DISRUPTION OF SEX PHEROMONE COMMUNICATION IN *CYLAS FORMICARIUS* (COLEOPTERA: APIONIDAE) AS A POTENTIAL MEANS OF CONTROL

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Sweetpotato weevil, *Cylas formicarius* (Fabricius), is the most limiting factor of sweet potato, *Ipomoea batatas* (L.) Lam., production worldwide (Jansson & Raman 1991). Feeding and oviposition damage in roots and vines can cause severe cosmetic and economic damage. In response to tissue damage, sweet potato roots produce foul tasting terpenoids (Uritani et al. 1975) rendering them unpalatable for human consumption. Thus, commercial growers can tolerate very little sweetpotato weevil damage.

Historically, weevil management has relied heavily on cultural and chemical control (Sutherland 1986, Chalfant et al. 1990). However, chemical control provides little protection once an egg is laid because immatures develop within roots and vines (Chalfant et al. 1990). Cultural controls, such as sanitation, crop rotation, planting away from weevil-infested fields, removal of alternate hosts, hilling plants, etc., can help to reduce damage (Talekar 1991); however, they require considerable labor and have not been universally adopted. Recent studies indicate that entomopathogenic nematodes and sex pheromones may provide new means to control the sweetpotato weevil (Jansson 1991, Jansson et al. 1991).

Pheromones have typically been used three ways: (1) monitoring insect populations using pheromone-baited traps; (2) mass-trapping, where large numbers of traps are used to reduce the insect population; and (3) mating disruption, in which the pheromone is used at high dosages to permeate the atmosphere so as to disrupt communication between the sexes, thus reducing mating (Kydonieus & Beroza 1982, Campion 1984). Mating disruption has been examined in many insect systems (McLaughlin et al. 1972, Shorey et al. 1972, Landolt et al. 1982, Sower 1982, Schwalbe & Mastro 1988, for reviews see Kydonieus & Beroza 1982, Campion 1984), and in general, some success has been achieved. The objective of our study was to examine the potential of sweetpotato weevil synthetic sex pheromone as a mating disruptant by examining male confusion (i.e. communication disruption) in a large commercial field plot.

Pheromone

The pheromone used in the field for evaluation of communication disruption was obtained from the USDA, ARS, Insect Attractants, Behavior, and Basic Biology Research Laboratory in Gainesville, Florida. The synthetic pheromone, (Z)-3-dodecen-1-ol (E)-2-butenoate, (>99.9% pure), was applied to methylene chloride-extracted rubber septa (Thomas Scientific, Swedesboro, NJ) as described by Heath et al. (1986).

Field Studies

Communication disruption potential was evaluated by comparing trap counts in two widely separated sections (0.5 ha each) of a commercial white-fleshed 'Picadito' sweet potato field (planted 1 June 1989). Sections were separated by an 1.3 ha non-pheromone treated buffer zone also planted in sweet potatoes. Experimental sections were east-west of the buffer zone due to the prevailing winds coming out of the east. The eastern section contained pheromone traps (5 traps per section - 25 m apart - running north-south) baited with an extremely low synthetic pheromone dosage (1 ng per trap). These traps were to simulate calling feral females. This section was compared with the western section that also contained pheromone traps baited with 1 ng placed identically to those in the eastern section. In addition to the low dose traps, twelve wooden stakes baited with a high pheromone dosage (100 μg per stake) to disorient male *C. formicarius* were placed (25 m apart and 10 m east and west of the low dose trapline running north-south) in the western section. Pheromone loaded rubber septa were pinned to the stakes at a level just above the height of the canopy. A plastic petri-dish was glued in an inverted position at the top of each stake to protect the rubber septa from rain. Septa on the stakes and in the traps were replaced every 3 weeks. Trap counts were recorded twice per week. Total counts were summed each week. The experiment was repeated, in a widely separated, distinct area of the same commercial field, south of the first replication.

All plots were treated with monthly chemical insecticide applications (parathion (2.25 kg a.i./ha), endosulfan (0.96 kg a.i./ha), and methamidophos (0.56 kg a.i./ha). Data were analyzed by analysis of variance and t-test analysis of log transformed weevil captured totals, using SAS statistical analysis package (SAS Institute 1985).

Pheromone trap counts were significantly lower on most dates in the pheromone-treated plots than the non-pheromone treated plots ($P<0.05$) in both trials. For example, trial 2 trap counts in the pheromone-treated section averaged 12 males/trap on week 1, whereas in the non-treated sections counts averaged over 400 males/trap. In trial 1, the pheromone-treated section had significantly lower trap counts on 13 of 21 weeks (Fig. 1); while in trial 2, the pheromone-treated section had significantly lower trap counts 11 of 21 weeks (Fig. 1). Trap counts dropped to zero and were not significantly different after 21 October when a cold front dropped temperatures considerably. These data suggest that pheromone communication was probably disrupted in pheromone-treated sections. However, due to the location of the plots in a large commercial field, there was no isolation from immigration of mated females. Therefore no data were obtained relevant to weevil control.

