The Potential of Indigenous Fungal Pathogens as a Component of Integrated Management of the Banana Weevil, *Cosmopolites sordidus* in Uganda: A New Research Project

G.B. Allard
International Institute of Biological Control, Kenya

C. Nankinga
Kawanda Research Station, Kampala, Uganda

M. Ogenga-Latigo
Makerere University, Uganda

ABSTRACT

The high cost of chemical control and the labour requirements of cultural controls, including trapping, favour the use of integrated pest management, centred around biological control, against the banana weevil, *Cosmopolites sordidus*. Biological control using insect natural enemies has had only limited success. The use of nematodes or fungi appears more promising. Efforts to control banana weevil by nematodes are discussed, and some technical constraints which remain are identified. Isolates of the fungi *Beauveria bassiana* and *Metarhizium anisopliae* from a variety of hosts have been found to be pathogenic to banana weevil in Africa and elsewhere. Research currently concentrates on screening of local isolates of these fungi, collected from both banana weevil and sweet potato weevil, *Cylas puncticollis*. Testing seeks to identify strains which are appropriately pathogenic and tolerant of the adverse conditions found in meristem and corm traps which may be used as a delivery system.

RESUME

Le coût élevé de la lutte chimique et le caractère fastidieux des méthodes de lutte culturale - dont le piégeage - favorisent le recours à la protection intégrée, centrée autour de la lutte biologique, contre le charançon du bananier, *Cosmopolites sordidus*. La lutte biologique au moyen des ennemis naturels des insectes n'a eu qu'un succès limité, même si l'on sait que des fourmis introduites à Cuba ont considérablement réduit la population du ravageur. L'utilisation de nématodes ou de champignons paraît plus prometteuse. Le contrôle du charançon du bananier par des nématodes a été réalisé aux Caraïbes, en Floride, à Tonga et en Australie, bien qu'il reste à résoudre certaines contraintes techniques. Des isolats des champignons

Beauveria bassiana et *Metarhizium anisopliae* extraits de divers hôtes se sont révélés pathogènes au charançon du bananier en Afrique et ailleurs. La recherche se concentre actuellement sur le criblage d'isolats locaux de ces champignons, récupérés aussi bien sur le charançon du bananier que sur le charançon de la patate douce, *Cylas puncticollis*. L'expérimentation vise à identifier les souches qui sont réellement pathogènes et qui tolèrent les rudes conditions des pièges de méristème et de bulbe qui peuvent être utilisés pour la distribution.

Introduction

The banana weevil *Cosmopolites sordidus* Germar appears to have spread with the cultivation of bananas. It was first noted in Uganda in 1918 but was probably accidentally introduced some time before that along with the first banana cuttings. As it appears to have spread from the Kampala-Entebbe area, it may have been introduced with bananas imported for the Botanic Gardens in Entebbe before 1908 (Greathead 1971). The weevil in combination with other biotic and abiotic factors has now become a significant impediment to production of one of the major food staples of Uganda.

Control of the banana weevil, when applied, relies on the application of costly chemicals such as Primicid, Furadan and Dursban and is thus beyond the reach of all but the wealthiest farmers. Trapping, utilising meristem and bole sections, is rather labour intensive, involving the manual collection of weevils. It is used only to a limited extent with varying degrees of success and acceptability. Other cultural control practices, again of limited application, include maintenance of clean plantations by removal of potential breeding sites such as fallen stems, cutting off old stems at ground level, covering the cut rhizome with impacted soil and using only uninfested suckers as planting material.

Alternative cost effective and environmentally sound practices are at present being evaluated. Integrated pest management (IPM) emphasising the role of biological control by introduction, conservation and augmentation of natural enemies is the most appropriate technique for use by small-scale farmers growing starch staple crops such as banana. This project addresses the development of such techniques for the control of banana weevil in Uganda.

Biological Control

Due to the mainly cryptic nature of the weevil, biological control in the classical sense has not been very successful. Previous attempts at biological control have included the release of general predators such as *Plaesius javanus* Erickson, *Hololepta quadridentata* Fabricius, *Hyposolenus laevigatus*

(*P. laevigatus*) Marseul and *Dactylosternum hydrophiloides* Macleay (Neuenschwander 1988). In Africa a few attempts have been made to introduce exotic agents but with no success. In 1934 the predatory histerid beetle *Plaesius javanus* was imported into Uganda from Java, its area of origin, and released on Kibibi Island in Lake Victoria but no recoveries were made (Greathead 1971).

