The Smells and Sounds of a Subterranean Sessid: Mating disruption and acoustic detection of grape root borer

Final Report for GS09-082

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Region: Southern
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Graduate Student:

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Major Professor:

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University of Florida

Project Information

Summary:

The smells and sounds of subterranean sessid: mating disruption and acoustic detection of grape root borer

The grape root borer, Vitacea polistiformis (Harris), is the key pest of grapes in Florida. A study was initiated to evaluate the potential to use acoustic devices for detecting V. polistiformis in the root of vines. The project goal is to provide additional monitoring tools for detecting V. polistiformis in the root system of grape vines and potentially reduce the cost of mounding since growers will be able to distinguish infested from un-infested roots. Experimenters and computer software were used to assess the likelihood of V. polistiformis infestations at various sites. Vine root systems were then excavated to determine infestation levels. The results indicate that acoustic methods could be developed and used as tools for detecting V. polistiformis, which will facilitate the use of mounding as a cost effective strategy. In a separate study the potential for mating disruption using V. polistiformis and Zeuzera pyrina pheromone blends was investigated as an alternative to chemical pesticides. Initial studies were initiated to determine the lowest density of pheromone dispensers that can be deployed to achieve effective mating disruption. Additional studies examined the release rates of a paraffin wax dispenser SPLAT (Specialized Pheromone & Lure Application Technology). The results indicated that one dispenser per plant will be sufficient to achieve 95% disruption. The wax dispenser (SPLAT) was an effective device that can be used to dispense pheromone at a release rate of 77.4 µg of pheromone per g of SPLAT per day. Both V. polistiformis and Zeuzera pyrina pheromone blends resulted in effective mating disruption of V. polistiformis males. Until more research is done, the Z. pyrina pheromone is recommended because it is cheaper and commercially available.

Introduction

The smells and sounds of subterranean sessid: mating disruption and acoustic detection of grape root borer

Grape root borer, Vitacea polistiformis Harris has become a widespread pest of grapes in the Eastern United States. It is one of the most destructive pests of grapes in North and South Carolina, Georgia and in Florida. Our goal was to develop an integrated management program for grape root borer in south eastern US.

Project Objectives:

Objective 1: To evaluate the potential of acoustic detection of grape root borer larvae in the root system of grape plants in a field setting

Acoustic records were collected from 28 root systems of muscadine vines. Two accelerometer amplifiers and a recorder were placed on the storage bed of an electric cart and transported throughout vineyard rows to sites with vines exhibiting symptoms of infestation: wilting, yellowed or dead leaves, and reduced leaf area as compared with neighboring plants of the same variety.

Objective 2a: To evaluate the potential of mating disruption

This experiment was established to measure the effect of dispenser density per area of crop on disruption of male V. polistiformis orientation.

Objective 2b:To determine which pheromone blend is more effective.

This experiment was established to compare disruption of V. polistiformis catch in monitoring traps using the ‘natural’ V. polistiformis pheromone [99% (E,Z)-2,13-ODDA: 1% (ZZ)-3-13-ODDA] versus the much less expensive and more readily available Zeuzera pyrina L. pheromone [95% (E,Z)-2,13-ODDA: 5% (E,Z)-3,13-ODDA). Both pheromone blends contain (E,Z)-2,13-octadecadien-1-ol as the main component.

Objective 2c: Determine release rate of new paraffin wax dispenser technology

The objective of this experiment was to quantify the release rate of pheromone from SPLAT dispensers used in mating disruption and trapping studies.

Cooperators

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Research

Materials and methods:

Objective 1: To evaluate the potential of acoustic detection of grape root borer larvae in the root system of grape plants in a field setting

A 30 cm nail was inserted into the root system of the selected vine. The accelerometer was attached to the nail head by a magnet. One or more listeners took notes and monitored the signals during a recording period of 3 min or longer. Within 1 to 2 h after recording, the vine was excavated and the contents of the root system were examined to obtain an independent verification of whether a site was uninfested or contained insects. Assessments were performed as in Mankin et al. (2007), where low indicates detection of no valid, insect-produced sounds or only a few faint sounds during a recording period, medium indicates detection of sporadic or faint groups of valid sounds, and high indicates detection of frequent, easily detectable groups of valid sounds. No attempt was made to distinguish between pest and non-pest species in the assessment. Comparisons between the distributions of assessed infestation likelihoods at infested and uninfested recording sites were performed using the NPAR1WAY procedure in SAS (SAS Institute 2004).

Objective 2a: Determine the lowest effective pheromone dispenser density

The field experiment was arranged as a complete randomized block design with four treatments that were replicated four times. Each plot consisted of 25 grape plants in five rows (five plants per row). Treatments consisted of wax dispensers containing V. polistiformis pheromone. Dispensers were deployed at various densities including one dispenser per five plants (5 total or 150/ha), one dispenser per plant (25 total or 735/ha), 10 dispensers per plant (250 total or 7,350/ha), and a no pheromone control. One monitoring trap was deployed per plot on the centermost plant 1.5 meters above the crown. Traps were checked weekly by counting the number of V. polistiformis captured and replacing sticky card inserts.

Objective 2b:To determine which pheromone blend is more effective.

The experiment was arranged as a randomized complete block with three treatments replicated four times. Wax dispensers were used to deploy pheromone treatments in the field with an area left untreated. Dispensers were deployed in rectangular plots of 25 grape vines, 5 plants per row in 5 rows, at a density of 5 per plant (125 per plot or 3,000/ ha). Dispensers were applied directly onto plants (~30 – 45 cm) near the tip of the vine. Each plot contained one monitoring trap hung on the centermost plant 1.5 meters above the crown. The traps were checked weekly and the number of trapped males was counted.

