Disease Management Strategies

Reviewed by Dan Egel – September 2021

Plant diseases are caused by a wide variety of microbial pathogens (including fungi, bacteria, viruses, and nematodes). For a plant disease to occur, three components must be present:

1. The pathogen
2. A susceptible host (the plant)
3. An environment conducive to disease.

In addition, insects spread some diseases, which makes them a fourth component of the disease cycle. Disease management strategies target one or more of those these factors to prevent and/or reduce the risk of disease. The sections below provide a broad overview of general management strategies. The crop-by-crop chapters go into much more detail for each disease.

Disease Diagnosis

Before making any management decisions, always make sure to correctly diagnose your problem first. Accurate diagnoses can save time and money because some diseases look alike but have very different management strategies.

Different pathogens have different modes of both survival and spread. Therefore, certain management practices will work for some diseases but may have no effect on others. Furthermore, disease control materials are usually effective against only a subgroup of specific diseases. For example, fungicides will have no effect on viruses.

Moreover, even among the various fungi, some materials may be effective against certain diseases but not others. In particular, the pathogens Pythium, Phytophthora, and the causal agents of downy mildews that we often discuss as fungi are not true fungi, they are in a different group of organisms called oomycetes. Many materials effective against true fungi are not effective for those organisms, and vice versa.

For example, numerous materials used to manage downy mildew will have no effect or a negligible effect on powdery mildew, and vice versa. A root disease may require very different management compared to a leaf spot or fruit disease.

Moreover, there are several plant health issues that mimic plant diseases (including environmental stress, nutritional problems, herbicide injuries, air pollution, and others). These are known as abiotic disorders.

Unwittingly treating a nutrient deficiency with pesticides wastes time and money, and does not solve the underlying condition. Submitting samples to a diagnostic laboratory is the best way to ensure the correct diagnosis. For a list of labs and instructions on how to submit plants, see the State Contact Information table.

Healthy Plant Material

Contaminated seed or transplants can introduce diseases, so saving vegetable seeds for next year's crop is not recommended unless you are trained and equipped to handle seed sanitation. You should not save seeds when a seedborne disease has been active. The Summary of Cultural Management Strategies for Disease table lists some diseases that may be transmitted by seed to transplants.

Whether you purchase transplants or produce them yourself, you should read Transplant Production to better understand transplant health. Be certain to inspect seedlings regularly. Examine the foliage and remove a few plants from the pots to inspect the roots. If you purchase transplants, keep newly-arrived materials away from other plants and the production area for a few days to prevent spread if a problem is found.

Talk to your supplier and ask questions about how the reduce disease risk. If a you suspect a disease on received plants, take photos and contact a diagnostic laboratory, and continue to keep the plants separate. Keep good records of where plants are sourced from so that you can contact the supplier if a problem arises.

Disease-Resistant Varieties

Whenever possible, use varieties resistant to diseases. Some varieties may not be completely resistant to particular diseases; however, incomplete or partial resistance may be available. Some seed catalogs may refer to tolerance. The Summary of Cultural Management Strategies for Disease table presents information about the availability of resistant varieties.

For certain vegetables (such as tomatoes) there are rootstocks available with resistance to some soilborne pathogens. A resistant rootstock may be an option if you have a history of a known soilborne disease but wish to grow a tomato scion variety that is susceptible.

Tillage and Crop Rotation

If a disease pathogen survives from year-to-year in crop residue or soil, then crop rotation and fall tillage are very effective factors in disease management. The pathogens are unable to survive once the crop residue decomposes.

Tillage (especially fall tillage) helps control diseases by reducing the amount of inoculum (pathogen structures) that survives the winter. Rotating fields to different crop families each year also helps control diseases by preventing the build-up of certain plant pathogens in the soil. Summary of Cultural Management Strategies for Disease provides tillage and crop rotation recommendations. A general rule is that you should not rotate a field to a crop in the same botanical family.

Unfortunately, there are several kinds of soilborne diseases that are unaffected by rotation. The first group of these diseases is caused by pathogens that produce resilient survival structures that can withstand the effects of time and nonhost crops. Two such diseases are Fusarium wilt, and root-knot nematode.

Another group of diseases unaffected by crop rotation has a broad host range, so they can survive indefinitely on many host crop and weed species. Examples include Sclerotinia, Rhizoctonia, and Verticillium diseases.

In addition, root-knot nematode can cause disease in multiple vegetable plant families (cucurbits, tomato, carrot, and many more) along with some field crops and even weeds.

