Managing Greenhouse Pests And Mites For Food Crops

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Overview: What To Expect

• Introduction
• Sanitation
• Scouting
• Pesticide applications
• Biological control
• Questions and discussion
Tomato Production System
Plant Protection Strategies Must Be Implemented As Soon As The Crop Is Planted Into The Greenhouse: Be Sure To Correctly Identify Insect And Mite Pests
Spotted Cucumber Beetle On Young Spinach Plant
Green Peach Aphids On Pepper Plant
Western Flower Thrips Damage To Peppers
Reproductive Capacity Of Certain Insect And Mite Pests Necessitates The Need To Implement Plant Protection Strategies Early In The Crop Production Cycle: “Numbers Game”

Aphid

Twospotted Spider Mites
Aphid Reproduction (Parthenogenesis): “Numbers Game”
“Many” Aphids Can Be Produced In A “Short” Period Of Time

In 5 Generations, A Single Green Peach Aphid Could Give Rise To 13,552,028 Individual Aphids (Harrison, 1969)
Green Peach Aphid (*Myzus persicae*): Vector Of Many Viruses
Western Flower Thrips, *Frankliniella occidentalis*

Plant Damage

* **Direct**: feeding injury to leaves and flowers.

* **Indirect**: transmit the tospoviruses—*Impatiens necrotic spot virus* (INSV) and *Tomato spotted wilt virus* (TSWV).
Cultural Practices And Sanitation

* Proper watering (irrigation)
* Proper fertility
* Proper spacing
* Removal of all weeds, and plant and growing medium debris
The “First Line Of Defense” Against Insect And Mite Pests, And Plant Diseases Involves Implementing Appropriate Sanitation Practices
Top Five Sanitation Tips

1. Throw Away Dead Plants
2. Pick-Up All Plant And Leaf Litter
3. Clean Filters
4. Use Filtered Water
5. Clean Bench Surfaces, Tools, And Containers
Sanitation: “First Line Of Defense” Against Insect (And Mite) Pests
Greenhouse Sanitation

* Place all debris in containers with tight-sealing lids or dispose of into “compost piles”

* Remove or “eliminate” algae from benches and floors

* Remove weeds, and plant material and growing medium debris

* Dispose of old stock plants or any left-over plant material
Weeds Growing Underneath Bench
Importance Of Weed Management

• Many broadleaf weeds are susceptible to and serve as a refuge or alternate host for insect and mite pests; including: aphids, whiteflies, spider mites, and thrips.

• A number of weeds may also harbor the viruses vectored by aphids, whiteflies, and thrips.
Many Weeds Serve As Reservoirs For Insect And Mite Pests
Spider Mite Feeding Damage On Weed Among Tomato Plants
Spider Mites On Weed Among Tomato Crop
ROLE OF WEEDS IN THE INCIDENCE OF VIRUS DISEASES

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INTRODUCTION

From the standpoint of control of virus diseases, there is perhaps no phase of virology more important than epidemiology. The role of weeds in the occurrence and spread of plant virus diseases is an integral part of the ecological aspect of virus transmission.
“Compost” Pile Outside Of Greenhouse: Is There A Location Issue?
Soil fertility management and insect pests: harmonizing soil and plant health in agroecosystems

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Abstract

Cultural methods such as crop fertilization can affect susceptibility of plants to insect pests by altering plant tissue nutrient levels. Research shows that the ability of a crop plant to resist or tolerate insect pests and diseases is tied to optimal physical, chemical and mainly biological properties of soils. Soils with high organic matter and active soil biology generally exhibit good soil fertility. Crops grown in such soils generally exhibit lower abundance of several insect herbivores, reductions that may be attributed to a lower nitrogen content in organically farmed crops. On the other hand, farming practices, such as excessive use of inorganic fertilizers, can cause nutrient imbalances and lower pest resistance. More studies comparing pest populations on plants treated with synthetic versus organic fertilizers are needed. Understanding the underlying effects of why organic fertilization appears to improve plant health may lead us to new and better integrated pest management and integrated soil fertility management designs.