Objective 2c: Determine release rate of new paraffin wax dispenser technology

Individual dispensers containing the V. polistiformis pheromone blend were deployed as 1 mg dollops onto acetate strips. Each dispenser was weighed and the acetate strip stapled to a numbered wooden board. Five blocks of 14 dispensers were prepared in this manner as well as 12 blank dispensers without pheromone (negative control). Dispensers were separated from the pheromone disruption experiments by approximately 60 m for the duration of V. polistiformis flight. During the first week of deployment, samples were collected daily to allow detection of a possible exponential decay in release rate near test onset. Thereafter, samples were collected weekly. One week’s sampling consisted of one treated dispenser per block, for a total of five replicates, and one untreated control dispenser from a randomly selected block. After removal, the dispensers were placed into separate glass vials and transported on ice to the laboratory where each vial received 5 ml of acetonitrile and internal standard, hexadecyl acetate (193.4 ng/ul, 99% purity, Sigma chemical, St. Louis, MO). The samples were stored at -20°C until analysis. Pheromone was extracted from SPLAT (Specialized Pheromone & Lure Application

Technology, ISCA Tech., Riverside, CA) dispensers. Pheromone within samples was quantified using a gas chromatograph (GC) (Varian 3800, Palo Alto, CA). The GC was equipped with a DBWAXETR polar column (model 122-7332, J&W Scientific Folsom, CA) of length 30 m and internal diameter 250µm. The initial GC temperature was held at 130°C for 2 min and then ramped at a rate of 2.5 C/min to 160°C, where it was held for 2 min. The program then ran at 40°C/min to a final temperature of 230°C. The carrier gas, He, entered the column at 20 psi. The pheromone content of the samples was calculated using the internal standard method. Release rate was modeled with multiple linear regression (SAS/STAT v 9.2, SAS Institute 2009).

Research results and discussion:

Objective 1: To evaluate the potential of acoustic detection of grape root borer larvae in the root system of grape plants in a field setting

The root systems at 25 sites exhibited V. polistiformis larval damage, although only one live larva was recovered. Altogether, 27 root systems contained one or more invertebrates of various species. Among these were 41 Coleoptera (including four Mycotrupes, three Tenebrionids, one Cerambycid, four Phyllophaga larvae and one Anomala larva) one Cetoniid larva, six Lepisma saccharina (L), and three burrowing roaches. Six sites contained Solenopsis invicta Buren workers, and three had termite workers. Other organisms found in the root systems included five unidentified worms, three Diplopoda, three large spiders, and an earthworm. Only the V. polistiformis was to be targeted as a pest but for purposes of categorizing sites, we considered a site to be infested if the excavated root system contained one or more invertebrates capable of producing sounds.

Two types of impulses that are typical of insect-produced sounds appeared frequently in initial screenings of signals where excavations verified infestation. A third type of impulse with a highly distinctive spectral pattern appeared less frequently. Spectral profiles of these impulses were calculated to assist in discriminating insect sounds from background noise.

Various types of background noise also occurred frequently in all recordings, comprising about 80% of all sounds detected. Continuous noise could be discounted easily because insect sounds usually occur as brief impulse bursts, but some low-frequency impulsive noise was discarded by matching it with one of two noise profiles. To exclude higher-frequency noise impulses, we constructed a noise profile, nhighdB , as an average spectrum of impulses produced during a gust of light wind. A second noise profile, nlowdB , was constructed as an average spectrum of a 5 s period where impacts of water droplets from an irrigation hose were detected.

Objective 2a: Determine the lowest effective pheromone dispenser density

Mean weekly trap catch declined with increasing dispenser density and all treatments resulted in greater than 95% disruption. Traps within the control plots caught significantly more moths than traps in plots of all other treatments. Traps in plots with 250 dispensers caught the fewest moths, but not significantly fewer than traps in plots treated with 25 dispensers.

Objective 2b:To determine which pheromone blend is more effective.

Both pheromone blend treatments resulted in complete disruption of male V. polistiformis catch in traps baited with the V. polistiformis pheromone for the entire monitoring period. Mean (± STD) catch of male V. polistiformis in control plots (7.0 ± 5.4) was significantly greater than in plots receiving either of the two treatments.

Objective 2c: Determine release rate of new paraffin wax dispenser technology

Release rate of V. polistiformis pheromone from SPLAT (Specialized Pheromone &

Lure Application Technology, ISCA Tech., Riverside, CA) dispensers fitted a linear model. The release rate predicted by the model is approximately 77.4 μg of pheromone per g of SPLAT per day. No pheromone was detected in the blank negative control.

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

William, S. Sounds and smells of a subterranean sesiid: Acoustic detection and mating disruption of grape root borer: MS thesis submitted to the Graduate School, University of Florida, Gainesville, FL 101 pages

Project Outcomes

Project outcomes:

Objective 1:To evaluate the potential of acoustic detection of grape root borer larvae in the root system of grape plants in a field setting

In summary, acoustic methods could be developed as tools for growers who employ mounding. And, because mounding can be such an expensive and labor intensive operation, acoustic methods can be used to determine whether or not vine roots are infested before mounds are employed. This will facilitate the use of mounding as a more cost-effective cultural strategy for control of V. polistiformis.

Objective 2a, b, and c:To evaluate the potential of mating disruption

Our results indicate that mating disruption show promise as an alternative to insecticide for managing V. polistiformis. At a release rate of ~ 77.4 μg of pheromone per day, season-long control was observed when sufficient number of dispensers was deployed per area of crop. Our results also indicate that as few as one dispenser every 5 grape vines (~140 per hectare) is sufficient to cause 95% orientation disruption.

Recommendations:

Areas needing additional study

Further work is needed to optimize the rate of dispensers per ha releasing the Z. pyrina blend for disruption of V. polistiformis.

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