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Managing Diseases

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Diseases that can affect yield and quality of field crops in Illinois are numerous. For plant diseases to develop, certain components of the disease triangle must be present (**Figure 14.1).** These components are a susceptible host crop, a plant pathogen able to infect the host crop, and an environment that favors disease development.

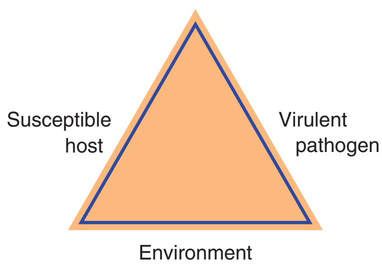

Figure 14.1. The plant disease triangle.

In general, plant diseases of field crops in Illinois are caused by biotic pathogens belonging to one of four groups: bacteria, fungi, nematodes, and viruses. Examples of important diseases that cause losses in Illinois field crops can be taken from each of these pathogen groups. Tactics used to manage these pathogens can vary, so it is essential to know the cause of the problem. (More details on the importance of diagnosis follow).

Principles of Plant Disease Control

Management practices designed to reduce plant diseases affect specific components of the disease triangle. Multiple practices need to be deployed to limit more than a single component, an approach known as integrated disease management. Integrating different management practices often results in better disease reduction and helps reduce selection pressures. Pathogens are affected by selection pressures when certain individual management practices are used (i.e., some host-resistant genes and some fungicides), and this can result in new "races" of the pathogen or fungicide-resistant strains of the pathogen being selected.

The first step in managing a plant disease is to diagnose the problem. Diagnosing a disease from symptoms alone is not always possible, and some pathogens can cause similar symptoms. Misidentification can lead to inappropriate control recommendations (e.g., applying a fungicide to control a bacterial disease), so properly identifying the problem is critical. Magnification with a hand lens or microscope may help in observing spores or fruiting bodies of some plant-pathogen fungi (**Figure 14.2).** When diagnosis is not possible with the tools and resources you have available, collect and send affected plant samples to a plant diagnostics lab. The University of Illinois Plant Clinic (plantclinic.cropsci.illinois.edu) serves Illinois producers during the growing season.

Fungicides

When used appropriately, fungicides can be effective disease management tools. For field crops grown in Illinois, fungicides generally are applied as seed treatments or as foliar sprays. Under some circumstances, fungicides can be applied through irrigation (chemigation) or in-furrow. When applying a fungicide, be sure to follow the directions on the product label.

In general, fungicides are most effective when they are applied just before or at the onset of disease development.

Some content was written by Dean Malvick and Terry Niblack for the previous edition of the Illinois Agronomy Handbook *(2002).*

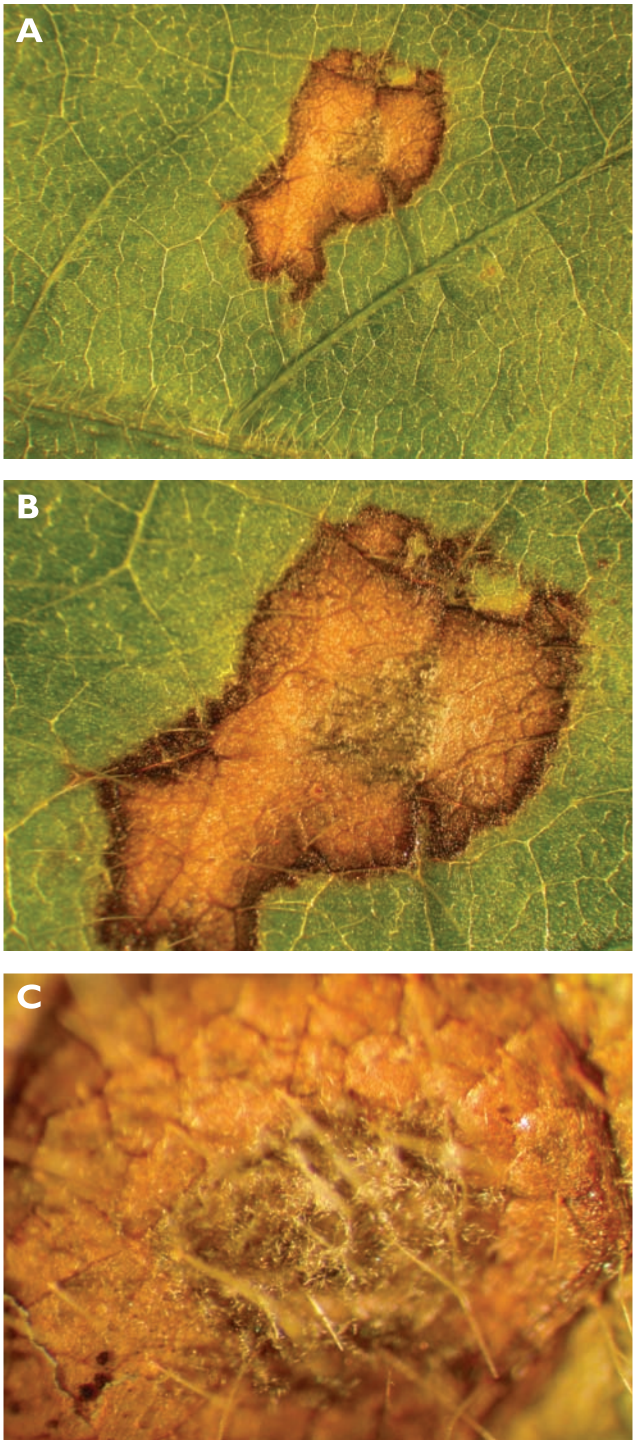

Figure 14.2. A) Low magnification of a soybean leaf with a "leaf spot" symptom. B) Medium magnification showing a grayish "clump" in the center of the leaf spot. C) High magnification showing that the "clump" is actually full of fungal spores.