Keywords: Soil fertility; Crop nutrition; Pest attack; Insect populations; Pest management
HOST PLANT QUALITY AND FECUNDITY IN HERBIVOROUS INSECTS

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Key Words  herbivory, offspring size, oviposition preferences, larval performance, nutrients, defensive metabolites

Abstract  Host plant quality is a key determinant of the fecundity of herbivorous insects. Components of host plant quality (such as carbon, nitrogen, and defensive metabolites) directly affect potential and achieved herbivore fecundity. The responses of insect herbivores to changes in host plant quality vary within and between feeding guilds. Host plant quality also affects insect reproductive strategies: Egg size and quality, the allocation of resources to eggs, and the choice of oviposition sites may all be influenced by plant quality, as may egg or embryo resorption on poor-quality hosts. Many insect herbivores change the quality of their host plants, affecting both inter- and intraspecific interactions. Higher-trophic level interactions, such as the performance of predators and parasitoids, may also be affected by host plant quality. We conclude that host plant quality affects the fecundity of herbivorous insects at both the individual and the population scale.
Reflective Mulches: May Reduce The Incidence Of Certain Insect Pests
Reflective mulches foil insects

An aerial view of an experimental reflective mulch plot at the Meloland Field Station near Riverside.

Below are seen plants that were established 18 inches apart through holes in the mulch. Later tests developed a system for laying down the mulch strips mechanically.

Above are 30-inch-wide mulch strips which were hand applied on the south slope of the squash planting beds.

Nick C. Toscano □ Jeff Wyman □ Ken Kido
Hunter Johnson, Jr. □ Keith Mayberry

Photos by Max Clover
Scouting food crops is important in determining the population dynamics of insect and mite pests throughout the growing season.
What Can Happen When You “Forget” To Scout: Lots Of Twospotted Spider Mites (*Tetranychus urticae*) On Tomato
Developing a Routine Scouting Schedule Will Prevent Insect and Mite Pest Problems From "Escalating"
Yellow Sticky Cards: Capture Adult Thrips, Whiteflies, And Moths
Yellow Sticky Tape: Capture Flying Insects Such As Winged Aphids, Adult Thrips, Adult Whiteflies, Beetles, And Moths
Using Pesticides To Suppress Insect And/Or Mite Pest Populations On Greenhouse-Grown Food Crops
Pesticides (Insecticides And Miticides) For Use On Vegetable Crops

• Contact Pesticide

• Stomach Poison
Pesticide Types

* **Broad-spectrum**: have activity on many insect and mite pests with “long” residual activity or persistence.

* **Narrow-spectrum (selective)**: active on a select number of insect or mite pests and have “short” residual activity or persistence.
How To Effectively Use Pesticides

1. **Timing:** apply pesticides (insecticides and miticides) when the most susceptible life stage (e.g. larva, nymph, and adult) of a given insect or mite pest is present.

2. **Coverage:** when spraying a pesticide, it is important to obtain thorough coverage of all plant parts including: leaves, stems, flowers, and fruits.

3. **Frequency:** apply pesticides within timely intervals, which is dependent on the residual activity of a given pesticide. Read the label for information associated with frequency of application.
The Life Stages (Eggs, Larvae, Nymphs, Pupae, And Adults) Of Insect And Mite Pests Are Typically Located On Leaf Undersides
Some Pesticides Can Directly And Indirectly Impact Insect And Mite Pest Populations: Kill Natural Enemies Or Stimulate Pest Outbreaks (Secondary Pest Outbreaks)
Carbaryl (Sevin): Broad-Spectrum Insecticide That Is Directly And Indirectly Harmful To Natural Enemies And Pollinators
Applications of certain pesticides such as pyrethroids may stimulate twospotted spider mite outbreaks.
Even Pesticides Certified For Use In “Organic” Production Systems May Be Directly Or Indirectly Harmful To Natural Enemies
Using organic-certified rather than synthetic pesticides may not be safer for biological control agents: Selectivity and side effects of 14 pesticides on the predator Orius laevigatus