It is not known if the lower trap counts in the pheromone-treated sections due to male disorientation would translate to a reduction in plant damage ratings without insecticide treatment. Information critical to the assessment of mating disruption studies includes distances over which insects can disperse for mating; if there is a dispersal flight after mating; whether virgin females search for males and/or visa versa (Campion et al. 1989); or, the breadth of the host range (Rothschild 1981).

Insects with a restricted host range may be more limited in their movement than polyphagous species (Campion 1984). Sweetpotato weevils are oligophagous; consuming plants primarily in the Convolvulaceae (Austin et al. 1991). If alternative hosts are removed from areas surrounding areas as suggested by Talekar (1991) as a method of weevil control, then immigration into fields by gravid females or nondisrupted males, should be limited. In addition to all host removal, the larger the area treated or the more isolated the field, the lesser the chance of immigration (Campion 1984). Sweetpotato weevil males can traverse considerably distances (280 m/16h) when no distractions are present (food, mates, etc.) (Mason et al. 1990). However, when marked males are released in a sweetpotato field with a resident sweetpotato weevil population, traversal distances drop to a maximum of 80 m/40 h in a 3 month old field to less than 60 m/40 h in a field ready for harvest (6 months old) (Mason & Jansson unpubl. data). Thus, sweetpotato weevil have limited dispersal abilities, especially as a field ages, and mating disruption may have potential.

Evidence from this work indicates that mating disruption has potential. Further behavioral studies to verify a reduction in mating under field conditions as well as testing without the use of insecticides should confirm its control potential. Current and future studies are focused on combining mass trapping, mating disruption, and en-

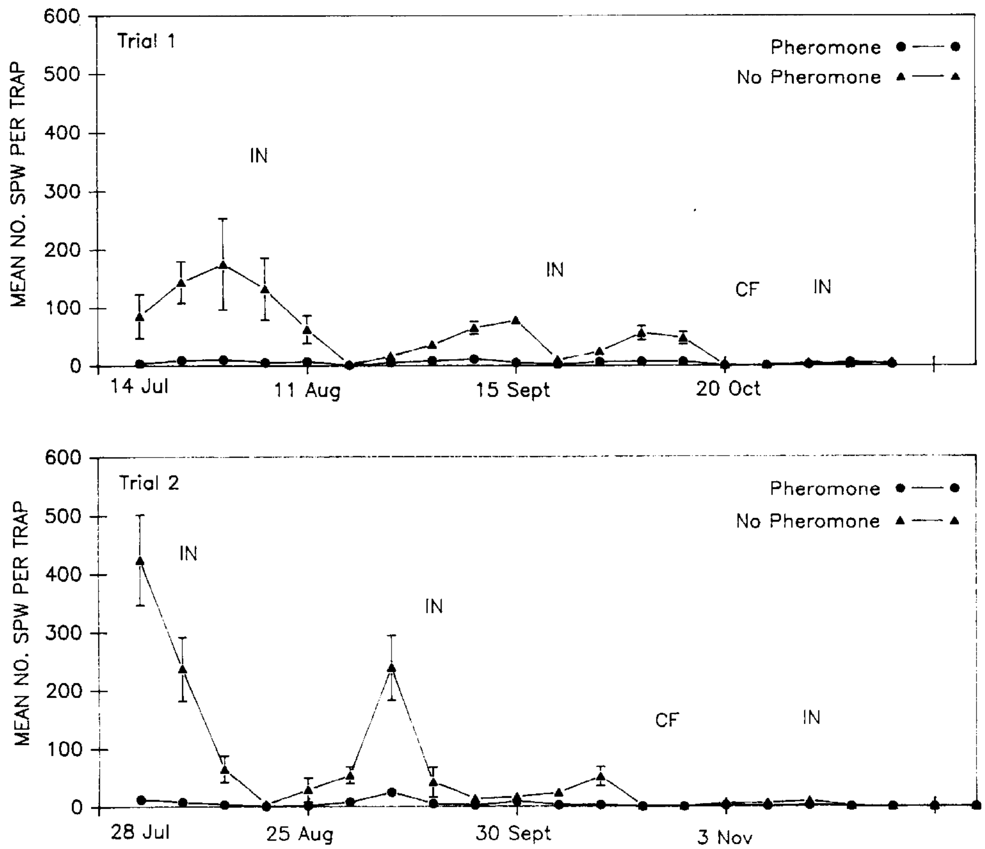

Fig. 1. Average number of sweetpotato weevil males caught per trap per week in pheromone traps baited with 1 ng of pheromone placed in pheromone-treated and non-pheromone treated sections of a commercial sweet potato field. IN = Insecticide application; CF = Cold front.

tomopathogenic nematodes for a comprehensive control program for this serious pest of sweetpotato in the tropics.

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