Managing Diseases

Nathan Kleczewski, former University of Illinois Extension Plant Pathologist and Chelsea Harbach, University of Illinois Extension Commercial Agriculture Educator

Editorial contributions by Daren Mueller (Extension Plant Pathologist, Iowa State University) and Diane Plewa (University of Illinois Plant Clinic Director)

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There are many pathogens that can cause disease in field crops grown in Illinois. However, diseases are not problematic in every field in every year. This is because several factors are required for a disease to occur. The plant disease triangle (Figure 14.1) outlines the three conditions that are needed in order for disease to occur, which include a virulent pathogen, a susceptible host, and a conducive environment. The longer these three conditions remain together the more disease will occur. Disease will not occur when these components are not simultaneously present.

In general, field crop diseases in Illinois are caused by pathogens belonging to one of five groups: bacteria, fungi, fungal like organisms (FLOs), nematodes, and viruses. Economically important diseases that affect field crops in Illinois are caused by pathogens from all five of these groups.

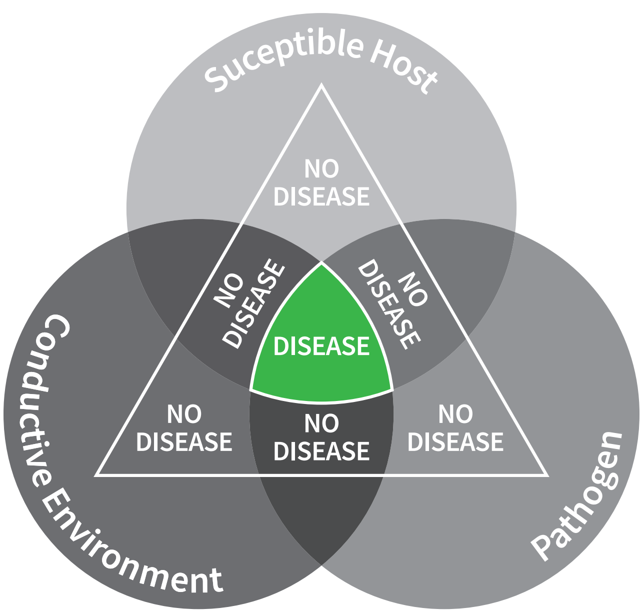

Fig. 14.1. The plant disease triangle outlines the three conditions necessary for disease to occur.

Tactics used to manage individual pathogens vary, so it is essential to know the cause of the problem. If the pathogen causing the issue is not correctly identified and managed, then the disease may be problematic in subsequent seasons. In addition, misdiagnoses can result in the use of ineffective (and potentially expensive) management tactics, further reducing producer productivity.

Principles of Plant Disease Control

Management practices designed to reduce the impact of plant diseases affect specific components of the disease triangle. Multiple practices should be used to manage plant diseases rather than relying on a single method, an approach known as integrated pest management.

These management practices include cultural, genetic, chemical, and biological control tactics. The overuse of one management practice can result in the pathogen acclimating or evolving to combat this tactic, which over time, reduces the utility of these tactics for managing the disease. Integrating different management practices often results in better disease reduction and reduces selection that leads to pathogens evolving. Examples of this occurring include the overuse of the main source of resistance to soybean cyst nematode (PI88788), and fungicide resistance development in the fungal pathogen that causes frogeye leaf spot on soybean.

Why does this happen? Pathogens are affected by selection pressures when certain individual management practices are used (i.e., some host-resistant genes and some fungicides). Continued exposure to the same resistance genes or fungicide modes of action selects for members of the population that are not affected by these strategies, and this can result in new “pathotypes” or “races” of the pathogen, or fungicide-resistant strains of the pathogen, becoming prevalent in the field.
Thus, it is important to use as many tactics as possible available and adopt an integrated pest management approach. Combining different strategies helps hedge your bets to reduce the risk to a particular pathogen or disease reaching epidemic proportions and reduces the

Fig. 14.2. An example of the interveinal chlorosis (yellowing) symptom on a soybean leaf. This disease symptom can be indicative of several plant diseases and some abiotic disorders. (image: Tristan Mueller, Bugwood.org)

likelihood of a pathogen developing resistance to a useful management tool.

