Disease Management Strategies

Managing diseases effectively involves making the best possible decisions to reduce the risk of serious disease-related losses. The strategies upon which effective management is based are those of disease prevention and slowing the spread of diseases. That is, within a given season or over several seasons, the objective is to prevent disease outbreaks and the development of severe early-season epidemics. Several options for achieving this objective are discussed below.

Disease Diagnosis

Accurate diagnosis of crop disorders is an essential first step in disease management. Knowledge that certain diseases occur regularly in particular fields can be helpful when planning for future crops. The chances for bad decisions regarding the use of fungicides for protection or remedial treatment are greatly reduced with knowledge of diseases and their symptoms. Even the ability to distinguish between infectious (those which can be spread from plant to plant) and non-infectious (nutrient imbalances, herbicide injury, etc.) disorders is valuable in making disease-control decisions because diagnosis in the field often involves eliminating unlikely possibilities first. Growers who have a reasonably good understanding of the types of infectious and non-infectious disorders that can occur have a better chance of making the correct disease-control decisions.

Healthy Plant Material

One of the fundamental prerequisites for a healthy crop is the use of healthy seed or transplants. A crop started with infected or infested plant material will result in low yields with poor quality and often will cost more to produce because of wasted efforts at chemical control. Also, the diseased crop may thoroughly contaminate a field and could remove it from production for an extended period of time. Diseases are occasionally introduced via contaminated seed from seed companies, but the commercial seed companies remain the most reliable source of plant material. Saving vegetable seeds for next year's crop is not recommended. There has been a recent trend throughout the Midwest towards local greenhouse production of transplants (see Transplant Production, page 4). Although local transplant production offers advantages in environmental control over the crop and an escape from chronic southern soil-borne diseases, there may be offsetting disadvantages in the risk of spread of seed-borne disease and other diseases endemic to northern states.

Disease-Resistant Varieties

The use of disease resistant varieties is among the most reliable and least expensive disease-control options. Although resistant varieties may not be as productive as traditional, susceptible varieties, the lower yields may be offset by the fact that disease-related losses will be reduced or eliminated. There are other advantages to using resistant varieties. If varieties that are resistant to a soilborne disease are used, then a long-term decline in the pathogen population can be expected, especially if implemented in combination with reasonably long crop rotations. If varieties resistant to a foliar disease are planted, then considerable savings from reduced fungicide applications can be expected. Unfortunately, resistant varieties do not exist for all diseases on all vegetable crops, so it is important to take advantage of such options when they are available.

Resistance may be complete, where no disease symptoms occur, or incomplete, where disease symptoms occur, but the severity of the disease is much reduced compared to susceptible varieties. Examples of diseases to which complete resistance is expressed include Fusarium wilt of tomato, Fusarium yellows of cabbage, and powdery mildew of muskmelon. Examples of diseases to which incomplete resistance is expressed include black rot of cabbage, Phytophthora blight of pepper, tomato anthracnose, and smut of sweet corn. It is possible for pathogen populations to overcome the complete type of resistance and result in a major disease outbreak. The chance of this occurring is rare, however, and should not prevent growers from using these varieties. Incomplete resistance is most effective when used in combination with other control methods.

Tillage and Crop Rotation

Many plant pathogens overwinter in association with crop residue and are unable to survive once the crop residue is decomposed. Tillage (especially fall tillage) helps control disease by reducing the amount of inoculum that survives the winter. Rotating fields to different crops each year helps control disease by preventing the build-up of certain plant pathogens in the soil. The longer the rotation, the less likely that a severe early season disease outbreak will occur. It is important to rotate to unrelated crops, (e.g., tomatoes to cucurbits, cucurbits to crucifers, crucifers to sweet corn, etc.). Crop rotation used in combination with effective tillage methods and resistant varieties offers a great opportunity to reduce the dependence on fungicides for disease control.

Some soilborne diseases are unaffected by rotation. Such diseases are caused by pathogens that produce resilient survival structures that can withstand the effects of time and non-host crops. Examples include Phytophthora blight, Fusarium wilt, and root knot nematode. Others have such a broad host range that they survive indefinitely because so many crop and weed species serve as hosts. Examples include Sclerotinia, Rhizoctonia, and Verticillium diseases. Also, there are some important pathogens that are not affected by tillage or crop rotation because they overwinter in Gulf Coast states. Examples include sweet corn rust and downy mildew of cucurbits. Decisions regarding tillage and crop rotation should be made with consideration that although rotation is a good general practice to improve or maintain good soil tilth, tillage (especially fall tillage) is often not in accord with recommended soil management and conservation practices.

