March 2009

منظمة الأغذية والزراعة للأمم المتحدة | 联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Продовольственная и сельскохозяйственная организация Объединенных Наций | Organización de las Naciones Unidas para la Agricultura y la Alimentación

DESERT LOCUST CONTROL COMMITTEE

Thirty-ninth Session

Rome, 10-13 March 2009

Introduction and use of bio-pesticides in locust control and challenges – when is Green Muscle® an operational option?

(Agenda Item 17)

What is Green Muscle® ?

Until very recently, the only effective way of controlling locusts was by spraying chemical products. Unfortunately, these broad-spectrum pesticides kill an array of non-target species and are potentially dangerous to users. Contaminated locusts are an easy prey and an attractive source of food for other animals in the food chain, with devastating consequences. For example, high bird mortalities have been observed after chemical treatment of locust swarms.

During the Desert Locust campaigns of 2003-05, the control teams applied almost 13 million litres of mainly organophosphate pesticides on 13 million hectares.

Although no serious accidents were reported during this and previous emergencies, the cost of the safety measures was however considerable and environmental damage caused by the pesticides was significant. Consequently, the Food and Agriculture Organization of the United Nations (FAO), in collaboration with other development agencies, has been working with the affected countries for 25 years to develop alternative control technologies, including a bio-pesticide based on the insect pathogenic fungus *Metarhizium anisopliae* var. *acridum* which causes disease in locusts and grasshoppers, and the hormone PAN (phenylacetonitrile) which affects the behaviour of the Desert Locust.

A natural and cost-effective acridicide, developed by the international research project LUBILOSA (*Lutte Biologique contre les Locustes et Sauteriaux*) and marketed under the trade name Green Muscle®, now represents a viable alternative to chemical pesticides. This product uses an entomopathogenic fungus that exists naturally and infects grasshoppers and locusts, but is generally harmless to other organisms. Out of the 30 isolates of *M. anisopliae* that act specifically on locusts, the one most tested for efficacy and its environmental risks is IMI 330189. Green Muscle® has been successfully tested under different conditions with spraying equipment normally used in Desert Locust control.

Metarhizium is dispersed by spores (called conidia) which are produced by the vegetative part of the fungus (mycelium). By mixing the conidia with mineral or vegetable oil the product can be used also under dry desert conditions (control methods based on fungi usually require humid conditions). After germination, the fungus penetrates the cuticle of the insect and begins to grow within the body of its host which, once infected, reduces feeding and its movements, before dying after six to ten days.

Green Muscle® has a very narrow spectrum and is only effective on locusts and grasshoppers. It has virtually no impact on non-target fauna (see below).

The spores have the advantage of persisting in the vegetation and maintaining their virulence for several days or even weeks. This reduces the need for repeated treatments which are often required with synthetic chemical insecticides. As Green Muscle® is not hazardous to other species, surplus quantities do not represent a risk to human health or the environment. If necessary, they can easily be buried or burned or returned to the producer/supplier for elimination.

However, mycoinsecticides are not appropriate for all situations. Fungi like *Metarhizium* kill through a natural process which takes time (1 to 3 weeks) and are therefore not suitable for urgent plant protection operations. A fast acting chemical insecticide will be needed, if the locusts have invaded crops. However, mycoinsecticides are a low-risk alternative when rapid mortality is not crucial.

Green Muscle® is effective against all stages of locust, nymphs and adults. Species that have been successfully treated in trials include the Desert Locust (*Schistocerca gregaria*) in Algeria, Mauritania and Sudan, the Red Locust (*Nomadacris septemfasciata*) in Tanzania and the Tree Locust in Sudan. Good results have also been obtained with the following Sahelian grasshopper species: *Hieroglyphus daganensis, Kraussella amabile, Kraussaria angulifera* and *Oedaleus senegalensis*.

Formulations and recommended application doses

Green Muscle® TC
This technical product is available in aluminium bags (between two plastic layers) containing 100 g of dry spores (other sizes are available on demand). These are mixed with appropriate oils to make a ready-to-use suspension for ULV application.

Green Muscle® OF
This is an oil concentrate, containing 500 g conidia/litre, to be diluted with diesel oil.

Once its stability has been confirmed and manufacturers are ready to produce this product, the OF formulation could be more suitable under field conditions than the TC formulation, because of the following advantages:

- it is much easier to handle and faster to prepare, which is critical given the narrow "window of opportunity" for treatment,
- compared to the TC formulation, the sedimentation of spores in the sprayer tank is reduced, which results in a more continuous flow, and less filter clogging while facilitating the cleaning of the spray equipment after use,
- it does not create any risk of dust inhalation,
- and makes more cost effective use of the spores as it reduces waste.

Review and planning workshop

A workshop was held in Saly, Senegal, from 12 to 15 February 2008 under the patronage of Mrs Viviane Wade, First Lady of Senegal and President of the "Action for Education and Health" foundation. It was convened as part of the FAO EMPRES[1] Programme aimed at building preventive control capacities in the affected countries. The workshop was jointly financed by FAO, the International Fund for Agricultural Development (IFAD), the *International Organization of the French Speaking World* (OIF) and the World Bank.

The workshop, organized under the guidance of the Orthopterists' Society, brought together 66 participants, including scientists, representatives of locust control organizations, manufacturers and donors, to determine:

- the role *Metarhizium* and PAN should play in Desert Locust management,
- actions needed to make biopesticides operational.

The participants reviewed and discussed the results of trials with biopesticides, and recommended that the responsible authorities should:

- implement the action plan as soon as possible to ensure that biopesticides are incorporated in practice as part of preventive Desert Locust control.

