

Disease Management in High Tunnels

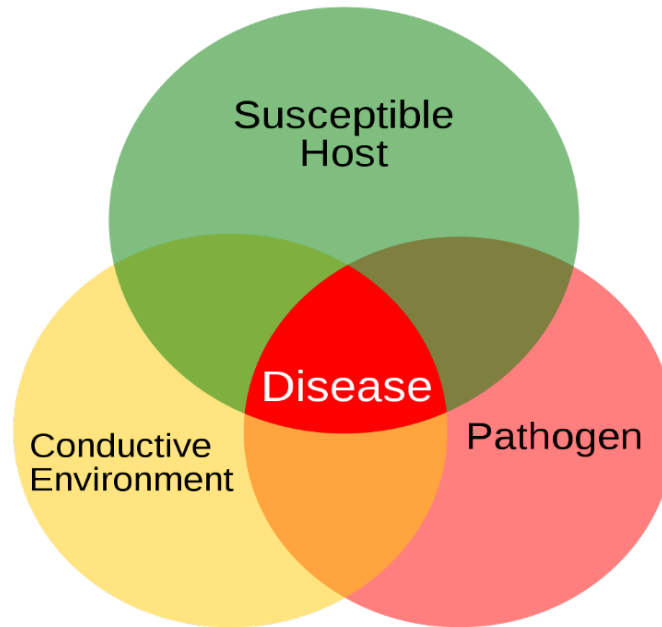


Delaware Ag Week-January 10th, 2023

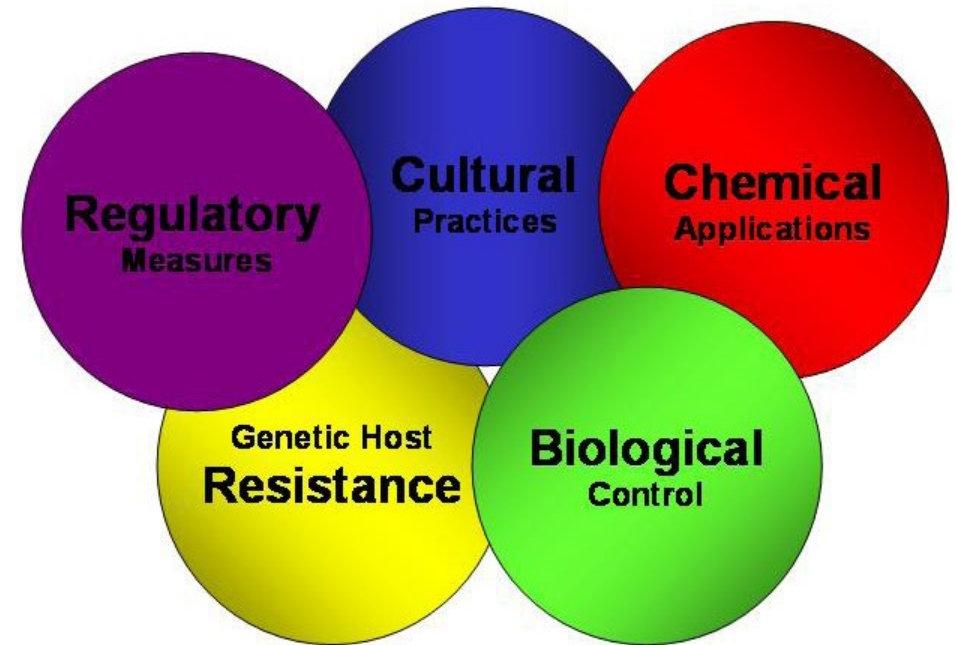
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Principles of Disease Management

Disease control principles; **exclusion, eradication, protection and resistance**



Disease Triangle



Integrated Plant Health Management

High Tunnels (Use is on the rise and continues)



High Tunnels at DSU-SORC



Hobby Farms by Jesse Frost

The HT environment

- **Physical exclusion** from some airborne pathogens
- Most fungal and bacterial pathogens require the **presence of moisture** over a certain period of time to infect a plant
- Lower incidences of **Bacterial spot, Septoria leaf spot, and Early blight** because plants are protected from heavy rainfall events

YES HIGH TUNNELS ARE GREAT.....**BUT.....there are diseases common to high tunnels**

- **Leaf mold, Botrytis gray mold and Powdery mildew** –all require **high humidity** for development

Factors to consider when planning construction of high tunnel structures and managing plant diseases.

