Cultural control strategies for banana weevil, *Cosmopolites sordidus* Germar

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Introduction

The banana weevil *Cosmopolites sordidus* Germar (Coleoptera: Curculionidae) is a major insect pest in all the banana- and plantain-growing areas of the world (Waterhouse and Norris 1987), particularly of plantains and cooking bananas (Sikora *et al.* 1989). Due to the fact that chemicals are expensive and hazardous to health and environment, alternative control strategies have to be developed/identified for the resource-limited small-scale farmers, who are the major banana producers. Several strategies, including habitat management (cultural control), host plant resistance and biological control have been advocated for controlling this weevil borer (Gold 1998). Cultural control tactics in particular are the tactful use of regular farm practices to delay or reduce the pest attack.

Weevil damage and losses

The weevil lays eggs in the rhizome of the plant and after hatching the larvae tunnel and feed on the rhizome, weakening the plant, reducing bunch weight and in serious cases, leading to snapping of the rhizome at the ground level before the bunch is ripe.

The yield losses associated with the weevil range from 40% to 100% in severe infestations (Mitchel 1980, INIBAP 1986). In order to reduce yield losses due the weevil, a number of cultural control options have been identified and studied. The cultural control tactics are an important component of biologically intensive pest management technologies for the banana weevil (Fig. 1) and include the selection of clean planting material, paring procedure, hot water treatment, deep planting, mulching, trapping, intercropping, application of organic-based manures, weeding, field sanitation, desuckering, propping, varietal mixtures and crop rotation. The advantages of these cultural control options, particularly for the small-scale farmers, are that they constitute the main farming operations and are environment-friendly, less costly, sustainable and offer long-term benefits.

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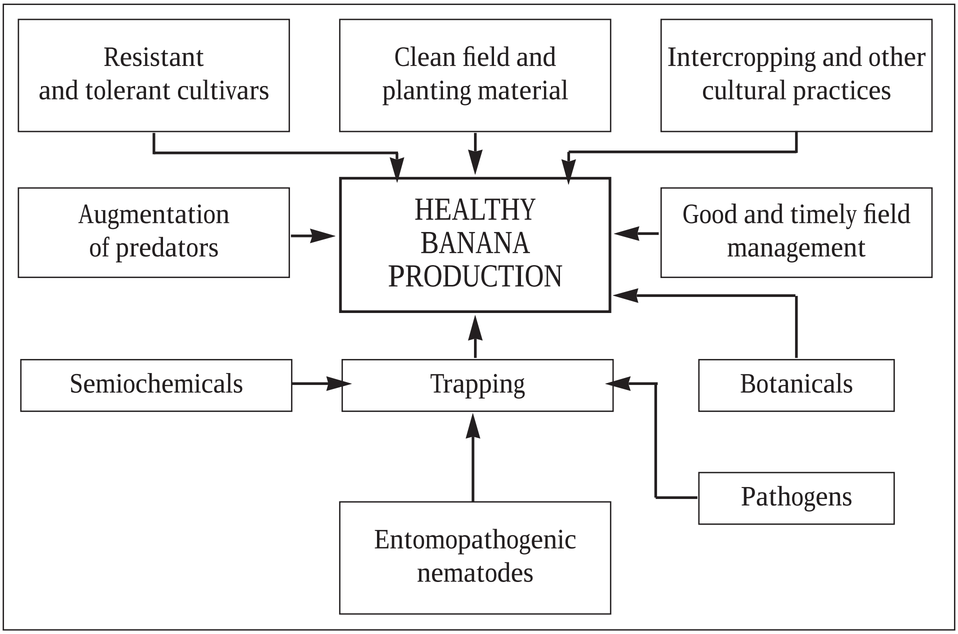

Figure 1. Diagrammatic representation of biologically intensive pest management technologies for banana weevil.

Selection of field for planting banana

The field selected for planting banana should not have a bad record of having grown bad banana crops the previous two years.

Clean planting material in weevil management

The most important mode of spreading of banana weevil to new fields is through infested planting material. The adult weevils move, but over short distances; therefore clean planting material reduces initial population and checks population buildup. Planting material should be selected by taking suckers from fields known to be free of the weevils.