Some fungicides have only preventative activity, meaning they are effective only when applied with this timing. Other fungicides may still be effective even after the fungal pathogen has invaded the plant tissue; they have what is referred to as early-infection, or curative, activity. (The term "curative" is used loosely here, as a curative fungicide will not "cure" damage that has already occurred.)

Fungicides differ in their ability to move within a plant. Some fungicides are strictly contact fungicides; they remain on the surface of the plant only (**Figure 14.3A**). Others are systemic fungicides, which means they are absorbed into the plant tissue and may move within the plant. Systemic fungicides currently available for use on field crops grown in Illinois are either locally systemic (move into the plant with some redistribution; **Figure 14.3B**) or upwardly systemic (move upwardly in the plant through the xylem; **Figure 14.3C**); none of them is fully systemic (able to move up and down throughout the plant).

Fungicide Resistance Management

Unfortunately, it is possible for fungal plant pathogens to develop resistance to a fungicide. This phenomenon has occurred worldwide in various cropping systems. Currently, no plant pathogens that affect field crops in Illinois are known to be fungicide-resistant, but the potential for them to develop is real.

Fungicide resistance can occur when a selection pressure is placed on a fungal plant pathogen population. Characteristics of both the fungicide and the pathogen play a role in the magnitude of the selection pressure and the risk of resistance occurring. Fungicides with a single site of action may be more at risk for resistance developing than those with multiple sites of action. Plant-pathogenic fungi with a lot of genetic variability in the population may be more prone to developing resistance to fungicides. The genetic variability in a plant population may be greater in certain fungi that undergo sexual reproduction. Fungi that cause diseases with multiple repeating stages within the same growing season (i.e., some foliar diseases) also may be more likely to develop resistance to a fungicide.

The Fungicide Resistance Action Committee (FRAC) is an international organization developed to address the issue of fungicide resistance. The FRAC codes are a system of numbers and letters used to distinguish fungicide groups based on mode of action and chemical class. Fungicides with the same FRAC code designation are similar, and a fungus that has developed resistance to a particular fungicide likely will be resistant to other fungicides with the same code. FRAC codes of fungicides currently registered for use on field crops grown in Illinois are shown in **Table 14.1**. A complete list of codes is available at www.frac.info.

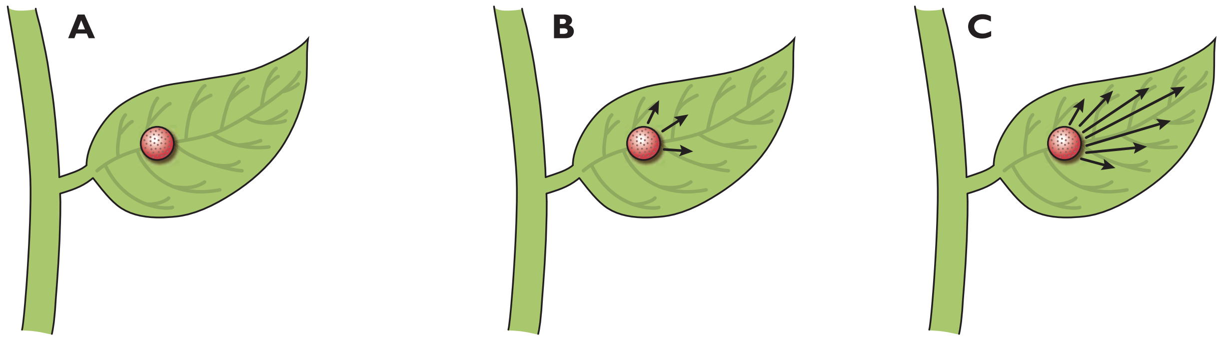

Figure 14.3. A) Contact fungicides stay on the outer surface and do not enter the plant. B) Locally systemic fungicides are absorbed but remain close to the site of uptake with some redistribution. C) Upwardly systemic fungicides move upwardly through the plant from the site of uptake.

A number of practices can minimize the risk that a fungus will become resistant to a fungicide. The best fungicide resistance management programs utilize all available practices to prolong the effectiveness and the life of the fungicides:

● **Apply a fungicide only when necessary.** Scout fields for disease and take into consideration disease risk factors such as variety susceptibility to disease, previous crop, and disease history of the field. Applying a fungicide only when necessary will help reduce the selection of fungicide-resistant pathogens.

● **Apply fungicides with different modes of action.** Applying mixtures of fungicides with different modes of action may help reduce the selection pressure placed on the pathogen population. This is only effective, however, if both fungicides control the target disease. If more than one application of a fungicide during a season is anticipated, then a fungicide with a different mode of action should be used each time.

● **Follow label recommendations.** Following the label, in addition to being the law, is another important component of fungicide resistance management. Some fungicides have restrictions on the number of applications allowed during a season and on back-to-back applications. Following label rates is also important; when sublethal doses of a fungicide are applied, the risk of fungicide resistance may increase.

Using Foliar Fungicides for Reasons Other than Disease Control

In some cases, fungicides may have an effect on plants without a foliar disease being present. Plants may react to fungicides in different ways, but one reaction sometimes observed is a stay-green effect. Results of research by university scientists have shown that the appearance of a stay-green effect is inconsistent, and that when it is present, it may not result in a yield increase. It is recommended that the decision to apply a foliar fungicide be based on disease management considerations only.

Managing Diseases by Crop

Alfalfa

Alfalfa can be affected by a number of diseases, which include seedling blights, root and crown rots, and leaf blights. Losses can be minimized by an integrated management approach that includes these steps:

● Grow winter-hardy, disease-resistant varieties.

● Plant high-quality, disease-free seed produced in an arid area.

● Provide a well-drained, well-prepared seedbed.

Table 14.1. Fungicide Resistance Action Committee (FRAC) codes of fungicides registered for use on common field crops grown in Illinois.

FRAC Code	Chemical group	Example	Risk of fungicide resistance
1	Methyl benzimidazole carbamates (MBC)	Topsin M	High
3	Demethylation inhibitors (DMI; includes triazoles)	Prosaro	Medium
4	Phenylamides	Apron XL	High
7	Carboxamides	Vitavax	Medium
11	Quinone outside inhibitors (QoI; includes strobilurins)	Headline	High
12	Phenylpyrroles	Maxim	Low to medium
14	Aromatic hydrocarbons	PCNB	Low to medium
M	Multi-site activity; inorganics	Bravo	Low

A complete list of FRAC codes can found at www.frac.info (click on "Publications").

- Use crop rotation with nonlegumes.
- Cut in a timely manner to minimize loss to foliar blights.
- Use proper fertilization practices and maintain proper pH.
- Avoid cutting or overgrazing during the last 5 or 6 weeks of the growing season.
- Control insects and weeds.
- Cut only when foliage is dry.
- Destroy unproductive stands.
- Follow other suggested agronomic practices.

Table 14.2 lists alfalfa diseases in Illinois and the effectiveness of various management methods. No control measures are necessary or practical for several of the common alfalfa diseases, including bacterial blight or leaf spot, downy mildew, and rust. For most diseases, producers should select resistant varieties.

Planting disease-resistant varieties. Many newer varieties offer resistance to bacterial wilt, Fusarium wilt, Verticillium wilt, anthracnose, Aphanomyces root rot, and Phytophthora root rot; however, no varieties are resistant to all diseases. Alfalfa producers should identify the pathogens common in their areas and select varieties according to local adaptability, high-yield potential, and resistance to those common pathogens.

Choosing planting sites and rotating crops. The choice of planting site often determines which diseases are likely to occur, because most pathogens survive between

Table 14.2. Alfalfa diseases that reduce yields in Illinois and the relative effectiveness of various control measures.

Disease	Plant winter-hardy, resistant varieties	Use high-quality seed	Have a well-drained soil, pH 6.5 to 7	Use correct crop rotation	Achieve adequate, balanced fertility	Cut in mid- to late-bud stage	Avoid late cutting and planting	Avoid rank growth and high stubble	Maintain insect and weed control
Bacterial wilt	1		2	3	3	3			3
Dry root and crown rots, decline	3	3	2	2	2		2	3	2
Phytophthora root rot	1		2	2	3		2		
Aphanomyces root rot	1		2	2	3		2		
Fusarium wilt	1		3	2	3		2	3	3
Verticillium wilt	1	2			3		3		
Anthracnose	1		3	1	2			2	3
Spring black stem	3	2	3	1	3	2		2	3
Summer black stem		2	3	2	3	2		2	3
Common or Pseudopeziza leaf spot	3		3	2	2	2		2	3
Stemphylium or zonate leaf spot	3	2		2	3	2		2	3
Lepto or pepper leaf spot	3		3	2	3	2		2	3
Yellow leaf blotch		2	3	2	2	2		2	3
Stagnospora leaf and stem spot			3	2	3	2		2	3
Rhizoctonia stem blight		2	2		2	2		2	3
Seed rot, damping-off		2	2	3	2				3
Sclerotinia crown and root rot[a]	2	3	2	2	2	3	2	2	2
Virus diseases		3							2

1 = Highly effective control measure; 2 = moderately effective control measure; 3 = slightly effective control measure. A blank indicates no effect or that the effect is unknown.
[a]Avoiding fall seeding is moderately effective for managing Sclerotinia crown and root rot.

growing seasons on or in crop debris, volunteer alfalfa, and alternative host plants. Aphanomyces, Pythium, and Phytophthora seedling blights generally are more common in heavy, compacted, or poorly drained soils and survive in infected root tissues. Leaf-blighting fungi survive in undecayed leaf and stem tissues, and they may die once residues decay. Other pathogens are dispersed by wind currents and can be found in almost any field, so planting site selection alone will not ensure a healthy crop. Alfalfa mosaic virus, for example, is transmitted by aphids that may be blown many miles.

The diseases strongly associated with continuous alfalfa production include bacterial wilt, anthracnose, a variety of fungal crown and root rots, Phytophthora root rot, Fusarium wilt, Verticillium wilt, spring and summer blackstem, common and Lepto leaf spots, bacterial leaf spot, and Stagnospora leaf and stem spot. The incidence of many diseases can be reduced by rotating crops and using tillage to encourage residue decomposition before the next alfalfa crop is planted. Since most alfalfa pathogens do not infect plants in the grass family, rotation of 2 to 4 years with corn, small grains, sorghum, and forage grasses will help reduce disease levels.

Cutting at the right time. Cut heavily diseased stands before bloom and before the leaves fall to maintain the quality of the hay and remove the leaves and stems that are the source of infection for later diseases. This will help ensure that later cuttings have a better chance of remaining healthy. Cutting in the mid- to late-bud stage, harvesting at 30- to 40-day intervals, and cutting the alfalfa short are practices that help to control most leaf and stem diseases of alfalfa. Cutting only when foliage is dry also minimizes the spread of fungi and bacterial that cause leaf and stem diseases, wilts, and crown and root rots.

Controlling insects and weeds. Insects commonly create wounds by which wilt, bacteria, and crown-rotting and root-rotting fungi enter plants. Insects also reduce plant vigor, increasing the risk of stand loss from wilts and root and crown rots.

Do not allow a thick growth of weeds to mat around alfalfa plants. Weeds reduce air movement; they slow drying of foliage and lead to serious crop losses from leaf and stem diseases. Seedling stands under a thick companion crop, such as oats, are commonly attacked by leaf and stem diseases. Weeds can also harbor viruses that can be transmitted to alfalfa by aphid feeding. Control broadleaf weeds in fencerows and drainage ditches, along roadsides, and in other waste areas. Whenever possible, do not grow alfalfa close to other legumes, especially clovers, green peas, and beans. Many of the same pathogens that infect alfalfa also attack these and other legumes.

Corn

Managing corn diseases requires an integrated approach to limit disease and yield losses. The use of disease-resistant hybrids, crop rotations, various tillage practices, balanced fertility, fungicides, control of other pests and weeds, and various other cultural practices is needed to provide the broadest spectrum of control of corn pathogens. **Table 14.3** lists diseases known to cause yield losses in Illinois and the relative effectiveness of various control measures.

Planting disease-resistant hybrids. The use of resistant hybrids is the most economical and efficient method of disease control. Although no single hybrid is resistant to all diseases, hybrids with combined resistance to several major diseases are available. Corn producers should select high-yielding hybrids with resistance or tolerance to major diseases in their area.

Rotating crops. Many common pathogens require the presence of a living host crop for growth and reproduction. Examples of such corn pathogens include many of the foliar diseases (Helminthosporium leaf diseases, Physoderma brown spot, Goss's wilt, gray leaf spot, eyespot) and nematodes. Rotating to nonhost crops (i.e., soybean) "starves out" these pathogens, resulting in a reduction of inoculum levels and the severity of disease. Continuous corn, especially in combination with conservation tillage practices that promote large amounts of surface residue, may result in severe outbreaks of disease.

Tilling. Tillage programs that encourage rapid residue decomposition before the next corn crop is planted help reduce population of pathogens that overwinter in or on crop debris. Although a clean plowdown is an important disease-control practice, the possibility of soil loss from erosion must be considered. Other measures can provide effective disease control if conservation tillage is implemented. Examples of diseases partially controlled by tillage include stalk and root rots, Helminthosporium leaf diseases, Physoderma brown spot, Goss's wilt, gray leaf spot, anthracnose, ear and kernel rots, eyespot, and nematodes.

Managing fertility. Balanced fertility and fertility levels play an important role in development of diseases such as Stewart's wilt, seedling blights, leaf blights, smut, stalk rots, ear rots, and nematodes. Diseases may be more severe where there is excess nitrogen and a lack of potassium, or both. Healthy, vigorous plants are more tolerant of diseases and better able to produce a near-normal yield.

Using foliar fungicides. The decision to apply a foliar fungicide should be based on the levels of disease incidence and severity and on certain risk factors. Factors that increase the risk of foliar diseases include these: previ-

Table 14.3. Corn diseases that reduce yields in Illinois and the relative effectiveness of various control measures.

