

General Tips on Identifying Plant Diseases

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1. Look for symptoms on rest of plant. Don't just focus on first symptom seen.
 - a. Examine leaves (young and old; both surfaces), stems, flowers, fruit, and growing points.
 - b. If affected plants are stunted or wilted, look at roots and cut open stems (including below ground portion) to see if there is discoloration anywhere. Location (xylem vs phloem) and extent of discoloration (just at crown vs extending up stem) can be important for diagnosis. Is plant completely wilted or just one side of plant or leaves?
2. Look at distribution of symptoms on plant.
 - a. Are leaf symptoms mostly on old leaves, young leaves, or evenly distributed?
 - b. Do symptoms appear to be progressive, or do they indicate one-time injury?
3. Look at distribution of affected plants when multiple plants of the same type in a planting.
 - a. Are symptoms throughout the planting? Or are affected plants in groups? Are these in a low area?
 - b. Are other plants (e.g. weeds) also affected? Abiotic factors, such as lightning, soil pH extremes, and nutrient deficiency/toxicity, often affect multiple plant species.
4. Look for signs of a fungal pathogen. A hand lens will be helpful.
 - a. Are spores present? Sclerotia? Fruiting bodies?

Early morning is the best time to look for spores as some pathogens (e.g. downy mildews) produce them overnight, then they are dispersed by wind during the day.

Signs of the pathogen may appear when affected tissue is incubated in a plastic bag with damp paper towel for 12 to 24 hours.
5. Make detailed notes about symptoms and environment. Take digital photographs if possible.
 - a. Are plants in full sun or partial shade?
 - b. Is soil very wet or very dry?

Put plant samples for diagnosis in plastic bag and promptly deliver to diagnostic laboratory, don't expose to excessive heat (e.g. closed vehicle) or cold (e.g. refrigerator) before they are examined more closely. Keep soil off of leaves if the whole plant is submitted (bag the roots).

Photographs and information about diseases of vegetables, herbs, and strawberries observed on Long Island posted at: <http://blogs.cornell.edu/livepath/gallery/>

Disease occurrences monitored on Long Island: basil downy mildew, cucurbit downy mildew, and late blight of tomato and potato. Please report to M T McGrath (mtm3@cornell.edu).

Downy mildew of basil. <http://livepath.cals.cornell.edu/gallery/basil/downy-mildew/>

Downy mildew of cucumber, squash and other cucurbits. <http://cdm.ipmpipe.org/>

Late blight of tomato and potato. <http://www.usablight.org/>

Basics on Plant Pathology and Managing Diseases

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I. Impact of Disease: Reduced yield, reduced market quality, toxins, increased labor

II. Causes of Disease

A. Biotic (living or infectious; pathogens)

1. Fungi (composed of thread-like hyphae; reproduce by spores. Diseases include powdery mildew, Septoria leaf spot, early blight, Verticillium wilt, clubroot)
2. Oomycetes (similar to fungi; more closely related to brown algae. Diseases include downy mildew, late blight)
3. Bacteria (one-celled organism. Diseases include bacterial wilt, soft rot)
4. Nematodes (non-segmented round worms. ex. root knot nematode)
5. Viruses (replicating molecules composed of protein and RNA or DNA ex. tomato spotted wilt virus)
6. Parasitic higher plants (ex. mistletoe, dodder)
7. Other (Viroids, phytoplasmas, etc.)

B. Abiotic (nonliving or noninfectious; physiological)

1. Air pollutants (ex. ozone)
2. Nutrient extremes + imbalances (ex. blossom end rot = Calcium deficiency)
3. Pesticide phytotoxicity
4. Temperature extremes (ex. catfacing in tomatoes = cool temperatures)
5. Moisture extremes
6. Soil pH extremes
7. Light extremes (ex. sunscald)
8. Lightning
9. Plant toxins (ex. walnut wilt)

III. History

1. Late Blight of Potato and the Irish Famine and the Germ Theory of Disease (1840s).
2. Coffee Rust and Downy Mildew of Grape - why the English drink tea and whiskey.
3. Chestnut Blight eradicated the American chestnut as a forest tree.
4. Dutch Elm Disease has virtually annihilated the American elm.