Disease Diagnosis

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. For example, yellowing between soybean veins , interveinal chlorosis (Fig. 14.2), is a symptom shared by both diseases and abiotic disorders. Diseases that cause this yellowing include sudden death syndrome (SDS), brown stem rot (BSR), stem canker, white mold, red crown rot, and plant-pathogenic nematode damage. Causes of abiotic disorders (plant damage caused by a non-living factor) that result in interveinal chlorosis symptoms can be caused by herbicides or fungicide toxicity.

Disease-like symptoms do not necessarily indicate there is a plant pathogen causing disease. There are many abiotic factors that can cause disease-like symptoms. When observing symptoms in a field, it is important to consider the distribution of the symptoms throughout the field, when the symptoms first appeared, and if there is progression in severity of the problem. Many plant diseases occur in patches within a field and can increase in severity over space and time. Abiotic disorders often have a more uniform or some sort of pattern-like distribution in a field (such as following compaction patterns in soil or along the edges of the field) and generally symptoms do not progress through space and time.

Misidentification of a plant disease can lead to inappropriate control recommendations (e.g., applying a fungicide to control a bacterial disease, FLOs, or an abiotic disorder), resulting in additional financial losses to the producer. Magnification with a hand lens or microscope may help in observing spores or fruiting bodies of some plant-pathogenic fungi (Figure 14.3). When diagnosis is not possible with the tools and resources you have available, collect and send affected plant samples to a plant diagnostics lab. These labs have trained plant disease diagnosticians who use specialized equipment, tools, and tests to identify different pathogens from plant tissues. The University of Illinois Plant Clinic (go.illinois.edu/plantclinic) is open year-round for all plant disease diagnostic needs.

Genetic resistance

Planting a crop with resistance to commonly occurring diseases is the most effective method for suppressing diseases and limiting the potential for a given disease to cause significant losses in a particular season. Producers

Fig. 14.3. 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. (images: Illinois Agronomy Handbook, 2009 Edition)

can select crops with two main types of resistance: quantitative and qualitative. Quantitative resistance provides a range of resistance responses from mildly resistant to highly resistant, and this resistance is effective against all genetic backgrounds (pathotypes/races) of a particular pathogen. This type of resistance is controlled by many different plant genes, each of which can contribute a portion of the total resistance response. Quantitative resistance results in reduced lesion sizes, growth, and reproduction of plant pathogens. It does not provide immunity. The use of this type of resistance helps reduce or delay the development and spread of pathogens, thereby reducing the likelihood that economic thresholds will be met during the growing season. Examples of this resistance type include Fusarium head blight resistance in wheat, gray leaf spot resistance in corn, and field tolerance to Phytophthora stem canker in soybeans.

Qualitative resistance (i.e. race-specific resistance) provides near immunity to pathogens containing a specific genetic background (race/pathotype). Qualitative resistance genes act as security dogs trained to recognize drugs or illegal materials at airports. For example, if the dog is trained to sense a specific drug, and the drug is present, the dog will alert security who will take action to stop the drug from advancing. This scenario plays out in the field, with a plant's resistance gene acting as the dog, a specific pathogen race or pathotype as the drug, and the plant's defense system as security. This sort of resistance is not effective against all races/pathotypes of a pathogen. Consequently, other races can continue to infect and cause disease unimpeded by the presence of such resistance genes. Examples of race-specific resistance include powdery mildew resistance in wheat, and Phytophthora resistance (Rps genes) in soybeans.

Occasionally, other types of resistance can limit diseases, such as ontogenetic (age-related) resistance. Examples of ontogenetic resistance in field crops include limiting anthracnose development in corn, stripe rust development in wheat, and frogeye leaf spot development in soybeans. This sort of resistance is due to differences in the chemistry or composition of the tissues throughout plant growth and development.

Traits for disease resistance are integrated into practically all varieties of commercially cultivated crops, providing insurance against diseases of major concern or diseases that commonly occur in different regions of the state. Unlike chemicals, disease resistance traits have a wide window of utility, which can assure producers that the built-in resistance to specific pathogens will likely limit significant issues with those diseases. In the past, resistant crops would often have a yield drag, meaning that plants with resistance yielded poorly compared to susceptible plants when diseases were not a factor. However, advancements in breeding technologies have made incorporation of resistance more precise, rendering yield drag effects less problematic than in the past.