Disease	Resistant or tolerant hybrids	Crop rotation	Clean plow-down	Balanced fertility	Fungicides: Seed treatment	Fungicides: Foliar spray	Other controls and comments
Seed rots and seedling blights	2			3	1		Plant high-quality, injury-free seed into soils that are 50 °F and above. Prepare seedbed properly, and place fertilizer, herbicides, and insecticides correctly.
Stewart's bacterial wilt	1			3			Early control of flea beetles may be helpful on susceptible hybrids; some insecticide seed treatments may provide this control.
Goss's bacterial wilt	1	1	2				Rotations of 2 or more years provide excellent control.
Helminthosporium leaf blights (northern leaf blight, northern leaf spot, southern leaf blight)	1	2	2	3		1	Foliar fungicide applications may be needed only on susceptible hybrids when conditions are favorable for disease.
Gray leaf spot	2	2	2			1	See comments for Helminthosporium leaf blights.
Physoderma brown spot		1	3	2			
Yellow leaf blight and eyespot	1	2	1			2	See comments for Helminthosporium leaf blights.
Anthracnose	1	2	1	3			
Common and southern rusts	1					1	Foliar fungicides for common rust may only be needed when infection occurs early or in late-planted fields.
Common smut	2	3	3	3			Avoid mechanical injuries to plants, and control insects.
Crazy top and sorghum downy mildew		1	3	3			Avoid low wet areas, and plant only downy mildew-resistant sorghums in sorghum-corn rotations. Control of shattercane (an alternate host) is very important.
Stalk rots (Diplodia, charcoal, Gibberella, Fusarium, anthracnose, Nigrospora)	2	2	2	2			Plant adapted, full-season hybrids at recommended populations and fertility. Control insects and leaf diseases. Scout at 30–40% moisture to determine potential losses.
Ear and kernel rots (Diplodia, Fusarium, Gibberella, Physalospora, Penicillium, Aspergillus, others)	2	2	3	3			Control stalk rots and leaf blights. Hybrids that mature in a downward position with well-covered ears usually have the least ear rot. Ear and kernel rots are increased by bird, insect, and severe drought damage.
Storage molds (Penicillium, Aspergillus, others)							Store undamaged corn for short periods at 15–15.5% moisture. Dry damaged corn to 13–13.5% moisture before storage. Low-temperature-dried corn has fewer stress cracks and storage mold problems if an appropriate storage fungicide is used. Corn stored for 90 days or more should be dried to 13–13.5% moisture. Inspect weekly for heating, crusting, and other signs of storage molds.
Maize dwarf mosaic virus	1						Control johnsongrass and other perennial grasses (alternative hosts) in and around fields.
Wheat streak mosaic virus							Plant winter wheat (an alternative virus host) after the fly-free date, and control volunteer wheat. Separate corn and wheat fields. See *Report on Plant Diseases No. 123*.
Nematodes (lesion, needle, dagger, sting, stubby-root)		2	2	3			Clean plow-down helps reduce winter survival of nematodes. Nematicides may be justified in some situations. Submit soil samples for nematode analysis before applying nematicides.

1 = Highly effective control measure; 2 = moderately effective control measure; 3 = slightly effective control measure. A blank indicates no effect or that the effect is unknown.

ous crop was corn, or corn debris on the soil surface is prevalent; weather was rainy in July and August, with high dew points; a susceptible hybrid was planted; and the crop was planted later than normal. A summary of university corn fungicide trials in 12 states (Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Minnesota, Missouri, Nebraska, North Dakota, Ohio, and Wisconsin) and one Canadian province (Ontario) in 2007 indicated that corn hybrids with good to excellent resistance to gray leaf spot and sprayed with a foliar fungicide had a yield benefit of 3 bushels per acre over the untreated, while hybrids with fair to poor resistance to gray leaf spot and sprayed with a foliar fungicide had a yield benefit of 6 bushels per acre over the untreated. The level of disease resistance in a corn hybrid is thus an important factor when making a fungicide application decision.

Soybean

Successful management of soybean diseases involves appropriately integrating resistant varieties, high-quality seed, tillage (where feasible), fungicides, scouting, and proper insect and weed control. Using multiple practices will provide the best management of diseases. **Table 14.4** indicates the effectiveness of these practices by disease.

Planting resistant varieties. Every soybean disease-management program should begin with selecting a variety with resistance to the diseases most common in the area. Many high-yielding public and private soybean varieties are available with resistance to important diseases, including Phytophthora root rot, soybean cyst nematode, and brown stem rot. Other less important diseases also can be controlled with resistant varieties. See Chapter 3 for more information on variety selection.

One major concern for soybean producers is the possible appearance of new or unexpected races of a pathogen. When race-specific resistant genes are used, this may place a selection pressure on the pathogen population, which may result in new races becoming able to overcome the resistance genes that were once effective. Examples of soybean pathogens that have different races in Illinois are the Phytophthora root rot pathogen (*Phytophthora sojae*) and the frogeye leaf spot pathogen (*Cercospora sojina*). Soybean cyst nematode populations are characterized as HG Types, but the examples provided also apply to soybean cyst nematode.

For Phytophthora root rot, there is the option of selecting *race-specific resistant varieties* and *non-race-specific tolerant varieties*. Race-specific resistant varieties contain one or more genes with resistance to specific races of a pathogen. This type of resistance is active from the time of planting until full maturity. It fails only where races occur that are not controlled by the genes in the plant. Non-race-specific tolerant varieties have a broad form of resistance to all races of the pathogen; however, they may not provide the level of protection needed where pathogen population levels are extremely high. This type of resistance (tolerance) is not active in the early seedling stage, and plants are considered susceptible until one or two trifoliolate leaves have developed. When non-race-specific tolerant varieties are used in fields with a history of Phytophthora root rot, using a seed treatment that contains either mefenoxam or metalaxyl may provide early protection until the plants become tolerant after trifoliolate leaf development.