- Proper Placement of Structure
- Optimum Growing Conditions
- Disease-Resistant Varieties
- Disease-Free Seed and Transplants
- Crop Rotation
- Sanitation
- Environmental Management
- Scouting for Disease
- Fungicides

Proper Placement of Structure

- Ensure adequate sunlight and wind movement
- Single-bay Hts should be positioned perpendicular to prevailing winds
- Structures with roll-up sides and multibay Hts should be situated parallel to prevailing winds
- Proper placement to ensure adequate drainage

Wind direction and ventilation are the overriding factor



Increased air movement reduces humidity and minimizes conditions favorable to disease development.

Optimum Growing Conditions

- Avoid excessive fertilizer (lush growth-reduces air movement and increases humidity and moisture retention within the plant canopy).
- **Fertilize** according to **soil test recommendations**.
- Provide **consistent soil moisture**, for vigorous plant growth



Avoid conditions that favor development of plant diseases.

Plant Disease-Resistant Varieties

- Disease-resistant varieties that are adapted to your climate should always be considered
- Source of information on resistant varieties for your area can be found at

https://www.udel.edu/content/dam/udelImages/canr/pdfs/extension/sustainable-agriculture/2022-2023_Vegetable_Production_Recommendations_10_Jan_22.pdf

Commercial Vegetable Production Recommendations

This copy of the **2022/2023 Mid-Atlantic Commercial Vegetable Production Recommendations** replaces all previous editions of the Commercial Vegetable Production Recommendations published



University of Delaware Booth
Ag week 2023

Disease-Free Seed and Transplants



Tomato plant infected by bacterial spot

Seed can carry bacterial, fungal, and viral pathogens, so always start with **disease-free seed**

Alternately, **treat seed** prior to planting to reduce the risk of introducing pathogens

Crop Rotation

- Avoid buildup of soil-borne pathogens, practicing **crop rotation**.
- Consider dividing the tunnel into distinct areas to keep plants of the **same family together** in one area.
- For maximum impact, rotations should be maintained for **at least three years**, (time for most soil-borne diseases to decline below damaging levels).



Practicing crop rotation in high tunnels

Recommended Resource: Kentucky Vegetable Crops Extension and Research-March 30, 2022

Grafting onto resistant rootstocks

- **Grafting onto resistant rootstock**, commonly used for solanaceous and cucurbitaceous crops, is an effective practice



Recent studies worldwide have shown the potential for grafting using resistant rootstocks as a sustainable and ecofriendly practice for *R. solanacearum* management.

Grafting onto resistant rootstocks

- Grafting is becoming common in tomato, eggplant, melon, watermelon, and cucumber.
- Rootstocks resistant to **root-knot nematodes** and diseases including **Fusarium wilt, Fusarium crown and Root rot, Verticillium wilt, bacterial wilt, Southern blight, and Sudden wilt** are available commercially.
- Field trials involving **Grafting has shown promise and is** considered an alternative to shrinking access to soil fumigants and cultivars reshaping resistance.
- The main challenge remains the **high cost of grafting**.

Interested in grafting vegetables?

- Visit-<https://u.osu.edu/vegprolab/grafting-guide/> and request a copy of a free grafting guide (Ohio State University)
- Selecting optimal combinations of root stock and scion
- **Register** at the DSU booth to be invited to a vegetable grafting workshop



Delaware State University Booth
Ag week 2023

Sanitation

- At the end of the growing period, all **plant material should be removed**. Diseased plant tissue should be destroyed by composting, burying, or burning.
- **Remove weeds** as they may harbor insect pests and pathogens and reduce air movement.
- Pruning tools, and knives should be **cleaned and disinfected** on a regular basis.
- Workers should practice **careful handling techniques** and avoiding handling plants when free moisture is present.



End of season cleaning

Environmental Management

- **Proper management of temperature and humidity** must be a priority. High RH (above 90 percent) is favorable for foliar fungal diseases, such as **leaf mold of tomato and Botrytis gray mold**.
- Provide **wider plant spacing** by reducing plant populations, encourage good air flow by providing **high tunnel ventilation**, and avoiding **excessive shading**.
- **Wet soils** promote soil-borne pathogens. Avoid overhead irrigation and provide adequate drainage.