Paring procedure and hot water treatment have been found to be effective and simple for eliminating weevils from planting material. The technique had earlier been quite difficult to manage by the small-scale farmers due to the critical balance in administering the required temperature at 54°C for 20 minutes. Prasad and Seshu Reddy (1994) developed a simple method suited to the small-scale farmers, hence overcoming this drawback. In this method, a metal piece is attached to a wooden piece by using molten wax having a melting point of 55°C. This assembly is dropped into the drum where suckers are to be given hot water treatment. When the temperature in the tank reaches 55°C, the wax melts and releases the wood to float on the surface and heating is stopped at this stage. Studies on the effect of paring and hot water treatment have shown that the treated planting material have faster rate of development, delayed/low infestation and improved yield (Ngode 1998) as opposed to untreated material (Table 1). The associated crop losses over three crop cycles were 53.1% in the infested material as opposed to only 16.6% in the infested material subjected to paring and hot water treatment. The advantages of clean planting material are best when there are no proximal sources for large weevil migration. It may have limited benefits for gap filling or planting adjacent to infested field. Gold *et al.* (1998) reported most benefits for the first crop cycle in the experimental plots in their studies in Uganda (Table 2).

Table 1. Effect of planting material on bunch weight (kg/bunch).

Treatment	Plant crop	First ratoon	Second ratoon
Infested suckers	8.7 ± 0.4a	7.6 ± 1.1a	6.8 ± 1.0a
Healthy suckers	11.0 ±1.5a	12.4 ± 1.0b	15.3 ± 1.0b
Infested, pared hot water-treated	10.3 ± 0.7a	11.9 ± 0.8b	13.3 ± 0.7b
Infested, pared hot water- and Furadan-treated	12.3 ± 0.1a	14.4 ± 0.5b	14.5 ± 0.5b

Table 2. Bunch weight and yield (kg) in plots grown from treated and untreated banana propagation material.

A. Trial 1.

	Bunch weight			Yield	
	Plant crop	First ratoon	17-28 MAP*	29-37 MAP	Total
Untreated	7.0b	9.7b	184b	171	355b
Pared	8.4a	13.3a	514a	198	712a
Pared/hot water	7.7b	12.4ab	398ab	225	623ab
F Value	0.59	5.55	7.02*	0.67	7.83*

* MAP = months after planting

B. Trial 2.

	Bunch weight		Yield
	Plant crop	First ratoon	15-27 MAP*
Untreated	12.6a	19.1a	865c
Pared	13.2a	19.2a	1162b
Pared/hot water	13.6a	20.2a	1461a
F Value	0.54	0.74	36.06**

* MAP = months after planting

Analysis of variance df (2, 6): ** P<0.01

Treatments with same letter are not significantly different by Least Square Means multiple range test.

Source: Gold *et al.* (1998)

Importance of deep planting

Bananas should be planted to a depth of at least 30 cm or more (Chalker 1987). The effect of planting depth on the incidence of weevils was studied at different planting depths of 15, 30, 45 and 60 cm (Seshu Reddy *et al*. 1991). Results indicated that shallowly-planted suckers were more prone to weevil infestation than deeply-planted suckers. The weevil populations were significantly higher (18.8) in shallow planting of 30 cm as opposed to deep planting of 60 cm (7.2). The weevils were still able to go as deep as 60 cm to find a site for egg laying. Kehe (1988) in Côte d'Ivoire observed low infestation levels where farmers covered the base of stools with a mound of soil around 30 cm. This made the corms less accessible to the egg-laying females. However due to the high mat effect, the bananas soon expose their corms, thus encourage weevil infestation and subsequent snapping. Deep planting has an added advantage of delaying high mat formation, and providing firm anchorage for the plant.

Effect of mulching

In cropping systems, mulches conserve water, regulate soil temperatures, prevent soil erosion, control weeds and provide organic manure in decomposition. Studies to determine the effect of mulching and intercropping on the population densities of *Cosmopolites sordidus* were conducted by Uronu (1992). The studies included maize, beans and sweet potato intercropped with banana and also their respective mulches. Results showed that mulches had higher population growth of *C. sordidus* but despite this, they had the best results in terms of plant growth parameters, crop maturity and yield.

Rukazambuga (1996) also showed that the populations were much higher in mulches. The plants in mulches were larger and cross-section samples revealed more damage in square centimetres and more yield loss in kilogrammes. This implies that overal yields were higher in mulches and so were yield losses. Therefore more studies are still needed to determine the contribution of mulches to weevil management.

Effect of intercropping

In intercropped systems, the insect pressure is maintained at low pressures due to interference with host plant location, by discouraging colonization and encouragement of the natural enemies. Studies conducted in Tanzania by Uronu (1992) on banana-maize, banana-sweet potato and banana-beans showed that there were no significant differences on population growth of *C. sordidus* in the intercrops. Sweet potato and maize had adverse effect on banana due to nutrient competition reflected in delayed banana maturity and reduced yield. Similarly, results of intercropping banana with groundnut did not influence weevil colonization on banana and their subsequent population buildup. It only influenced their distribution during the early banana growth stages (Ngode 1998). However studies conducted in Côte d'Ivoire suggested that intercropping banana with coffee may reduce weevil numbers (Kehe 1988). With a sedentary insect like the weevil, emigration and immigration rates are not likely to be so affected and so the chances of cropping systems affecting weevils are less than with other insects.

