

Short communication

Reduction of pre-harvest infestations of African sweetpotato weevils *Cylas brunneus* and *C. puncticollis* (Coleoptera: Apionidae) using a pheromone mating-disruption technique

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Abstract

A trial was carried out in Uganda for the control of sweetpotato weevils, *Cylas puncticollis* and *C. brunneus*, by mating-disruption using the synthetic sex pheromone of *C. brunneus* formulated in PVC resin dispensers. Almost no *C. brunneus* males were caught in pheromone traps in the treatment plot, whereas catches in the control plot ranged up to 30 weevils per trap over each two-night monitoring period. Suppression of *C. puncticollis* catches was weaker. Mating of *C. puncticollis* was significantly suppressed on one sample date, 18 weeks after planting, but not on two subsequent occasions, at 19 and 33 weeks. Yields of roots in the two plots were similar, but root infestation was lower in the plot treated with pheromone on four out of five sample harvest dates, from 17 to 36 weeks after planting. © 2001 Elsevier Science Ltd. All rights reserved.

1. Introduction

Sweetpotato weevils of the genus *Cylas* (Coleoptera: Apionidae) are the most important insect pests worldwide of sweetpotato, *Ipomoea batatas* L. (Jansson and Raman, 1991). *Cylas formicarius* F. occurs throughout the Americas and Asia, while *C. puncticollis* Boheman and *C. brunneus* F. are exclusively African species (CAB International, 1993). The cryptic feeding habits of the larvae and the nocturnal activity of the adults make detection and control of infestations difficult, while varieties of sweetpotato having significant levels of resistance to weevils have not yet been developed. As a result, attention in recent years has focussed on sex pheromones as a potential component in their management.

Heath et al. (1986) identified the female-produced sex pheromone of *C. formicarius*. Development of traps and lures for this species has been carried out by Jansson et al. (1992, 1993). The pheromones of *C. puncticollis* and *C. brunneus* were identified by Hall et al. (unpublished) and confirmed by Downham et al. (1999) as decyl- and dodecyl (*E*)-2-butenoate, respectively. Development of

traps for *C. puncticollis* and *C. brunneus* was reported by Smit et al. (1997). Mass-trapping has been shown to suppress populations of *C. formicarius* males in several countries (e.g. Yasuda, 1995), but this has not always resulted in significant reductions in infestation rate or increases in yield (e.g. Braun and Van De Fliert, 1999). Similarly in Uganda, mass-trapping of both African species reduced numbers of males without any beneficial effects on yield or infestation rates (Laboke et al., 1997; Smit et al., unpublished).

The use of arrays of pheromone dispensers to control insect pests by mating-disruption is now practised with a wide variety of insect species (e.g. Cardé and Minks, 1995). Using this method, Mason and Jansson (1991) demonstrated a marked reduction in catches of *C. formicarius* males in traps in a trial conducted in Florida, USA, but they gave no infestation or yield data. This paper reports a trial to control *C. brunneus* and *C. puncticollis* in Uganda by mating-disruption.

2. Materials and methods

The trial site was on the Namulonge Agricultural and Animal Production Research Institute (NAARI), which is

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at 0°32' N, 32°35' E, 1128 m above sea level, with a mean annual rainfall of 1270 mm over two seasons. The trial consisted of one treatment (mating-disruption) and one untreated control plot, each of 0.5 ha, planted with the local susceptible sweetpotato variety 'Tanzania'. The plots were separated by about 200 m of uncultivated bush and were situated at least 500 m from other sweetpotato fields which might have acted as sources of infestation. Both were planted on 6 March 1998. No sweetpotato had been cultivated on the plots during the previous five years.

Both *C. brunneus* and *C. puncticollis* occur at this location, but as the pheromone of *C. puncticollis* acts as a powerful inhibitor of attraction of *C. brunneus* (Downham et al., 1999) it was not considered advisable to use both pheromones in the disruption treatment. The formulation used contained the synthetic pheromone of *C. brunneus*, as this attracts both species (Downham et al., 1999). Dodecyl (*E*)-2-butenate was prepared at the Natural Resources Institute and was at least 98% pure by gas chromatographic (GC) analysis. It was formulated by Agrisense-BCS, Cardiff, UK in a PVC resin, controlled-release formulation (Cork et al., 1989). The resin formulation, containing 5% of dodecyl (*E*)-2-butenate, was cut into lengths (85 mm × 4 mm diameter) each containing 64 mg of active ingredient. Dispensers were set out two days after planting in the treatment plot. They were attached to stakes 0.5 m above ground level on a 4-m grid giving 625 dispensers ha⁻¹ and an effective application rate of 40 g ha⁻¹ a.i. Repeat applications were made at approximately 8, 16 and 24 weeks after planting (WAP). In a laboratory wind-tunnel with a continuous wind-speed of 1.4 m s⁻¹, at a temperature of 27°C, the half-life of the pheromone in this formulation had previously been shown to be 44 days (Hall, unpublished).

