Proposal for Oregon Department of Agriculture for Nursery Research (2024)

Title: Identification of thrips volatiles for pheromone components for nursery crops

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Project Background and Justification:
Western flower thrips (WFT) is one of the most economically important pests causing severe damage to agricultural and horticultural crops worldwide. In addition to direct damage from feeding on leaves, flowers and fruits, they also transmit economically important plant viruses. Due to their small size and wide host range, detecting and preventing the spread of WFT is extremely difficult. Thrips control methods mainly rely on chemical insecticides, despite many negative impacts, including insecticide resistance and environmental risks. Therefore, we need to develop thrips-specific management strategies that focus on less toxic and environmentally friendly alternatives using biological targets.

We have recently initiated to identify biological targets such as bioactive peptides (= small protein molecules) from WFT, which will be developed into active ingredients to control thrips. In addition, we started to investigate WFT pheromones from both male and female adults because thrips rely primarily on their sense of smell to find the plants that they cause economic damage. In the case of thrips, the thrips detect volatile odorants that are emitted by plants including flowers and find their host plants. Thrips have specialized tiny antennae that contain chemosensory receptors that are responsible for detecting volatile compounds. Thrips adults also produce sex-specific pheromones to find mating partners, thrips are expected to using volatile compounds such as sex and/or aggregation pheromones.

However, since the two aggregation pheromone components have been identified, the attraction of these two pheromones to thrips is not strong and significant for aggregating thrips. Currently, the thrips pheromones are not available for thrips management in the field, although many insect pheromone products are used as green chemicals for species-specific control tools. Therefore, we hypothesized some component(s) for the thrips pheromone are missing and need to be identified.

To study on thrips pheromone, the experimental challenge is the detection method for extremely small amounts (~picogram, 10^{-12} gram) of volatile compounds from individual thrips. The goal of the study is to identify the volatile compounds from male thrips and evaluate their pheromonal activities on thrips aggregation and mating with females. This is the first step towards our *long-term goal* of adding novel biological targets for pheromone application in thrips chemical communication. Therefore, successful results from this study will add a biologically based green chemicals for thrips control and would be significant for thousands of growers and stakeholders in the nursery and horticulture industry.

Projective objectives: We recently developed a gas chromatography-mass spectrometry (GC-MS) coupled with solid-phase microextraction (SPME) method for the detection of thrips volatiles. Surprisingly, we found more volatile compounds, including the two known aggregation pheromones (LA and NMB), from WFT male adults, but they were not detected from WFT female adults (see figure 1). In this project, therefore we are focusing on the identification of unknown volatile compounds from both adult males and females. To achieve this goal, the following specific objectives need to be accomplished in this project:

1. Chemical analysis of volatile compounds from adult male and female thrips.
2. Evaluation of the pheromonal activity of each volatile on thrips.

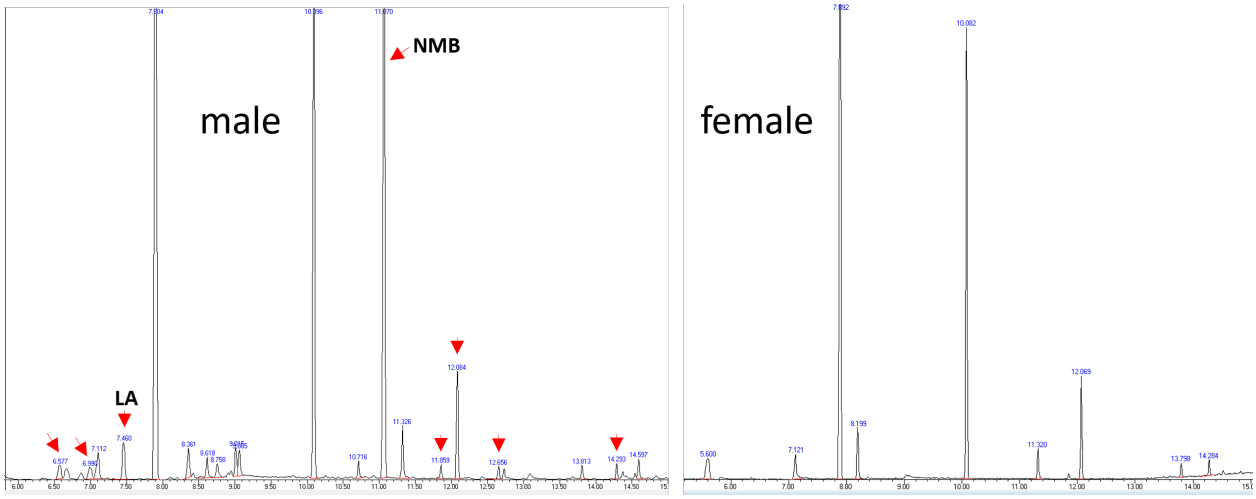

Figure 1. GC-MS gram of volatile candidates from 1–5-day old WFT males and females. For the SPME analysis, we collected volatiles from 100 males and females at least for 24h, and confirmed the results over 500 adults tested. Arrows indicate that volatiles were detected only from adult males. LA: lavandulyl acetate; NMB: neryl (S)-2-methylbutanoate.

Methods and Timeline:

1. Chemical analysis of volatile compounds from adult male and female thrips (0.5 yr): Thrips adults will be obtained from the laboratory colony that had been maintained for several years in USDA ARS lab in Corvallis OR. Approximately one hundred age-matched adult males or females from 1 to 5 days old will be collected and placed in a 2 ml glass vial, then a SPME (Agilent) will be set up in the vial for 24 hr. Each SPME will be analyzed by GC Agilent 7890B GC system) coupled with a Mass Selective Detector (Agilent 5977B). The GC-MS will be equipped with a capillary column (HP-5, 30 m x 0.25 mm; Agilent). The oven will be temperature programmed to 80 °C for 1 min, then to increase by 5 °C/min to 300 °C and will be held for 10 min. Pheromone volatiles will be analyzed in the scan ion monitoring mode using an NIST 2020 MS Library (Agilent).

2. Evaluation of the pheromonal activity of each volatile on thrips (0.5 yr): The test will be a Y-tube olfactometer test. The transparent Y-tube glass will consist of a 100 mm stem with two 80 mm arms separated by a 45° angle. The inner diameter of the Y-tube is 10 mm. The two arms will be supplied with humidified air filtered through activated carbon. All behavioral tests are conducted in a dark room under infrared light (1000 lx illumination) at 25 ± 1°C and 65% relative humidity. In each run, 50 adults will be placed at the bottom of the stem tube. Test insects or compounds will be placed on one side of the arm tube. The duration of each run is 10 minutes. Positive insects are defined as those that pass more than 60 mm from the bifurcation. Each treatment will consist of four replicates, with the installation position of the test insects changed between two arms in each replicate.

Budget summary:

Salary & Benefit[1]	Travel[2]	Materials & Supplies[3]	Total
$23,000	$800	$5,200	$29,000

[1]Salary & benefit (0.3 FTE = $17,000 + $6,000 = $23,000) for research associate. [2]Support the postdoc or graduate student travel for commission and/or entomological meetings; [3]GC-MS supplies, including SPMEs, columns, vials, He gas, Air ($3,000), Y-tubes ($1,500), and thrips rearing materials – dish and soybean ($700). The USDA base fund and other grants will support this project.