Integrated Pest Management of black weevil in banana cropping systems

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Innovative options to control the black weevil *Cosmopolites sordidus* in banana fields include the management of pitfall traps with pheromones, along with that of fallows (seen here in Guadeloupe, French West Indies). © CIRAD, France

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Pheromone trapping as a short-term alternative to insecticides in banana fields

The black weevil *Cosmopolites sordidus* Germar (Coleoptera: Curculionidae) is a major pest of bananas and plantains in most production areas. Female *C. sordidus* lay eggs in the corm of banana plants. After egg hatching, larvae bore inside, which damages the points of insertion of primary roots and leads to plant snapping and toppling. Yield losses are important both in industrial plantations for export and in traditional smallholder farms: 25% corm infestation reduces the yield by 30%. In the past, insecticides were massively used worldwide to control the banana weevil, but their use is now decreasing, in particular in European banana producing areas. As an example, 2kg of insecticide active ingredient were used per hectare in 2008 in Martinique in the French West Indies, compared to 7kg in 1999 (source: CIRAD, France). The weevil *C. sordidus* contaminates banana fields through infested planting material, residual populations from the previous planting, or colonisation (crawling) from neighbouring fields. Traditionally, banana pseudo-stem pieces laid on the soil were used to trap and control populations of *C. sordidus* adults. However, the effectiveness of these traps varies with their age, location and environmental conditions. Moreover this trapping method is laborious and has been progressively replaced by pheromone-pitfall traps. In Cameroon, a disc-on-stump trap is also used by smallholders and some larger plantations.

From top: the black weevil is a crawling insect. At the larval stage it bores into the banana corm, causing plants to topple. © Philippe Tixier, CIRAD, France. Pitfall trap with pheromone attractant. © Philippe Tixier, CIRAD. Disc-on-stump trap used in Cameroon. © Justin Okolle, CARBAP, Cameroon.

Pheromone-pitfall traps effectively control populations of *C. sordidus*. The pheromone Sordidine is specific to *C. sordidus* and attracts both sexes. Nevertheless the spatial and temporal organisation of trapping is a key factor in its success because of the patchy distributions of weevils within the field. The most common and effective strategy consists in:

> Monitoring the population with a regular network over the farm (4 traps per hectare)

> Mass trapping in highly infested fields (16 traps per hectare are recommended, placed 20m apart) or on the periphery of the field to limit its colonization with a barrier of traps (see Figure 1 on following page).

Fallows can be managed to control black weevil

Fallows are primarily used in banana cropping systems to sanitize fields against plant-parasitic nematodes and to renew soil fertility. Fallows also have a strong effect on *C. sordidus* populations by suppressing their resource (banana crop residues). As a consequence, after some weeks, when the resource has become very low, *C. sordidus* populations seek new banana plants and may contaminate neighbouring fields in production. To prevent this dissemination throughout the farm, complementary strategies can be implemented:

> Early crushing (by hand with a machete, or mechanically) and elimination of the banana corm residues issued from the previous crop.

> Mass trapping using pheromone-pitfall traps, in and around fallows, to provide better sanitation of banana plantations. The pheromone-pitfall traps prevent a large part of *C. sordidus* populations from moving from fallows to other banana plots. Therefore, fallows must not be located next to new banana plantations in order to avoid massive damage to the young plants. The control of *C. sordidus* should be managed at the farm and landscape scales rather than at the field scale, with special attention on the location of fallows and associated trapping.

> Setting up new banana crops with tissue culture plants to avoid the dissemination of weevil-infested planting material.

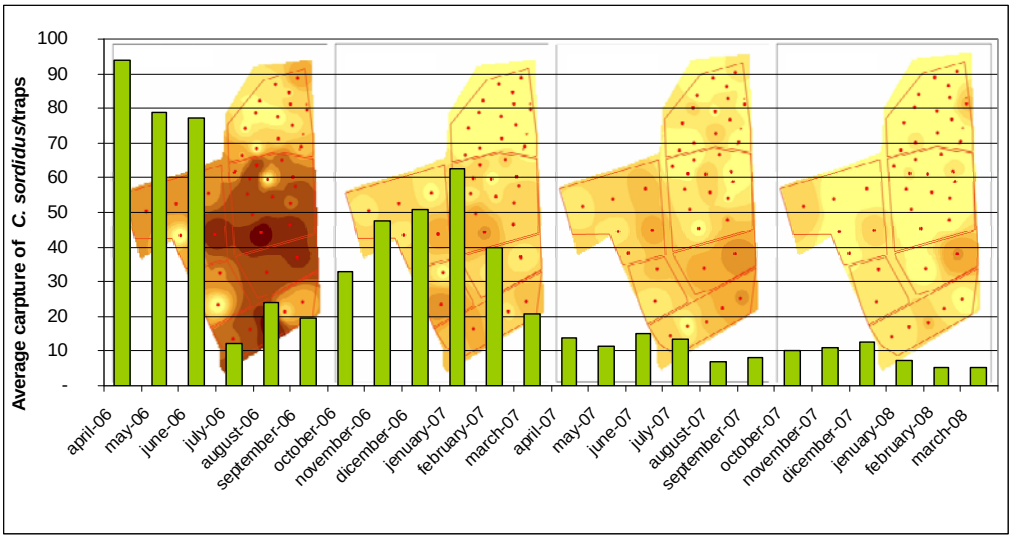

Figure 1: Population dynamics of *Cosmopolites sordidus* in a banana plot with mass pheromone trapping over two years in the sub-tropical conditions of the Canary Islands. © Ángeles Padilla Cubas, ICIA, Spain.