IV. Symptoms and Diagnosis

1. Stunting, general unhealthy appearance
2. Damping off of seedlings
3. Root and crown rots
4. Wilts
5. Leaf diseases (Spots, blights, mosaics, blisters, enations, etc.)
6. Rusts
7. Mildews
8. Smuts
9. Twig and stem diebacks
10. Stem cankers
11. Galls and tumors
12. Field and storage fruit rots
13. Wood rots and decays
14. Parasitic plants

V. Requirements for Disease (first 3 form the 'Disease Triangle')

1. Pathogen (disease-causing organism)
2. Susceptible plant
3. Favorable environmental conditions
4. Time for disease to develop

VI. Management of Diseases

Focus on Prevention. Integrated approach. No cures.

Need information on biology of disease cycle

VII. Gardener's Roles in Community Disease Management (e.g. late blight)

1. Detect.
 2. Report.
 3. Educate.
- Expect and respond to unexpected diseases and occurrence.

VI. Components of Disease Cycle to Target in Managing (these vary among diseases)

A. Sources of Disease-causing Organisms

1. Infested debris
2. Infested seed
3. Live in soil in absence of host
4. Alternate hosts (weeds, other crops). Host range varies from very narrow to huge!
5. Plants in another location
6. Survival structures (ex. fungal sclerotia, nematode cysts)
7. Insect vectors

B. Mechanisms for Dispersal

1. Wind
2. Rain and irrigation
3. Soil
4. Seed
5. Insects and other vectors
6. Humans (handling, machinery)

VII. Management Practices (these vary among diseases)

A. Control the Source of Pathogens

1. Select certified seed and transplants (less likely to harbor pathogens).
2. Use treated seed: hot water*, chlorine or fungicide. (*correct temp and time critical)
3. Rotate land to a nonsusceptible crop for at least one year (longer for some diseases).
4. Control weeds.
5. Control insect vectors.
6. Plant when pathogen does not normally occur.
7. Exclude exotic pathogens.
8. Destroy infected plants when disease is detected early, few plants are affected, and the pathogen likely has not had opportunity for extensive spread.
9. Amending soil with compost might increase activity of beneficial microorganisms.

B. Minimize the Opportunity for Dispersal

1. Cover soil with mulch.
2. Do not handle plants when they are wet.
3. Disinfect pruning and cutting tools frequently.
4. Physically separate plantings of similar crops.

C. Reduce Plant Susceptibility

1. Select disease resistant varieties.
2. Maintain plant vigor through proper nutrition, watering, weed control, etc. But avoid luxuriant growth.
3. Plant when temperatures are favorable for germination and growth of the plant.

D. Make the Environment Less Favorable for Disease Development

1. Locate plants where there is good air movement, avoid shady areas, and plant rows parallel to the prevailing wind direction.
2. Use raised beds.
3. Plant when conditions are not favorable for disease.
4. Grow a diversity of crops.
5. Stake or trellis plants when possible.
6. Avoid a dense plant population.
7. Control weeds.
8. Provide adequate soil moisture - do not over or under water.
9. Use trickle irrigation or use sprinkle irrigation in morning before good drying period.

E. Examine Plants Weekly. Identify Cause of Any Problems.

F. Suppress Disease Development

1. Fungicides and Bactericides. Most effective when used preventively or at the first sign of disease. Note that documented efficacy for disease on plants is not a basis for registration; decision based on potential environmental impact. Read safety precautions before purchasing.

G. Maintain Records of Disease Occurrence, Management and Severity.

Diseases That Can Occur In The Home Vegetable Garden

Air Pollution (ozone) - (Most susceptible = beans, cucurbits, potatoes, tomatoes)
Symptoms: Leaves - white or brown spots, bronzing, bleaching.

Virus Diseases

Symptoms: Leaves - mosaic pattern, ringspots, malformed. Fruit - ringspots, color-breaking.