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ABSTRACT

The generalist predator Orius laevigatus (Fieber) (Hemiptera: Anthocoridae) is a key natural enemy of various arthropods in agricultural and natural ecosystems. Releases of this predator are frequently carried out, and it is included in the Integrated Pest Management (IPM) programs of several crops. The accurate assessment of the compatibility of various pesticides with predator activity is key for the success of this strategy. We assessed acute and sublethal toxicity of 14 pesticides on O. laevigatus adults under laboratory conditions. Pesticides commonly used in either conventional or organic farming were selected for the study, including six biopesticides, three synthetic insecticides, two sulfur compounds and three adjuvants. To assess the pesticides' residual persistence, the predator was exposed for 3 d to pesticide residues on tomato sprouts that had been treated 1 h, 7 d or 14 d prior to the assay. The percentage of mortality and the sublethal effects on predator reproductive capacity were summarized in a reduction coefficient ($E_0$) and the pesticides were classified according to the IOBC (International Organization for Biological Control) toxicity categories. The results showed that the pesticides greatly differed in their toxicity, both in terms of lethal and sublethal effects, as well as in their persistence. In particular, abamectin was the most noxious and persistent, and was classified as harmful up to 14 d after the treatment, causing almost 100% mortality. Spinosad, emamectin, metaflumizone were moderately harmful until 7 d after the treatment, while the other pesticides were slightly harmful or harmless. The results, based on the combination of assessment of acute mortality, predator reproductive capacity, pesticide residual and pesticides residual persistence, stress the need of using complementary bioassays (e.g. assessment of lethal and sublethal effects) to carefully select the pesticides to be used in IPM programs and appropriately time the pesticides application (as function of natural enemies present in crops) and potential releases of natural enemies like O. laevigatus.

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The influence of chemical management of pests, diseases and weeds on pest and predatory arthropods associated with tomatoes

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Abstract

The effects of selected pesticide application regimes on pest predator populations as well as pests were investigated in tomato (Lycopersicon esculentum L.) agroecosystems. The treatments included: (i) the full spectrum of recommended pesticides, including insecticides (carbaryl, endosulfan, and esfenvalerate), a fungicide (chlorothalonil), and herbicides (trifluralin and paraquat); (ii) only insecticides, using the same insecticides and doses as in the full-spectrum pesticide treatment; (iii) only fungicides and herbicides; using the same fungicides and herbicides and doses as in the full-spectrum pesticide use treatment; (iv) control plots which received no pesticide applications. In 1994, the insecticides controlled aphids and flea beetles, and reduced their populations by 85% and 72%, respectively. However, aphid populations were 125% greater in the insecticide-treated plots than in the control plots in 1995. The fungicides and herbicides caused increases in the numbers of aphids by 33% in 1994 and by 39.8% in 1995 and those of flea beetles by 55% in 1994 and 17% in 1995. All the full-spectrum pesticide treatments had some degree of detrimental effects on populations of predatory arthropods. The different pesticide applications reduced coccinellid beetle Coleomegilla maculata (Col: Coccinellidae), populations by 6.6% to 35.5% in 1994 but only slightly in 1995; Anthocoridae (Heteroptera) numbers by 26.2% to 55.8% in 1994 and 13.5% to 38.8% in 1995; spider (Araneae) populations by 44.6% to 70.9% in 1994 and 37.0% to 91.4% in 1995. Five hypotheses are proposed to explain these results: (1) the fungicide and herbicide applications reduced the populations of predatory arthropods which in turn resulted in higher pest populations; (2) the fungicide and herbicide applications suppressed the fungal parasites of the pests; (3) the applications increased the fecundity of the pests and resulted in more offspring of the pests and hence higher populations; (4) the applications caused some physiological changes in the tomato plants that attracted more pests or stimulated their reproduction and; (5) the fungicide applications provided more nutritious and suitable habitats for the pests by suppressing the disease of the tomatoes. © 1998 Elsevier Science B.V. All rights reserved.

