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Defending the Castle: Integrated Pest Management in High Tunnel Strawberries

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Introduction

In recent years, the use of high tunnels for extending the growing season has become fairly widespread. High tunnels operate and look like greenhouses (Image 1), but are passively heated and cooled which helps keep operating costs low. They are temporary structures typically constructed with galvanized steel, PVC pipe, or wood framing and covered with greenhouse grade plastic. Even without additional heating, high tunnels can be 15-30˚F warmer than the outside air temperature during the day. This temperature increase extends the growing season earlier into the spring and later in the fall. Extending the season can significantly increase the amount of produce grown, increasing profits. In areas where season extension is not as critical, high tunnels are often used for rain exclusion and wind protection. Following is an outline of integrated pest management for high tunnel strawberries; however, the concepts presented hold true for many high tunnel fruit and vegetable crops.

Image 1. High tunnel constructed with PVC and wood frame.

Integrated Pest Management (IPM) is a comprehensive approach to pest control that uses a combination of methods to keep pests at tolerable levels while maintaining a quality environment. An effective IPM program requires four steps. *First*, know your pest, disease, or plant health problems. Knowing which pests to monitor for and how to identify them (either by the insect itself, frass, damage, or symptoms) is critical for proper IPM implementation. Correctly identifying diseases can be challenging. Monitor for pathogens by looking for characteristic signs and symptoms. If needed, samples can be sent to pathology labs for identification. *Second*, decide upon the level of crop damage that is unacceptable for your situation. Although it may be tempting to leap for the sprayer at the first sign of damage, it is important to determine if the number of pests present warrant a control action. *Third*, consider all available management practices. A successful pest management system integrates chemical, biological, cultural, and mechanical control methods. *Finally*, time insect and disease control actions to correspond with points during the pest or disease life cycle when they are most susceptible to controls.

IPM in High Tunnels

While high tunnel IPM practices differ significantly from field pest control there are similarities between greenhouse and high tunnel IPM. Many IPM practices used in greenhouse production can be implemented within a high tunnel. Both can utilize biological control methods effectively in their enclosed environments. Pesticides listed for greenhouse use are also safe for a high tunnel, however the enclosed environment may prolong pesticide residual activity and potential exposure

for workers. Therefore, soft pesticides, such as insecticidal soaps or horticultural oils, may be more appropriate.

Despite similarities of high tunnels to greenhouses, there are several important differences. Greenhouse production uses sterile potting media while high tunnel plants are often grown in existing soils, which contain potential insects and diseases. Soil solarization is an effective and inexpensive way to combat pests in field soils. Soil solarization uses solar energy to heat the soil which controls insect populations and soilborne diseases. High tunnels are well suited to solarization. Methods of ventilation are another major difference between greenhouses and high tunnels. Unlike greenhouses, high tunnel temperature is controlled manually. Tunnel doors and walls are opened to the outside for ventilation, creating access for pests (Image 2). To mitigate this problem, varying sizes of mesh covers can be used in conjunction with the polyethylene tunnel to exclude pests ranging in size from flea beetles to grasshoppers.

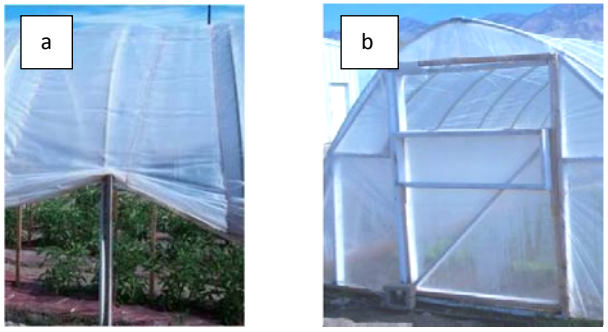

Image 2. Venting by lifting side (a) walls or opening door vent (b).

Timing of pesticide and biological control applications will be different for a high tunnel than a greenhouse. Temperature and humidity influences the effectiveness of pesticides and biological control agents, such as predators, parasitoids, nematodes, and fungi. Because weather conditions significantly affect the environment inside a high tunnel, they should be monitored to determine the proper time to introduce a biological control agent, or to apply a pesticide. Cool temperatures and low light levels in winter production are a great deterrent for many pest problems. However, increased spring and fall temperatures may result in extended pest life cycles and higher population densities.

One interesting component of high tunnel IPM is the effect of UV-blocking properties of the polyethylene cover on insect behavior within the tunnel. The greenhouse grade plastic that is typically used in high tunnel construction blocks most, if not all, UV radiation and also has an effect on the dispersal of light. Insect eyes detect light in the UV spectrum and use this mechanism to locate food sources (Briscoe and Chittka, 2001). UV-blocking plastic film has been shown to decrease populations of aphids, thrips, whiteflies, leafhoppers, and beetles compared to tunnels without UV-blocking plastic covers.

Strawberry Production Timeline

June-bearing strawberry cultivars have been successful in a high tunnel system in Cache Valley, Utah (see Image 3). For optimal yields in a high- elevation, cool climate, strawberries are planted as plug plants on approximately September 1st (Rowley et al., 2010). In colder climates, strawberry plugs need to be planted from late July to August.

Image 3. Strawberry high tunnel production on raised beds.

In climates warmer than Cache Valley, plant from mid-September to October. Because of the additional heat in a high tunnel, strawberries usually come into production in mid-April, approximately four weeks sooner than field strawberry production. Harvest continues until temperatures are too hot for strawberry production, usually in mid-July. This high tunnel strawberry production system requires pest management through three seasons: fall, winter, and spring.

Common Insects in High Tunnel Production

The season extending properties of high tunnels also extend the pest season. Insects can be present later into the fall than in the field. Cold temperatures are a good deterrent for most insects, simplifying winter management. However, some insects can be present all year. In the spring, temperatures within the high tunnel warm up much sooner than outside production. Spring insect pests may appear several weeks earlier than they would normally appear in field production.

Insect Pests	Identification/Life cycle	Action Threshold	Control Options
Aphid (Image 4)	Soft bodied, piercing-sucking mouthparts, various colors. Many species are parthenogenic during the growing season (can reproduce without fertilization); short life cycles of several weeks lead to many generations per year.	30 aphids per plant or 30% of plants infested	Use pest-free transplants and keep high tunnel weed free. Bio control: lady beetle, lacewings, predatory midge (*Ahpidoletes ahpidimyza* L.) Home use insecticides: insecticidal soap, horticultural oil, malathion, neem oil. Commercial use insecticides: Imidacloprid, Thiamethoxam
Slugs (Image 5)	Soft, slime-covered bodies, usually tan. Hermaphroditic (both female and male reproductive organs present), lay eggs up to six times a year.	Monitor by trapping (shelter traps or pits) Action Threshold: 3-5 slugs per trap.	Remove debris in high tunnel, lower humidity levels, and hand removal. Insecticides: iron phosphate or metaldehyde bait.
Mites (Image 6)	Extremely small (0.5 mm long), live on the underside of leaves, various colors. Hot, dry conditions favor mites. Sexually mature in several weeks and lay hundreds of eggs in a lifetime.	Collect 60 leaves throughout the tunnel at random and examine underside for mite presence. If 15 or more leaves have mites present, control measures should be taken.	Reduce dust on leaves. Predatory mites can be effective if released before mite densities are high. High pressure water wash. Home use insecticides: horticultural oil, insecticidal soap, sulfur. Commercial use insecticides: Miticides can be used if labeled for strawberries and greenhouse use, but they kill beneficial mites as well as pests.
Root Weevil (Image 7)	Larvae are C-shaped, without legs, a dark head, and feed on roots. Adults are 3 to 9 mm long, dark colored, and feed on foliage (characteristic scallops on leaf edges). Parthenogenic females lay eggs in soil 2-4 weeks after emergence.	More than two weevil larvae per plant cause economic damage.	Scout for night-feeding adults and damage with a flash light. Crop rotation, remove weeds. Home use insecticides: carbaryl, malathion, pyrethrin. Commercial use insecticides: azadirachtin, thiamethoxam. Soil fumigation can be used in extreme cases, but should be considered a last resort.

Image 4. Aphids on the bottom of a strawberry leaf. Photo source: UC Davis.

Image 5. Slug on a spinach leaf.

Image 6. Mite webbing on leaf. Plants are often stunted by mite feeding.

Image 7. Strawberry root weevil damage. Characteristic scallop feeding pattern.

Common Diseases in High Tunnel Production

Most modern cultivars have some level of disease resistance. Using resistant cultivars reduces the need for expensive chemical disease control. Cold winter temperatures slow the growth and spread of disease, making disease incidence rare in winter production, but as temperatures rise in the spring, diseases become more common. Because of the humid, cooler conditions that are present within high tunnels in late fall and early spring, fungal diseases can become a problem.

Image 8. Upward curling of strawberry leaves infected with powdery mildew. Photo source: UC Davis.

Diseases	Identification	Control
Powdery Mildew (Image 8)	First sign is an upward curling of leaves. White or gray somewhat powdery coating on leaf of strawberry follows.	Lower humidity levels, keep leaf surface dry. Some resistant cultivars available. Home use fungicides: sulfur, fixed copper, myclobutanil. Commercial use fungicides: Triflumizole, Pyraclostrobin
Botrytis Blight (Grey Mold) (Image 9)	Silver or gray spores on dead tissue. Infected fruit soft with gray spores, usually in spots. Pre- and post-harvest disease.	Keep humidity levels low, encourage air circulation. Some resistant cultivars available. Home use fungicides: captan, fixed copper. Commercial use fungicide: Pyraclostrobin.
Leather Rot	Bleached or light pink area. Lesion tissue is tough and bitter.	Pre-plant soil solarization, minimize water on leaf surface, good air circulation. Keep berries from contacting soil.

Image 9. Botrytis bright (grey mold) on strawberry.

Rodents

Rodents have the potential of being a severe pest during the winter season. High tunnels provide rodents with a warm winter home with an abundant food supply. Once established, rodents can become difficult to eliminate, and have the capacity to eat large amounts of plant material. Control methods vary in effectiveness and require a combination of traps, baits, and poisons to control the population. Keep high tunnels a minimum of 50 feet from compost or garbage piles to minimize rodent occurrence.

Conclusion

Whether the high tunnel is being used to grow strawberries, vegetables, or cut flowers, implementing a combination of IPM practices within a high tunnel can be very effective in controlling undesired pests. Since the semi-closed environment of a high tunnel can create an ideal environment for the growth and development of pests, vigilant monitoring is needed to detect increasing pest populations in time to take appropriate action to prevent unacceptable crop damage. As the use of high tunnels becomes more common in modern production systems, more research is needed to test the effectiveness of new IPM practices within a high tunnel system.

Additional Reading

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