HORTICULTURE SERIES

TIMELY INFORMATION

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Pest Management in High-tunnel Crop Production

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Scope of IPM in High Tunnels

IPM is an economically feasible, environmentally friendly and socially responsible way of farming. IPM is based on the principle of economic thresholds, i.e., pests are managed only when populations exceed certain levels as determined by the type of crop, growth stage, insect pest species and the ability of plants to tolerate pest damage. High tunnel production allows manipulation of the environment and crops tend to be grown for an extended season which makes them attractive to many pests. Due to the open sides, hoop houses are considered semi-open structures with insect control benefits accruing from early crop production before insect pest population become too high.

How does High Tunnel Microenvironment Moderate Pest Populations?

Before describing various pest species that may occur in a high tunnel crop, it is important to examine some key features of the microenvironment that can moderate pest populations. Some key microenvironment issues are:

- Passive ventilation: Since ventilation under high tunnels is achieved by natural air movement aided by the rolling sides, air movement could become restricted as the canopy thickens. This results in pockets of high temperature and humidity inside the crop canopy.
  How ventilation affects insect populations? Many insects like aphids and whiteflies prefer high moisture conditions. Initial infestation of those insects may rapidly increase from favorable hot-spots.

- Exclusion of rainfall: The plastic used in high tunnels forms a barrier to rainfall thereby necessitating the use of irrigation.
  How it affects insect populations? Rainfall is unfavorable to many insect pests not only due to the direct force of falling droplets but moisture also favors development of diseases that cause natural epidemics in insect populations. However, the lack of rainfall under hoop house reduces effectiveness of insect pathogens.

- Planting density and diversity: High tunnels are limited by size and design; therefore, producers tend to plant crops in high density and mixes. Thus, many plant species may be grown by farmers under a single structure or monocropping may be favored.
  How plant variety and density affect insect populations? Polyphagous insects (that feed on plants belonging to different families) are serious pests of fruits and vegetables. Corn earworm (= tomato fruitworm), tobacco budworm, thrips, stink bugs, and aphids are a few examples of polyphagous insects that readily migrate between host crops. With a diverse array of crops under high tunnels (Fig. 2), pest management could be difficult due to insect migration between crops. Multiple cropping may also limit the use of synthetic insecticides due to thick planting.

Insect Monitoring in and around Hoop House

The first steps to the correct practice of IPM are early pest detection, monitoring and scouting with emphasis on the correct identification of pests. Many nocturnal moths and beetles can be monitored continuously using commercial pheromone traps; trap catches indicate insect density and activity throughout the season. Pheromone traps are a scouting tool; they may be ineffective in trapping out all insects that get under a hoop house. The Alabama Cooperative Extension System (ACES) is conducting a statewide insect monitoring program for field crop and vegetable producers using pheromone traps; readers are encouraged to refer the 2009 and 2010 insect advisories or visit the detailed insect monitoring project archive at http://www.aces.edu/go/85. Pheromone traps and lures should always be purchased from reliable sources to avoid disappointing results. Consult Regional Extension Agents for additional sources of pheromone traps and lures.

Insect Pest Exclusion under Hoop House

An important aspect of IPM is the <u>prevention</u> of pests. There are mixed reports regarding the direct benefit of high tunnels for crop protection by insect exclusion. Hoop houses may contribute to slight reduction of pest pressure by acting as a physical barrier to migratory insects. Technologies such as insect screens may be integrated with hoop houses for taking advantage of multiple insect exclusion techniques (conceptual photo in Fig. 1). Insect screens with low mesh size (i.e., large openings) can be installed along with screen doors at the entrances to prevent medium- and large-sized insects from entering the hoop house when side walls are open during the day without reducing air movement inside crop canopy. Further research is needed to understand insect pest dynamics under modified hoop houses.

Fig. 1. Hoop house with insect screen on rolling sides (arrow) may exclude pests.