Chemical control

Fungicides and bactericides

Fungicides and bactericides are chemicals that kill fungi and bacteria. In field crops, bactericides are not frequently used, while fungicides are used regularly. When used appropriately and as part of an integrated pest management program, fungicides can be effective disease management tools. For field crops grown in Illinois, fungicides are generally 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. If label directions are not followed, you leave yourself vulnerable to phytotoxicity and crop disease control or legal issues in the future.

In general, fungicides are most effective when they are applied just before or at the onset of disease development. Some fungicides have only preventative activity, meaning they are effective only when applied prior to infection. 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.) It is important to note that this curative activity is only effective for a couple days after a pathogen infects the plant. A final type of activity in some fungicides is eliminative activity. These fungicides can kill spores and spore-bearing structures when applied to an infected leaf. Most often this sort of activity can be observed in diseases caused by pathogens that need a living host to grow and reproduce, such as rusts and powdery mildews.

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 semi-systemic fungicides, which means they are absorbed into the plant tissue and may move within the plant. Semi-systemic fungicides currently available for use on field crops grown in Illinois are either locally systemic (move into the plant with some redistribution-from one side of a leaf to the other or throughout a leaf; Figure 14.3B) or acropetally systemic (move upwardly in the plant through the xylem; Figure 14.3C); none of them are fully systemic (able to move up and down throughout the plant in the phloem).

Fungicides work by targeting specific physiological processes of the fungus that are vital in growth and reproduction. Often, they work by binding to specific enzymes, which carry out important activities in the fungus. For example, strobilurins bind to an enzyme that is needed to produce energy. When this enzyme is inactivated, the fungus starves and dies. Fungicides can be classified as having multi-site or single site modes of action.

Multi-site fungicides work by attacking specific bonds that hold together several proteins within a fungus. By breaking these bonds, these fungicides cause targeted proteins to unravel and lose activity. In multi-site mode of action fungicides, there is no specific metabolic pathway targeted, which gives these products broad spectrum activity, i.e., effective on a wide range of fungi. However, they cannot be taken up by plant tissues, and do not redistribute after application. This means that they only protect tissues that they contact, and that any growth that occurs after an application will not be protected by the fungicide. In addition, these products are not very rainfast and can be washed off plant tissues with a couple rain events. Multi-site products (e.g., coppers, Bravo) are not often used in conventional field crop production in Illinois, except for some seed treatments.

Most fungicide active ingredients have a single site mode of action, meaning they target one, specific enzyme in the fungus. However, because of this specificity, it is possible for some fungi to develop insensitivity or resistance to specific fungicide modes of action. Single site mode of action fungicides are applied at significantly lower use rates than multi-site fungicides, and also have fewer off-target effects on other organisms and the environment.

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. In Illinois, documented examples of fungicide resistance in pathogenic populations include *Cercospora sojina* (frogeye leaf spot) resistance to QoI (strobilurins) in soybeans, *Fusarium graminearum* (Fusarium head blight) insensitivity to DMI (triazoles) fungicides in