Scouting for Disease

- Proper diagnosis of a disease or disorder is vital in the determination
- weekly scouting is recommended
- Foliar diseases usually start in the lower canopy where air flow is limited and then spread upward. Root and crown diseases often begin in areas of the structure where drainage is poor.
- For proper diagnosis, contact your **regional Extension agent** or submit a sample to your **local Plant Diagnostic Lab**.



Some high tunnel scouting measures

Fungicides

- Fungicides tend toward specificity for a particular pathogen.
- Preventive spray programs require a regular schedule when conditions favor disease
- Read and understand the safety precautions and application restrictions.
- Adequate spray coverage is essential for disease control, and lack of good coverage often leads to disease outbreaks.
- Options to control soilborne pathogens include the use of soil fumigants, soil solarization, and root grafting. In severe cases, relocation of the high tunnel may be the only option

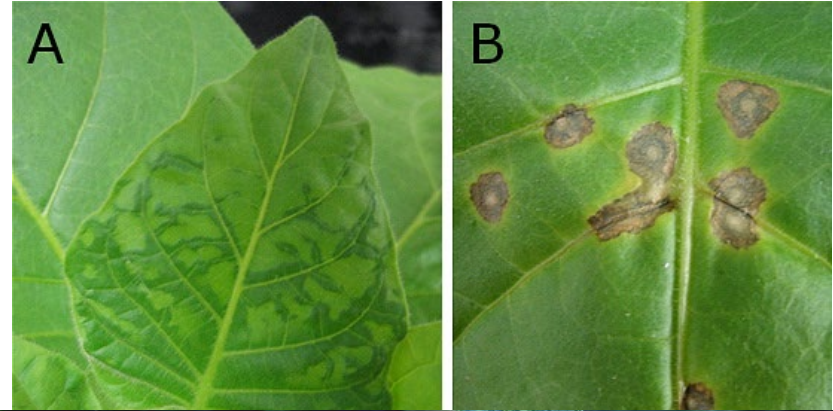
Common Diseases and Management Practices for High Tunnel Production

Common HT Diseases

- Tomato Mosaic virus (**TMV**)
- Tomato Spotted Wilt Virus (**TSWV**)
- **Leaf mold**
- Bacterial canker
- *Verticillium* wilt
- **Gray mold**
- White mold
- **Powdery mildew,**
- *Alternaria* leaf spot, and root rot complexes

Tobacco Mosaic Virus (TMV)

- TMV is readily spread by human activities
- Infected leaves, root debris, and seeds are common sources of TMV.
- **Symptoms** appear as light and dark green mottled areas on leaves. Leaves on infected plants are often small, curled, and puckered.
- Plants infected early in their development are stunted and have a yellowish cast.
- TMV can reduce the size and number of fruit produced.



Symptoms of Tobacco Mosaic virus

Tobacco Mosaic Virus (TMV)

- **Control practices**

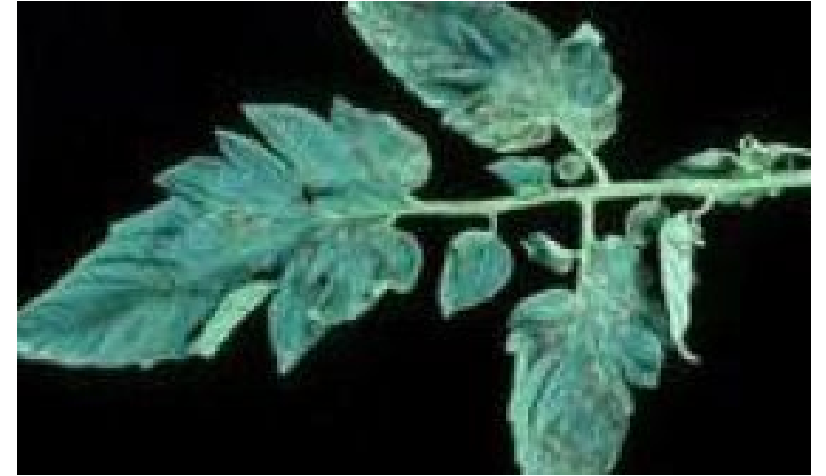
- Eradicate weeds
- **Use TMV-resistant varieties when feasible**
- Make sure that transplants are healthy and certified as disease free
- Discourage use of tobacco by workers, and encourage the practice of washing hands with soap and water before and after handling plants
- Destroy infected plants found at transplanting and during the season



Symptoms of Tobacco Mosaic virus

Tomato Spotted Wilt Virus (TSWV)

- TSWV is a disease of tomatoes that is spread primarily by thrips
- Plants become stunted and often die. Initially, leaves in the terminal portion of the plant stop growing, become distorted, and turn pale green. In young leaves, veins thicken and turn purple, causing the leaves to appear **bronze**
- Infected fruit may exhibit **ring spots** and blotches and may become distorted if infected when immature
- **Control**
 - Plant resistant tomato varieties
 - Control weeds to reduce the thrips population and virus inoculum prior to planting.