The effectiveness of the treatment was assessed by monitoring male populations with pheromone traps, by sample harvesting in each plot and by determining the incidence of female mating. Monitoring of males was carried out using 5-l jerry-can traps baited with lures containing 0.1 mg of the appropriate pheromone (Smit et al., 1997). Ten traps (5 for each species) were deployed in each plot for 2 nights at 4 week intervals. Based on previous mass-trapping trials (Smit et al., unpublished), more frequent deployment of traps could be expected to have suppressed nightly catches, thus obscuring the effect of the mating-disruption treatment. Trap lures were polyethylene vials for *C. puncticollis* and white rubber septa for *C. brunneus* as these are optimal for the respective species (Downham et al., 1999).

Yield and damage assessments were made five times at approximately monthly intervals beginning 17 WAP. At each sample date, four sample sub-plots, of 20 m² each, were randomly selected for harvesting. Data at harvest included total number and weight of all roots, and the number and weight of *Cylas*-infested roots.

Mature (2 week-old) virgin female *C. puncticollis*, obtained from a laboratory culture at NAARI, were used to determine the incidence of mating in the plots on three dates. No mating assessments were undertaken for *C. brunneus* females because high rates of loss and predation overnight were observed for this smaller species in previous work (Smit et al. unpublished). Individual females of *C. puncticollis* were tethered overnight to sweetpotato vines by 20 cm lengths of fine copper wire (0.046 mm diameter, Johnson Matthey Ltd., UK) attached to one leg. Between 10 and 20 females per plot were tethered between 17:00 and 18:00 h on each occasion; individuals were placed 5 m apart in the centre of the plots. Live females were recovered at 07:00 – 08:00 h the following morning. They were individually placed on pieces of sweetpotato for 5 days, and these subsequently replaced and checked daily for the presence of eggs. Smit et al. (1994) established previously that oviposition or its absence is a definitive indicator of mated status in *C. puncticollis*.

Means and standard errors of the trap catches or harvest sub-plot data were calculated, and are indicated in the results. However, the means cannot be compared statistically as the individual traps and sample sub-plots do not constitute true replicates. The proportions of mated and unmated female *C. puncticollis* in the treatment and control plots were compared by tests of independence on the appropriate 2 × 2 contingency table.

3. Results

Trap catch data are shown in Fig. 1. Initially, catches of both species in both plots were very low but, except for *C. brunneus* in the treatment plot, these increased by varying degrees through the season. Only a single *C. brunneus* weevil was captured in the treatment plot throughout the season (around 20 WAP), whereas up to 30 *C. brunneus* males per trap per 2-nights were captured in the control plot. The number of *C. puncticollis* trapped in the treatment plot was lower than in the control, up to 20 WAP, but thereafter catches were similar in the two plots.

Total yields in both plots were similar on each sample date. They ranged from approximately 8 t ha⁻¹ at the first sample harvest (17 WAP), to approximately 30 t ha⁻¹ at the last harvest, 36 WAP. However, the percentage infested yield was greater in the control on all occasions except the third sample harvest (approximately 26), when the figures were similar (Table 1).

Table 2 provides data on the proportion of mated female *C. puncticollis* in each of the plots. These indicate that mating was significantly suppressed in the treatment plot on the first sample date (18 WAP) but not on the two subsequent occasions (19 and 33 WAP).