The third group of diseases unaffected by rotation overwinter in Gulf Coast states, and then spread north by wind during the growing season. Examples include sweet corn rust and downy mildew of cucurbits.

In addition, certain viruses spread by highly motile insects (such as aphids), so rotation does not reduce these diseases either. Since the pathogen does not overwinter locally in the field, survival in residue is not a factor.

Consider all options before making management decisions. Rotation is a good general practice that improves or maintains good soil tilth. Tillage (especially fall tillage) often is not in accord with recommended soil management and conservation practices. If you practice no-till or reduced tillage, you will need to be even more vigilant with other strategies in order to reduce your risk of disease.

Two publications that may be useful for no-till or reduced tillage growers are Building Soils for Better Crops: Sustainable Soil Management and Managing Cover Crops Profitably, both available from the Sustainable Agriculture Research & Education (SARE) Learning Center, sare.org.

Water and Humidity Management

Many bacterial and fungal pathogens thrive in wet conditions. Certain soilborne pathogens such as *Phytophthora* and *Pythium* species are favored by wet soils with poor drainage. Avoid planting into sites with known drainage problems. Improve drainage, and consider using raised beds.

Many leaf spot and fruit rot diseases are favored by high humidity and wet plant surfaces. Using drip irrigation instead of overhead irrigation will reduce leaf wetness. If you use overhead irrigation, irrigate in the morning so that plant surfaces dry before nighttime. Avoid overhead irrigation in the evening.

Reduce plant density to allow better airflow and sunlight to penetrate, which will decrease leaf wetness and humidity. With certain crops (such as tomato) appropriate staking or trellising will also increase airflow. Reducing weed pressure in and along the sides of the crop can also improve airflow. Align rows to maximize airflow and sun exposure.

In greenhouses and high tunnels, use passive ventilation and/or fans to reduce humidity. See Transplant Production for details about water and humidity management in that setting. Avoid working wet fields.

Scouting and Sanitation

Depending on the disease and the size of your operation, you can and should rouge (remove) infected plants. For example, there are no treatments for viral diseases, so you should remove infected plants to reduce the spread to other plants.

Bacterial canker of tomato is another disease where you should rogue out the infected plants and several neighboring plants. Flag the area and come back to check for further spread. Culls should be removed far from the field.

In greenhouse situations, remove the trash frequently, and always keep lids on trash cans to prevent pathogens (and insects) from building up in discarded plant materials. For some crops (such as tomato) stakes and trellises can harbor certain bacteria from one crop to the next. So always use new stakes, or at minimum disinfest them. Disinfest tools frequently, such as at the end of rows. Avoid working fields under wet conditions.

Other Cultural Practices

Insects (such as thrips, aphids, cucumber beetles, and others) spread numerous diseases, so cultural practices that reduce the insects will reduce the risk of diseases. The comments for the Summary of Cultural Management Strategies for Disease table lists some of these practices. See the Insect Management Strategies section for guidelines about cultural controls to reduce insects that may spread diseases.

Chemical Control and Resistance Management with Fungicides and Bactericides

Disease control products (fungicides, bactericides, and nematicides) are pesticides. Be sure to read the general section about Pesticide Application and Safety for information about safety, equipment, calibration, formulations, storage, and other important topics. For a disease control material to be effective, you must apply an appropriate material at the right time, in the right concentration, and in the right way.

Fungicides can be broadly classified as either contact or systemic. Within those groups, however, there are many active ingredients and multiple modes-of-action. Some fungicides are allowed in organic vegetable production, and some are designated as reduced-risk, including certain biopesticides/biological controls.

Both contact and systemic fungicides are most effective if you apply them before disease develops. Many diseases are very difficult or impossible to control with chemicals once a severe epidemic is underway. Throughout the crop-specific sections of this book there are details about when you should apply fungicides in order to be most effective (and information about when they may be ineffective).

Pathogens usually require a specific temperature and moisture range in order to cause diseases. For some diseases, knowing those specific requirements can help you time fungicide applications to coincide with disease risk. In some cases, the guidelines are informal, and may simply make you more aware that a wet season may require more applications and a dry season may require fewer. In other cases, the pathogen life cycle is understood well enough that you can use a formal disease forecasting system. Here are some resources for tracking weather and predictive models related to diseases:

- enviroweather.msu.edu
- newa.cornell.edu
- melcast.ceris.purdue.edu

Contact fungicides (also called protectant fungicides) provide a “coat” of protection on the plant’s surface when applied properly. These fungicides are designed to kill fungi on-contact on the surface of plants — hence, the name. Most contact fungicides have multiple modes of action, so fungal pathogens are unlikely to develop resistance to all of these different modes of action at the same time. For this reason, alternating contact fungicides is unnecessary. Good coverage is essential to maximize the efficacy of contact materials.