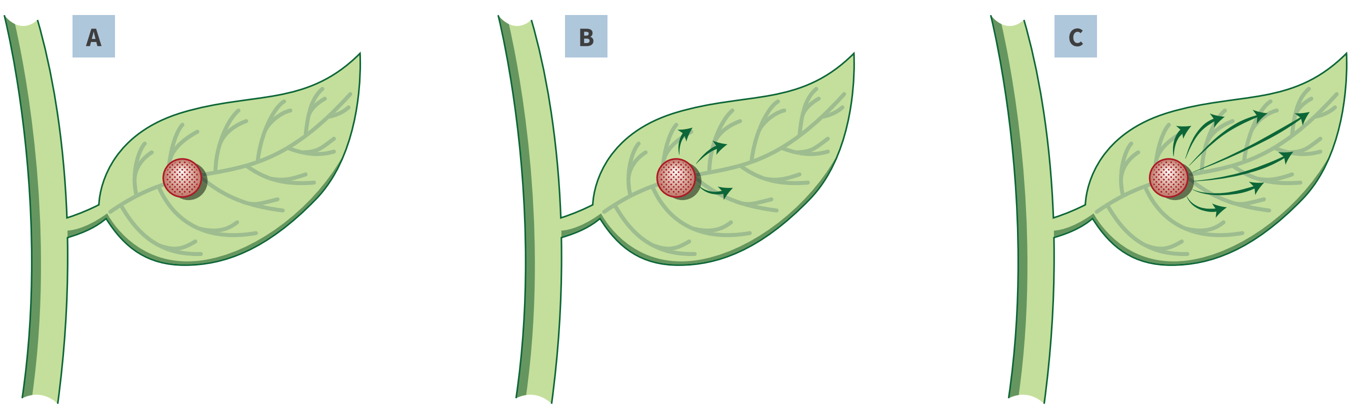

Fig. 14.4. A) Contact fungicides stay on the outer surface and do not enter the plant. B) Locally systemic fungicides are absorbed but remain close to the site of uptake with some redistribution. C) Upwardly systemic fungicides move upwardly through the plant from the site of uptake.

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, Tilt, Domark	Medium
4	Phenylamides	Apron XL	High
7	Carboxamides	iLeVO, Saltro	Medium
11	Quinone outside inhibitors (QoI; includes strobilurins)	Aproach, Headline Quadris	High
12	Phenylpyrroles	Maxim	Low to medium
14	Aromatic hydrocarbons	PCNB	Low to medium
M	Multi-site activity; inorganics	Bravo, Kocide	Low
A complete list of FRAC codes can found at www.frac.info (click on “Publications”).			

wheat, *Parastagonospora nodorum* (leaf and glume blotch) insensitivity to QoI in wheat, and *Pythium spp.* insensitivity to metalaxyl, ethaboxam, and QoI.

Fungicide resistance develops when a particular fungicide mode of action is frequently and repeatedly applied to a field. A plant-pathogenic fungi population in a field is genetically diverse, generally containing strains that are sensitive to the active ingredient and a small amount of strains within the population are inherently insensitive to the active ingredient due to chance mutations, which naturally occur at low levels in pathogen populations. When a fungicide is applied, all the sensitive strains of plant pathogen target will die. However, those that are insensitive or resistant will continue to grow and reproduce, surviving into the next season. Repeated use of the same fungicide mode of action will continue to select for these insensitive strains, which will become the common strain of the pathogen within the field, eventually reaching a frequency that is sufficient to cause substantive damage to the crop, even with fungicide intervention. Once insensitive strains dominate the pathogen population, the use of any fungicide active ingredient in that fungicide class will no longer work for controlling that disease. Some fungicide modes of action are more prone to resistance development than others.

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.

Several 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.

1. **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.
2. **Apply fungicides with different modes of action.** Applying mixtures of fungicides with different modes of action may reduce the selection pressure placed on the pathogen population. This is only effective, however, if both fungicide active ingredients control the target disease. When applying a fungicide with a single mode of action, it is important to use a different mode of action if a second fungicide application is warranted. However, most fungicides used in field crop production are premixes that

contain two or more fungicide active ingredients. You can consult FRAC codes to help you choose fungicides with different modes of action.

3. **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 important- when low, off-label doses of a fungicide are applied, the risk of fungicide resistance increases.

Using Foliar Fungicides for Reasons Other than Disease Control

In some cases, fungicides may influence 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 and occasionally a small yield improvement (less than 3 bushels per acre in corn) when disease pressure is low. Results of research by university scientists have shown that these effects on corn are inconsistent, occurring less than 10% of the time. It is recommended that the decision to apply a foliar fungicide be based on disease management considerations only.

