BAITING TECHNIQUES FOR THE CONTROL OF *COSMOPOLITES SORDIDUS* GERMAR (COLEOPTERA: CURCULIONIDAE) BY *STEINERNEMA CARPOCAPSAE* (NEMATODA: STEINERNEMATIDAE)

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ABSTRACT

Schmitt, A. T., S. R. Gowen, and N. G. M. Hague. 1992. A baiting technique for the control of *Cosmopolites sordidus* Germar (Coleoptera: Curculionidae) by *Steinernema carpocapsae* (Nematoda: Steinernematidae). Nematropica 22:159–163.

Spraying *Steinernema carpocapsae* ALL and UK strains at a dosage of 5×10^6 nematodes/m^2 in 0.4 L water onto split pseudostems and pseudostem stumps as a baiting technique gave up to 70% mortality of adult *Cosmopolites sordidus* recovered from traps 7 days after treatment and up to 40% mortality of adults recovered from traps 14 and 21 days after treatment. Overall, the application of nematodes to pseudostem traps gave significantly greater control of weevils than the application of nematodes to soil around banana plants. Results suggest that baiting techniques could be used to control adult banana weevils on a field scale.

Key words: biological control, baiting, *Cosmopolites sordidus*, emtomopathogenic nematodes, *Steinernema carpocapsae*.

RESUMEN

Schmitt, A. T., S. R. Gowen y N. G. M. Hague. 1992. Técnicas basadas en la utilización de cebos para el control de *Cosmopolites sordidus* Germar (Coleoptera: Curculionidae) con *Steinernema carpocapsae* (Nematoda: Steinernematidae). Nematrópica 22:159–163.

La aplicación de *Steinernema carpocapsae* (patotipos ALL y UK) en forma de aspersión a una dosis de 5×10^6 nematodos/m^2 en 0.4 L de agua sobre pseudotallos partidos y tocones de pseudotallos, alcanzó un 70% de mortalidad de adultos de *Cosmopolites sordidus* recuperados en trampas a los 7 días después del tratamiento y 40% mortalidad para adultos recuperados en trampas a los 14 y 21 días. En general, la aplicación de *S. carpocapsae* sobre el pseudotallo presentó un mayor control de gorgojos que la aplicación de nematodos directamente al suelo alrededor de la planta de banano. Estos resultados sugieren que técnicas basadas en la utilización de cebos podrían ser usadas para el control de adultos del gorgojo (picudo) de banano en escala comercial en campo.

Palabras clave: banano, cebos, control biológico, *Cosmopolites sordidus*, nematodos entomopatógenos, *Steinernema carpocapsae*.

INTRODUCTION

Cosmopolites sordidus is considered a major pest of bananas in many parts of the world (10) but there is still some disagreement about the insect's overall pest status (13). Weevil incidence is usually monitored by placing fresh pseudostem traps in a plantation and recovering adults that are attracted to them (6). The number of weevils recovered from traps is an indication of the severity of infestation. In Brazil, populations of two adult weevils per split pseudostem are considered damaging (7).

In the last 40 years, control of *C. sor-*

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didus has relied on insecticides, initially on organochlorines against which resistance soon developed, and later on organophosphates and carbamates for which there is now evidence of resistance (2). The incentives to develop alternative control measures include the worldwide need to decrease the use of toxic chemicals, and the promising results that have been obtained from the use of natural control agents, such as *Beauvaria bassiana* (1).

Entomopathogenic nematodes are able to infect a wide range of insects (11). *Steinernema carpocapsae* species enter the insect haemocoel through natural orifices (4,8,11), and release symbiotic bacteria of the genus *Xenorhabdus* into the insect blood causing septicemia and rapid death. The nematodes feed on the bacteria in the cadaver and reproduce. As the supply of nutrient is depleted the infective juveniles emerge from the cadaver and are capable of seeking new hosts.

The application of *S. carpocapsae* ALL and NC 513 strains into drilled holes in rhizomes or onto the cut surfaces of rhizomes (12) was reported to reduce damage caused by *C. sordidus*. Adult weevils were susceptible to several strains of nematodes (9) and there were indications that adult weevils might be controlled using rhizomes baited with nematodes (12). Baiting techniques have been used to control the black cutworm (*Agrotis ipsilon*) and the tawny mole cricket (*Scapteriscus vicinius*) in the laboratory but a baiting technique was inferior to application of nematodes in aqueous suspension in the field (5).

Laboratory studies (A. T. Schmitt, unpublished) have indicated that adult *C. sordidus* are susceptible to both *Steinernema* and *Heterorhabditis* species. Therefore, a field experiment was done in Brazil to see if a baiting technique could be used to control the weevil in a commercial banana plantation.

MATERIALS AND METHODS

The experiment was conducted during August 1991 on a commercial banana plantation in Miracatu County, São Paulo State, Brazil. The average temperature was 26 ± 1C, the average relative humidity was 85%, and the total rainfall was 53 mm. All banana plant material was of the cultivar Nanicao (Musa AAA Cavendish subgroup).

