THE BANANA WEEVIL
COSMOPOLITES SORDIDUS

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Biology and life cycle

The banana weevil *Cosmopolites sordidus* (Germar, 1824) (Coleoptera: Curculionidae) is an important pest of banana, plantain and ensete. The adult weevil is black and measures 10-15 mm. It is free living, though most commonly found between leaf sheaths, in the soil at the base of the mat or associated with crop residues. The weevil is nocturnally active and very susceptible to desiccation. Adults may remain at the same mat for extended periods of time, while only a small proportion will move > 25 m within 6 months. The weevils rarely fly. Dissemination is primarily through infested planting material.

The banana weevil is a “k” selected insect with long life span and low fecundity. Many adults live 1 year, while some survive up to 4 years. On moist substrates, the weevil can survive without feeding for several months. The sex ratio is 1:1. Oviposition rates of more than 1 egg/day have been recorded, but, most commonly, oviposition has been estimated at 1 egg/week. The female places its white, oval eggs singly into holes made by the rostrum. Most oviposition is in the leaf sheaths and rhizome surface. Flowered plants and crop residues are favoured stages for oviposition.

The emerging larvae preferentially feed in the rhizome, but will also attack the true stem and, occasionally, the pseudostem. The larvae pass through 5-8 instars. Pupation is in naked cells near the surface of the host plant. Developmental rates are temperature dependent. Under tropical conditions, the egg to adult period is 5-7 weeks. Egg development does not occur below 12°C; this threshold may explain why the weevil is rarely encountered above 1600 masl.

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Mature larvae of the banana weevil
Cosmopolites sordidus *on a residual rhizome*

Symptoms

Adult banana weevils are attracted by volatiles emanating from host plants. Cut rhizomes are especially attractive. Therefore, it can be difficult to establish a new crop in previously infested fields or near stands supporting heavy infestations. Banana weevils are attracted to cut rhizomes, making suckers used as planting material especially susceptible to attack. Loss of more than 40% of the plant crop to banana weevil has been recorded.

Banana weevil attack has been reported to interfere with root initiation, kill existing roots, limit nutrient uptake, reduce plant vigour, delay flowering and increase susceptibility to other pests and diseases. Yield reductions are caused by both plant loss (plant death, rhizome snapping, toppling) and lower bunch weights. Toppling, more commonly attributed to nematodes, has been observed under conditions of high weevil attack in the absence of nematodes.

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Adult of banana weevil

Control methods

Control methods for banana weevil are likely to vary from system to system and reflect the importance and pest status of the weevil. In commercial plantations, chemical control is the most widespread method for controlling the weevil. Cultural control is very valuable in preventing the establishment of the weevil and is the only means currently available by which resource-limited, small-scale growers can reduce established populations. Biological control agents (including arthropods and entomopathogenic fungi) are under study and may become important in the development of integrated strategies for the management of the weevil. Resistant clones are known which may ultimately provide genetic sources of resistance for plantain and highland banana breeding programmes.

Banana weevil damage showing distinct larval galleries

Banana weevil levels are often low in a newly planted field. With low oviposition rates, population build-up is slow and weevil problems are most often encountered in ratoon crops. In one trial, yield loss increased from 5% in the plant crop to > 40% in the third ratoon. In areas where bananas or plantains are replanted after 1-3 years, weevil populations may not have time to build up to pest levels, even in the presence of susceptible germplasm.

Distribution

The banana weevil evolved in Southeast Asia and has spread to all banana and plantain production regions in the tropics and subtropics. Weevil problems appear to be most severe in plantains, highland cooking bananas and ensete. The weevil has contributed to the decline and disappearance of highland cooking banana in parts of East Africa. Pest status may vary across sites and farms: in one study, 100-fold differences in weevil densities were found among farms in a single watershed. Weevil pest status in other groups of bananas is variable. In commercial Cavendish plantations, the banana weevil has been reported to be relatively unimportant.

Chemical control

Control in commercial banana plantations is mainly chemical, using nematicides with insecticidal activity and specific insecticides applied close to the base of the mat. Insecticides are fast acting and efficient. Cyclodiene insecticides were once widely used but eventually abandoned with the development of resistant weevil populations and because of environmental concerns. Less persistent organophosphates are available but these are more expensive and more toxic to the handler and therefore less suitable for smallholder production systems. The banana weevil has now shown the ability to develop resistance to most classes of chemicals.