Seed treatments

Seed treatment fungicides, which are coated directly onto the seed coat, are commonly used in field crop production in Illinois. The main purpose of these products is to provide protection for emerging seedlings. Seed treatments are active in a small area of the root zone and help minimize colonization by any nearby root-rotting organisms near the seed. Some can even be taken up by the roots of the seedling and move with the xylem to developing foliage. However, seed treatment fungicides are not fumigants- they only work on actively growing pathogens for around 3 to 4 weeks after planting (depending on the growing conditions). Seed treatments will not affect pathogens that are limited in activity or growth as a result of temperatures or other environmental conditions after planting. So, if after the seed treatment effect wears off and conditions are favorable for disease development, these pathogens may become active and infect roots. Most fungicides, once they enter the soil water, are immediately inactivated by soil organic matter, and do not move far outside of the initial seedling root zone.

Biological control

Biological control is using living things (organisms) to control pathogens. Biological control can take many forms in field crops. For example, some biocontrol organisms directly consume specific pathogens (e.g., *Pasteuria nishizawae* and the soybean cyst nematode, *Coniothyrum minitians* and *Sclerotinia sclerotiorum* [soybean white mold]). Others may contain organisms that compete with pathogens for resources or induce defense responses of the plant. Plant pathogens are often poor competitors. Therefore, practices that enhance microbial diversity and soil health can help reduce the ability of many soilborne pathogens to cause diseases. Practices such as crop rotation, green manuring, the use of some cover crops, and minimizing tillage all can improve microbial diversification and soil health, which has the potential to help reduce soilborne pathogen buildup.

An important consideration with biological control products is that every living organism needs the correct environmental conditions to survive and thrive. Things that can impact the potential for a biocontrol agent to "wake up" and grow include but are not limited to: plant genetics, soil type and composition, resident microbes, temperature, and moisture. This fact means that performance of biocontrol products tends to be more variable when compared to synthetic chemicals.

Managing Diseases by Crop

Alfalfa

Alfalfa can be affected by several diseases, including 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.
- Use crop rotation with nonlegumes.
- Cut in a timely manner to minimize loss to foliar blights.

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

Disease	Plant winter-resistant varieties	Use high-quality seed	Have a well-drained soil pH 6.5-7	Use correct crop rotation	Achieve adequate balanced fertility	Cut in mid-bud stage	Avoid cutting and planting	Avoid rank 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 rota	2	3	2	2	2	3	2	2	2
Virus diseases									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.

- Use proper fertilization practices and maintain proper soil 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.
- Timely application of foliar fungicides

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 growing seasons on or in crop residue, 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 bacteria and crown-rotting, root-rotting, and wilt 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, fungicide seed treatments and foliar applications, control of other pests and weeds, and other cultural practices are needed to

Table 14.3. Corn diseases that reduce yields in Illinois and the relative effectiveness of various control measures. *(Cont'd on next page)*

Disease	Resistance	Crop rotation	Clean plowdown	Balanced fertility	Fungicides		Other controls and comments
					Seed treatment	Foliar Spray	
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	3			3		1	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			3	Rotations of 2 or more years provide excellent control.
Bacterial leaf streak		1	1			3	
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.
Tar spot	2	3	2			1	Resistant hybrids currently under development. Fungicides must be applied at disease onset, typically around R2-3
Physoderma brown spot	2	1	3	2		3	Hybrids with foliar symptoms do not show stalk rots and vice versa. Stalk rots are the most significant issue with this disease
Yellow leaf blight and eyespot	1	2	1			2	See comments for Helminthosporium leaf blights.
Anthracnose	1	2	1	3		3	Yield limiting anthracnose occurs as top dieback and or stalk rot
Common and southern rusts	2					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		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	3	3		3	Plant adapted, full-season hybrids at recommended populations and fertility with good stay green characteristics. Control insects and leaf diseases. Scout at 30–40% moisture to determine potential losses.

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.

Table 14.3. (Cont'd) Corn diseases that reduce yields in Illinois and the relative effectiveness of various control measures.

Disease	Resistance	Crop rotation	Clean plowdown	Balanced fertility	Fungicides		Other controls and comments
					Seed treatment	Foliar Spray	
Ear and kernel rots (Diplodia, Fusarium, Gibberella, Physalospora, Penicillium, Aspergillus, others)	2	2	3	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 around V5 to determine if rotation is needed to reduce nematode populations.

