IPM Methods for Insect Management
Plant-Mediated Systems for Managing Western Flower Thrips

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Introduction. Western flower thrips (WFT) [*Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae)] are one of the most persistent and damaging pests of many greenhouse crops, including ornamentals and vegetables. Their cryptic behavior and rapid rate of reproduction make management difficult. When populations are high their feeding results in significant cosmetic damage. Even when populations are low, they pose a threat to crops by transmitting deadly plant viruses. Chemical pesticides are commonly used against WFT, often requiring frequent reapplications. Despite repeated chemical sprays, growers often find it difficult to keep populations below damaging levels. Several biological control options are available, but their effectiveness has been inconsistent. This presentation reports on our research to develop plant-mediated systems using granular formulations of insect-killing fungi for WFT IPM. Though this work focuses on use of these systems in ornamentals, they also could be used effectively in greenhouse tomatoes.

Several preparations of the insect-killing fungi *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium lecanii* have been shown to reduce WFT in greenhouse vegetable and floral crops. These products have many desirable traits–they leave no toxic residues, are generally harmless to beneficials and pose minimal risk to humans and the environment. In commercial greenhouses, results with fungal-based management have been unreliable. Good spray coverage is essential for pest control with mycopesticides, and our research shows that spray techniques used in commercial greenhouse crops are unlikely to provide the necessary coverage. In addition, efficacy may be reduced because a large portion of the WFT population is in the soil, protected from direct contact with fungal inoculum. Targeting the soil stage with a fungal formulation could enhance efficacy by reducing the number of emerging adults.

Though insect-killing fungi are commonly sold as wettable powder (WP) or suspension concentrate (SC) formulations for greenhouse use, they can also be formulated as granules, which have advantages over a spray when targeting a soil-borne insect. Nutrients can be incorporated into granules to support fungal growth and sporulation, baits can be added to attract target pests, and granules do not need to be incorporated throughout a potting mix, but in the top 2-3 cm of soil where thrips generally pupate.

Fungi are not the "silver bullet", and must be used as part of a total IPM program. Early detection is critical so action can be taken before WFT reach damaging levels. When plants are started in Jan or Feb, WFT populations are usually low, but increase rapidly as temperatures rise and day length increases. We tested marigolds as trap or indicator plants, and found that WFT were detected several weeks earlier on flowering marigolds than on sticky cards (Fig. 1). Beneficials are best used preventatively, and introduced early in an infestation when pest populations are low. We found the marigolds could serve as 'banker plants', which, when inoculated with the predatory mite, *Neoseiulus californicus*, served as a sustained source of natural enemies.

Based on our past results, we have initiated research to test a novel plant-mediated approach for WFT IPM, combining predatory mites, granular entomopathogenic fungi and indicator plants into one effective "habitat plant system". The concept of this system is that adult WFT will be attracted from the crop to the marigolds, where they will become established. The predatory mite, *N. cucumeris*, is released onto the plant, and is sustained on thrips in the foliage. A portion of the WFT escaping predation will drop to the soil to pupate, where they will come in contact with and become infected by insect-killing fungi, applied as a granular formulation. This nutrient-based formulation will enable the fungus to colonize the potting mix, eliminating the need for repeat applications. This concept represents a sustainable, low-cost, ecological approach to combating WFT.

Fig. 1. Marigold indicator plant in commercial greenhouse.

Methods. Lab-based caged trials were conducted to test several fungal formulations of GHA, the *B. bassiana* isolate found in the commercial mycopesticide, *BotaniGard* (Laverlam International Co., USA) in combination with marigold habitat plants (variety Hero Yellow). The following treatments were tested:

1. Granular millet-based fungal formulation of GHA (containing 1 x 10^8 conidia/g) applied at a rate of 2, 4 or 8 g/pot and introduced into the potting mix to a depth of 2-3 cm around the marigold plants;
2. Fungal drench of the wettable powder formulation (WP) of *BotaniGard* (2.0×10^{10} conidia/g) applied once to the potting soil around the marigold plants according to label recommendations.
3. Fungal spray of the WP formulation of *BotaniGard* (2.0×10^{10} conidia/g), applied to the marigold foliage for four consecutive weeks according to label recommendations.
4. Untreated control.

Fungal treatments were applied on the same day that WFT adults were released onto the flowering marigolds (3/plant). For 6 wk, plants were sampled weekly to determine the number of WFT per plant and the amount of damage based on a visual scale.

Results. WFT populations (adults and immature combined) were consistently less throughout the 6 weeks for the 8-g fungal treatment. At week 5 average populations were around 10 WFT per plant for the 8-g treatment compared with ~40 WFT per plant for the control and the spray treatments. WFT populations increased significantly at week 6 in the 8-g treatment resulting in similar pest levels to those in the non-treated control. Though overall differences in WFT populations throughout the trial were not detected between the 2-g and 4-g/pot fungal granular treatments, these two treatments were more effective than the *BotaniGard* foliar spray and drench treatments. WFT populations were less for the drench than the spray treatment.

Foliar damage was significantly less on plants for the 8-g treatment than plants for all of the other treatments at weeks 5 and 6. At week 5, damage in the 8-g treatment was half that of the other treatments (damage rating of 2 [feeding on 10-25% of the plant] compared with 3-4

[feeding on 51-75% of the plant). At the end of the experiment (week 6), 40-70% of WFT emerging from pots treated with the granular formulation and the drench were infected with *B. bassiana*. Less than 6% of the WFT emerging from the potting mix for the foliar spray treatment were infected with *B. bassiana*, and none were infected in the untreated control. Our results clearly demonstrated the potential of granular fungal formulations to reduce WFT populations. This treatment used once at a rate of 8 g/pot was significantly more effective than the standard recommended foliar fungal spray made weekly. Despite the promising results from this trial, WFT populations were not reduced below levels at which no damage occurred. The addition of predatory mites to the foliage of the marigold habitat plants may address this problem. Together, these two biological control treatments may effectively suppress WFT populations over a longer period. Studies are underway to test this hypothesis. Our research could revolutionize IPM for WFT though further refinement of the system is needed before it can be deployed widely in commercial settings.

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