Using fungicide seed treatments and foliar sprays. Historically, using fungicides as either seed treatments or foliar sprays has not been common. However, when the market price of soybeans is above $10 a bushel, fungicides may be more easily justified economically. Beginning in 2009, some soybean seed companies will be treating the majority of soybean seed being sold.

A benefit from a fungicide seed treatment is more likely to be observed in these circumstances:

- Planting early into cool soils or into no-tilled soils
- Planting into a field with a history of problems with stand establishment
- Having only poor-quality seed available (as a result of fungal infection rather than mechanical damage)

Foliar fungicides are highly effective in controlling some foliar diseases, including frogeye leaf spot, Septoria brown spot, and soybean rust. Varieties susceptible to frogeye leaf spot should be scouted at regular intervals for the appearance of the disease, and a fungicide application may be justified when conditions are favorable for frogeye leaf spot. Septoria brown spot can be found in almost every soybean field every year, but the yield loss caused by this disease generally is considered to be minimal. Only in years with excessive rainfall might a fungicide be considered for control of Septoria brown spot.

Foliar fungicides are the only tool currently available for managing soybean rust. Monitoring the movement and progression of soybean rust in the U.S. is important in determining the risk of its occurring in Illinois. The Soybean Rust IPM PIPE website (www.sbrusa.net) provides maps and information on the whereabouts of soybean rust in the U.S. during the growing season.

Understanding agronomic characteristics affecting disease development. The relative maturity of soybean cultivars can dramatically affect disease development. Early-maturing varieties are more commonly damaged by

Table 14.4. Soybean diseases that reduce or threaten yields in Illinois and the relative effectiveness of various control measures.

Disease	Resistant or tolerant varieties	Crop rotation	Clean plow-down	High-quality seed	Fungicides: Seed treatment	Fungicides: Foliar spray	Other controls and comments
Phytophthora root rot	1				2		Multiple races of the pathogen are present in Illinois soils. Race-specific resistant varieties and non-race-specific tolerant varieties are available. Fungicide seed treatments are effective only for the seed and seedling blight phases of this disease; higher rates may be needed for best control.
Seedling blights and root rots (Pythium, Rhizoctonia, and Fusarium)				2	2		Plant high-quality seed in a warm (>55 °F), well-prepared seedbed. Shallow planting may help establish uniform, vigorous stands.
Charcoal rot	3?		2	3			Some rotational crops (e.g., corn) also are susceptible. Management practices that avoid moisture stress may help escape infection.
Brown stem rot	1	1					Rotations of 2 or more years are necessary for control. Early-maturing varieties may be less affected than late-maturing varieties. Infection by soybean cyst nematode (SCN) may break resistance to brown stem rot; check affected fields for presence of SCN.
Sudden death syndrome	2						Avoid planting too early into cool soils. Management practices that reduce soil compaction may help reduce the likelihood of SDS. Infection by SCN may increase the likelihood of SDS; check affected fields for the presence of SCN.
Frogeye leaf spot	1	3	3			1	Varieties that contain the Rcs3 gene for resistance control all races of the fungus currently present in Illinois.
Cercospora leaf blight				2	2	2	
Septoria brown spot		3	3			1	
Powdery mildew	1					2	
Soybean rust						1	Monitoring the movement and progression of soybean rust in the U.S. is important in determining the risk of soybean rust's occurring in Illinois. The Soybean Rust IPM PIPE website (www.sbrusa.net) provides maps and information on the whereabouts of soybean rust in the U.S. during the growing season.
Downy mildew	2	2	2	2	2		Seed treatments containing metalaxyl or mefenoxam may provide control of seedborne downy mildew.
Bacterial blight, bacterial pustule, wildfire	1	2	2	2			Seeds should not be saved from fields heavily infected with these diseases.
Soybean mosaic, bean pod mottle, and bud blight viruses	2			2			Plant high-quality, pathogen-free seed. Some insecticide seed treatments may provide protection against early feeding by bean leaf beetles and soybean aphids that can transmit viruses. Damage from bud blight may be reduced by bordering soybean fields with 4 to 8 rows or more of corn or sorghum. This may be helpful where soybean fields border alfalfa or clover fields. Before planting, apply herbicides to control broadleaf weeds in fencerows and ditch banks.
Pod and stem blight, anthracnose, stem canker		2	2	2	2	2	
Sclerotinia stem rot (white mold)	2	3		2	2	2	No completely resistant varieties are available, but varieties differ in level of susceptibility. Avoiding infected seed and seed lots containing sclerotia will prevent introducing the disease into a field. Some seed treatments are effective in controlling infected seed. The effectiveness of foliar fungicides has been inconsistent.
Soybean cyst nematode	1	1					Avoid planting the same variety in the same field twice, and rotate varieties with different sources of resistance.

1 = Highly effective control measure; 2 = moderately effective control measure; 3 = slightly effective control measure. A blank indicates no effect or that the effect is unknown.

pod and stem blight, anthracnose, purple seed stain, and Septoria brown spot. The longer the time from maturity to harvest, the greater the likelihood of damage by these diseases. However, early-maturing varieties are generally less affected by brown stem rot.

