Novel technologies for control of African armyworm on smallholder cereals in East Africa

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African armyworm (*Spodoptera exempta*) is a serious migratory pest of pasture and grain crops in Africa. Outbreaks occur every year in primary outbreak areas of Tanzania, and under favourable conditions the armyworm can then move across Tanzania and migrate to many parts of eastern and southern Africa. This project aimed to develop and evaluate two novel approaches to replace environmentally damaging and expensive synthetic chemical pesticides to control African armyworm: applying *S. exempta* nucleopolyhedrovirus (*Spex*NPV), a naturally occurring biological control agent; and neem, a locally available botanical agent. Field work confirmed that the candidate technologies work well in practice, and both were used successfully in small-plot trials and for large-scale aerial application (the first use of aerial application for any NPV biopesticide in Africa). In Tanzania the use of *Spex*NPV has been adopted as National Policy, and local neem is being promoted in target districts by the PCS. Work has started on adapting an existing Brazilian production model for NPV which should lead to a stable product that is affordable for poorer farmers in Tanzania. Benefits of this research will accrue throughout Tanzania, with likely spillover benefits for surrounding countries.

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ISSUES

Poor farmers are especially vulnerable to armyworm outbreaks. Losses due to armyworm may be virtually zero in some years, and immense in others. Yield losses within an outbreak area may be very high, although 30% loss in recently planted maize has been estimated as an average loss. Armyworm populations often originate in game parks and environmentally sensitive areas; there are also growing environmental problems with the stockpiling of pesticides. Reducing the impact of armyworm attack in Tanzania currently hinges around the timely supply and use of effective pesticides, supported by a centralised forecasting unit (the PCS). Concerned about the environmental effects of wide-scale pesticide use, and the high cost of imported pesticides, the Ministry of Agriculture and Food Security in Tanzania sought assistance to develop better armyworm management based on biological control. Under a previous project (R6746), the *Spodoptera exempta* nucleopolyhedrovirus (*Spex*NPV) was evaluated in the field in Tanzania. Following on from that work, this project aimed to continue field testing and work towards sustainable production of the virus; and also to examine the use of the local botanical agent neem as a possible tool for armyworm management.

Project findings on Spex*NPV have been disseminated widely in the local and international press (from Dalyell, 2004, courtesy of* New Scientist*)*

ACHIEVEMENTS

An initial workshop was held to discuss the project with stakeholders and plan project activities in detail. This generated a better understanding of those who are at risk from armyworm outbreaks, and of the appropriateness and adoptability of the proposed technologies.

The laboratory work had shown that both *Spex*NPV and neem could kill armyworm, and initial field trials confirmed *Spex*NPV could be effective at application rates [5×10^{11} to 5×10^{12} occlusion bodies (OB) per hectare] that would be practical in the field. A survey of farmers confirmed that neem was available in armyworm outbreak areas, and could therefore be harvested and used where resources were not available to purchase pesticides.

Working with a sporadic, migratory pest such as armyworm makes it difficult to obtain trial data in some years (such as 2001 and 2003), but field trials in 2002 did demonstrate that *Spex*NPV can be used successfully to control armyworm outbreaks. Progress made by the project attracted additional funds from USAID, which enabled aerial spraying trials of NPV to be carried out. In both the major field trials in 2004 (aerial and ground), application of *Spex*NPV was followed by armyworm population collapses and the appearance of large numbers of *Spex*NPV-infected and killed larvae.

Overall, the trials showed that *Spex*NPV can be as effective as chemical insecticides in controlling armyworm, when applied at rates as low as 1×10^{12} OB per hectare using ground-based or aerial application. PCS is committed to controlled expansion of the scope of field trials, including yield trials, to ensure that this technology is sufficiently robust before full replacement of chemical control by *Spex*NPV is adopted.

The same trials also showed that simple extracts of neem leaves and seeds can be used to kill armyworm. While these are not as effective as either chemical insecticides or NPV, use of neem should be useful to local communities who lack access to other resources. Local neem may be highly variable, but the results to date indicate that neem can be of value where no other control options are available. It is the intention of PCS to conduct participatory field trials during the next few years to validate neem and determine its utility and reliability.

Major armyworm outbreaks can decimate cereal crops

Ecological studies have shown that *Spex*NPV is widespread in Tanzania in adult armyworm moths, but is found as a non-symptomatic, or latent, infection – the first scientific confirmation of a latent NPV in an African insect. The role of these non-symptomatic infections in relation to natural outbreaks of overt lethal NPV disease in larvae is not yet clear. However, the *Spex*NPV disease is likely to be an important factor influencing the population dynamics of armyworm, and understanding this relationship could be a major breakthrough and a key to better forecasting of outbreaks. A reliable method of forecasting outbreaks will greatly enhance the application of control methods, and progress towards this has been made by the linked project R7966 (see page 96).

The virus is present as a wide variety of genotypes, 60 of which have already been identified and collected. A number of these genotypes have been cloned and assayed, but none has proved individually to be more pathogenic than the wild type used in the field trials.

For scaling up production of the virus, field trials confirmed that it is a viable strategy in Tanzania to produce *Spex*NPV for armyworm control by spraying naturally occurring armyworm outbreaks with an inoculating dose of *Spex*NPV, then harvesting the diseased larvae.

Farmers discussing armyworm forcasting and control with the research team under neem trees in central Tanzania

Field trials included the first use of aerial application for any NPV biopesticide in Africa (with funding from USAID)

The head of PCS in Tanzania visited EMBRAPA in Brazil to be trained in low-cost NPV production techniques. He judged these to be appropriate for use in Tanzania, and that the techniques could produce armyworm NPV at a cost comparable to that in Brazil (US$3.00 per hectare). This is much lower than the current cost of imported synthetic insecticides (around US$10 per hectare). Initial work has shown that the clay-based formulation developed by EMBRAPA can be produced for use in Tanzania. The system for harvesting infected field populations needs additional work, as the Brazilian larval collection system is not appropriate for African armyworm. The development of low-cost NPV is crucial – the cost of chemical insecticides is the major reason why 65% of poor farmers cannot control armyworm.

Neem leaves can be used in the many areas where neem is already planted as a shade tree. Some 50–80% of farmers have neem trees, and their leaves and/or berries could be used to protect cereal crops by the majority of smallholder farmers. The high bulk of neem needed and high transport costs mean it is not feasible to recommend its use for strategic control on a large scale, where NPV is more practical.

A strategy to disseminate the project's findings to a wide range of clients has been implemented, including articles in local and international newspapers and popular journals; TV broadcasts in Tanzania; and leaflets and posters.

Institutional capacity in PCS Tanzania has been improved by staff receiving training in the production and use of both NPV and neem.

FURTHER APPLICATION

Tanzania has agreed as National Policy, through its National Plant Protection Advisory Committee, to adopt *Spex*NPV as the replacement for chemical pesticides for armyworm control. PCS will continue to promote the use of *Spex*NPV through its own channels, and the findings of the project will inform the USAID-funded armyworm control project. The use of neem is currently being promoted to farmers in several trial districts by PCS, as part of the armyworm control project funded by USAID and the Government of Tanzania.

However, while the field use of *Spex*NPV is proven, research is still needed to develop a system for mass harvesting the NPV cheaply and in bulk, and is being undertaken in the 2005 field season (R8408).

The results are being disseminated to interested African countries (Kenya, Uganda, Mozambique, South Africa, etc.) and organisations mandated to lead regional armyworm control, such as the Desert Locust Control Organization. Some countries, such as Kenya, already have the legislation in place for adoption of biopesticides as a result of other CPP activities.