Special Research Report #216: Granular Formulations of Insect-killing Fungi in Combination with Plant-Mediated IPM Systems for Thrips

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BACKGROUND

Western flower thrips [*Frankliniella occidentalis* (Pergande)] is a major pest of greenhouse ornamentals. Substantial economic loss can result from leaf and flower damage or virus vectoring. The effectiveness of chemical insecticides is limited and resistance is a serious problem. Most insecticides applied to the foliage require direct pest contact. A significant percentage of the thrips population may escape contact with the insecticide by entering the soil to pupate. In addition, thrips are difficult for growers to find on plants. However, when detected early and before damage occurs, growers have a greater chance for management success either with releases of biological control agents or spot pesticide applications.

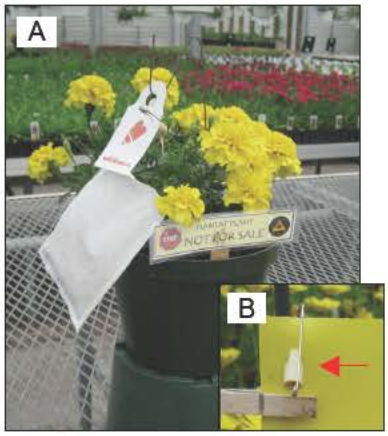

Fig. 1. Marigold guardian plant system in a test greenhouse (A). Thrips lure on sticky card (red arrow) (B).

Plant-mediated IPM systems use plants in combination with other suppression tactics to manage insects or mites. These systems are developed to: (1) improve early pest detection (indicator or sentinel plants); (2) attract pests away from the crop where they can be targeted with biological control or insecticides, or removed from the crop entirely (trap crop); or (3) provide habitat, food and shelter for biological control agents (habitat, insectary or banker plants). When a plant-mediated IPM system is used for multiple purposes simultaneously, it is called a "guardian plant".

This project has evaluated a guardian plant system for thrips in spring bedding plants grown in commercial greenhouses in Vermont and New Hampshire. It uses a flowering marigold (*Tagetes* sp.) on which predatory mites (*Neoseiulus cucumeris*) are released on the flowers and foliage; a millet-based granular formulation of *Beauveria bassiana*, an insect-killing fungus, which is mixed into the upper surface of the potting mix; and a thrips pheromone lure attached to a wire stake is added (Fig. 1A). This guardian plant system is based on the concept that adult thrips are attracted out of the crop to the flowering marigolds, where they will reproduce. This "attractiveness" may be enhanced by a pheromone lure (Fig. 1B). The thrips adults and immatures serve as prey for predatory mites on the flowers and foliage, sustaining them and encouraging their dispersal throughout the crop. In the absence of thrips, the mites feed on pollen produced by the marigold. Thrips that escape predation drop to the soil to pupate, where they become infected with the fungus. The granular formulation enables the fungus to colonize the potting mix thus, eliminating the need for reapplication.

The objectives of this project were to: (1) evaluate effectiveness of this system to manage thrips in greenhouse-grown bedding plants, and (2) assess the persistence of predatory mites and fungi over time to determine how often they must be reapplied within the system.

MATERIALS & METHODS

For the past two years marigold (var. Hero Yellow) guardian plant system trials were conducted at six commercial greenhouse sites: five in Vermont and one in New Hampshire. At three sites, trials were in single gutter-connected greenhouses (approx. 10,000 sq. ft each). At the other three sites, trials were in three separate, side-by-side, greenhouses (approx. 2,000 sq. ft. each). All of the test greenhouses contained the following six treatments, each replicated three times in each house: (1) marigold with a granular formulation of an experimental strain of *B. bassiana* incorporated into the upper layer of the potting mix, thrips pheromone lure and predatory mites (EXP); (2) marigold with a granular formulation of the GHA strain of *B. bassiana* in the potting mix (the strain in BotaniGard®)(GHA); thrips lure and predatory mites; (3) marigold with thrips lure only; (4) marigold without thrips lure, fungus, or mites (THE CONTROL); (5) yellow sticky card with thrips lure; and (6) yellow sticky card without lure. For 12 wks marigolds and sticky cards were monitored bi-weekly for thrips and other arthropods. Foliar damage (Fig. 2) was assessed on a scale of 0 (no damage) to 5 (76-100% damage). In addition, three plants located within 1 meter (3 ft) of each marigold were inspected for thrips, mites, and damage. The plants were tapped gently to dislodge the thrips and mites onto a piece of laminated white paper so they could be counted. At each sampling date, two flowers were collected per marigold and placed in ethanol. Later, they were dissected under the microscope to determine the number of thrips and predatory mites. At the start and end of the experiment, soil samples were taken to determine the level of fungal inoculum. The 3rd and final year of these trials will begin in spring 2014.