Bronzing of leaf



ring spots and blotches

Viral Diseases of Cucurbits

- Viral diseases are a major problem of cucurbits. Zucchini yellow mosaic virus (ZYMV), cucumber mosaic virus (CMV), papaya ring spot virus (PRSV), and watermelon mosaic virus (WMV) are aphid-transmitted viruses.
- Management of the insect vector is extremely difficult.
- Symptoms vary depending on the host and plant age at the time of infection but may include stunting, leaf malformation, and yellowing or light green mottling of the foliage.
- Plants infected when young produce few marketable fruit.
- **Control**
 - use of virus-resistant varieties.



leaf malformation, yellowing, or light green mottling of the foliage.

Powdery Mildew

- The powdery mildew pathogens have a broad host range
- Inoculum sources require high relative humidity (75-85%) and can cause disease at any temperature ranging from 50 to 98°F with 70°F being optimal for spore germination.
- Infection can occur with little or no free moisture under high humidity. Spores are readily windborne.



Powdery mildew on tomato.

Powdery Mildew

- The fungal disease first appears as pale, yellow spots on stems, petioles, and leaves. These spots expand, merge, and become covered with a superficial, powdery, white fungal growth. Severely infected leaves gradually turn yellow, wither, and die.
- Powdery mildew can overwinter on weeds around high tunnels, and air currents can carry spores of the fungus long distances into an area.
- The disease is favored by dry plant surfaces, high humidity, moderate-to-high temperatures, low-light intensity, and excessive plant growth.
- **Control**
 - Use of resistant varieties and timely fungicide applications.
 - Weed control and good sanitation practices may help limit powdery mildew.



superficial, powdery, white fungal growth

Leaf Mold



Leaf mold on tomato.

- The disease is most destructive very **high humidity** (above 85 percent). Fungus develops rapidly on foliage, starting on the lower leaves progressing upward.
- **Symptoms** first appear as small, pale green or yellowish spots on the upper leaf surface. The fungus appears on the corresponding lower leaf surface as an **olive green to grayish purple velvety growth** composed mostly of spores of the pathogen. Infected leaves become yellowish brown, curl, and drop prematurely.
- Fruit infections appear as a **black, leathery**, stem-end rot, which can develop on both green and ripe tomato fruit.



olive green to grayish purple
velvety growth



Fruit infections appear
black

Leaf Mold

- The fungus survives between seasons on plant debris, seed, and soil.
- Spores survive in greenhouses for one year in the absence of a host.
- Large numbers of spores are produced on the undersurface of infected leaves. These easily spread from plant to plant by air currents and splashing water and on tools and clothing of workers.
- **To control** leaf mold
 - Keep the relative humidity in a structure **below 85 percent**
 - Keep free moisture from persisting on leaves.
 - Provide **good ventilation** and as much light as possible
 - Keep leaves dry when watering
 - Provide **adequate spacing** to avoid excessive shading