Keywords: Pests; Predators; Pesticides; Non-target effects; Tomatoes

²Inertis
Ecological Impact Of Pesticide Use On Natural Enemies

* Secondary Pest Outbreaks
Secondary Pest Outbreak

Pesticide Application

Pesticide Applications

Pest Species 1

Pest Species 2

Time
Selective Insecticide: *Bacillus thuringiensis* subsp. *kurstaki* (Dipel®)—Only Kills Caterpillars.
Selective Insecticide: Spinosad (Entrust®). Active on Certain Insect Pests.
Factors Responsible For Inadequate “Control” Of Insect And Mite Pests

- Spray timing: life stages of insect and mite pests present
- Spray coverage
- pH of spray solution
- Frequency of applications
- Migration of insects into greenhouses from other sources
Immigration Of Insect Pests Such As The Western Flower Thrips Into Greenhouses From Nearby Fields: May Be Exposed To Insecticides With The Same Mode Of Action

Tracer (spinosad)

Entrust (spinosad)
Be Careful Using Pesticides In The Presence Of Bumble Bees: Direct And Indirect Effects
Insecticides Commercially-Available In USA Based On Entomopathogenic (Beneficial) Organisms (Fungi Or Bacteria)

- **Beauveria bassiana** (BotaniGard/Mycotrol)
- **Isaria fumosoroseus** strain FE 9901 (NoFly)
  - **Isaria fumosorosea** Apopka Strain 97 (Preferal)
- **Metarhizium anisopliae** (Met52)
- **Chromobacterium subtsugae** Strain PRAA4-1T (Grandvevo)
How Beneficial Fungi Kill Insect Hosts
Alternative Plant Protection Strategy: Biological Control
What Is Biological Control?

- Use of biological control agents (=natural enemies) such as parasitoids and predators to regulate insect and/or mite pest populations.

- Natural enemies will not eradicate an insect and/or mite pest population. The success of natural enemies is contingent on maintaining insect and/or mite pest numbers at levels low enough to minimize plant damage.

- Key=regulation of insect and/or mite pest populations.
Biological Control Products Available From Suppliers/Distributors
Types Of Biological Control Agents (Natural Enemies)

1. Parasitoids

2. Predators:
   * Hover flies
   * Green lacewings
   * Ladybird beetles
   * Predatory midges
   * Predatory mites
Parasitoids: Aphids

- *Aphidius colemani* (green peach and cotton/melon aphid)
- *Aphidius ervi* (potato and foxglove aphid)
- *Aphidius matricariae* (tobacco aphid)
- *Aphelinus abdominalis* (wide-range of aphid species)
Female Parasitoid Getting Ready To Attack An Aphid
Parasitized “Mummified” Aphids On Plant
Methods (Formulations) Of Releasing Aphid Parasitoids
Banker Plant System
Both Alive And “Mummified” Aphids On Banker Plant
Parasitized ("Mummified") Aphids On Leaf Underside
Banker Plants
Aphids For Banker Plants
Incorporate Plants Into Greenhouse Production Systems That Attract Natural Enemies Such As Sweet Alyssum
Green Lacewing: Predator Of Aphids And Mites
Predatory Mite
Container With Approximately 250,000 Predatory Mites That Are Distributed Either By Hand Or Using A Mechanical Blower
Methods Of Applying Predatory Mites
Amblyseius swirskii
Sachet Breeding System
Method Of Applying *Neoseiulus cucumeris* (Sachet)
Shipment Of Biological Control Agents (Natural Enemies) From Commercial Supplier
Container Of *Phytoseiulus persimilis* After Introduction
Be Sure To Make Releases Of Biological Control Agents (Natural Enemies) Early In The Production Cycle

Also, Be Sure To Receive Shipments Every Week Or Every Two Weeks
Tomato Crop Using Biological Control Against Twospotted Spider Mite

Key: Release Rates And Release Timing
Cucumber Crop In Another Enclosed Structure (Hoop-House) That Did Not Use Biological Control Against Twospotted Spider Mite
The Success Of Biological Control May Vary Depending On Plant Type: Plant Architecture And Leaf Characteristics (Hairs Or Trichomes)
Summary

* Be sure to correctly identify all insect and mite pests

* Start plant protection strategies early in the cropping cycle

* Implement sanitation practices

* Avoid over-fertilizing vegetable crops

* Establish a reliable scouting program

* Use pesticides appropriately

* Use biological control agents preventatively
Thank You For Your Attention!

I Hope You All Learned Something!
It's QUESTION TIME!!