Systemic fungicides (sometimes called eradicant or curative fungicides) don’t merely coat the surface, they also enter the plant. Once inside the plant, some stay relatively localized. Others move across to the opposite leaf surface, some move upward in the plants, and a few move downward into the roots. They can sometimes eradicate or cure a portion of existing infections. Most systemic fungicides have a single mode of action, so the risk of pathogens developing resistance to these products is greater. The fungicides target a very specific function of the pathogen’s cells, and sometimes the fungus develops methods to evade the activity.

Powdery mildews and downy mildews are particularly prone to resistance development, but there are other examples. The crop sections in this guide flag diseases that are at risk for fungicide resistance. Always read and follow label directions that list how to alternate systemic fungicides and/or combine and rotate with contact fungicides to minimize the resistance development.

The Fungicide Table lists several fungicides and their modes of action to help in resistance management. Each fungicide label is marked with a FRAC (Fungicide Resistance Action Committee) code to designate a mode of action group and help growers design a rotation plan. Try to avoid using products with the same FRAC codes repeatedly to conserve their efficacy against diseases.

Bactericides (copper and antibiotic compounds) can help reduce the risk of early-season bacterial disease epidemics, but are most effective when used with other control methods. Copper compounds also are mediocre fungicides and are handled similar to protectant fungicides. Antibiotics serve a similar purpose in certain crops.

Summary of Cultural Management Strategies for Disease

This table describes several diseases listed by crop. This list is not exhaustive, but represents important Midwest diseases. Also listed are the cultural management options available for each disease. The management options are described in more detail in the text. Note that some pathogens have races. The reaction of a particular race of fungus or bacterium will depend on the cultivar or variety grown. Rotation refers to the number of years that the field should be planted to a different crop.

Crop	Disease	Tillage[1]	Seedborne	Rotation[2]	Resistance	Comments
Allium garlic, onion, leek	Alternaria purple blotch, Botrytis leaf blight	3	Yes	3-4	No	Thrips-damaged tissues are more susceptible
	Aster yellows	1	Yes	NE	No	Seed transmission is low, but possible; transmission from garlic bulb/cloves occurs
	Botrytis neck rot	2	No	3	No	Cure bulbs rapidly and properly and avoid injury to neck
	Downy mildew	2	Yes	3	Yes	Resistance in onion only (limited varieties)
	Fusarium basal rot	1	No	4	Yes	
	Smut	1	No	3	No	Transmitted on sets and transplants
	White rot	1	No	NE	No	Do not move Allium spp. into quarantine areas of the U.S. (Columbia Basin)
Asparagus	Cercospora leaf spot and rust	NA	No	NA	Yes	Remove or burn down ferns in the late fall to reduce inoculum
	Fusarium crown and root rot	NA	Yes	NA	Yes	Avoid long harvest periods to maintain vigor
	Phytophthora crown and spear rot	NA	No	NA	No	
Cruciferous vegetables	Alternaria leaf spot	3	Yes	3-4	No	
	Black leg	3	Yes	3-5		Leave 1/4-mile buffer from previously infected fields, delay plant until conditions are dry
	Black rot	3	Yes	2-3	No	
	Club root	NE	No	5-7	Yes	Club root pathogen survives on some grass, clover, weedy, and other plants, which influences rotation or cover crop selection
	Downy mildew	3	Yes	2-3	Yes	Resistance in broccoli only
	Fusarium yellows	2	Yes	>6	Yes	
	Powdery mildew	3	No	3	Yes	Resistance for Brussels sprout and cabbage only, avoid over applying nitrogen and drought
	Rhizoctonia diseases	3	No	NE	No	Can form disease complex with black leg pathogen for stem canker
	Sclerotinia stem rot	2	No	NE	No	Very wide host range; rotation for greater than 3 years into grasses, onions, or corn may reduce severe infestations
	White rust	NE	Yes	3	Yes	Remove crop debris from area after harvest
Cucurbits cantaloupe, cucumber, pumpkin, squash, watermelon	Alternaria leaf blight	3	No	2	No	
	Angular leaf spot	3	Yes	2	Yes	
	Anthracnose	3	Yes	2	No	Race 1 affects mainly cucumber. Race 2 affects mainly watermelon
	Bacterial fruit blotch	3	Yes	2	No	
	Bacterial leaf and fruit spot	3	Yes	3	No	Primarily on pumpkin and winter squash
	Bacterial wilt	1	No	NE	No	Spread by cucumber beetles
	Downy mildew	1	No	NE	Yes	Resistant varieties of cucumber and cantaloupe available
	Fusarium wilt	1	Yes	5-7	Yes	
	Gummy stem blight/black rot	3	Yes	3	No	Also affects pumpkin and watermelon
	Phytophthora blight	2	No	>4	No	Avoid excess water and rotation with solanaceous crops; good drainage is important. Treating seeds with mefenoxam may prevent seedling death.
	Plectosporium blight	3	No	3-4	No	Primarily on pumpkins; manage like black rot
	Powdery mildew	2	No	2	Yes	
	Root-knot nematode	2	No	>6	No	Wide host range will affect rotation choices
	Viruses (several)	1	No	NE	No	Spread by aphids; plant crops before insect pressure becomes severe