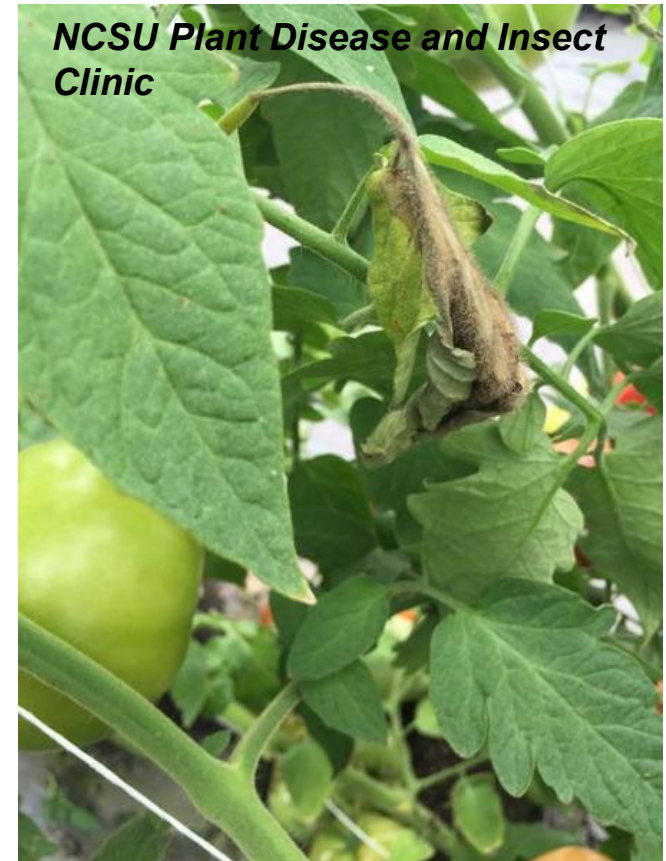
Underside of a tomato leaf with leaf mold spots

Gray Mold

- Gray Mold can occur on all aboveground plant tissue.
- Sign of gray mold is the **profuse fuzzy, gray-brown growth of conidiophores** (spore-bearing structures) from necrotic plant tissue.
- Lesions on leaflets **expand** to cover the whole leaflet, to the petiole, and finally the stem. **Stem lesions** may girdle the stem and cause wilting above the lesion. These cause of **plant death**.
- On fruit-typical **soft rot symptoms** and decayed areas whitish in color are seen. **Ghost spots** characterized as necrotic flecks surrounded by whitish halos form.



Gray mold fruit lesions with conidiophores on tomato



Gray mold on high tunnel tomatoes.

Gray Mold

- There are several sources of inoculum for gray mold. *B. cinerea* has a wide host range.
- Spores are easily windborne. Sporulation occurs under wet conditions with **high humidity (>80%)** and **moderate temperatures (65 to 75°F)**.
- Gray mold begins in relatively **cool weather** and does not require prolonged periods of high humidity.
- **Innoculum** can survive as a **saprophyte** on organic matter in the soil. The fungus can also survive from season to season as **sclerotia**, which form on woody tissues of tomato plants.
- **Control**
 - good pruning techniques



Summary-General Disease Management

- **Wider plant spacing and improved ventilation-**
 - **Raise the sides of high tunnels** to improve air movement.
 - **Use fans** to replace the air multiple times per day especially during rainy or cloudy periods
- **Remove lower leaves** as the plant ages to improve air movement. Suckering below the first flower cluster on tomato plants will promote air circulation
- **Manage temperatures** to reduce condensation.
- Trays, benches, tools, stakes, twine, wire, high tunnel structures, and any other tools should be **washed and sanitized** between crops.
- **Workers should wash hands often**—at least at the end of each row—to minimize spread of pathogens.
- **Eliminate weeds from the high tunnel.** Weeds can harbor diseases that can affect vegetables.

Summary-General Disease Management

- **Scout** for disease routinely.
- **Remove infected seedlings and diseased tissue.**
- **Remove and destroy crop residue.**
- **Place cull piles away** from the high tunnel.
- **Avoid overhead irrigation.** Use drip tape or water at the base to reduce moisture on leaves and splash dispersal of pathogens.
- **Avoid damaging plants**, especially for the prevention of Botrytis gray mold.
- **Avoid handling wet plants.**
- **Practice Crop Rotation**
- **Use resistant varieties when possible**

Resources

- <http://www.uvm.edu/vtvegandberry/videos/hightunnelvideo.html> *Disease Management in High Tunnels* by Janna L. Beckerman, University of Minnesota <https://hortintl.cals.ncsu.edu/articles/disease-management-high-tunnels>
- Cornell University Department of Horticulture High Tunnels Site <http://blogs.cornell.edu/hightunnels/>
- Visit-<https://u.osu.edu/vegprolab/grafting-guide/> and request a copy of a free grafting guide

To learn more about High Tunnels

- Learn from fellow farmers-Subscribe to high tunnel farmer groups
- Visit the NRCS booth (EQIP)
- Register at the DSU and UD booths for related programs



Much thanks to;

- The Delaware State University- Small farms crew
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Thanks!
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