1 = Highly effective control measure; 2 = moderately effective control measure;
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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 including gray leaf spot (Figure 14.5), northern corn leaf blight, Physoderma brown spot (Figure 14.6), Goss's wilt, bacterial leaf streak (Figure 14.7), and eyespot, and some 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 residue. Although a clean plowdown is an important disease-control practice, the possibility of soil loss from erosion must be considered. Other measures can

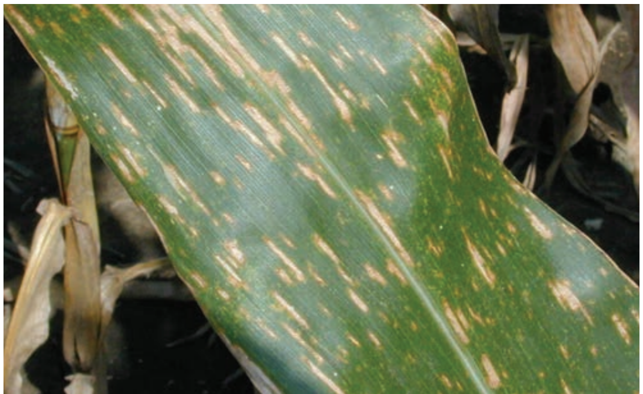

Fig. 14.5. Symptoms of gray leaf spot on corn (image: Daren Mueller, Iowa State University, Bugwood.org)

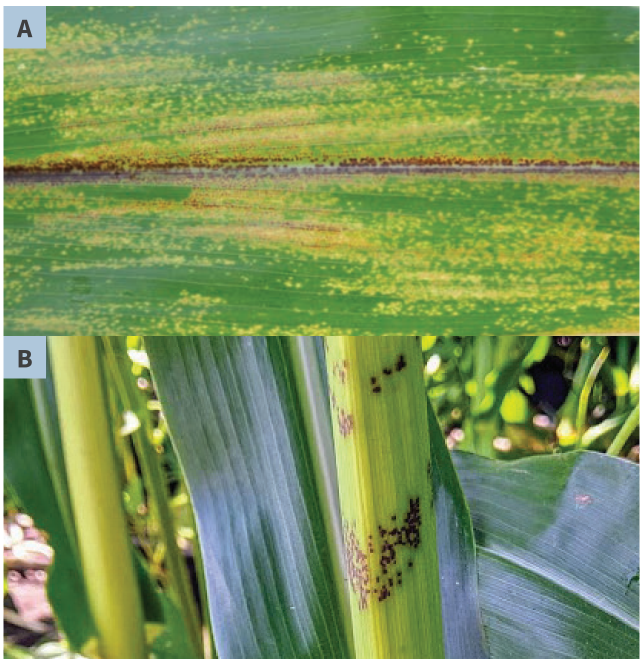

Fig. 14.6. A) Foliar symptoms of Physoderma brown spot on corn (Image: Daren Mueller, Iowa State University, Bugwood.org), B) stalk symptoms of Physoderma brown spot on corn (image: Chelsea Harbach, University of Illinois Extension)

Fig. 14.7. Symptoms of bacterial leaf streak on corn (image: Tamra Jackson-Ziems, Bugwood.org)

Fig. 14.8. Symptoms and signs of tar spot on corn. The raised black structures (stromata) are diagnostic of this disease. The stromata will not come off the leaf when scraped with a fingernail, which distinguishes them from insect frass or dirt. (image: Chelsea Harbach, University of Illinois Extension)

provide effective disease control if conservation tillage is implemented. Examples of diseases partially controlled by tillage include stalk and root rots, Physoderma brown spot (Figure 14.7), Goss's wilt, bacterial leaf streak (Figure 14.8), tar spot (Figure 14.8), gray leaf spot (Figure 14.6), northern corn leaf blight, anthracnose, ear and kernel rots, eyespot, and some pathogenic 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: previous crop was corn and had disease of concern, or the presence of disease-infected corn residue on the soil surface; rainy weather 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.

Application timing can have implications for the efficacy and economics of a fungicide application. Research indicates that the most economic timing is when the fungicide is applied between VT-R2, while multi-pass programs provide little and/or inconsistent yield benefits. Recent products claim to control foliar diseases when applied at plant in furrow. The claim is that the fungicide is taken up by the plant year long, therefore reducing the need for a VT application. There is currently little data supporting these claims. What data we have generated indicate that this practice may provide disease suppression better than a typical V5/6 application but not as much as a VT foliar application. More data are needed before use recommendations can be confidently made.

Soybean

Successful management of soybean diseases involves appropriately integrating resistant varieties, high-quality seed, tillage (where feasible), fungicide seed treatments, timely foliar fungicide applications, scouting, crop rotation to a non-host crop, 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 sudden death syndrome (Fig. 14.9), Phytophthora root rot, soybean cyst nematode (Fig. 14.10), frogeye leaf spot (Fig. 14.11), and brown stem rot

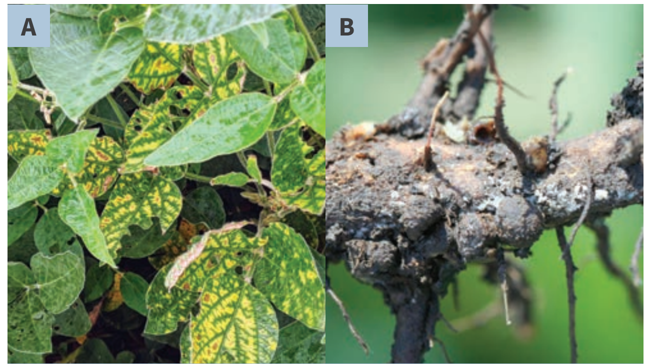

Fig. 14.9. A) Foliar symptoms of sudden death syndrome on soybean include interveinal chlorosis that can progress to interveinal necrosis and defoliation (image: Chelsea Harbach, University of Illinois Extension) B) Root symptoms of sudden death syndrome and signs of the fungus that causes sudden death syndrome can sometimes be observed on roots in these tiny patches of blue fungal growth (image: Daren Mueller, Iowa State University, Bugwood.org)

Fig. 14.10. A) Example of the damage that an unchecked soybean cyst nematode infestation can cause in a field of soybean (image: Craig Grau, Bugwood.org) B) Small, pale to yellow soybean cyst nematode females are visible on soybean roots carefully removed from the soil. The observation of these females on roots is diagnostic for a soybean cyst nematode problem, but future field testing should be done to determine the extent of the problem. (image: Greg Tylka, Iowa State University, Bugwood.org)

Fig. 14.11. Frogeye leaf spot on soybean is caused by a fungus that has developed fungicide resistance. This disease is a great example of the importance of fungicide resistance management, as it can cause detrimental yield losses, especially in southern Illinois where it is more likely to occur. (image: Daren Mueller, Iowa State University, Bugwood.org)

Table 14.4 Soybean diseases that reduce or threaten yields in Illinois and the relative effectiveness of various control measures *(Cont'd on next page)*

Disease	Resistance	Crop rotation	Clean plowdown	Balanced fertility	Fungicides		Other controls and comments
					Seed treatment	Foliar Spray	
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			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	3	3		2		Select SDS resistant variety if SDS is problematic. Consider SDS fungicide if SDS has been problematic. Clean harvest corn if preceding soybean.
Red crown rot		1					Rotation to corn or non host for 2 years may be needed to reduce populations
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. Do not use fungicides that only contain strobulurins.
Cercospora leaf blight				2	2	2	
Septoria brown spot		3	3			2	Not a yield limiting disease in most situations
Powdery mildew	1					2	Not often found not yield limiting
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. Not a major issue in Illinois
Downy mildew	2	2	2	2	2		Seed treatments containing metalaxyl or mefenoxam may provide control of seedborne downy mildew. Not yield limiting in majority of situations

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.

Table 14.4 (Cont'd) Soybean diseases that reduce or threaten yields in Illinois and the relative effectiveness of various control measure							
Disease	**Resistance**	**Crop rotation**	**Clean plowdown**	**Balanced fertility**	**Fungicides**		**Other controls and comments**
					Seed treatment	**Foliar Spray**	
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, SVNV, 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 suscepti- bility. Avoiding infected seed and seed lots containing sclerotia will prevent introduc- ing the disease into a field. Some seed treatments are effective in controlling infected seed. Labeled fungicides should be applied between R1-R3.
Soybean cyst nematode	1	1			3		Avoid planting the same variety in the same field twice, and rotate varieties with differ- ent 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.							

