Latest Research Results

organic SCIENCE CLUSTER 3

Saponins as inducers of host resistance for insect and disease management in organic greenhouse production

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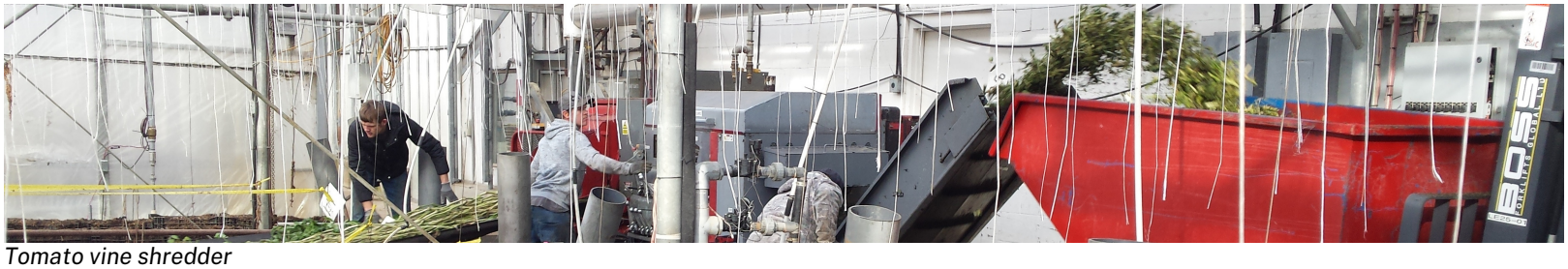
A large amount of agricultural residue is generated around the world annually, representing an untapped resource for the development of new bioproducts. Valuable bioactive phytochemicals such as saponins and essential oils are found in appreciable quantity in plant biomass, including agricultural residues. Saponins and essential oils extracted from plants, such as tomato vines or spent hops, could be effective as crop protectants, for control of both fungal and insect pests. Specific objectives for this project were: **1)** to determine the efficacy of saponin preparations extracted from tomato residues (from vines or peels) in controlling insect and fungal pests of economic importance to greenhouse crop production; **2)** to assess the potential crop phytotoxicity of the biopesticides, **3)** to determine the efficacy of hops and geranium essential oils (EO), and hop vine extracts for insect control in greenhouse production.

Crop vine residues were collected from a commercial greenhouse producer, and tomato processing wastes (peels) were collected from a food processing plant. Yield obtained from the extraction methods was assessed. Hydrodistillation of spent hops allowed for the extraction of a noteworthy amount of hop oil. The bioactivity of saponin extracts, and preparations of commercially available essential oils, including hop essential oil, were tested against the agricultural arthropod pests tarnished plant bug, long-tail mealybug and melon aphids. Notably, significant undesired phytotoxicity was observed in high doses of the natural products when applied to plant leaves.

Efficacy of the various saponin tomato extracts was fairly limited in bioassay tests with the long-tail mealybug and the tarnished plant bug, although the higher doses increased mortality slightly. Bioassays were therefore focused on the melon aphid from late 2020 onward. Deterrence and mortality were evaluated using a no-choice bioassay in a laboratory setting with melon aphids. The saponin extracts and essential oils were prepared in doses per bioassay of 0, 1, 5, 10, 25, 50, 100, and 200 mg/ml, applied to a leaf or a leaf-disk. Bioassays of direct toxicity were performed on cucumber leaves and cucumber plants in the greenhouse.

Greenhouse with vines down and Melanie Charbonneau.

The fumigant toxicity of hop and geranium EO to melon aphid adults was also evaluated on cucumber seedlings using a 1 L glass beaker used as a fumigation chamber. Cucumber seedlings were 8 to 11 cm high, at the first leaf stage, and placed within the beaker. The efficacy of both tomato extracts and hop EO against the tarnished plant bug and the melon aphid increases at doses above 25 mg ml^{-1}, with the highest doses of 100 and 200 mg ml^{-1} having the most significant effect on repellence and mortality. We observed 40% mortality in the melon aphid when treated with 100 mg ml^{-1} of tomato skin extract after 24 hours in our bioassay.



Tomato vine shredder

Hop EO contains β-Farnesene, an important aphid alarm pheromone. The aphid's natural response to the release of β-Farnesene (within the alarm pheromone) signals aphids in the surrounding area to move to a new location on the plant, or to leave the plant entirely. This behaviour was observed during the hop EO bioassay, where aphids were more likely to be moving to a new area on the plant, moving more frequently, or more likely to be observed falling off of the plant. The next step was to develop a greenhouse trial to assess the potential use of the EO volatiles in an on-farm greenhouse setup. Within the first two-hour period of that trial, a significant number of aphids fell from leaves on the plants close to the diffused hop oil, and not the control plant pairing, showing a real behavioral impact on the melon aphid. However, in general, the hop oil had no greater effect than a control treatment on the movement of melon aphids from cucumber leaves toward or away from an adjacent plant under greenhouse conditions. Increasing EO volatiles surrounding the plants to protect may improve the efficiency further.

There was noticeable phytotoxicity on tomato and cucumber foliage when the higher doses of extracts and essential oils were applied directly to the leaves. The phytotoxic effect could be reduced by altering formulation, such as microencapsulation or addition of surfactants, and should be considered in future tests. The phytotoxicity in the higher doses could affect the feasibility of use for insect control in greenhouses. The volatilization characteristics of the EOs could be beneficial, if applied in a greenhouse setting by diffusing the EOs within the crop for both insect mortality and repellence from plants. The active components in hop oil and their relationship to insect pheromones and modification of the behavior of the melon aphid was a significant finding in this research project. Hop wastes contain appreciable quantities of essential oils after processing. Essential oils as fumigants have the potential to be used with other phytochemicals, as synergistic action has also been observed in some of our previous tests. The multiple active substances contained in phytochemicals, with different mechanisms of action, can also help prevent the development of resistance in insect pests. Additional tests of the fumigant effect of some essential oils in a greenhouse setting are warranted, to prevent insect damage in greenhouses or other controlled environments.

For more information visit the OSC3 Activity 19 webpage and/or DAL.CA/OACC/OSCIII & https://organicfederation.ca/organic-science-clusters/

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