CHEMICAL ECOLOGY OF THE SUGARCANE BEETLE, *EUETHEOLA HUMILIS*, BURMEISTER (COLEOPTERA: SCARABAEIDAE)

Abner M. Hammond[1] and Tara P. Smith[1]
[1]LSU AgCenter, Department of Entomology, Baton Rouge, LA

INTRODUCTION

Sweet potato production plays a vital role in the agroecosystem of the southern United States (Curtis 2003). Sweet potatoes are an important agricultural commodity to Louisiana, with over 16,000 acres harvested in 2005 (USDA 2006). The sugarcane beetle was first reported as a pest of sweet potato in Louisiana in 2001 (Hammond 2002). In Louisiana, 2002 and 2003, sweet potato producers reported excessive losses due to adult sugarcane beetle feeding on roots prior to harvest. Limited information is available on the ecology and feeding behavior of this insect, probably because it was considered a minor insect pest until recent damage reports warranted concern.

BIOLOGY AND CHEMICAL ECOLOGY

The sugarcane beetle is a univoltine insect with four distinct life stages (Baerg 1942). The adult stage of the beetle feeds on sweet potato roots, creating jagged holes and unattractive scarring. The sugarcane beetle has two distinct periods of activity, with peak spring flight occurring in April and May, and peak fall flight occurring in August and September. Planting date studies have suggested that fall flights of beetles are damaging sweet potatoes prior to harvest (Smith and Hammond, unpublished). Sugarcane beetles demonstrate an aggregation behavior in the field. Damage observations in 2003 suggested that the majority of damage occurs over a short period of time. One hypothesis for the aggregative behavior is that there is a cue that beetles are responding to, which may attract subsequent beetles to a particular location.

Insect behaviors, such as communication within species and recognition of food sources, are mediated by chemicals (Harris and Foster 1994). Most attractive plant substances are secondary chemicals (Schoonhoven et al. 1998) and volatile and non-volatile phytochemicals can be involved in plant insect interactions as attractants, stimulants or deterrents to feeding and oviposition (Starr et al. 1991). Sweet potato plant volatiles have been shown to be attractive to sweetpotato weevil, and they have also been implicated as resistance factors for the weevil (Nottingham et al. 1989, Wang and Kays 2002).

Pheromones are also integral components of insect chemical ecology and they allow for more effective control measures in integrated pest management systems (Justsom and Gordon 1989). A successful example of the use of pheromones in IPM systems is the mandatory state-wide trapping program for sweetpotato weevils by the Louisiana Department of Agriculture and Forestry.

The objective of this study was to evaluate the aggregation behavior of the sugarcane beetle using a classical Y-tube olfactometer and to determine if sweet potato cultivars were differentially damaged by the sugarcane beetle.

MATERIALS AND METHODS

Insects: Adult sugarcane beetles used in experiments were collected with black light traps located near Zachary, LA during April and May 2005. After collection beetles were sexed and held in plastic containers in a bioclimatic chamber with a 14:10 light:dark cycle at 28° C and 80 % relative humidity. Beetles were maintained on sweet potato roots and were held without food 48 h prior to testing.

Olfactometer Tests: A dual choice olfactometer (Fig 1) was used to test the anemotactic response of sugarcane beetles to sweet potato volatiles and conspecifics. Air from a single source was split into two streams and maintained at 100 ml/min. The air was then filtered and humidified before entering sample containers. Beetles were introduced to the system at the Y-tube opening. For a choice to be counted beetles had to walk 5 cm down one arm of the Y-tube within 8 min of introduction. Three replications (20 insects/rep) were evaluated for each of the paired odor tests. Male and female sugarcane beetles were tested with four of the odor pairs and both sexes were evaluated for the remaining four odor pairs. Data were pooled for each arm (odor) and were compared to a hypothesized 50:50 ratio using G-test for goodness of fit (Sokal and Rohlf 1995).