Effect of weevil trapping

The use of trapping for weevil control has been a subject of controversy (INIBAP 1988, Gowen 1995). Seshu Reddy *et al.* (1993) showed that traps made of cooking-type bananas are more attractive to the weevil than traps made of dessert-type bananas. The influence of continuous trapping using split pseudostem traps was conducted in western Kenya over a 2-year period and this brought about a 47% reduction in weevil numbers and a 31% increase in banana yields (Seshu Reddy *et al.* 1995). The use of split pseudostem traps for weevil management has been shown to be very effective at low weevil population density and has the potential of suppressing weevil population and damage. However when the infestation and resulting damage are left to build up to high levels, traps may not reduce weevil populations and increase banana yields significantly (Ngode 1998). In Uganda, Gold and Okech (unpublished data) concur that following one year of trapping in researcher-managed fields, weevil populations declined by 61%, by 43% in farmer-managed fields and by 23% in the controls. The populations were however variable with no significant treatment effect and so it was concluded that trapping can, but does not always reduce weevil numbers. The concern for the use of pseudostem traps is the labour requirements and presence of pseudostems for traps when needed. Thus, reducing the amount of pseudostem needed and increasing trap efficiency through the use of semiochemicals at farm level economically and sustainably may provide some solution. More studies are required to develop these aspects.

Field and crop sanitation

The destruction of crop residues from harvested plants and exposing them to dry reduces damage to the growing plants and limits weevil breeding sites. If old plantations are to be re-established, all the old corms, banana trash and volunteer crop must be ploughed and destroyed to reduce infestation. The cut surface of the corm is more attractive to the weevils for oviposition and since the weevils can burrow up to 60 cm, they may still locate it (Seshu Reddy *et al.* 1993). Observations in Uganda, Ntungamo district, suggest that crop sanitation was closely related with differences in the level of management among farms, but was not related to weevil population levels (Gold 1998). Weevils thrive in trashy and weedy plantations and hence the need for good weeding and detrashing (Wallace 1938). However, more information is needed on field sanitation and weevil population dynamics.

Favourable growing conditions combined with good cultivation and manuring induces high degree of tolerance and helps banana escape attack by *C. sordidus*. Reduction of competition for growth factors through desuckering should be encouraged to leave few plants in a mat leading to sturdy plants which can withstand weevil and wind damage. Plants with heavy bunches are prone to breakage and snapping if they have weevil infestation leading to premature bunch losses. This can be reduced by propping and guying, hence premature losses due to snapping can be minimized.

Conclusion

From the foregoing it is evident that culturally-based practices provide the first line of defence against the weevil attack and are the widely available options practiced by most banana-farming communities in East Africa. Research and extension protocols should lay more emphasis on them, especially when addressing banana-based IPM options for the small-scale farmers in the region. However, studies are being undertaken to assess what farmers know, who adopts, modifies, rejects, how weevil management fits into priorities of farming systems and how farmers perceive feasibility of control methods, their costs and benefits.

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Potential of classical biological control for banana weevil, *Cosmopolites sordidus* Germar, with natural enemies from Asia (with emphasis on Indonesia)

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Potential for biological control of banana weevil

General basis and protocol for classical biological control

Biological control is defined as "the action of parasites (parasitoids), predators or pathogens in maintaining another organism's population density at a lower average than would occur in their absence" (Debach 1964). Thus, biological control represents the combined effects of a natural enemy complex in suppressing pest populations. The concept of biological control arose from the observed differences in abundance of many animals and plants in their native range compared to areas in which they had been introduced in the absence of (co-evolved) natural enemies. As such, populations of introduced pests, unregulated by their natural enemies, may freely multiply and rise to much higher levels than previously observed. Biological control is a component of **natural control** which describes environmental checks on pest buildup (Debach 1964). In agriculture, both the environment (i.e. farming systems) and natural enemies may be manipulated in an attempt to reduce pest pressure.

Classical biological control concerns the search for natural enemies in a pest's area of origin, followed by quarantine and importation into locations where the pest has been introduced. One underlying assumption is that herbivores are under natural biological control by co-evolved natural enemies and may be inconspicuous (i.e. non-pests) in their endemic range. These herbivores may reach pest status when they move into areas when freed from control by their natural enemies. Chances of natural enemy establishment

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