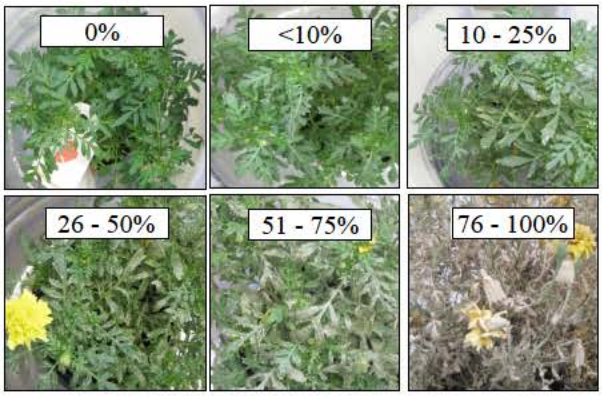

Fig. 2. Foliar damage ratings.

RESULTS

Guardian plant systems: In year 1, results were analyzed for 5 of the 6 sites. At one site, crop plants heavily infested with thrips were brought into the test greenhouses after the trials began. Marigolds were extremely effective in attracting thrips out of these plants and became heavily infested. It was feared these marigolds could serve as a reservoir to reinfest the crop (average of 64 per marigold vs. 3 per randomly inspected crop plant). Therefore, marigolds at this location were removed after 6 wks. The guardian plant system is not a fast-acting control. It is designed to prevent the buildup of thrips; not to control a pre-existing heavy infestation. Therefore, data from this one site were omitted from the analysis. In year 2, results were analyzed for all six sites.

In both years, over the entire 12-wk experimental period, higher numbers of thrips were detected on marigolds than on randomly selected crop plants located within 1 meter (3 ft) of the marigolds (Fig. 3). In both years and in all greenhouses, when averaged throughout the entire experiment, over 95% of the thrips observed were on the marigolds rather than on the randomly inspected plants. At all sites, there was more thrips damage on the marigolds than on the ornamental crop. On many occasions, marigolds without the mite/fungus treatment had over 50% foliar damage; whereas nearby crop plants had less than 10% damage.

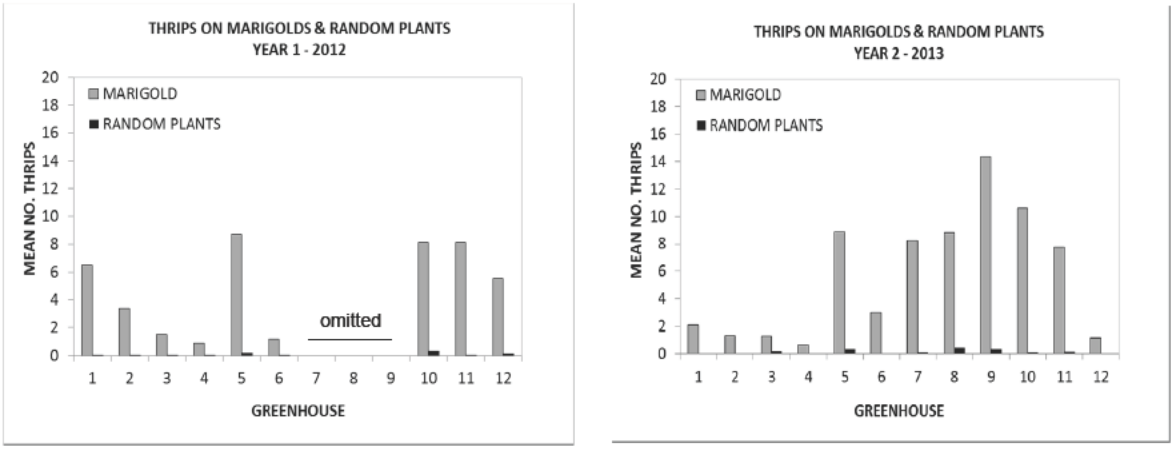

Fig. 3. Thrips on marigolds and randomly inspected plants in years 1 and 2.

In both years over the 12-wk test periods, there were more thrips on marigolds with no mite/fungus treatment (control) than on those treated with mites and fungi (Fig. 4). At some sites, thrips numbers increased rapidly on marigolds without the fungal/mite treatments and had to be removed 2-4 wks before the end of the experiment in order to avoid the risk of reinfesting the crop. On these plants, thrips foliar damage of over 75% was observed. Both fungal treatments (GHA and EXP) provided a similar level of thrips suppression. Differences in the number of thrips on plants with and without the pheromone lure were not significant in either year.

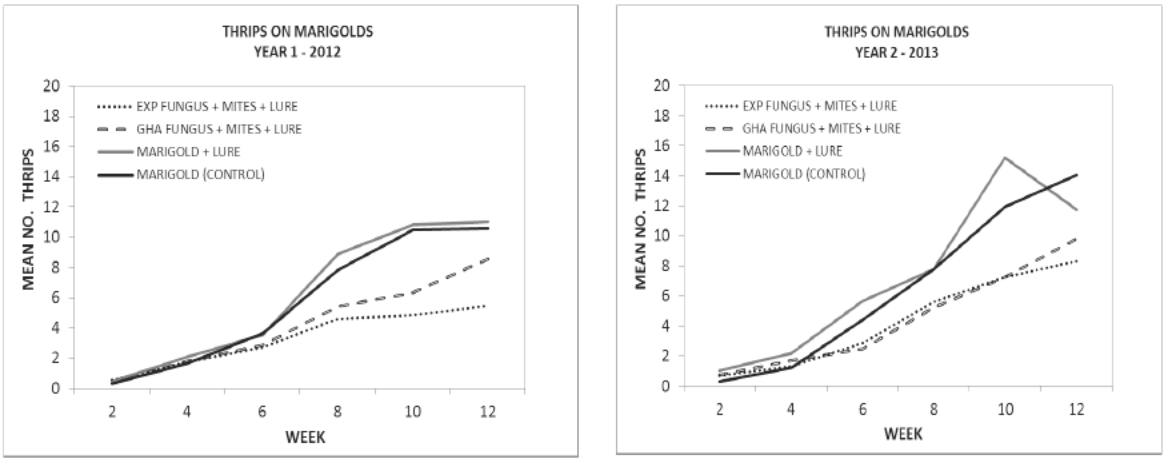

Fig. 4. Thrips on marigolds subjected to the different treatments in years 1 and 2.

Predatory Mite Persistence and Thrips Abundance in Flowers: In both years, low numbers of mites were detected with plant tapping. No mites were found on randomly-inspected crop plants adjacent to guardian plants. Thrips and mites were difficult to detect on the marigolds due to their small size and tendency to hide within the flowers. Dissections of the flowers provided a more reliable estimate of their populations. In year 1, mites were observed in marigold flowers throughout the 12 wks. When averaged over the test period, more thrips were found in control marigolds (average of less than 4 thrips/flower) than in those treated with mites and fungi (average of less 2 thrips/flower). Year 2 samples are currently being processed.

Fungal Persistence: In year 1, both fungal strains tested persisted within the guardian plant potting mix throughout the 12-wk test period. The granular fungal formulations were applied at a rate of $1.0x10^8$ (13.2 g/pot). The number of spores per gram of soil was 5.27 x 10^5 at week 0 (post application) and 4.96 x 10^3 after 12 wks for the EXP treatment. For the GHA fungus, the number of spores per gram of potting mix was 4.61 x 10^5 at week 0 and 8.07 x 10^3 after 12 wk. Samples for persistence for year 2 are currently being processed.

Sticky Cards: In both years, there were no significant differences in thrips numbers on sticky cards with or without lures (Fig. 5).

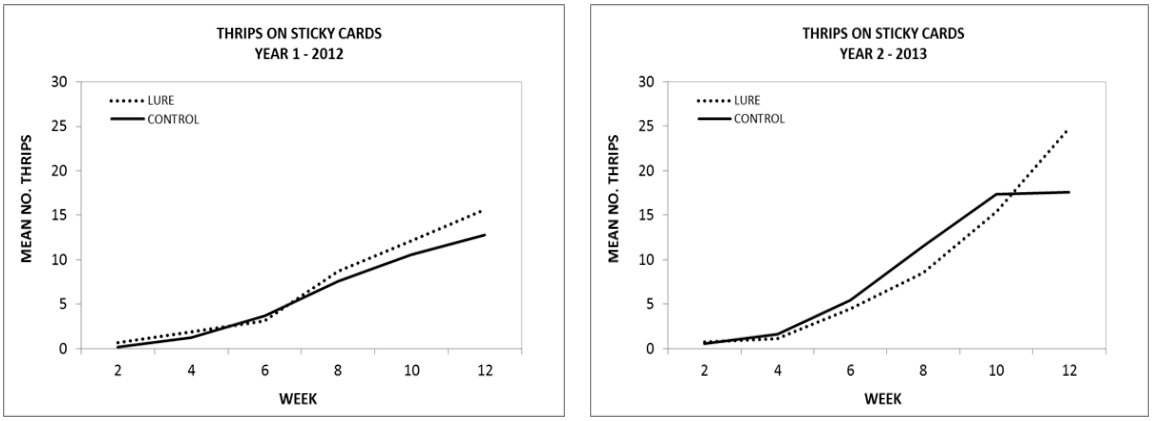

Fig. 5. Thrips on sticky cards with and without pheromone lures in years 1 and 2.

CONCLUSIONS

We found that marigolds were highly effective in attracting thrips from the crop. The guardian plants combining predatory mites, a fungal granular formulation in the potting mix, and a pheromone lure, maintained thrips populations at relatively low levels for up to 12 wks in greenhouses with a low-moderate infestation of thrips. In addition, untreated marigolds had significantly more damage than treated ones (Fig. 6). These outcomes demonstrate the effectiveness of the system both for reducing thrips populations and damage. Predatory mites and both fungal strains persisted in the guardian plant for over 12 wks, providing a sustained source for biological control without the added expense of re-application. Though mites were found in marigold flowers throughout the experimental period, they were not found on adjacent randomly-inspected crop plants. This suggests that mite dispersal from the guardian plant is minimal, or that they escape detection by

hiding in the flowers. In the future, flower samples will be taken from adjacent crop plants to evaluate this further. The lures did not enhance thrips attractiveness of the marigolds or sticky cards, suggesting they may not be a valuable addition to this system.

Fig. 6. Marigold guardian plant with the fungus/mite/ lure treatment after 12 wks (left) and untreated (right).

INDUSTRY IMPACT

This is a low-cost, easy-to-use, non-chemical pesticide system that suppresses thrips populations through a holistic approach: ATTRACT, SUSTAIN & KILL. Because fungal treatments and mite releases are applied to the guardian plant rather than the entire crop, management costs are reduced, and the thrips control is targeted. The result is production of plants of higher quality and value with little or no insecticides. This reduces the need to use chemical insecticides over the season, thereby prolonging their efficacy, and minimizing human exposure and environmental contamination.

The marigold guardian plant has numerous desirable traits: (1) the granular fungal material leaves no toxic residues, is relatively harmless to natural enemies and is environmentally-friendly; (2) the system offers a unique approach to sustain biological control agents when pest populations are low or absent, using a fungus for the below-ground stages of the pest, and a predator for the foliar phases; and (3) it can lower costs associated with biological control by reducing the number of releases needed over the season.

The public (consumer) is becoming more aware of environmental and human health hazards of chemical insecticides and increasingly wants to buy plants grown under ecologically controlled conditions. Growers who adopt this system can benefit from promoting their use of non-chemical approaches by appealing to this consumer demand. Several growers participating in this project proudly display educational signs informing their customers of their use of this IPM system (Fig. 7). One of our cooperating growers received an environmental award this year (2013) for his efforts to reduce pesticide use.

Fig. 7. Signs displayed in commercial greenhouse describing this project and promoting biological control, used for public education.

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