Soybean growth habit also can affect disease development. Tall, bushy varieties may be more severely affected by Sclerotinia stem rot (white mold) than shorter, more compact varieties. Shorter varieties, however, also may be more prone to damage by water-splashed pathogens such as Septoria brown spot, pod and stem blight, and purple seed stain.

Planting dates also can affect diseases. Early-planted fields may have a greater incidence of seedling blights. Conditions in early spring favor these pathogens and may delay the emergence of the seedling soybean plants. Early planting also may increase the incidence of sudden death syndrome.

Crop rotation and tillage are very important in controlling most diseases of soybean. Most soybean pathogens depend on crop residues for overwintering and do not colonize other hosts. So when crop residues are removed or are completely decayed, or when rotation with nonhosts (corn, small grains, etc.) is used, pathogen populations and disease levels may decline over time.

Row spacing also can influence disease. Diseases that thrive in cool, wet conditions typically increase when soybean is planted in rows less than 30 inches. If previous soybean residue is present, earlier and more severe epidemics may occur. Diseases such as downy mildew and Sclerotinia stem rot (white mold) are greatly affected by high humidity. Narrow rows may increase both humidity and disease levels. If tall soybean varieties are planted, there may be little air circulation within the canopy, keeping the soybean canopy moist. Where Sclerotinia stem rot or downy mildew is a problem, wider rows or shorter beans may help reduce disease levels.

Wheat

Successfully managing wheat diseases involves appropriately integrating resistant varieties, high-quality seed, fungicide treatments, proper planting time and site, crop rotation, tillage, high fertility, and other cultural practices. **Table 14.5** indicates the effectiveness of these practices by disease.

Planting disease-resistant varieties and high-quality seed. Growing resistant varieties is the most economical and efficient method of controlling wheat diseases. Resistance to rust diseases, Fusarium head blight (scab), loose smut, Septoria/Stagonospora diseases, powdery mildew, and viral diseases is of major importance in Illinois. No single wheat variety is resistant to all major diseases, so varieties should be selected according to their local adaptability, yield potential, and resistance to the most common and serious diseases.

Seed that has been improperly stored (bin-run) will lose vigor and may develop problems in the seedling stage that continue throughout the season. Diseases such as bunt, loose smut, black chaff, ergot, Septoria/Stagonospora diseases, and scab may be carried on, with, or within the seed.

Choosing planting sites and rotating crops. The choice of a planting site often determines which diseases are likely to occur, because many pathogens survive on or in crop debris, soil, volunteer wheat, and alternative host plants. Site choice is most important in controlling Septoria/Stagonospora leaf and glume botches, Helminthosporium spot blotch, tan spot, scab, ergot, take-all, Fusarium and common root rots, crown and foot rots, Cephalosporium stripe, bunt or stinking smut, downy mildew, eyespot, Pythium and Rhizoctonia root rots, soilborne wheat mosaic virus, and wheat spindle streak mosaic virus. Other diseases are not affected by choice of planting site, including airborne and insect-transmitted diseases, among them barley yellow dwarf virus, wheat streak mosaic virus, and rust diseases.

Crop rotation is an extremely important means of reducing carryover levels of many common wheat pathogens. Diseases strongly associated with continuous wheat production include take-all, Helminthosporium spot blotch, tan spot, crown and foot rots, root rots, scab, Septoria/Stagonospora leaf and glume blotches, black chaff, powdery mildew, Cephalosporium stripe, soilborne wheat mosaic virus, wheat streak mosaic virus, downy mildew, eyespot, ergot, and anthracnose.

With many common wheat diseases, crop debris provides a site for pathogens to survive adverse conditions. Many of these pathogens do not survive once crop debris is decomposed. Rotations of 2 or 3 years with nonhost crops, coupled with other practices that promote rapid decomposition of crop residue, will reduce the carryover populations of these pathogens to very low levels. Soilborne wheat mosaic and wheat spindle streak virus increase when wheat is planted continuously in the same field. To control these diseases, rotations must cover at least 6 years.

Tilling. A clean plowdown may be of great help in disease control, but the losses to soil erosion should be carefully weighed against potential yield losses due to disease. Pathogens dispersed short distances by wind and splashing rain may infect crops early and cause more severe losses where debris from the previous wheat crop remains on the soil surface. The need for clean tillage is thus based on the prevalence and severity of diseases in the previous crop, other disease control practices available, the need for erosion control, rotation plans, and other factors.