More recently attempts are being made to study the effects of indigenous natural enemies on banana weevil (Koppenhöfer 1993). In surveys carried out in Kenya (Seshu-Reddy 1988) three species of curculionids, including *C. sordidus* and *Temnoschoita nigroplagiata* Quedenfeldt, were found as well as two indigenous predators, *Eulissus* sp. (Staphylinidae) and *Anochaetus* sp. (Formicidae).

Successful control of the weevil has been recorded from Cuba by the introduction of the ant *Tetramorium bicarinatum* Nylander to infested stools. Possibly this technology could be tried in Africa with the same or another suitable genus. Speed of colonisation by the ant in infested plantations is dependent on the number of stools initially infested and the ant should be released on 25-30% of the stools if it is to colonise the whole plantation within 3-4 months. Results show that within the first year weevil populations can be reduced by 65% in heavily infested plantations and by 83.5% in less heavily infested plantations. By the second year the population of *C. sordidus* in less heavily infested plantations could be reduced by 74% (Roche & Abreu 1983).

Non-classical alternative methods of biological control include the application of entomopathogenic nematodes and fungi. The effectiveness of entomopathogenic nematodes of beetles with cryptic life cycles has been well demonstrated. For example, Allard & Moore (1989) documented successful control by nematodes against the coffee berry borer. Figueroa (1990) and Peña (pers. comm.) showed the effectiveness of nematodes against the banana weevil in the Caribbean and in Florida, the latter with varying degrees of strain specificity. In Tonga, Sikora & Parnitzki (1990) working with steinernematids as control agents found that up to 80% larval mortality could be achieved in corms but that there was a lesser effect on *C. sordidus* adults. In Australia, Treverrow & Bedding (1990) applied the nematode *Steinernema carpocapsae* Weiser into cuts made in banana rhizomes and significant mortality of both banana weevil larvae already in the rhizome and of adults attracted to the treatment sites was observed. Two large scale field trials have since been carried out with acceptable levels of control, although there still remains the problem of the large numbers of nematodes required. Whilst CSIRO Australia are investigating a strain of nematode for commercial release against the banana weevil, it is possible that the effect of the nematode could be enhanced with other agents. For example, simultaneous application of the chemical chlordecone and the nematode *Steinernema carpocapsae* Weiser (= *Neoaplectana carpocapsae)* was found to produce better results than either applied alone and mortality of *C. sordidus* increased from day five onwards (Kermarrec & Nauleon 1989).

Entomopathogenic nematodes have a distinct advantage over fungi as they are able to actively seek out their host in response to a CO_2 gradient and thus should be able to find the larvae within the tunnels provided they can withstand the pH and desiccation. To date these nematodes have not been evaluated in Uganda, but rather emphasis has been placed on the potential of entomopathogenic fungi for integration into control programmes.

Fungi, *Beauveria bassiana* (Balsamo) Vuillemin and *Metarhizium anisopliae* (Metschnikoff) Sorokin have been tested against *C. sordidus* in Brazil and Guadeloupe with promising results (Delattre & Jean-Bart 1978, Mesquita *et al.* 1981). Mesquita *et al.* (1981) tested the pathogenicity of four strains of *B. bassiana* and one of *M. anisopliae* isolated from a variety of hosts and localities in Brazil. The isolate was applied to adult weevils either directly by spraying the insects or indirectly by introducing weevils to sprayed soil or to treated pseudostem traps. Strains of *B. bassiana* isolated from *C. sordidus* were shown to be most pathogenic when applied directly onto the insect, leading to death of all insects within 12 days of application.

In Africa extensive surveys for the collection of fungal pathogens infecting sweet potato weevils have already been made (Allard & Rangi 1991). Various laboratory tests and selections have been made of these isolates culminating in a field application of an oilbased formulation of *B. bassiana* in Burundi against the sweet potato weevil, *Cylas puncticollis* Summers. As a large collection of these African isolates already exists, including some from Uganda, they are being incorporated into a screening programme for control of banana weevil.

Preliminary laboratory investigations have confirmed that an isolate of *B. bassiana* obtained from *C. puncticollis* can cross-infect *C. sordidus* adults. As sweet potatoes and bananas are grown closely together in Uganda, sometimes as intercrops, these results may open the doors to exciting prospects for combined field applications. In Cuba, Diaz-Sanchez & Grillo-Ravelo (1986) also found that an indigenous isolate of *B. bassiana* obtained from *C. formicarius elegantulus* was pathogenic to three weevils including *C. sordidus*.