Conceptual photo by A. Majumdar

Synthetic Insecticides for Hoop House Vegetable Production

The pesticide industry currently does not have a separate label or restriction on insecticide labels for high tunnel crop production; so, growers may use registered commercial (synthetic) insecticides for rescue treatments. However growers should be aware of the following issues that <u>discourage</u> insecticide usage under hoop houses:

- Spot-treatment may be adequate for treating hot-spots: Spot-treatments will save cost of insecticide as well as conserve natural enemies.
- High temperature under tunnels: Pesticides should not be applied if it violates temperature recommendations mentioned on the product label.
- Structural damage due to drift: Although wind velocity under high tunnel is expected to be low, casual application of synthetic chemicals may damage the plastic and metal parts or leave undesirable residues that may not break down for extended time periods.
- Alternative pest management strategies are available: There are alternative pest management tactics that can be used effectively. Use of cultural control methods (early planting & harvest, sanitation, vigorous crop varieties, trap cropping, etc.), natural enemy conservation, and biological control (Table 1) are some environmental-friendly IPM tactics. Growers are encouraged to test and try alternative tactics before resorting to the use of synthetic insecticides under high tunnel.

Examples of Insect Pests under High Tunnel

Below are some sucking insect pests of vegetable crops and excludes lengthy discussion of caterpillars and beetles that may not reach outbreak status under hoop houses. Table 1 provides a list of natural enemies that can be released under high tunnel for pest management (do not use synthetic insecticide before release of bioagents).

Aphids

<u>Identification</u>: Several species of aphids are known to occur in both greenhouse and field crops; aphids can be the first invaders of crops in high tunnel. Green peach aphid, potato aphid, and melon aphid are common species. Aphids can be

distinguished by locating a pair of tail-pipes or cornicles at the end of abdomen. Aphid populations may increase rapidly in densely-packed hoop houses if undetected or left unmanaged.
Monitoring techniques: It is important to monitor aphids using yellow sticky cards in order to detect migrating populations (alate aphids). Sticky traps should be placed close to the plants about 3-4 per tunnel to increase the accuracy of observation. Sticky cards should be checked daily (early in the season) or weekly (late season). While scouting crops, check the underside of leaves and examine the growing points.
Organic management: Aphids also can be managed by weekly (or more frequent) applications of insecticidal soap and horticultural oils. Growers can treat insect hot-spots and save on the cost of insecticide applications. Naturalis O (BioWorks, Inc., VA) is a broad-spectrum organic formulation containing the fungus *Beauveria bassiana* with activity against aphids, thrips and whiteflies (most effective against immature stages). These alternative insecticides may persist longer under shaded condition of a hoop house.

Whiteflies
Identification: Common whitefly species found in the field and greenhouse conditions can also infest crops under high tunnels, e.g., greenhouse and silverleaf whiteflies. Proper identification of whitefly may require a strong magnifier for viewing after sampling (see below). Under magnification, the greenhouse whitefly appears to have flattened wings whereas the silverleaf whitefly holds wings in a tent-like position. Citrus white flies are also prevalent in Alabama and can be found on many host plants - not just fruits. Whiteflies are small, white-winged insects that pass through egg, 4 larval stages, and a pupal stage before becoming winged adults. Whitefly feeding can cause direct leaf damage by their piercing-sucking mouthparts or indirect damage by excretion of honeydew giving rise to sooty mold on leaves. Secondary insect pests can also be attracted to the honeydew.
Monitoring techniques: A simple way of collecting whiteflies, aphids, and thrips is by closing a Ziploc bag over leaves or flowers and vigorously shaking the plant part. For observation, flatten the Ziploc bag by excluding air and hold bag over a white sheet of paper. It is important to start scouting soon after crop establishment; look for whiteflies on the underside of leaves. Yellow sticky cards placed close to the plant canopy also are effective in catching these insects. Storms and high winds may move whiteflies to new location; so, scouting should be repeated after such weather events.
Organic management: Periodic applications of insecticidal soap, pyrethrin, neem or insecticidal oil can suppress populations. Check insecticide label before application to avoid phytotoxicity.

Thrips
Identification: Thrips are elongate and slender insects with size ranging from 0.02 to 0.55 inch. The adults have two pairs of narrow wings which are held over the body at rest. Edges of both the forewings and hindwings are fringed with setae (hair). Thrips cause damage by transmitting plant diseases as they feed. Over 20 plant viruses are known to be transmitted by thrips like the spotted wilt.

Monitoring techniques: Scouting should start soon after plant establishment; look for thrips on the underside of leaves or inside flowers. Thrips generally migrate from surrounding weeds as they dry up. The use of pink sticky cards has been shown to be effective in monitoring thrips.

Organic management: The use of sulfur, insecticidal soap, and diatomaceous earth have been shown effective in suppressing thrips and other pests on several crops. Spray formulations of *Beauveria bassiana* (e.g., Mycotrol-O®) and spinosyn (Entrust®) are also effective against thrips for organic crop production.

