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Insect Pest Report: Banana

One of the most important cultivated plants worldwide is the banana plant, being the fourth most important crop for developing countries (Heslop-Harrison & Schwarzacher, 2007). It contributes around $1.7 billion of exportation revenue (Novak & Brunner, 1992). This crop is cultivated for food mainly in tropical and sub-tropical regions of the Americas, Africa, and Asia, as well as areas of Europe and Australia (Heslop-Harrison & Schwarzacher, 2007).

Most of the bananas that are cultivated worldwide are a cross between two wild banana plants, *Musa acuminata* and *Musa balbisiana* (Heslop-Harrison & Schwarzacher, 2007). These commercial bananas differ from the wild fruit in that they are seedless and can grow without fertilization; they essentially clone themselves (Heslop-Harrison & Schwarzacher, 2007). Many of the commercial fruits are also triploid as opposed to being diploid like the wild fruit (Heslop-Harrison & Schwarzacher, 2007). An important note to consider for the domestic banana is that these previously mentioned traits have arisen many times in separate cross-breeding occurrences, thus resulting in a high variety of banana types (Heslop-Harrison & Schwarzacher, 2007). This also means that it is important to keep wild banana populations stable and genetically diverse so that if any commercial crops become devastated by pests or disease, they can be replaced by new plants from wild banana crosses.

In banana plantations, plants consist of a pseudostem that contains a large bunch of fruit that can be 20-40 kg in total weight (Heslop-Harrison & Schwarzacher, 2007). Once the crop is harvested, the plants are destroyed and replaced with new, young banana plants that are grown to become the next crop (Heslop-Harrison & Schwarzacher, 2007). New shoots are obtained from mature banana plants, as bananas reproduce by making vegetative growths, called suckers, at their bases (Heslop-Harrison & Schwarzacher, 2007). These suckers can be removed and planted elsewhere to develop into another banana plant (Heslop-Harrison & Schwarzacher, 2007).

Although there are plenty of arthropod pests of bananas, perhaps the most important insect pest is *Cosmopolites sordidus*, commonly called the banana weevil (Gold et al., 2001). It is present worldwide in banana crops, as well as other banana-like plants, such as the plantain and ensete (Gold et al., 2001). Both the adult and larval stages of this beetle are difficult to observe when they are active, as adults are nocturnal and larvae tend to be buried in the corm of the banana plant (Gold et al., 2001). The specific damage that this weevil causes is to the root and rhizome systems of the banana (Ostmark, 1974). Significant damage to plants can be caused by the burrowing of *C. sordidus* larvae in the rhizomes, which can cause death in newly planted crops, as well as increased risk of mature crop's damage to wind changes (Ostmark, 1974). As damage by this pest is only underground, the only way to assess crop damage, aside from crop destruction by the beetles, is to physically remove plants from the ground (Gold et al., 2001). However, this comes with its own consequences, as this destroys a section of the crop and can cause reduced viability of surrounding banana plants (Gold et al., 2001).

The adult weevil generally has low a reproductive rate, with females tending to lay one egg per week in the tropics and laying two to four eggs per week in the subtropics (De Graaf, 2008). During the dry season in tropical areas, oviposition by adults is lessened, and during winter in Australia, egg laying is reduced further to almost none (De Graaf, 2008). Also, during spring and autumn in Australia, adult activity is greatest, but like egg laying is almost non-existent in the winter months (De Graaf, 2008). This weevil is a multivoltine species; therefore, larvae can attack banana plants multiple times during a year (De Graaf, 2008). At the same time, in warmer climates, the weevil larvae will develop into adults more rapidly, leading to more eggs being laid and thus a greater need for weevil population reduction (De Graaf, 2008).

Due to *C. sordidus*' hidden larval lifestyle, it is difficult to find biological control measures for reducing larval populations (Gold et al., 2001). That is, it is difficult to locate organisms that will prey on the larval stage of this organism. There are, however, a handful of known predators of the adult weevil. These include a species of ground toad, *Bufo marinus*, a histerid beetle, *Plaesius javanus*, and a hydrophilid beetle, *Dactylosternus hydrophiloides* (Ostmark, 1974). The latter two predators were once introduced to banana plantations in the Pacific Islands, Uganda, Jamaica, Australia, Formosa, and Puerto Rico (Ostmark, 1974). The effectiveness of their control on C. sordidus populations were unclear, though, since these predators do not prey solely on the banana weevils, and it was difficult to determine if they were effective at reducing larval populations for reasons mentioned above (Ostmark, 1974).

Despite the difficulty of reaching the larvae of *C. sordidus*, there has been discovered a way to potentially control their populations without the use of pesticides. In an experiment, the endophytic fungus *Beauveria bassiana* has been shown to reduce the lifespan of weevil larvae in infested banana tissue (Akello et al., 2008). Since the fungus greatly reduced the amount of larva infesting the plant, much of the treated plant tissue was able to be saved from boring damage (Akello et al., 2008). Therefore, the use of this fungus may be a solution to targeting and killing the pest weevil at its cryptic larval stage (Akello et al., 2008).

In addition to *C. sordidus*, some other pests include several beetle species, *Odoiporus longicollis, Nodostoma subcostatum*, and *Colaspis hyptochlora* (Singh, 1970). These beetles damage the banana plant in several parts, including the stems, leaves, and fruits (Singh, 1970).

Some non-beetle species are the banana scab moth, *Nacoleia octosema*, the banana aphid, *Pentalonia nigronervosa*, the banana rust thrip, *Chaetanaphothrips signipennis* (Singh, 1970), the banana skipper, *Erionota torus*, and the banana lacebug, *Stephanitis typica* (Wang et al., 2016). Specifically, the larvae of *E. torus* feed on the leaves of the banana plant and curl them up to pupate, and both nymphs and adults of *S. typica* are phloem feeders of the plant (Wang et al., 2016). In addition to feeding on the plant, *S. typica* is a known vector of the banana rosette dwarf disease, which significantly lessens fruit production (Wang et al., 2016).

In China, insecticides are mainly used to be rid of insect pests, namely controlling *E. torus* and *S. typica* (Wang et al., 2016). As a method of biocontrol, Wang et al. (2016) proposed to use the invasive red imported fire ant, *Solenopsis invicta*, as a method of biocontrol, as they prey on an abundance of herbivorous insects (Stiles & Jones, 2001). In a study, they found that fire ants can keep the populations of both *E. torus* and *S. typica* down (Wang et al., 2016). However, using red imported fire ants as biocontrol has its own implications, as these ants may reduce populations of native and non-pest organisms, and they may become pests themselves in areas where they are introduced.

With the importance of the banana as a source for global fruit production, it is important to consider the many different types of pest organisms that can be detrimental to the crop. Therefore, it will be beneficial to continue to research what types of measures can be taken, especially if controls can be found that do not significantly disrupt the surrounding environment or crop yield.

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Biological Control of Banana Pests

The economically important banana plant has many insect pests that could endanger crop yields. *Cosmopolites sordidus*, or the banana weevil, is one of the most significant insect pests of this plant (Gold et al., 2001). To discover a potential method to control them without the use of pesticides, Akello et al. (2008) performed an experiment to determine whether the endophytic fungus, *Beauveria bassiana*, could be used as a potential method of biocontrol of weevil larvae. Given that the larvae bore into the rhizomes of the banana (Ostmark, 1974), it would be beneficial to use this type of organism for biocontrol, as it can grow within the plant where the larvae are and access the larvae where predators may not be able to invade.

Akello et al. (2008) found that, at least in one of their three experimental replicates, more *C. sordidus* larvae died in plants treated with *B. bassiana* than in control plants that lacked the fungus. Given this, they noticed a decrease in larval development over time in treated plants from the other two replicates (Akello et al., 2008) They also found that in all plants treated with *B. bassiana*, larval damage to plant tissue was significantly reduced (Akello et al., 2008). Therefore, their results greatly suggested that the use of *B. bassiana* on banana crops is a potentially effective treatment to reduce damage from the larvae of *C. sordidus*, and perhaps could also be used for treating cryptic pest organisms in other crops (Akello et al., 2008).

Another important pest of the banana crop is the banana rust thrip, *Chaetanaphothrips signipennis* (Clercx et al., 2015). The nymphs of this thrip feed on the peel of the banana, causing it to oxidize and become red in color, hence the name rust thrip (Clercx et al., 2015). Heavy damage from this insect can cause lesions and water loss in the fruits (Clercx et al., 2015).

C. signipennis is generally difficult to control, although there has been found a potential method to manage this pest (Clercx et al., 2015). A study in Peru tested the effects of the fungus *Lecanicillium lecanii* and the soil fungus *Isaria fumosorosea*, on the growth and activity of the rust thrip (Clercx et al., 2015). They found that *L. lecanii* had no entomopathogenic effects on thrip nymphs, while *I. fumosorosea* caused death in 90% of nymphs (Clercx et al., 2015). With these results, it is suggested that *I. fumosorosea* may be a potential key for controlling populations of the banana rust thrip and lessening crop damage (Clercx et al., 2015).

One other crop pest of the banana is the banana lace bug, *Stephanitis typica*. Mainly occurring in Asia and the tropical Pacific (Poorani et al., 2019), this insect's adult and nymph stages are phloem feeders of the banana plant and are also vectors of banana rosette dwarf disease (Wang et al., 2016). They can also cause severe leaf damage to the plant (Poorani et al., 2019). For these reasons, this hemipteran is an important pest to keep in check.

There are some insects that have been identified as predators of *S. typica*. Through the years 2015-2017, Poorani et al. (2019) conducted a survey where banana crop containing regions in India were studied to find natural predators of the bug. In the survey, they verified that the predatory mirid, *Stethoconus praefectus*, and two genera of parasitoid wasp, *Erythmelus* spp. and *Anagrus* spp. are predators or parasitoids of the lace bug (Poorani et al., 2019).

S. praefectus has been known to feed on *S. typica* since observations of this predatory interaction on coconut plants (Mathen & Kurian, 1972), and is an obligate predator of tingid insects. It has been seen preying on other species of lace bugs in addition to *S. typica* in bananas, but further research is necessary to ascertain the effectiveness of *S. praefectus* to keep banana lace bug populations down (Poorani et al., 2019).

The parasitoid wasp species found in the study were of the genera *Erythmelus* and *Anagrus*; both are parasitoids of the eggs of *S. typica* (Poorani et al., 2019). *Erythmelus panis* was found in the survey area, although parasitism was very low (Poorani et al., 2019). Therefore, if used as a biocontrol for *S. typica* in the future, it may be necessary to rear and release many of this species into an infested cropland. At the same time, perhaps *E. panis* is not a very effective controller of lace bug populations, but experimental evidence would be required to find that out.

The other wasp Poorani et al. (2019) found was an unknown species of egg parasitoid from the genus *Anagrus*. In a banana leaf collection done in 2017, this wasp was able to be reared from *S. typica* eggs present on the leaves (Poorani et al., 2019). Like *E. panis* and *S. praefectus*, further studies are required to determine the effectiveness of this parasitoid as a control measure for pest populations of *S. typica* (Poorani et al., 2019).

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