The mid-term: Use of biocontrol agents and modelling tools to promote IPM

To achieve control of *C. sordidus* in the mid-term by promoting a strategy of Integrated Pest Management, two additional strategies are being evaluated:

> **Challenging options with biocontrol agents:** In the near future, trapping systems should be enhanced with biocontrol agents such as the entomopathogenic fungi *Beauveria bassiana* and *Metarhizium anisopliae* or the entomopathogenic nematode *Steinernema carpocapsae* and *S. feltiae*. Another attractive approach currently being tested is to confer bioprotection to banana vitro plantlets with endophytic fungi such as non-pathogenic *Fusarium oxysporum*.

> **Designing new cropping system scenarios with modeling tools:** Simulation models, such as COSMOS (Fabrice Vinatier, CIRAD), calibrated from bibliographical and experimental data, allow testing of the effects of the location and the density of pheromone-pitfall traps on the epidemiology of *C. sordidus*. Figure 2 shows the simulation of different densities of pheromone-pitfall traps over a one-hectare field. These simulations help determine the optimal density for traps: *C. sordidus* populations decrease strongly when the trap density is increased, but control is not improved when there are more than 16 traps per hectare. Models can also provide relevant information to find the best compromise between the effectiveness and the cost of the control method. The COSMOS model is also well designed for Integrated Pest Management of *C. sordidus*, including the use of more tolerant varieties, spatial arrangement of banana plantations, and heterogeneity of crop residues and trapping.

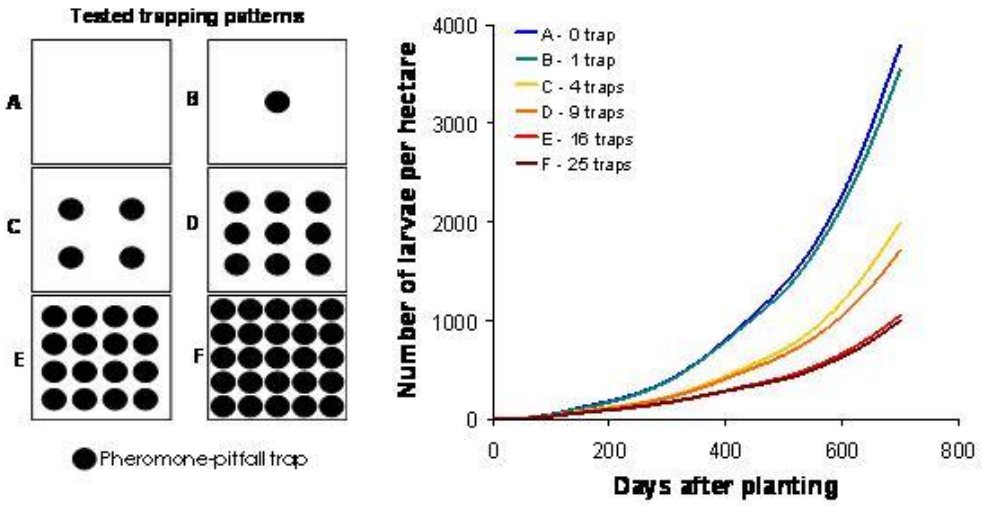

Figure 2: Simulation with the COSMOS model of the number of larvae of *C. sordidus*, on a one-hectare plot for six patterns of trapping, from zero to 25 pheromone-pitfall traps per hectare. Infestation is initialised from a clustered contamination by adults. © Fabrice Vinatier, CIRAD, France.

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Summary

The black weevil, *Cosmopolites sordidus* (Coleoptera: curculionidae) is a major pest of banana in export farms and for smallholders in developing countries. New Integrated Pest Management strategies include the implementation of prophylactic cropping practices and the use of pheromone-pitfall traps.

The combined use of pheromone-pitfall traps and fallows reduces the number of *C. sordidus* adults in the field and has significantly reduced insecticide use in the French West Indies and in the Canary Islands.

Because of the patchy distribution of *C. sordidus* and the capabilities of weevils to invade neighbouring fields, these methods should be deployed at the farm and landscape scale, with special focus on their spatial and temporal organisation.

To further refine the Integrated Pest Management of this pest in the longer term, we are evaluating biocontrol agents and modelling tools developed to simulate the spatial organisation of traps at the plot and landscape scales.

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> Building a lasting crop protection research community

> Providing end-users with a broader range of short-term solutions

> Developing a holistic approach to sustainable pest management

> Taking stock of and informing plant protection policy changes.

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