Assessment of weevil population in plantation: Before applying nematodes, the banana weevil population in the plantation was assessed using 10 split pseudostem traps (6), which were examined 7 days later. The mean population of adult weevils was six per trap (range 3–13), which is considered to be a heavy population in Brazil. The weevils were released after counting.

Entomopathogenic nematodes: Steinernema carpocapsae ALL and UK strains were chosen for the study on the basis of laboratory studies at Reading University (A. T. Schmitt, unpublished). Commercial formulations of these nematodes were supplied by Biosys, Palo Alto, California, U.S.A., and were applied with a hand-operated pressure sprayer at a rate equivalent to 5×10^6 nematodes in 0.4 L water/m^2. Nematode viability was determined under the microscope prior to application and also by *Galleria mellonella* bioassays.

Methods of application: There were three methods of nematode application. The first was the split pseudostem or Telha technique. A suspension of nematodes was applied to the cut surface of 40-cm lengths of longitudinally divided pseudostem from recently harvested banana plants. The treated section was then

laid on the soil surface with its cut face down, close to an uncut banana plant.

The second method of application was the disc-on-stump or Queijo technique. Stumps of pseudostems of recently harvested banana plants that had been severed 60–80 cm above ground level were cut horizontally three-quarters of the way through the pseudostem at about 30–40 cm. The top part of the pseudostem above the cut was bent back and nematodes were applied to the cut surface of the pseudostem. The top part of the pseudostem was then pushed back into its natural position.

The third method was ground application. Nematodes were applied to 1 m^2 of the soil surface around growing banana plants and then a split pseudostem trap was placed near the plant and covered with banana leaves.

All treatments were replicated 10 times in a randomised design.

Collection of weevils and nematodes: Each trap was sampled 7, 14, and 21 days after treatment. The adult weevils were counted and removed from the traps. Weevils were placed in a 500-ml glass container with a piece of pseudostem for food and observed over a period of 20 days. The number of dead weevils was recorded. A sample of 30 dead weevils from each treatment was dissected to find out how many nematodes were in the haemocoel. Weevils infected with *Beauveria bassiana* were discarded.

RESULTS AND DISCUSSION

There was no significant difference between the efficacy of the two strains of *S. carpocapsae* and the mortality data for adult weevils have been pooled (Table 1). Mortality for the split pseudostem technique at 7 days (51%) was similar to the soil treatment (58%), and at 14 and 21 days was almost double that of the soil treatment. Up to 70% mortality was obtained during the first week with the disc-on-stump technique and mortality declined in the following weeks. However, even after 3 weeks, mortality of about 30–40% was obtained with both disc-on-stump and split pseudostem trap techniques.

Table 1. The percentage of *Cosmopolites sordidus* adults killed by *Steinernema carpocapsae*[x] after being exposed to nematodes applied to soil or to pseudostem traps.

Application method	Number of days after treatment		
	7	14	21
Soil	57.8 A b[y] (3.30)[z]	24.3 B b (2.70)	24.8 B b (1.65)
Disc-on-stump	69.6 A a (8.20)	51.1 B a (2.90)	31.5 C ab (1.85)
Split pseudostem	51.2 b (7.15)	40.0 a 3.60)	40.1 a (2.25)

[x]Pooled data for *S. carpocapsae* strains ALL and UK, 10 replications per strain.
[y]Values in columns and rows followed by a common letter do not differ significantly at $P = 0.05$ according to *t*-test. (Capital letters are for comparisons within rows. Lower case letters are for comparisons within columns.)
[z]Standard errors in parentheses.

In the samples of dead weevils obtained from the various traps, the number of pre-adult and adult *S. carpocapsae* per weevil was 11 ± 4 for both strains of the nematode. In the controls no weevils were found to be infected.

Fresh banana pseudostems attract adult weevils. They also provide a favourable environment for steinernematid nematodes because the moist conditions enable the nematodes to remain active and potentially ineffective.

The degree of control we obtained compares favourably with that reported

by other researchers (3,12). Thus it may be practicable to trap out adult weevils either by applying entomopathogenic nematodes directly to split pseudostems or by placing split pseudostems on the surface of soil that has been sprayed with nematodes. The cost of these methods of application would have to be compared to determine the most economically effective technique.

Although larvae of *C. sordidus* are more susceptible to entomopathogenic nematodes than are adult weevils in the field (12), our results suggest that baiting techniques targeted against adults might be more practical than methods targeted against larvae because the larvae occur inside the rhizome where they are physically isolated from the nematodes.

Pseudostem traps may attract only a small portion of the adult weevil population (6); however, it may be economically possible to periodically apply new split pseudostems containing nematodes throughout the period when adult *C. sordidus* populations are maximal. Treating small pieces of pseudostem with relatively high doses of steinernematid nematodes would reduce the overall cost per hectare and thus may be economic even if the treatment had to be repeated.

ACKNOWLEDGEMENTS

The authors wish to thank the Brazilian agencies CNPq, Brasilia/DF, and EPAGRI, Santa Catarina, for providing financial support for the development of this study, and the Instituto Biológico Campinas (SCBP), for providing field and laboratory facilities. Biosys kindly supplied the nematodes.

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Received: *28.IV.1992*
Recibido:

Accepted for publication: *11.VIII.1992*
Aceptado para publicación: