Pennsylvania Vegetable Growers
Final Report

"Control of thrips in high tunnel tomato production with natural enemies and entomopathogenic fungi"

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OBJECTIVES:

1. To utilize one-on-one training with an IPM/biocontrol specialist to help growers integrate a biological control program for management of thrips in high tunnel tomato production.
2. To reduce the use of conventional and high-risk pesticides in high tunnels of participating growers by at least 50%.

BACKGROUND:

There are several species of thrips (western an eastern flower thrips, onion thrips) in high tunnel tomato production that are very difficult to manage, particularly when populations are allowed to get large. Thrips can easily overwinter in high tunnels and attack young transplants early in the season. The goal of this project is to provide efficacious control of thrips, through the inoculative introductions of predatory mites (*Neoseiulus* (*Amblyseius*) *cucumeris**)*** and the collateral use of entomopathogenic fungi (*Isaria fumosoroseu).*

Thrips cause damage to vegetable plants by feeding on the leaves and flowers, which involves tissue being cut away by their chewing mouthparts and then feeding on the sap that arises from those wounds. Another way thrips can damage plants is through the transfer of some very serious plant diseases: tomato spotted wilt virus (TSWV) and impatiens necrotic wilt virus (INSV). These viruses will lead to the death of a plant, so their impact is a very serious concern.

The traditional method used by most growers in their attempt to control thrips is the repeated application of broad-spectrum pesticides. Unfortunately, this heavy application of pesticides can cause thrips populations to develop pesticide resistance, making them even more challenging to control. Growers will be taught how to monitor thrips populations through plant inspection, and with sticky traps. This project will demonstrate the value and effectiveness of implementing biological and other IPM techniques into high tunnel vegetable production.

Getting started on biocontrol program

Using biocontrol requires a hands-on approach over an extended period to learn and apply successfully. Growers were taught pest monitoring techniques, pest and biocontrol life cycles, timely release of biocontrols, population assessment of pests, how to determine economic pest thresholds, appropriate biocontrols available, and when necessary, the blending of compatible pesticides with biocontrols to manage the pest complex.

EXCLUSION – how can pest problems be prevented before they start?

Clean transplants – In many cases, serious pest and disease problems that plague growers throughout the growing season result from purchasing infested transplants, cuttings or plugs. Inspect what you are buying! Selection of a reputable grower ensures a quality transplant. If you are growing your own transplants, follow strict sanitation procedures and inspect seedlings weekly for pest and disease development. Preventing a problem before it becomes established can save a lot of time, effort and expense.

SCOUTING – what pests are present?

Crop scouting is the cornerstone of a successful IPM program. Early detection and treatment of pests is critical in high value greenhouse vegetable crops. With regular (weekly) scouting, insects, diseases and cultural problems are detected early before they become major problems. Instead of relying on a weekly spray program, use this time to scout the crop to determine if a spray treatment is really necessary. Growers who scout weekly feel they save money by avoiding unnecessary sprays in addition to making the environment more worker friendly.

Monitoring and Management Strategies

Direct Plant Inspection

- Correctly identify the species to make the best management decisions.
- Early detection of thrips is critical. Use a hand lens or microscope for accurate identification.
- Inspect individual plants in the field for thrips adults and larvae by carefully beating or shaking foliage and/or flowers over a sheet of light paper.
- Give special attention given to fields near small grains or alfalfa, at times of harvest of small grains and alfalfa, or during times of hot, dry weather.
- If transplants are used, inspect for presence of thrips before planting.
- Examine folds in leaf tissue near the base of the plant for larval stages.

Sticky Traps

- Yellow or white sticky traps are essential in greenhouses for early detection of thrips. Place cards vertically, 6 inches above crop canopy at a rate of one card per 1,000 square feet.
- Monitor for adult thrips with yellow sticky traps. Blue sticky traps are more sensitive for trapping thrips, however, the dark background makes them harder to identify. Yellow

traps will attract other pests for monitoring purposes. Record counts weekly to follow trends in population development.

DESCRIPTION AND IDENTIFICATION OF THRIPS

Identification:

Adult thrips are tiny, 1.0 to 1.5 mm in length, with narrow bodies and long, strap-like fringed wings. Colors vary from yellow to brownish-black to black. (Figure 1.) Females lay microscopic eggs in leaf tissue or deep inside flower buds. In 2 – 4 days, eggs hatch into white to yellow larvae with red eyes. Larvae range in size from 0.5 to 1.2 mm in length. (Figure 2.) The pre-pupa and pupa appear as a form that resembles the larval stage, but with shorter antennae and wing buds that are visible, but not functional. (Figure 3.) Microscopic examination of characters is required to accurately identify thrips species.