Managing fertility. The effect of fertility on wheat diseases is quite complex. Adequate and balanced levels of nitrogen, phosphorous, potassium, and other nutrients will help reduce disease losses. This is particularly true with take-all, seedling blights, powdery mildew, anthracnose, and Helminthosporium spot blotch. Research has shown that both the level and form of nitrogen play an important role in disease severity. The severity of certain diseases is decreased by using ammonia forms of nitrogen (urea and anhydrous ammonia) and is increased by using nitrate forms. In other cases, the reverse is true. The general effect on disease severity caused by the nitrogen form used is specified in **Table 14.6.**

Deciding when to plant. Planting time can greatly influence the occurrence and development of a number of diseases. Early fall planting and warm soil (before the Hessian fly-free date) promote the development of certain seed rots and seedling blights, Septoria/Stagonospora leaf blotches, leaf rust, powdery mildew, Cephalosporium stripe, Helminothosporium spot blotch, wheat streak mosaic virus, soilborne wheat mosaic virus, barley yellow dwarf virus, and wheat spindle streak mosaic virus. Wheat that is planted early may have excessive foliar growth in the fall, which may favor the buildup and survival of leaf rust, powdery mildew, and Septoria/Stagonospora leaf blotches. Disease buildups in the fall commonly favor earlier and more severe epidemics in the spring. Many of these problems can be avoided if planting is delayed until after the Hessian fly-free date.

Using fungicide seed treatments and foliar fungicides. Wheat seed treatment trials in Illinois have been shown to increase wheat yields. Seed treatments can control diseases such as bunt, loose smut, Septoria/Stagonospora diseases, seed rots, and seedling blights. Failure to control seedling blights may result in serious winter-kill of diseased seedlings.

No single fungicide controls every disease. A combination of fungicides generally is necessary to control the broadest range of pathogens. When deciding whether to use a fungicide seed treatment, consider seedling disease history and anticipated seedbed conditions, product effectiveness, and application method. Seed treatments can lead to improved stand establishment but will not always result in increased yields.

Fusarium head blight (scab), Septoria/Stagonospora leaf and glume blotch diseases, powdery mildew, and rusts are diseases that appear at different severity levels in the state almost every year. They are favored by rainy weather and heavy dews. With proper applications of fungicides, these diseases can be managed. The decision to apply a foliar fungicide should be based on the prevalence of disease or on the risk of disease and the yield potential of the crop. As a general guideline, the upper two leaves (flag leaf and flag leaf-1) should be protected against foliar pathogens, since head-filling depends largely on the photosynthetic activity of these two leaves. Loss of leaves below flag leaf-1 usually causes little loss in yield.

Weekly scouting for foliar diseases should begin no later than the emergence of the second node (growth stage 6). If diseases are present and weather conditions favor continued disease development, consider a fungicide application. Be certain that diseases are correctly diagnosed to ensure proper fungicide selection. If foliar diseases are present or conditions are favorable for foliar diseases at the flag leaf emergence stage (growth stage 9), a fungicide application may be warranted at this time. For Fusarium head blight (scab) control, it is important to understand the current risk level of disease. The *Fusarium Head Blight Risk Assessment Tool* is an online tool developed to help predict the risk of Fusarium head blight (www.wheatscab.psu.edu).

In addition, the risk of Fusarium head blight may be increased when wheat follows corn and/or a susceptible variety is planted. If a fungicide will be applied for Fusarium head blight control, timing is critical. Results from research trials have indicated that the early anthesis stage (growth stage 10.5.1) is the best time to apply a foliar fungicide to control Fusarium head blight. It is important to know which fungicides have efficacy against it and which ones can be applied at this growth stage. Fungicides that contain a strobilurin fungicide active ingredient (Headline, Quadris, Quilt, Stratego) should never be applied at the 10.5.1 growth stage.

Table 14.5. Relative effectiveness of various methods of controlling the major wheat diseases in Illinois.

						Fungicides	
Disease	**Resistant varieties**	**Crop rotation**	**Clean plow-down**	**Balanced fertility**	**Planting after fly-free date**	**Seed treatment**	**Foliar spray**
Seedling blights			3	3	2	1	
Take-all[a]	2	1	3	2	2		
Stem rust	1				3		1
Leaf rust	1				3		1
Stripe rust	1				3		1
Septoria and Stagonospora leaf blotches[b]	1	2	2		2	3	1
Tan spot		2	2		3		1
Cephalosporium stripe		1					
Powdery mildew	1				3		1
Helminthosporium spot blotch		2			3		2
Bacterial blight; bacterial leaf streak[c]	1	3					
Loose smut[c]	1					1	
Bunt or stinking smut[c]						1	
Glume blotch[c]	1	2	2		3	2	1
Fusarium head blight (scab)[c,d]	2	1	3	3	3	2	2
Black chaff[c]							
Soilborne wheat mosaic virus	1	3			2		
Wheat spindle streak virus	1				1		
Wheat streak mosaic virus		3	3		2		
Barley yellow dwarf virus	1				1		

1 = Highly effective control measure; 2 = moderately effective control measure; 3 = slightly effective control measure. A blank indicates no effect or that the effect is unknown.
[a]Control virus diseases.
[b]Seed treatment will control seedborne infection only.
[c]Avoid bin-run seed; plant high-quality seed.
[d]Avoid planting into corn stubble.

Table 14.6. Effect of the form of nitrogen on wheat disease severity.

	Nitrogen form	
Disease	**Nitrate**	**Ammonium**
Root and crown diseases		
Take-all	Increase	Decrease
Fusarium root rot	Decrease	Increase
Helminthosporium diseases	Decrease	
Foliar diseases		
Powdery mildew	Increase	
Leaf and stem rust	Increase	Decrease
Septoria leaf blotch	Increase	

A blank cell means that there is no effect or data are not available.