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Intensive banana weevil damage to rhizome and pseudostem resulting in death of plant

Botanical compounds may serve as substitutes for pesticides. Dipping suckers in a 20% neem *(Azadirachta indica)* seed solution at planting protects the young suckers from weevil attack by reducing oviposition through its repellent effect on adult weevils. Egg eclosion rates may also be lowered in neem-treated plants.

Cultural control

Wherever possible, new production areas should be established in uninfested fields using clean planting material. Tissue cultured plantlets are widely used in commercial banana plantations for pest and disease control. Where tissue culture is not available, farmers should pare suckers to remove weevil larvae and eggs. Badly damaged suckers should not be used for planting. Hot-water treatment has also been widely promoted for weevil and nematode control. Recommendations suggest immersing pared suckers in hot-water baths of 52-55°C for 15-27 minutes. These baths are very effective in eliminating nematodes, but kill only a third of the weevil larvae. Thus, clean planting material is likely to provide protection against weevil for several crop cycles only.

Systematic trapping with pseudostem or rhizome pieces may be effective in reducing populations of adult banana weevils. However, trapping is labour-demanding and often limited by available materials. Crop sanitation (i.e. destruction of residues) is also believed to eliminate weevil refuges and breeding sites and to reduce weevil numbers. Currently, no data are available on the relationships between different methods of crop sanitation and weevil status.

Biological control

The banana weevil is most important where it is an introduced pest (e.g. Africa, Australia, the Americas), suggesting that classical biological control may be possible. A number of predaceous beetles have been found feeding on banana weevil larvae in the insect's area of origin in Southeast Asia. However, attempts to introduce these natural enemies into other banana growing regions have largely met with failure. Research on endemic predators (beetles, earwigs) in Africa suggest only limited potential for control under field conditions. By contrast, the myrmicine ants *Tetramorium guinense* and *Pheidole megacephala* have reportedly contributed to the successful control of banana weevil in plantain in Cuba. The ants can be encouraged to nest in pseudostem pieces that can then be used for their dissemination. Myrmicine ants are widespread and may also be important predators on the weevil in other localities.

The use of entomopathogenic fungi (e.g. *Beauveria bassiana* and *Metarhizium anisopliae*) for the control of banana weevil has been studied since the 1970s. Numerous strains have been screened for activity against banana weevil adults and many of these effect mortality of > 90%. However, few data are available on the performance of candidate strains of entomopathogens under field conditions. Therefore, the development of efficient and cost-effective field delivery systems is probably the most critical area of research at this time. The entomopathogenic nematodes, *Steinerma* and *Heterorhabditis* spp., attack both adults and larvae in the field, but economic cost and efficacy only under high weevil population densities limit their use on a larger scale for the moment.

Host plant resistance

Screening trials, surveys and clonal comparisons suggest that plantains are the most susceptible group to banana weevil attack. East African Highland cooking banana and ensete also appear to be highly susceptible. Primary sources of resistance seem to be found in Yangambi Km5, FHIA-03 (or its parents) and some IITA diploid hybrids (TMB2x8075-7, TMB2-7197-2 and TMB2x6142-1). The banana weevil is readily attracted to and will freely oviposit on resistant clones. Host plant resistance appears to be primarily due to antibiosis mechanisms causing high mortality rates in the larval stage.

Research needs

The pest status of the banana weevil is poorly defined and few yield loss studies are available. The impact of crop management on the ecology of weevil populations and severity of attack needs to be clarified. Research results on population dynamics need to be linked to an understanding of the efficiency of control strategies. Economical thresholds should also be defined according to the cropping system and socio-economic context.

Research on non-chemical control measures is imperative in order to develop strategies for integrated pest management. Intensive searches in Southeast Asia should be undertaken to clarify whether effective natural enemies (especially egg parasitoids) may exist. Additionally, the role of ants in controlling banana weevil merits further investigation.

Effective and cost-efficient delivery systems for entomopathogens are required. The use of semio-chemicals may enhance trapping systems and also serve as means of aggregating weevils for delivery of entomopathogens.

Standardization of methodologies for varietal screening is necessary, as well as additional work in identifying resistant or tolerant reference genotypes. Breeding for resistance can offer a safe and long-term control strategy for the banana weevil within the framework of integrated pest management. It is important to study mechanisms of resistance to make it possible to define selection criteria which can be applied earlier than the harvest stage in order to make breeding experiments less time consuming.

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Mature larvae of banana weevil feeding on residual rhizome