Spider mites
Identification: Several mite species are important pest of fruit and vegetable crops. Mites are not insects but are more closely related to spiders. They have four pairs of legs, no antennae and an oval body. Most spider mites have the ability to produce fine silk webbing. Magnification is required to see spider mites because they are usually very tiny, less than 1/50 inches in adult stage. Spider mites damage plant cells using their piercing mouthparts and extensive feeding causes yellow or white speckles. When the feeding spots coalesce, the foliage takes on a yellow or bronzed coloration.

Monitoring techniques: No traps or lures are available for monitoring mites. Shake leaves over a white sheet of paper and watch for tiny moving specks. Species identification may require sending samples to experts. Otherwise, watch for damage symptoms such as bronzing in mite hot-spots and treat locally under high tunnel.

Organic management: Spider mites can be controlled with insecticidal oils and soaps. Higher rates of horticultural oil (3 to 4%) or dormant oil are useful for killing mite eggs. Insecticidal soaps are useful in the warm season. It is important to get thorough plant coverage with soaps and oils for good mite control.

Table 1. Predators and parasitic wasps commercially available for insect pest management in fruits and vegetables.

				Suppliers & Product Name	
Target insect	Biological control agent	Common name	Mode of action	Koppert Biological Systems	Syngenta-Bioline
Aphid	*Adalia bipunctata*	Lady beetle	Predator	Aphidalia	Adalline b
	Aphidoletes aphidimyza	Gall midge	Predator	Aphidend	Aphidoline
	Chrysoperla carnea	Lacewing	Predator	Chrysopa	Chrysoline c
	Episyrphus balteatus	Syrphid fly	Predator	Syrphidend	-
	Aphelinus abdominalis	Parasitic wasp	Internal parasite	Aphlin	Apheline
	Aphidius colemani	Parasitic wasp	Internal parasite	Aphipar	Aphiline c
Leafminer	*Dacnusa sibrica*	Parasitic wasp	Internal parasite	Diminex	Dacdigline
	Diglyphus isaea	Parasitic wasp	Internal parasite	Miglyphus	Digline i
Mealy bug	*Anagurus pseudococci*	Parasitic wasp	Internal parasite	Citripar	-
	Leptomastix dactylopii	Parasitic wasp	Internal parasite	Leptopar	-
	Coccidoxenoides perminutus	Parasitic wasp	Internal parasite	Planopar	-
	Cryptolaemus montrouzieri	Predatory beetle	Predator	Cryptobug	Cryptoline m
Caterpillars	*Hypoaspis aculifer*	Predatory mite	Predator	Entomite A	-
	Macrolophus caliginosus	Predatory bug	Predator	Mirical	Macroline
	Trichogramma brassicae	Parasitic wasp	Internal parasite	Tricho-strip	Tricholine

Spider mite	*Macrolophus caliginosus*	Predatory bug	Predator	Mirical	Macroline
	Amblyseius californicus	Predatory mite	Predator	Spical	Amblyline
	Feltiella acarisuga	Gall midge	Predator	Spidend	-
	Phytoseiulus persimilis	Predatory mite	Predator	Spidex	Phytoline
Thrips	*Hypoaspis miles*	Predatory mite	Predator	Entomite m	Hypoline m
	Amblyseius swirskii	Predatory mite	Predator	Swirski-mite	Bugline s
	Orius insidiosus	Predatory bug	Predator	Thripor - I	Oriline i
	Orius majusculus	Predatory bug	Predator	-	Oriline m
	Eretmocerus eremicus	Parasitic wasp	Internal parasite	Ercal	Eretline e
Whitefly	*Eretmocerus eremicus* + *Eretmocerus mundus*	Parasitic wasp	Internal parasites	Bemimix	-
	Encarsia formosa	Parasitic wasp	Internal parasite	En-Strip	Encarline
	Encarsia formosa + *Eretmocerus eremicus*	Parasitic wasp	Parasite premix	Enermix	-
	Amblyseius swirskii	Predatory mite	Predator	Swirski-mite	Bugline s

Disclaimer: Product availability may change from time to time. Other products or suppliers can be recommended by Regional Extension Agents. Call the toll free numbers provided for each manufacturer to find current list of products or visit company websites. Mention of names does not mean endorsement of products by Alabama Cooperative Extension System.