Biology and Life Cycle:

In PA, many generations of thrips can occur throughout the growing season.
Thrips overwinter as adult females or eggs on plant debris, and in small grain, clover and alfalfa fields. The life cycle from egg to adult is completed in 14 to 30 days, or sooner at higher temperatures. Thrips populations can be more severe during periods of hot, dry weather. Adult thrips live up to 20 days and cause plant damage by scraping the plant tissue with a mandible (tooth-like structure) that punctures the plant cells. The emerging fluid is sucked up with a specialized mouthpart called a stylet (straw-like structure). Adult females lay eggs deep inside plant tissue (leaf or flower), exposing one end of the egg for the larva to emerge. In approximately six days, pale yellow larvae emerge and increase in size through two instars while feeding on actively growing plant tissue. The first instar lives for approximately 2 -4 days and the second instar larvae for 22 – 24 days. Both adults and larvae feed on plant tissue causing scarring on leaves, flowers and fruit. Plant terminals may appear stunted and twisted as they unfold. Petals, leaves and other plant parts may be discolored, stippled and scarred and possibly drop from the plant prematurely. Feeding damage on the leaf surface appears as silvery patches surrounded by black fecal specks. (Figure 4.)(Figure 5.) Egg laying scars on fruit are black with a white halo.(Figure 6.) Second instar larvae fall from the host plant into the soil or leaf litter to molt into the non-feeding prepupal, and pupal stages. Pupation in some thrips species may also occur on the leaf surface. Controlling thrips can be difficult due to their small size and tendency to hide in protected plant parts. Regular field scouting is essential for early detection.

Figure 1. Adult thrips cause plant damage by scraping the plant tissue with a mandible (tooth-like structure) that punctures the plant cells and females lay microscopic eggs in leaf tissue or deep inside flower buds

Figure 2. Pale yellow larvae emerge and increase in size through two instars while feeding on actively growing plant tissue.

Figure 3. The pre-pupa and pupa appear as a form that resembles the larval stage, but with shorter antennae and wing buds that are visible, but not functional.

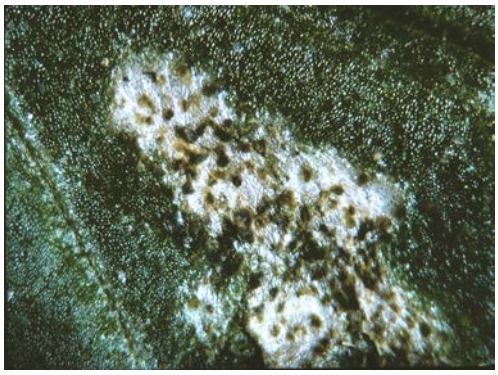

Figure 4. Feeding damage on the leaf surface appears as silvery patches surrounded by black fecal specks

Figure 5. Thrips feeding damage on tomato leaf (transplant)

Figure 6. Egg laying scars on fruit are black with a white halo

Biocontrol life cycle

***Neoseiulus* (*Amblyseius*) *cucumeris* – a predatory mite for thrips**

N. cucumeris is a beige colored predatory mite less than 1 mm long. (Figure 7.) After mating, the female mite deposits eggs on leaf hairs close to the veins on the underside of the leaf. This mite passes through one larval stage and two nymphal stages before becoming an adult. Both the nymphal and adult stages feed on thrips larvae. Total development time from egg to adult is about six to nine days at 77°F. These mites kill prey by piercing the thrips larvae and sucking out the body contents.(Figure 8.) They attack thrips larvae and eggs on foliage and flowers. High numbers are needed for effective control. Second instar and adult thrips will defend themselves against the mites by striking out with their abdomen. Therefore, timing predatory mite introductions with the presence of first instar larva increases their effectiveness. *Neoseilus* may also prey on spider mites or their eggs.

N. cucumeris has been used successfully to control thrips on greenhouse tomatoes, peppers, and eggplants. Mites are distributed loosely or in sachets (small envelopes). (Figure 9.) These sachets may provide several generations of reproducing predatory mites over a six-week period.

N. cucumeris should be introduced when thrips populations are at low levels or as a preventative treatment. They are not effective as a rescue treatment.

Figure 7. Adult *N. cucumeris* is a beige colored predatory mite less than 1 mm long

Figure 8. *N. cucumeris* kills prey by piercing the thrips larvae and sucking out the body contents

Figure 9. *N. cucumeris* are distributed loosely or in sachets (small envelopes) hung on plants. These sachets may provide several generations of reproducing predatory mites over a six-week period.

Purchase and Distribute Biocontrol Organisms

Biocontrols are available for purchase from numerous producers worldwide and are available for nearly all types of major pests, including aphids, beetles, bugs, caterpillars, leafminers, spider mites, thrips and whiteflies. More than twenty producers in the United States specialize in production of natural enemies for biological control, such as lacewings, predatory mites, beneficial nematodes, and *Trichogramma* parasitoids.

These biocontrol producers have distributors in the United States and Canada. Many of them have technical support staff including full-time entomologists to answer pest control and pollination questions. Check the Association of Natural Biocontrol Producers (ANBP) web site (http://anbp.org/) for a list of distributors. This professional organization's membership includes researchers and producers, distributors, and users of natural enemies.