Other Cultural Practices

Other practices, such as altering time of planting, modifying irrigation methods or scheduling, use of raised beds, and altering plant density can also be used to make conditions less favorable for disease. For example, planting seeds only in warm, well-drained soils can reduce levels of seedling diseases caused by *Pythium* and other soilborne fungi.

Chemical Control: Fungicides, Bacteriacides, Nematicides, Fumigants

The decision to apply chemicals for disease control can save a crop from certain economic loss or can result in a waste of financial resources. The difference in the results of such a decision often depends upon the user's understanding of the nature of the disease in question. Knowing which disease is present is of primary importance; once that is understood, the grower only has to select the appropriate product for treatment and read and follow label directions.

Fungicides can be classified as protectants or eradicants. A protectant fungicide is designed to serve as a chemical barrier to infection by plant pathogenic fungi. Protectant fungicides are not absorbed by the plant and do not "burn out" existing infections. Their purpose is only to prevent successful spore germination and infection. Once an infection has occurred, a lesion will develop and produce more spores, despite the presence of a protectant fungicide. Because the fungicide deposit must come into contact with a germinating spore to be effective, incomplete coverage of the plant surface by the fungicide can result in unexpectedly high levels of disease. Therefore, for a protectant fungicide to be effective, it should be applied repeatedly throughout the season and in such a manner as to achieve acceptable coverage of the crop. Protectant fungicides are often referred to as "broad spectrum" fungicides because they traditionally have been effective against diverse groups of plant pathogenic fungi.

Eradicant fungicides are also called "systemic" fungicides because they are absorbed into the plant, where they are able to eradicate existing infections. Advantages of using eradicant fungicides are that coverage of plant surfaces does not need to be as extensive as with protectant fungicides, and that they do not need to be applied as often. Disease scouting programs can often be used if an eradicant fungicide is available. Unfortunately, eradicant fungicides have been developed for only a few pathogens. Also, if these fungicides are not used properly, they can prompt the development of new strains of some pathogens that are resistant to the fungicide. In order to maintain the effectiveness of eradicant fungicides, they usually are applied as a tank mix with a broad spectrum, protectant type of fungicide. The need for fungicide applications can be affected by several factors, including the following: weather conditions (moisture and temperature), levels of host resistance, stage of crop development, and levels of pathogen inoculum. A more complete understanding of how these factors affect the disease process can allow the grower to use fungicides more efficiently and effectively.

Bacteriacides (copper and antibiotic compounds) can play a role in reducing the risk of early-season bacterial disease epidemics. Copper compounds are also mediocre fungicides and are handled similarly to protectant fungicides. They will be effective only if disease incidence is very low prior to the initial application and if protection is maintained during extended periods of disease-favorable weather. Antibiotics serve a similar purpose in certain crops. Normal summers in Midwestern states include periods of warm, rainy weather that are ideal for the increase and spread of bacterial diseases. Because bacterial diseases spread so rapidly, chemical control alone is not sufficient to protect against severe epidemics. Bacteriacides are most effective when used in conjunction with other control methods.

Nematicides and fumigants are designed to reduce populations of nematodes and soilborne fungi before the crop is planted. Like other disease-control chemicals, they are most effective when used in combination with cultural control options such as extended crop rotations and resistant varieties.

Systemic Acquired Resistance

Plant pathologist have known for several years that under specific circumstances, plants exposed to various chemicals, microorganisms or physical stress are better able to withstand plant diseases. This phenomenon is known as Systemic Acquired Resistance. Today, there are two pesticides that induce Systemic Acquired Resistance in vegetable plants: Actigard and Messenger. Neither of these pesticides affects the fungi, bacteria or viruses that cause plant disease directly. Instead, these pesticides seem to cause an increase in the plant's ability to fight plant diseases.

There is still much to be learned about Actigard and Messenger in particular and about Systemic Acquired Resistance in general. At this point, we can make several generalizations:

- Both chemicals should be used as part of a general overall program to control plant diseases. Such a program should include the cultural and chemical controls listed in this guide. Do not use either Actigard or Messenger as an act along pesticide.

- It takes some time for both Actigard and Messenger to affect any changes in plants. Therefore, application of both chemicals should begin early, before the plants become diseased.

- These pesticides acta by a different mode of action and therefore have a relatively novel set of instructions. As always read and follow the label carefully.

Actigard - Labeled for tomatoes for bacterial spot and bacterial speck, and for spinach for downy mildew and white rust. Some positive results have been obtained with Actigard, particularly with bacterial spot of tomato. Actigard has been associated with yield loss in some situations. Therefore, follow precautions on the label carefully. For example, avoid applying Actigard to plants that are stressed by drought, heat, etc.