Management: Destroy affected plants.

Root Rot (various fungi)

Root Knot and Root Lesion (nematodes)

Dodder (parasitic higher plant)

Basil

Downy Mildew (fungus)

Symptoms: Yellow to brown spots on leaves, usually angular, dark-grayish, fuzzy fungal growth lower surface, affected tissue killed quickly.

Source: Wind-blown spores, infected transplants, contaminated seed.

Management: Control humidity (grow in sunny spot with good air movement), harvest early. Check monitoring web site:

<http://vegetablemndonline.ppath.cornell.edu/NewsArticles/BasilDowny.html>

Beans

Anthracnose (fungus)

Symptoms: Pods - black, sunken spots with salmon-ooze when moist.

Source: Crop debris, seed, spores spread by wind or rain.

Management: Rotate, treat seed, mulch, fungicides, destroy plant debris.

Bacterial Blights (bacteria)

Symptoms: Leaves - brown spots often with yellow halo.

Pods - water-soaked spots, become brown, sometimes sticky.

Source: Crop debris, seed, bacteria spread by rain.

Management: Rotate, copper fungicides, avoid dispersing bacteria with water or by handling plants, destroy plant debris.

White Mold (fungus)

Symptoms: Pods + stems – water-soaked spots; white cottony growth with black ‘peas’.

Source: sclerotia (black ‘peas’), spores spread by wind or rain.

Management: Long rotation, minimize leaf wetness, fungicides, destroy plant debris.

Corn

Smut (fungus)

Symptoms: Fleshy galls on ears, leaves, stems and tassels.

Source: Soil, wind-blown spores; injury promotes.

Management: Remove galls before they open, rotate.

Crucifers (broccoli, cabbage, cauliflower)

Black Rot (bacterium)

Symptoms: Yellow, wedge-shaped spots at leaf margins.

Source: Seed, crop debris. Spread: Splashing water

Management: Hot-water-treated seed, resistant varieties, water at base of plant, work when plants are dry.

Soft Rot (bacterium)

Symptoms: Brown rotting tissue often with foul odor.

Source: Soil.

Management: Avoid injury, water at base of plant, cut broccoli at angle.

Cucurbits (cucumber, melons, squash, pumpkin)

Bacterial Wilt (bacterium)

Symptoms: Wilt-starts with leaf spots; then leaves, vines, plant.

Source: Cucumber beetles.

Management: Control beetles.

Downy Mildew (fungus)

Symptoms: Yellow to brown spots on leaves, often angular, dark-grayish, fuzzy fungal growth lower surface, affected tissue killed quickly.

Source: Wind-blown spores, infected transplants.

Management: Resistant cucumber varieties (little control for new strain), fungicides, cover plants?. Monitor forecasting web site: <http://cdm.ipmpipe.org>

Powdery Mildew (fungus)

Symptoms: White, powdery spots on leaves, petioles and stems.

Source: Wind-blown spores.

Management: Resistant varieties, fungicides, control weeds.

Phytophthora Blight (fungal-like pathogen)

Symptoms: Seedling death (uncommon). Large, brown leaf spots. Plant collapse. Soft decay at crown or on vine. Death of growing tip (summer squash). White yeasty growth on rotting fruit.

Pythium Fruit Rot (fungus)

Symptoms: White cottony growth on rotting fruit.

Source: Soil, infested surface water, spores moved in storms.

Management: Manage soil moisture.

Choanephora Fruit Rot (fungus)

Symptoms: gray cottony growth; looks like black-capped pins.

Lettuce

Downy Mildew (fungus)

Symptoms: Yellow to brown spots on leaves, often angular, dark-grayish, fuzzy fungal growth lower surface; lower leaves often first affected.

Source: Wind-blown spores, infected transplants.

Management: Resistant varieties (effective for specific strains), fungicides, minimize humidity, avoid growing when cool and damp.

Soft Rot (see crucifer section)

Peppers

Bacterial Leaf Spot (bacterium)

Symptoms: Small brown spots on leaves and fruit; leaves fall off.