Most greenhouse biocontrols are shipped from Europe or Canada, which is why most distributors require orders to be placed a week before delivery. Products are typically delivered by an overnight shipper, such as UPS or FedEx.

Most producers screen for quality and use specialized packaging with expiration dates. Be cautious of suppliers who do not put dates on their materials. When biocontrols arrive, check for viability. Predatory mites can be checked by shaking material onto a white sheet of paper and looking for movement. During warm weather, biocontrols should be shipped with cooling material, such as an ice pack. Inform employees that you will be receiving biocontrols so that the materials can be stored in a cool area if they cannot be released immediately.
Most reputable biocontrol suppliers can give growers accurate release rates for their particular pest situation.

Entomopathogenic fungi - Mycoinsecticides

Insects are attacked by all major disease-causing organisms, including fungi, viruses, bacteria, and microsporidia. Entomopathogenic fungi (mycoinsecticides) are pathogens that infect and kill insects. Fungal spores must have direct contact with insects to be effective. As spores attach to the insect cuticle, they germinate and the fungus grows into the body cavity. Hyphae, which are small thread-like structures that are produced by the fungal spores, invade the body cavity of the pest and attack the internal organs. The infected insect stops feeding and dies within a few days.

Integrate entomopathogenic fungi into your program for management or suppression of thrips populations, then application costs may be less expensive than when using conventional insecticides. There are many commercially available products formulated for greenhouse vegetable growers.

Benefits of using mycoinsecticides

- Broad-spectrum activity on both foliar and soil insects
- Contains blastospores which germinate and infect faster
- Effective for resistance management
- Little or no effect on beneficial insects
- OMRI listed
- 4 hour Restricted Entry Interval (REI)

Preferal ™ Microbial Insecticide

Preferal is a mycoinsecticides that is comprised of blastospores of the fungal species *Isaria fumosorosea*. Blastospores provide faster germination and infection of the insect cuticle. When blastospores of Preferal are sprayed onto the insect, these spores attach to the insect and then

germinate. The germinated spores will penetrate the outer skin of the insect and grow into and inside the insect.

Results

This project began with selection of a two high tunnel tomato growers who expressed a strong interest to implement a IPM/biocontrol program in their high tunnel tomato operations.

The IPM specialist worked with these growers throughout one entire crop cycle.
After an initial orientation meeting, growers and the IPM/biocontrol specialist met on a weekly basis starting at crop transplant initiation in the high. Growers were taught pest-scouting techniques and identification, lifecycles of pests, and monitoring pest populations to determine pest thresholds.

During periodic scouting visits, the lifecycle of thrips was discussed and the appropriate biocontrol was recommended to the grower, as well as other pests and their respective biological control agents. Additionally, the specialist trained growers on proper timing of biocontrol releases according to pest lifecycles and population numbers. The usage and application timing of the mycoinsecticide Preferal™ was taught in order to form a complete pest management system.

Grower No. 1

Crop: High tunnel tomatoes, 2,000 square feet

Variety: Red Deuce

This crop was planted the first week of April, 2016. In late May, low populations of thrips were detected in the crop on the lower leaves of the plants. This grower started introductions of *Neoseiulus cucumeris* to control larval stages of thrips with Slow Release Sachet system. One sachet (Figure 9.) was hung on each plant in the tunnel. This sachet will release predators throughout a 5 -7 week periods. Three introductions of sachets were made up to the beginning of August. At this point the thrips were at a level that was satisfactory to the grower.

Grower No. 2

Crop: High tunnel tomatoes, approximately 3,000 square feet

Variety: Red Deuce and Primo Red

This crop was planted the second week of April, 2016. In mid-June, thrips were found feeding in the mid-canopy of the crop. This grower chose to treat thrips initially with the Preferal™ microbial insecticide, since the populations were close to developing fruit.
Three applications of the mycoinsecticide were made according to label directions. These treatments were effective in reducing thrips populations, however, predators were introduced to maintain control through the end of the season. Introductions of *Neoseiulus cucumeris*, sachet system were initiated after the sprays. Three subsequent introductions were made providing satisfactory control of thrips.

Both treatments provided adequate control of thrips. Growers were able to eliminate chemical pesticide applications. Growers felt that the biocontrols were more expensive in some instances; however, project growers with a direct market (mainly road side stands) were able to sell their produce at a premium price. Both growers agreed that the one on one teaching method helped them to understand the process of using biocontrol. These growers also used bumble bees to pollinate their tomato crops. Bumble bee pollination results in heavier fruit and thus higher yields.

Important Steps when using biocontrols in high tunnels:

- Inspect crop weekly for insect pests and diseases
- Start introductions of biocontrols when pests are first detected
- Place predators as close as possible to mite infestations
- Introduce predators as soon as they arrive, do not hold
- Continue inspecting plants to monitor the effectiveness of the biocontrol
- Integrate compatible compounds, such as mycoinsecticides to augment the effectiveness of the biocontrol treatments
- Always check with supplier on rates for biocontrol introductions
- If a pesticide was used prior to introducing biocontrol, check with the supplier on compatibility issues.