Messenger - Labeled for several different vegetable crops including greenhouse use. Instructions for some crops include mention of specific diseases, while for other crops Messenger is said to "boost overall vigor and to aid in the management of disease". Since Messenger is a relatively new pesticide with a new chemistry, little work has been done by University personnel to test its effectiveness. Therefore, Messenger is not listed under individual crops in the *Midwest Vegetable Production Guide for 2003*.

Summary of Cultural Management Strategies for Disease

This table describes several diseases, listed by crop. The list is not exhaustive, but represents diseases of importance in the midwest. 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*	Seedborne	Rotation**	Resistance	Other
Cabbage	Alternaria leaf spot	3	Yes	3-4 Years	No	
	Black Rot	3	Yes	2-3 Years	Yes	
	Yellows	2	Yes	Long	Yes	Fusarium fungus survives in soil
Carrot	Bacterial Blight	3	Yes	2-3 Years	No	
	Alt. Leaf Blight	3	Yes	2 Years	Yes	
Cucumber	Angular Leaf Spot	3	Yes	2 Years	Yes	
	Anthracnose	3	Yes	2 Years	Yes	
	Bacterial Wilt	1	No	-------	No	Spread by cucumber beetles
	Scab	3	Yes	3 Years	Yes	Favored by cool (<70º F), wet weather
Muskmelon	Alt. Leaf Blight	3	No	2 Years	No	
	Anthracnose	3	Yes	2 Years	No	
	Bacterial Wilt	1	No	------	No	Spread by cucumber beetles
	Gummy Stem Blight	3	Yes	2 Years	No	Also affects pumpkin, watermelon
	Powdery Mildew	2	No	2 Years	Yes	
	Root Knot	2	No	Long	No	
Pepper	TMV	1	No	2 Years	Yes	Mechanical transmission
	PVY	1	No	2 Years	Yes	Aphid transmission (reflective mulch)
	TEV	1	No	2 Years	Yes	Aphid transmission (reflective mulch)
	Phytophthora	2	Yes	2-3 Years	Yes Races	
	Bacterial Spot	3	Yes	2 Years	Yes Races	
Potato	Early Blight	3	No	3-4 Years	Partial	More disease on early maturing cultivars
	Late Blight	3	Yes	2-3 Years	Partial	Survives on cull piles and volunteers
Pumpkin	Virus Diseases (several)	1	No	-------	No	Aphids spread virus. All cucurbits affected. May also be mechanically spread. Control with planting date & reflective mulch.
	Black Rot	3	Yes	2 Years	No	Same as GSB on muskmelon, watermelon
	Powdery Mildew	2	No	-----	Yes	Some new cultivars with resistance
	Bacterial Fruit Spot	3	Yes	2 Years	No	Affects pumpkins and squash

*1 = tillage has limited effect; 2 = tillage is of moderate importance; 3 = tillage is an important tool.
**Long = rotations are not generally effective unless longer than 5 or 6 years.

Summary of Cultural Management Strategies for Disease (cont.)

Crop	Disease	Tillage*	Seedborne	Rotation**	Resistance	Other
Snap Bean	Rhizoctonia Root Rot	3	No	----	No	Deep plow residue
Sweet Corn	Stewart's wilt	1	Yes	----	Yes	Spreads & survives in flea beetles
Tomato	Early Blight	3	No	3-4 years	Partial	Some resistance to stem canker
	Septoria	3	No	2-3 years	No	
	Fus. Crown Root	2	No	Long	No	(Fus.=Fusarium)
	Bacterial Spot	3	Yes	2-3 years	No	
	Speck	3	Yes	2 Years	Yes	
	Canker	3	Yes	3-4 years	No	
	Verticillium	2	No	Long	Yes	
	TMV	1	No	2 Years	Yes	Can be spread by contact
	Fusarium Wilt	2	Yes	Long	Yes races	
	Root Knot	2	No	Long	Yes	
	Anthacnose	3	Yes	2-3 years	Partial	Stake & Mulch
Vegetables (all)	Damping-off	1	No	----	No	Warm soils; sanitation
Watermelon	Anthracnose	3	Yes	3 Years	No	
	Gummy Stem Blight	3	Yes	3 Years	No	Also affects muskmelon, pumkin & squash
	Root Knot	2	No	Long	No	
	Fusarium Wilt	2	Yes	Long	Partial	
	Bacterial Fruit Blotch	3	Yes	2 Years	No	Volunteer watermelon and cucurbit weeds can spread disease next season
Broadleaf Vegetables	Sclerotinia	2	No	w/grasses 3-4 years	No	Flood 23-45 days

*1 = tillage is an important control; 2 = tillage is of limited help; 3 = tillage has limited effect.
**Long = rotations are not generally effective unless longer than 5 or 6 years.
Data compiled by Dan Egel.