Cultivar Tests: Response of sugarcane beetles to four sweet potato cultivars was investigated in laboratory experiments. The paired choice test included: Georgia Jet vs. Beauregard, Beauregard vs. Bunch Porto Rico, and Beauregard vs. White Star. Beauregard is the most cultivated cultivar in the US and is highly susceptible to soil insects. Georgia Jet has been associated with reduced susceptibility to soil insects in preliminary field observations and Bunch Porto Rico and White Star are in the lineage of the Georgia Jet. One root of each cultivar to be evaluated was placed in a 5.6 L plastic arena (Fig 2) with a screened lid. Ten beetles were placed at the opposite end of the container evaluated in each test and the Beauregard vs. Georgia Jet pairing was also evaluated with one beetle per container. A minimum of five replications were conducted for each pairing. Each test lasted 72 h after which the number of feeding scars (Fig 3) per root was determined. All data were analyzed with paired t-test (PROC UNIVARIATE, SAS Institute 2004).

Figure 1. Olfactometer used in experiments evaluating the aggregation behavior of the sugarcane beetle

Figure 2. Arena used to evaluate cultivar preference

Figure 3. Characteristic sugarcane beetle feeding scar

RESULTS OLFACTOMETER EXPERIMENTS

Female and male sugarcane beetles responded significantly more to damaged roots (biotic / abiotic) than to uninjured roots and male beetles responded significantly more to beetle injured roots vs. mechanically injured roots (Fig 4). Washing injured roots did not significantly affect beetle choice (Fig 4). Beetles previously fed on Beauregard roots and Georgia jet roots did not respond differentially to host plant volatiles from these cultivars in the olfactometer (Fig 5). Male and female sugarcane beetles responded significantly more to female conspecifics (Fig 6) and sugarcane beetles (both sexes) responded more to sweetpotato weevil injured roots vs. sugarcane beetle injured roots Fig 7).

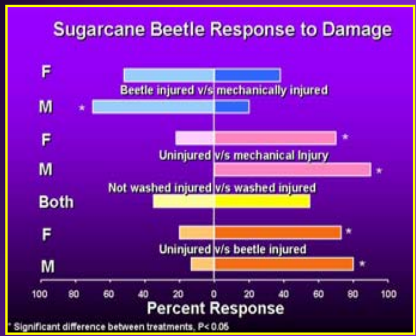

Figure 4. Percentage of SCB walking toward one of two paired sweet potato roots in a Y-tube olfactometer Non-responders were < 10% in all trials.

Figure 5. Percentage of SCB walking toward one of two paired sweet potato cultivars in a Y-tube olfactometer Non-responders were < 15% in all trials, * indicates significant difference between treatments, P < 0.05.

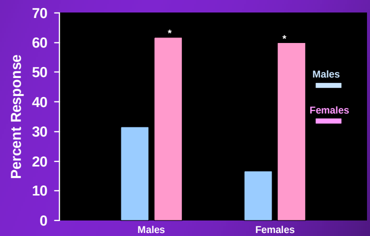

Figure 6. Percentage of SCB walking toward male and female conspecifics in a Y-tube olfactometer. Non-responders were < 10% in all trials. * Indicates significant difference between treatments, P < 0.05.

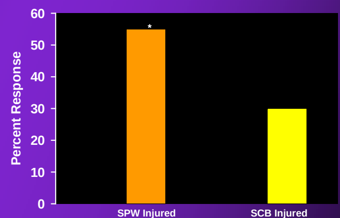

Figure 7. Percentage of SCB walking toward sweetpotato weevil and sugarcane beetle injured sweet potato roots in a Y-tube olfactometer. Non-responders were < 10% in all trials. * Indicates significant difference between treatments, P < 0.05.

RESULTS CULTIVAR EXPERIMENTS

Beauregard roots had significantly more feeding scars in single and multiple beetle tests. Bunch Porto Rico roots had significantly more feeding scars than Beauregard roots and no difference in number of feeding scars was detected in the Beauregard vs. White Star pairing (Table 1). Sugar analyses have revealed that Bunch Porto Rico has Increased sucrose content compared to Beauregard. Sugars or various other surface chemicals may be mediating sugarcane beetle behavior and feeding.