An isolate of *M. anisopliae* obtained from field collected weevils subjected to stress, has been discovered which is of great interest as the isolate appears to form slime and does not disperse readily in oil; this aspect is of importance for developing an application strategy. An isolate of *B. bassiana* has also been collected from *C. sordidus* from Uganda and this, together with the *Metarhizium* isolate will be tested and compared with further isolates collected from soil screening of plantation soils using *Galleria mellonella* Linneas larvae as baits.

Present work is mainly concentrating on laboratory investigations into the selection of an appropriate strain of fungus that is both pathogenic to weevils and which can tolerate the changing pH of meristem and corm traps over time. This last factor is vital if trapping is to be used as an effective delivery system for the fungal pathogens until such a time when either suitable pheromones or kairomones have been characterised and are ready for field application (Budenberg & Ndiege, these proceedings) .

This work is forming the basis of M.Sc. studies carried out by Ms Nankinga at Kawanda Research Station, sponsored through a Rockefeller Foundation grant administered by the International Institute of Biological Control in their collaborative project with IITA / BCP on the biological control of the banana weevil. Ms Nankinga's work is being co-supervised by Gillian Allard and Morris Ogenga-Latigo.

Acknowledgements

We would like to take this opportunity of thanking Dr John Lynam of the Rockefeller Foundation without whose support this project could not have been initiated. Dr Lynam has contributed not just in the procurement of the necessary grant but with scientific interest and support and a lot of foresight.

References

Allard, G.B. & D. Moore. 1989. *Heterorhabditis* sp. nematodes as control agents for coffee berry borer, *Hypothenemus hampei* (Scolytidae). Journal of Invertebrate Pathology 54: 45-48.

Allard, G.B. & D. K. Rangi. 1991. The potential of entomopathogens for the control of sweet potato pests with particular emphasis on the sweet potato weevil *Cylas* spp. Integrated Control of Arthropod Pests of Root Crops, Final Report in IDRC Centre File 3-p-88-0111, CAB Internal Report.

Delattre, P. & A. Jean-Bart. 1978. Activités des champignons entomopathogènes (*Fungi imperfecti*) sur les adultes de *Cosmopolites sordidus* Germ. (Coleoptera: Curculionidae). Turrialba 28: 287-293.

Diaz-Sanchez, J. & H. Grillo-Ravelo. 1986. An isolate of *Beauveria bassiana* Bals (Vuillemin) as a pathogen of *Cylas formicarius elegantulus* Sumner. Centro-Agricola 13: 94-95.

Figueroa, W. 1990. Biocontrol of banana root borer weevil, *Cosmopolites sordidus* (Germar) with Steinernematid nematodes. J. Agric. Univ. Porto Rico 74: 15-19.

Greathead, D.J. 1971. A Review of Biological Control in the Ethiopian Region. Technical Report 5. Commonwealth Institute of Biological Control.

Kermarrec, A. & H. Nauleon. 1989. Synergy between chlordecone and *Neoplectana carpocapsae* Weiser (Nematoda; Steinernematidae) in the control of *Cosmopolites sordidus* (Coleoptera: Curculionidae). Revue-de-Nematologie 12: 324.

Mesquita, A.L., F. Luchini, E. Alves, *et al.* 1981. pesquisa em Amdamento 14: 4.

Neuenschwander, P. 1988. Prospects and proposals for biological control of *Cosmopolites sordidus* (Germar) (Coleoptera:Curculionidae) in Africa. In: INIBAP, (ed). Nematodes and the Borer Weevil in Bananas: Present Status of Research and Outlook. Proceedings of a workshop held 7-11 December 1987, Bujumbura, Burundi. pp. 54-57.

Roche, R. & S. Abreu. 1983. Control of the banana weevil (*Cosmopolites sordidus*) by the ant *Tetramorium guineese*. Ciencias de la Agricultura (Cuba) 17: 41-49.

Seshu-Reddy, K.V. 1988. Some biological observations on the banana weevil in Western Kenya. In: INIBAP, (ed). Nematodes and the Borer Weevil in Bananas: Present Status of Research and Outlook. Proceedings of a workshop held 7-11 December 1987, Bujumbura, Burundi. INIBAP.

Sikora, R.A. & P.F. Parnitzki. 1990. Intricacies involved in developing a biological control program for the banana weevil borer, *Cosmopolites sordidus*, using entomopathogenic nematodes in Tonga. In: Caribbean Meetings on Biological Control, Guadeloupe. INRA. p. 8.

Treverrow, N. & R. Bedding. 1990. Control of the banana weevil borer, *Cosmopolites sordidus* (Germar) with entomopathogenic nematodes. In: Soc. Invert. Path, (eds). Vth Int. Colloq. Invert. Path and Microb. Contr.: Proc. and Abstr.