Source: Seed, crop debris. Spread: Splashing water

Management: Hot-water-treated seed, resistant varieties, water at base of plant (keep leaves dry), work when plants are dry, copper fungicides.

Blossom End Rot (abiotic)

Symptoms: Brown to black area at blossom end, depressed, leathery.

Cause: Calcium deficiency due to moisture fluctuations or excess nitrogen.

Management: Adequate moisture and nutrients; avoid root pruning.

Phytophthora Blight (see cucurbit section)

Sunscald (abiotic)

Symptoms: White area on fruit part facing sun; soft, wrinkled, then papery.

Cause: Fruit exposed to intense sunlight due to insufficient leaves.

Management: Control leaf diseases.

Soft Rot of Fruit (bacterium)

Management: Avoid injury. Control insects.

Tomatoes

Anthracnose (fungus; not the fungus causing anthracnose of bean)

Symptoms: Round, sunken spots on ripe fruit; turns black from center out.

Entire fruit often rots.

Source: Crop debris, soil, seed, weeds (nightshade, velvetleaf).

Management: Rotate, treat seed, mulch, control weeds, fungicides, destroy plant debris.

Blossom End Rot (see pepper section)

Catface (abiotic)

Symptoms: Malformation and scarring of fruit, usually blossom end.

Cause: Cool temperatures early in fruit development.

Management: Protect young plants from cool temperatures.

Late Blight (fungal-like pathogen) (occurs infrequently but devastating)

Symptoms: Leaves - large, irregular, green to gray spots that turn brown; white mold on undersurface. Fruit - firm, large, irregular, brown/green spots with greasy, rough look; sharply defined margin.

Source: Infected potato tubers and transplants, wind-blown spores.

Management: Inspect tomatoes, potatoes routinely, fungicides, destroy affected plants.

Buckeye Rot (fungus)

Symptoms: Fruit - gray/green or brown large spot; becomes dark, firm leathery rot; concentric rings; smooth, undefined margin.

Source: Soil

Management: Rotate, mulch, stake plants, manage water, fungicides.

Early Blight (fungus)

Symptoms: Leaves - small, circular, dark brown spots with concentric rings and yellow border. Fruit - dark, leathery, sunken spots.

Source: Seed, debris, infected transplants, weeds, wind-blown spores.

Management: Rotate, treat seed, mulch, control weeds, fungicides, destroy plant debris.

Septoria Leaf Spot (fungus)

Symptoms: Leaves - small, circular spots; gray with dark border; tiny black specks on gray part.

Source: Seed, debris, infected transplants, weeds.

Management: Rotate, treat seed, mulch, control weeds, fungicides, avoid dispersing spores with water or by handling plants, destroy plant debris.

Bacterial Speck, Bacterial Spot and Bacterial Canker (bacteria)

Symptoms: Speck & Spot: Leaves - small, dark circular spots. Fruit - small, black spots. Canker: Wilt. Leaves - margins brown and yellow. Fruit - corky spots. Stems - spots.

Source: Seed, debris, infected transplants.

Management: Treat seed, copper fungicides, avoid dispersing bacteria with water or by handling plants, destroy plant debris.

Wilts (fungi: *Fusarium*, *Verticillium*; bacteria)

Symptoms: Leaves - turn yellow, die, old ones first. Stems - brown inside.

Source: Infected transplants, soil, planting materials.

Management: Destroy affected plants.

Resources:

Tomato MD App. <https://www.plantmanagementnetwork.org/pub/php/news/2014/PlantHealthApp/>

My LIHREC Vegetable Pathology Program page: <http://blogs.cornell.edu/livegpath/gallery/>

Photo gallery: Vegetable diseases observed on Long Island including information about them.

Section for gardeners. Section on Managing vegetable diseases organically

Identifying Diseases of Vegetables. by A. A. MacNab, A. F. Sherf and J. K. Springer. 1983.

Pennsylvania State University. \$13 (2019). <https://extension.psu.edu/identifying-diseases-of-vegetables>