Variety Test Results

Test	Treatment	Mean Difference ± (SE)	*t*	P-value	*n*
1	Beauregard Georgia Jet	4.75 (1.43)	3.31	0.0455*	8
2 [(1)]	Beauregard Georgia Jet	0.8 (0.29)	2.75	0.0224*	10
3	Bunch Porto Rico Beauregard	10.8 (1.93)	5.58	0.0050*	5
4	Beauregard White Star	1 (1.92)	0.52	0.6306	5

*Significantly different, P < 0.05
[(1)] One beetle evaluated in each container

Table 1. Effect of sweet potato cultivar on number of feeding scars in a series of paired choice tests

DISCUSSION

Host plant chemistry has the potential to modify herbivore host finding, feeding, and oviposition (Wang and Kays 2002). This report demonstrates that sugarcane beetles are attracted to host plant volatiles from wounded sweet potatoes. In another system, sweet potato volatiles (terpenes) from sweetpotato weevil injured roots have been identified as behavioral modifiers (Nottingham et al. 1989, Wang and Kays 2002). Sugarcane beetles were highly attracted to sweetpotato weevil injured roots in olfactometer trials. Sugarcane beetles may be attracted to some of the same volatiles as the sweetpotato weevil. Sugarcane beetles (both sexes) also responded more to female conspecifics than to male conspecifics, suggesting that females may produce an aggregation pheromone that is attractive to both sexes. Cultivars were not differentially chosen in olfactometer trials, however the small container cultivar experiments suggests that some cultivars may be more preferred than others. Additional research investigating the attraction of sugarcane beetles to host plant volatiles and conspecifics is warranted

REFERENCES

Baerg, W. J. 1941. The rough-headed cornstalk beetle. Arkansas Agricultural Experiment Station Bulletin 415, Fayetteville, AR. 22 pp.

Curtis, J. 2003. Strategic Plan for Pest Management Research and Education in Southern Sweet potato Production Systems, Sponsored by North Carolina State University Dept. of Horticulture, with funding from the U.S. Environmental Protection Agency, Region 4.

Hammond, A. M. 2002. Sugarcane beetle, *Euetheola rugiceps* (LeConte), Scarabaeidae, Coleoptera. Louisiana State University Agricultural Center. Publication number 2892.

Harris, M. O., and S. P. Foster. 1992. Behavior and integration, pp. 3-47. *In* R. T. Carde and W. J. Bell. Chemical Ecology of Insect 2. Chapman and Hill, New York, NY.

Jutsum, A.R. and R.F.S. Gordon. 1989. Introduction. Pheromones: Importance to insects and role in pest management, pp. 1-13. *In* A.R. Jutsum and R.F.S. Gordon (eds.) Insect Pheromones in Plant Protection. John Wiley and Sons Ltd. New York, NY.

Nottingham, S. F., K. C. Son, R. F. Severson, R. F. Arrendale and S. J. Kays. 1989. Attraction of adult sweetpotato weevils, *Cylas formicarius elegantulus* (Summers) (Coleoptera: Curculionidae), to sweet potato leaf and root volatiles. J. Chem. Ecol. 15:1095-1106.

SAS Institute Inc. 2004. SAS OnlineDoc® 9.1.2. Cary, NC: SAS Institute Inc.

Schoonhoven, L. M., T. Jermy, and J. J. A. van Loon. 1998. Host-plant selection: Why insects do not behave normally, pp. 195-220. *In*. L. M. Schoonhoven, T. Jermy, J. J. A. van Loon (eds.) Insect -plant biology: from physiology to evolution. Chapman and Hall. New York, NY.

Sokal, R. R., and F. J. Rohlf. 1995. Biometry. 3rd ed. Freeman, New York.

Starr, C. K., R. F. Severson, and S. J. Kays. 1991. Volatile chemicals from sweet potato and other Ipomoea: Effects on the behavior of *Cylas formicarius*, pp. 235-247. *In*. R. K. Jansson and K. V. Raman (eds.) Sweet Potato Pest Management: A Global Perspective. West View Press

(USDA) U. S. Department of Agriculture. 2006. USDA-NASS, National Agricultural Statistics Service: Vegetables. http://www.nass.usda.gov:8080/QuickStats/PullData_US

Wang, Y. and S. J. Kays. 2002. Sweet potato volatile chemistry in relation to sweet potato weevil (*Cylas formicarius*) behavior J. Amer. Soc. Hort. Sci. 127:656-662.

ACKNOWLEDGEMENTS

The authors wish to thank Will Shepherd who provided the olfactometer that was modified and used in experiments. We would also like to thank Mike Stout for suggestions and advice on this project. Special thanks are also extended to Josh Temple who assisted with insect collections. We would like to acknowledge the LSU AgCenter and the USDA-ARS for funding this research project.