In order to achieve this objective, the participants also recommended that actions should be taken to:

Research and development:
- improve the current formulation of Green Muscle® to facilitate its use,
- investigate the synergy of Green Muscle® and PAN,
- verify the efficacy of biopesticides under operational field conditions using standard methods, preferably carried out by multi-agency teams.

Quality and availability of biopesticides:
- accelerate the registration process of biopesticides in all affected countries, with particular attention to environmental risks,
- promote standard procedures to maintain the product quality, from production to application;
- clarify the open licence questions.

Training, information, coordination and promotion:
- raise awareness and reinforce the capacities of all actors involved in Desert Locust management at the national, regional and international level;
- develop appropriate standard procedures for the use of biopesticides in Desert Locust control.

[1] Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases

Recent developments

Green Muscle ® for Yemen: *no risk to bees.*

Green Muscle® was delivered to Yemen in 2008 for use in ecologically sensitive areas, particularly in beekeeping areas. The absence of any effect of Green Muscle® on bees was demonstrated to beekeepers and government officials.

Green Muscle TC®: *a promising formulation?*

In spite of some advantages of the OF formulation compared to TC (dry fungal spore powder), the latter has been subject of extensive research. The main reason is that, in contrast to OF, TC can be stored for years, on condition that temperature does not exceed 20°C for too long. On the other hand, preparing the spray product from TC powder is more difficult and requires special training. TC is one of the formulations included in the CNLA[2] research programme. The first results concerning its efficacy and sedimentation are promising.

Recent use of Green Muscle® in Desert Locust control

In April 2008, Green Muscle® was applied with good results over an area of 40 ha in Mauritania by the CNLA as part of its routine Desert Locust operations. In September of the same year, some 8 000 ha were treated with Green Muscle® against *Oedaleus senegalensis* in Senegal. The first results indicate good efficacy at a dose of 25 g/ha.

The Yemen Government has shown international solidarity by offering Green Muscle® -TC formulation received in 2008 to interested countries. In January 2009, a shipment of 150 kg (enough for 3 000 ha) was sent to Tanzania and Malawi to treat Red Locust populations.

Ongoing research

New formulations

The Research Centre of Akjoujt, in Mauritania, has been equipped according to the standards of Good Laboratory Practices. The laboratory has tested five new Green Muscle® solvents on reared locusts. The first question to be examined was the impact of five new solvents on the efficacy of the fungus. The solvents proved to be quite beneficial, as the resulting formulations were more effective on the target than the classic Green Muscle® -OF. These results remain to be confirmed in the field. The next step will be to determine the speed of sedimentation of the formulations during storage and transport, and the shelf life of each formulation stored under differing conditions.

Green Muscle ® + 1% PAN: *greatly enhanced efficacy*

The CNLA and ICIPE[3] demonstrated that GM-OF efficacy is more than doubled when mixed with phenylacetonitrile (PAN) at 10 ml per litre of pesticide (= 1%). It was observed that, by adding PAN, the Green Muscle® application rate can be reduced by 50 to 75% as compared to the one recommended by the manufacturer. These results need to be confirmed in field tests. In the absence of natural populations, the tests were carried out in enclosures ("bomas")

[2] CNLA: National Desert Locust Control Centre, Mauritania.

[3] ICIPE: *International Center for Insect Physiology and Ecology*

on reared insects. These tests were sometimes preceded by screening tests in the laboratory, using reared insects in cages. The results will be addressed in the presentation.

Green Muscle ® + PAN: *no ecotoxicity?*

The ICIPE field station in Sudan and CERES-Locustox in Senegal carried out tests with Green Muscle ® + PAN on non-target organisms, beneficial insects and reptiles. ICIPE tested the beetles *Adesmia antiqua* and *Trachyderma hispida* (two natural enemies of Desert Locust nymphs), the ant-lion *Bankisus* sp. (predator ant) and the very abundant lizard *Acantodactylus dumerilii*. No toxic effect was observed; neither in the laboratory nor in the field using dermal, oral and topical application. CERES-Locustox conducted eco-toxicological laboratory tests with terrestrial (including bees) and aquatic insects, as well as reptiles, fish and crustaceans. No effect was noted even with application rates much higher than those normally applied in the field. Additional studies with aquatic organisms and bees are under way. A field study on bees will be carried out with the Beekeepers' Association of Senegal to make sure the results are confirmed by the beneficiaries. The final results will be addressed in the presentation.

A socio-economic study of pesticides used in Desert Locust control: *the advantages of* Green Muscle®

The *Imperial College*, in collaboration with the University of Hanover, calculated the costs of the human and environmental risks of chemical pesticides, except insect growth regulators. The study covered the period 2003-2005 in Senegal. The investigators estimated the "externalities", i.e. all expenses related to safety, cleaning, storage of obsolete stocks and costs linked to secondary effects on the ecosystem and poisonings. These costs were converted into euros per treated hectare. With a sprayed area of 300 000 ha and externalities calculated at 8 million euros, the cost per hectare amounted to 27 euros. This is significantly higher than the cost of one litre of pesticide. A comparison with the costs (purchase + externalities) of using Green Muscle® will be addressed in the presentation.

Outlook

An awareness raising programme needs to be initiated. A first step was the organization of an international workshop in February 2009 to present the research results to decision-makers, Heads of National Locust Control Units, development partners and experts in affected countries. Television spots and broadcasts in the local languages are envisaged in all countries concerned, as has already taken place in Niger. Training in the new techniques has started in five countries (Egypt, Ethiopia, Eritrea, Sudan and Yemen).

As the bio-pesticide should be stored at low temperature (4°C for oil formulation and/or <20°C for GM-TC), the necessary infrastructure needs to be set up at the national and regional levels. One economical option is to use the cold chains that exist in most of the countries (vegetables and fishery products for export).