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Northeast Regional IPM Competitive Grants Program (RIPM)

Project Title: Identification of host-plant attractants for cranberry weevil and cranberry fruitworm

Final Report

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Nontechnical summary. This project investigated the role of plant volatiles as attractants for the cranberry weevil (CBW) and cranberry fruitworm (CBFW), two major pests in blueberries and cranberries in the northeast US. Headspace volatile collection apparatus and gas chromatography (GC) were used to collect and analyze the volatile emissions from blueberry leaves, buds, and flowers. More than 30 compounds were identified by GC-mass spectrometry. Volatiles from flowers were attractive to CBW in Y-tube olfactometer assays. Electro-antennogram (EAG) analyses showed that CBW antennae are responsive to flower extracts. EAG responses to individual volatiles showed that weevil antennae are highly responsive to hexyl acetate, cis-3-hexenyl acetate, nonanal, methyl salicylate, cynnamyl alcohol, and linalool oxide. The EAG response of CBFW to blueberry volatiles was also investigated. Antennae of both sexes responded similarly and strongly to hexyl acetate, cis-3-hexenyl acetate, cis-3-hexenyl butyrate, methyl salicylate, hexanol, and linalool. Male CBFW antennae responded to hexyl butyrate, cis-3-hexenyl propionate, and limonene more strongly than females; whereas female antennae did not respond to any volatiles more strongly than males. This project has identified several volatile compounds from blueberries that can serve as potential attractants for CBW and CBFW.

Introduction. Highbush blueberries (*Vaccinium corymbosum* L.) and cranberries (*Vaccinium macrocarpon* Aiton) are both native to North America, and have been under commercial cultivation for many years. These are two important crops in the northeast US: blueberries are grown on 48,310 acres, primarily in Michigan, New Jersey, and Georgia. New Jersey account for more than 15% of the total US blueberry acreage and for approx. 20% of the total utilized production, valued at $55.5 million. Cranberries in the US are grown in over 39,000 acres, primarily in Wisconsin, Massachusetts, and New Jersey. New Jersey cranberries account for 8% of the total US acreage and total US production, valued at $17.9 million.

The two insect pests in this study, cranberry weevil (CBW), *Anthonomus musculus* Say, and the cranberry fruitworm (CBFW), *Acrobasis vaccinii* Riley, can cause major economic losses in the northeast US. Both insects feed on the plant's reproductive organs (flower buds, flowers, and fruit), which makes them major direct pests in blueberries and cranberries in the growing areas where they occur. In New Jersey blueberries, adults of CBW are monitored using beating trays. In cranberries, adults CBW are monitored using sweeping. These monitoring methods for CBW are labor-intensive. In blueberries, monitoring techniques for CBFW involve the use of sex-pheromone baited traps for capturing male moths, combined with berry inspections. In cranberries, IPM programs do not rely on monitoring for determining the timing of the initial sprays and instead, recommend two prophylactic sprays based upon crop phenology; these are followed by collection and visual examination of fruit for presence of visible eggs. Berry inspection is labor-intensive. A cost-effective and reliable method for monitoring CBW and CBFW adults is critical to accurately time insecticide applications.

This study's ultimate goal was to provide cranberry and blueberry growers with new tools for monitoring CBFW and CBW populations. This project investigated a low-cost, easy-to-use, and reliable monitoring technique based on host-plant attractants. This research is desperately needed to eliminate or precisely time insecticide applications. The present project addressed a top research priority stated by the Fruit IPM Working Group, which is to develop and implement *"Effective monitoring strategies for key pests in which technologies currently do not exist"* http://northeastipm.org/work_fruipriority.cfm.

There are several environmental, health, and economic benefits that are anticipated from this study. By monitoring and better timing of applications of insecticides to control CBW and CBFW, we expect a reduction in insecticide use in cranberry and blueberry fields. This reduction of insecticide use coupled with an increase in use of selective reduced-risk practices will have a positive impact on the environment. Unnecessary insecticide applications will reduce pesticide residues in fruit and maximize farm-worker protection. Furthermore, use of traps will reduce the need for scout visits that are costly and labor-intensive, and thus minimize exposure of scouts to pesticide residues.

Objectives:

1. Assess the behavioral responses of adult cranberry fruitworm and cranberry weevil to host-plant volatiles;

2. Isolate and identify volatiles important in attraction of the cranberry fruitworm and cranberry weevil to plants.

Approach. Adults of the CBW were collected from blueberries in late March to early April. Adult male and female CBFW were collected from infested blueberry fields; CBFW-infested blueberries were collected in late June a year prior to the study, and larvae (hibernacula) were reared in the lab until adult emergence. Adult CBW was assessed for their behavioral response to volatiles from blueberry plants in a Y-tube olfactometer. Electroantennogram (EAG) responses of CBW and CBFW to individual compounds from blueberries were investigated.

Further studies were conducted to identify volatiles from blueberries. Tissue samples were analyzed by coupled gas chromatography-mass spectrometry (GC-MS).

Results. In Y-tube olfactometer assays, 73% of adults CBW were attracted to blueberry flowers compared to clean air.

Adult CBW antennae strongly responded to blueberry flower extracts compared to clean air or solvent (methylene chloride) alone. At 1 μg, adult CBW antennae strongly and consistently responded to hexyl acetate, cis-3-hexenyl acetate, nonanal, methyl salicylate, cynnamyl alcohol, and linalool oxide. These volatiles are major components of the blueberry flower and leaf blends.

In EAG analyses, CBFW antennae were also responsive to several blueberry volatiles. Thus far, six compounds consistently elicited a strong response from CBFW antennae compared to clean air or solvent alone. CBFW antennae from both sexes responded strongly to 1 μg of hexyl acetate, cis-3-hexenyl acetate, cis-3-hexenyl butyrate, methyl salicylate, hexanol, and linalool. Male CBFW antennae responded also to hexyl butyrate, cis-3-hexenyl propionate, and limonene. In addition, dose-dependent EAG responses were conducted to determine a range of active concentrations. Methyl salicylate elicited a dose-dependent response from both male and female CBFW antennae. Female antennae also responded in a dose-dependent manner to linalool.

GC and GC-MS analyses showed that blueberry flowers emit higher amounts of volatiles compared to flower buds and leaves. Several compounds were emitted from all plant tissues; however, most esters were emitted only from flowering plants.

This grant has serve as seed money for obtaining additional NE-IPM funding to continue this project (Project title: Development and implementation of novel trapping systems for monitoring cranberry fruitworm and cranberry weevil populations; funded in 2007).

Impact. We are making progress towards the identification of host-plant attractants for CBW and CBFW. This project is still on-going, and host-plant volatile-baited traps are currently being tested in field trials. This work has contributed to our better understanding of CBW and CBFW responses to host-plant volatiles, and to our efforts to implement better monitoring techniques into pest management programs in cranberries and blueberries.

Current monitoring methods for CBW and CBFW are labor-intensive. Results from these studies are expected to provide growers with novel traps that are economically feasible, easy-to-use, and reliable.

Better monitoring methods for CBW and CBFW will likely help in better timing insecticide sprays, and thus reduce the amount of insecticide use.

Appendices. Attached is a Powerpoint presentation, showing the results of this project. These slides were part of an invited talk (Semiochemical-based management of blueberry pests), presented at the ESA Eastern Branch Meeting, Harrisburg Pennsylvania; Fruit Symposium.