LMC	240	240			M	
		DMA	120	120				
Chlorpyrifos + cypermethrin	OP + PY	LMC	120 + 14	120 + 14			F	
α-Cypermethrin	PY	CIT, DMA, LMI	15	15			F	
Deltamethrin	PY	LMC	15	15			F	
Diflubenzuron	BU	CIT, DMA	12	n.a.	24	12	S	Barrier ratio treated:untreated = 1:1 (irregular blanket spray)
		LMC			60	12		Barrier spacing 500-700 m
Fipronil	PP	LMC			7.5 [4]	1.1	M	Barrier spacing 700-1000 m
		CTE			1.0	0.33	M	Track spacing of 300 m (irregular blanket spray)
Metarhizium anisopliae (IMI 330189)	fungus	LMC	50	50			S	
		NSE	50 [5]	50 [5]				

Insecticide	**Class**	**Species**	**Dose rate** (g a.i./ha) [1]				**Speed of action** at verified dose rate [3]	**Remarks**
			Blanket treatment		**Barrier treatment** (hoppers) [2]			
			Hoppers	Adults	Intra-barrier	Overall		
Teflubenzuron	BU	LMC			50	10	S	Barrier spacing 500-700 m
		CIT, DMA, LMI	9	n.a.	18	9		Barrier ratio treated:untreated = 1:1 (irregular blanket spray)
Thiamethoxam + λ-cyhalothrin	NN + PY	CIT, DMA, LMI	14.1 + 10.6	14.1 + 10.6				
Triflumuron	BU	LMC			50	10	S	Barrier spacing 500-700 m

Abbreviations:

BU: benzoylurea, CA: carbamate, NN: neonicotinoid, OP: organophosphate, PY: pyrethroid, PP: phenyl pyrazole; n.a. = not applicable.

CIT = *Calliptamus italicus*, *CTE = Chortoicetes terminifera*, DMA = *Dociostaurus maroccanus*, LMC = *Locusta migratoria capito*, LMI = *Locusta migratoria*, NSE = *Nomadacris septemfasciata*

Notes:

[1] Application volumes for the recommended dose rates differ depending on the formulation available.

[2] Calculated dose rate applied over the total target area based on the listed ratio treated:untreated

[3] Speed of toxic action: F = fast (1-2 hours), M = moderate (3-48 hours) and S = slow (> 48 hours).

[4] A lower dose rate is likely to be possible but requires confirmation.

[5] A reduction to 30 g/ha may be possible under ideal conditions.