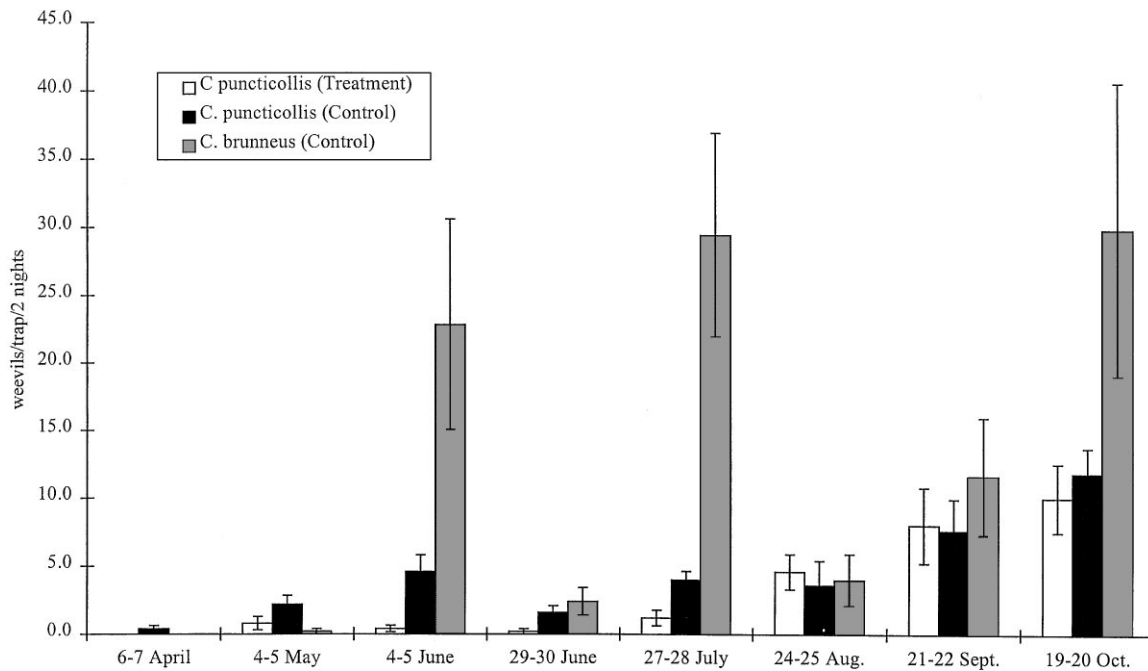


Fig. 1. Mean catches by 5 traps for each species in the control plot and *C. puncticollis* in the treatment plot. Only 1 *C. brunneus* male was captured in the treatment plot, 20 WAP, so this data-set has been omitted for clarity. Vertical bars indicate standard errors of the means.

Table 1

Mean percentage infestation by weight (\pm s.e.) of 4 sample sub-plots in treatment and control plots at each sample harvest date

Sample harvest date (WAP)	Percentage infestation	
	Treatment	Control
17	0.0 (0.0)	2.6 (1.3)
22	0.0 (0.0)	7.7 (1.9)
26	6.3 (4.2)	5.6 (1.6)
31	9.7 (4.4)	17.6 (7.2)
36	8.7 (4.3)	19.7 (5.0)

Table 2

Proportions of tethered, mated female *C. puncticollis* recovered from the treatment and control plots on each of the three sample dates

Sample date (WAP)	Treatment plot		Control plot	
	Proportion mated	<i>N</i>	Proportion mated	<i>N</i>
18	0.00 ^a	7	0.83	6
19	0.40	5	0.57	7
33	0.64	14	0.62	13

^a $P < 0.005$ for comparison with the respective data of control plot (Fisher's Exact Test); for other sample dates, $P \geq 0.88$ (Fisher's Exact Test and Pearson's χ^2 statistic for 2×2 contingency table).

4. Discussion

In this trial, a single formulation of dodecyl (*E*)-2-butenate, the sex pheromone of *C. brunneus*, was used as this compound also shows significant attractiveness for *C. puncticollis* (Downham et al., 1999). However, although it caused complete suppression of catches of *C. brunneus* it was much less effective in reducing catches of *C. puncticollis*. By comparison, Mason and Jansson (1991) observed strong trap catch suppression in their trial in the USA involving *C. formicarius*.

Mating of *C. puncticollis* was successfully prevented by the treatment on the first sample date, but not thereafter. This may be a reflection of the subsequent increase in the population of *C. puncticollis* males in the treated plot, which appeared to begin around 20 WAP (Fig. 1). It is unfortunate that no mating assessments could be made

with *C. brunneus* in view of the strong trap catch suppression for this species.

The trial provided evidence for a reduction of root infestation rates in the treatment plot, and it is thus one of very few studies to show a beneficial effect of a pheromone treatment alone on root infestations by *Cylas* spp. Based on the trap monitoring and mating assessment data, it may be speculated that most of the reduction of infestation arose from suppression of mating activity of *C. brunneus* populations.

With this single unreplicated trial, there is obviously need for caution in the interpretation of the results, which could have been influenced by a variety of factors, unrelated to the treatment. However, trial sites were chosen in anticipation that pest pressure in both plots was initially equal and low and this was confirmed by the first two

rounds of trap monitoring. This increases confidence that the presence or absence of the treatment was the main influence on weevil infestations. Further trials of mating-disruption of African species of *Cylas* will be required to confirm the potential of this technique.

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