HOW DO BOLL WEEVILS LOCATE OVERWINTERING SITES?

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Abstract

Field trapping studies showed that late Summer and Fall dispersing boll weevils responded better to traps containing grandlure plus synthetic plant components than to traps baited with grandlure alone. They also were weakly attracted to essential oils of honeysuckle, willow oak and red oak, and to extracts of leaf litter. Gas chromatographic and mass spectral analyses of the leaf litter extracts revealed the presence of two of the three compounds to which dispersing boll weevils responded.

Introduction

New boll weevil eradication strategies are being investigated which are aimed at attacking the insects at overwintering sites. This approach is especially appropriate in areas of the Mississippi and Arkansas Delta where overwintering habitat is more limited than in other areas. To take advantage of these new approaches, a better understanding is needed of how the boll weevil locates favorable overwintering.

In temperate regions during the winter, boll weevils can be found in leaf litter in woods, along ditch banks, in brushy areas, and other places where there is abundant litter and humus. It has been shown that the insects cannot survive temperatures much below freezing, and the leaf litter provides insulation. Winter kill of boll weevils, as measured by the numbers of weevils in ground trash samples taken in the fall compared with numbers in late winter, is largely a function of the severity of the winter. Weevil mortality is especially high when temperatures remain below freezing for several days at a time. Dispersing boll weevils leaving cotton fields in late summer and fall must therefore find favorable overwintering sites in order to survive. The mechanism by which they find these sites is still largely unknown. In the current study we tested the hypothesis that olfactory cues play a major role in the boll weevil's location of areas favorable to winter survival.

Materials and Methods

Plant extracts were prepared by steam distillation of freshly collected green leaves with continuous extraction with methylene chloride in a Neckerson apparatus. Species tested were Cedar, Honeysuckle, Cotton, Sweet Gum, Pine, Red Oak, and Willow Oak. Leaf litter from an apparently favorable overwintering site (mixed hardwood forest on well-drained slope) was likewise extracted. Extracts were concentrated in a rotary evaporator at 50º C and applied to cotton dental rolls for the field tests. Approximately 2 kg of fresh green leaves from Red Oak, Willow Oak, and Honeysuckle were combined and steam distilled in an effort to obtain more material for testing than in earlier distillations. The yield from this batch was approximately 200 mg of "leaf oil".

The study was done in Coahoma and Quitman Counties, Mississippi in September and October, 1997. Traps were baited with Grandlure using the standard 10 mg dispensers used in the eradication programs. Three synthetic plant components (compounds "a", "b", and "c") were chosen from a larger group of compounds from preliminary field data that indicated dispersing boll weevil response to them. The synthetic materials were prepared for field tests in traps by applying 40 mg of the oil to ¼ in. by 1 in. cotton dental rolls. Statistical analysis was done using the Least Squares means separations from the SAS GLM procedure.

Results and Discussion

Results with the 4 synthetic plant components are shown in Table 1. Two compounds, when used with grandlure, significantly improved the trap captures. Earlier, preliminary tests with the compounds indicated a weak response without grandlure.

In the first test with leaf extracts without grandlure, the weevil response was low, with no statistically significant differences (P>F 0.27, 7,32 df) among treatment means, with Honeysuckle leaf extract capturing 33% more than did the unbaited control. In the study of McKibben et al. (1977), 100 or 300 mg of cotton essential oil was used.

In the test with 65mg of the leaf oil, the oil appeared to be repellent for the first 2 days. This was similar to results from the earlier study by McKibben et al. (1977) with cotton essential oil, indicating that some of the lower molecular weight compounds are repellent. After the first 2 days, for example, the leaf oil had captured a total of 5 weevils while the unbaited check captured 17. Means for the combined 3 and 4 - day results were 6.3 for the check and 16.3 for the leaf oil. These means were statistically different (P>T 0.05; 1,4 df), though clearly more replication is needed.

There was no significant difference between ground trash extracts tested at 90g eq./ dispenser and an unbaited control (0.69 vs 0.54 weevils/trap; P>F 0.31; 1,54 df). When the remaining ground trash extract available was concentrated to provide 670g eq./dispenser, the capture mean of 7.7 weevils/trap for the extract was significantly higher (P>F 0.02; 1,2 df) than that of 5.3 for the unbaited control. As

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with the leaf extract, more material is needed to confirm these results.

Twenty five compounds were identified from the mass spectra of the ground trash extract. Two of the compounds identified were 2 of the 4 compounds that showed attractancy when tested with grandlure. Most identified compounds were those commonly found in green leaves, though several are not thought to have been reported in green leaves, and may represent compounds formed after abscission.

As early as 1918 it was reported that an "ethereal oil" from the cotton plant was attractive to the boll weevil (Viehoever et al.). Minyard (1969) reported a positive boll weevil response to several synthetic compounds in laboratory studies, and Dickens (1989) reported attraction of boll weevils to certain green leaf volatiles. Chang et al. (1987) reported field tests with a synthetic mixture derived from studies of cotton plant-derived compounds; no consistent pattern of boll weevil response in the field was reported. As far as the authors are aware, the present study represents the first field study that relates boll weevil response to plant-derived chemicals to the late season dispersing behavior.

The hypothesis that late-season dispersing boll weevils find favorable overwintering sites by olfactory cues seems to be strengthened, though clearly more work needs to be done with sufficient quantities of extracts. The authors believe that boll weevils tend to be attracted to green leafy plants in general for feeding, but are more strongly attracted to cotton than to other plants. One of us (GM) observed heavy boll weevil feeding on sicklepod (*Cassia*) in Mississippi during the Fall after an adjacent cotton field had been chemically defoliated. Rummel et al. (1978) reported overwintering weevils feeding on the pollen of yellow wooleywhite (H*ymenopappus flavescens* Gray) during the Spring in Texas. Since boll weevils settle into hibernation sites primarily within 0.5 mi. of the cotton field (Bottrell et al. 1972), it seems likely that they are attracted to green plants in the vicinity of cotton fields after cotton foliage is scarce.

The relative attractancy of green leaves versus fallen leaves is not known at the present time. It is also not known what cues induce weevils to leave green leaf foliage and move to ground trash. Temperature could be a factor in this behaviorism.

Summary

Certain synthetic plant components, when used with grandlure, improved the attractancy of late-season dispersing boll weevils to traps. Boll weevils were also weakly attracted to extracts of ground trash and certain tree leaves, strengthening the hypothesis that they use olfactory cues to find overwintering sites. Future work will include testing these materials to see if they are attractive for the entire season. If attractive to late-season dispersing weevils only, it may be possible to formulate a lure that will be a more sensitive indicator of when dispersal begins. The role of plant volatiles on the behavior of dispersing boll weevils needs further study.

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Table 1. Response of dispersing boll weevils to grandlure plus synthetic plant components.

Average boll weevils captured/trap/day		
Treatment	Capture	P>T
Grandlure alone	24	-
Grandlure + 'a'	37	0.25
Grandlure + 'b'	47	0.05
Grandlure + 'c'	50	0.03
Grandlure + 'd'	23	0.98

LSMEANS from SAS GLM Procedure; P>F 0.06; 7,69 df. T Prob. values compared with blank.