Crop	Disease	Tillage[1]	Seedborne	Rotation[2]	Resistance	Comments
Leafy vegetables endive, herbs, lettuce, spinach	Botrytis gray mold	2	No	NE	No	Provide adequate spacing to reduce humidity
	Bottom rot and drop	2	No	NE	No	
	Downy mildew, white rust	NE	Yes	3	Yes	
	Lettuce mosaic virus	2	Yes	1	Yes	There are many hosts that may harbor the virus; manage aphid populations
	Powdery mildew	2	No	2	No	
Legumes cowpea, dry bean, lima bean, pea, snap bean	Anthracnose	3	Yes	3	Yes	Resistance is race-dependent
	Bacterial blights	3	Yes	2	No	
	Rust	1	No	3-4	Yes	
	Soybean cyst nematode	1	No	1-3	No	Rotation interval depends on the cyst count in soil samples
	White mold and gray mold	2	No	NE	No	
Root crops beet, carrot, parsnip, radish, turnip	Aster yellows	2	Yes	NE	No	Seed transmission is low, but possible; destroy perennial weed hosts near high-value crops
	Cercospora leaf spot, Alternaria leaf blight	3	Yes	2	Yes	Resistance availability varies by root crop and pathogen
	Downy mildew, white rust	3	Yes	3	No	Cruciferous weeds and crops are also hosts
	Root-knot nematode	2	No	>6	No	Wide host range affects rotational options
	White mold	2	No	NE	No	Avoid rotation with beans, cucurbits, celery, and cabbage
Sweet corn	Anthracnose	3	No	1-3	Yes	
	Goss' wilt	3	Yes	1	Partial	Control grassy weeds that are hosts
	Leaf blights (southern corn leaf blight, northern corn leaf blight, northern corn leaf spot)	3	No	1	Yes	
	Rust	NE	No	NE	Yes	
	Smut	2	No	NE	Yes	Maintain balanced soil fertility
	Stewart's wilt	1	Yes	NE	Partial	Spreads and survives in flea beetles
Fruiting vegetables eggplant, pepper, tomato	Anthracnose	3	Yes	3-4	No	Stake and mulch
	Bacterial canker	3	Yes	3-4	No	Disease is systemic
	Bacterial speck	3	Yes	2	Yes	Some strains are copper resistant
	Bacterial spot	3	Yes	2-3	Yes[3]	Copper resistance reported — check with your state pathologist
	Early blight	3	Yes	3-4	Partial	Some resistance to stem canker
	Fusarium crown and root rot	2	Yes	>6	Yes	Graft to resistant root stocks; use resistant varieties
	Late blight	1	No	NE	No	Does not overwinter in the Midwest
	Leaf mold	2	Yes	2	Yes	Notably a problem in high tunnels and greenhouses; infected transplants will experience disease outdoors
	Powdery mildew	2	No	2	No	
	Root-knot nematode	2	No	>6	Yes	Wide host range
	Septoria leaf spot	3	No	2-3	No	
	Southern blight	3	No	>6	No	Favored by high temperatures
	Tobacco mosaic virus	1	No	2	Yes	Spread by contact
	Tomato spotted wilt virus	1	No	NE	Yes	Spread by thrips
	Verticillium	2	No	>6	Yes	
	White mold	2	No	5-6	No	Wide host range; rotate with grasses; flood for 23-45 days
All vegetables	Damping-off	1	No	NE	No	Avoid excess moisture, sanitize seedling trays

[1]1=tillage has limited effect, 2=tillage is of limited help, 3=tillage is an important control
[2]Numbers refer to the number of years that the field should be planted to a different crop. NE=not effective.
[3]Pepper only