(Fig. 14.12). Other less important diseases also can be controlled with resistant varieties. See Chapter 3 for more information on variety selection.

Fig. 14.12. A) Foliar symptoms of brown stem rot on soybean (image: Tristan Mueller, Bugwood.org), B) splitting the stem reveals a brown pith, diagnostic of brown stem rot on soybean (image: Martin Draper, USDA-NIFA, Bugwood.org)

One major concern for soybean producers is the possible appearance of new or unexpected races of a pathogen. When race-specific resistant genes are repeatedly used, this may place a selection pressure on the pathogen population, which may result in new races with the ability to overcome the resistance genes that were once effective. Examples of soybean pathogens that have different races in Illinois are one of the Phytophthora root rot pathogens (*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 (See Chapter 15 for more on soybean cyst nematode).

For Phytophthora root rot, there is the option of selecting race-specific resistant varieties and non-race-specific tolerant varieties, described previously. Varieties with race-specific (qualitative) resistance 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 (quantitative resistance) 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 (field 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 mefenoxam, metalaxyl, ethaboxam, or oxithiopiprolin may provide early protection until the plants become tolerant after trifoliolate leaf development. Do not expect more than three weeks of protection from seed treatments. Also, keep in mind that seed treatments will not protect seedlings from drowning due to flooding conditions.

Using fungicide seed treatments and foliar sprays. 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 frogeye leaf spot and brown spot and can help suppress white mold and pod and stem blight under the right conditions. 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. If selecting to apply a fungicide for control of frogeye leaf spot (Figure 14.10), do not use products whose sole active ingredients are QoI (e.g., Aproach, Headline, Quadris). There have been multiple sites throughout Illinois with fungicide-resistant populations of the pathogen that causes 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 minimal as it does not often move into the upper third of the canopy, which is responsible for the majority of yield-filling carbohydrates. Only in years with excessive rainfall should a fungicide be considered for control of Septoria brown spot. Target spot is gaining more attention in the South but has yet to show up to significant degrees in Illinois. There is widespread fungicide resistance to target spot pathogens in the south where it occurs. However, most data show that the disease is not especially yield limiting, much like brown spot.

Understanding agronomic characteristics affecting disease development. The relative maturity of soybean varieties can dramatically affect disease development. Early-maturing varieties are more commonly damaged by 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 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 soybean seedlings. However, it is not recommended to delay planting to avoid seedling diseases as planting too late can result in significant yield penalties. Producers should ideally plant into warm soils that promote rapid germination and establishment of their crop.

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.

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

Disease	Resistant varieties	Crop rotation	Clean plowdown	Balanced fertility	Planting after fly free date	Fungicides	
						Seed treatment	Foliar spray
Seedling blights			3	3	2	1	
Take-all[a]	2	3	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			2	3		1
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	2	3	3	3	3	2
Black chaff[c]							
Soilborne wheat mosaic virus	1	3			2		
Wheat spindle streak virus	1	3			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 ef- fective 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.

Brown stem rot (Figure 14.11) is one disease that can be controlled well by this practice.

Row spacing also can also influence disease incidence. 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, Figure 14.13), stripe rust, loose smut, Septoria/Stagonospora diseases, powdery mildew, and viral diseases are 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.

Fig. 14.13. Bleached glumes on wheat that carry mycotoxins from the fungus that causes Fusarium head blight (image: Mary Burrow, Montana State University, Bugwood.org)

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 residue, soil, volunteer wheat, and alternative host plants.

Site choice is most important in controlling Septoria/ Stagonospora leaf and glume botches, 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 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 residue provides a site for pathogens to survive adverse conditions. Many of these pathogens do not survive once crop residue is decom- posed. Rotations of 2 or 3 years with nonhost crops, coupled with other practices that

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

Disease	Nitrogen form	
	Nitrate	Ammonium
Root and crown diseases		
Take-all	Increase	Decrease
Fusarium root rot	Decrease	Increase
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.		

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 plow-down 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 residue 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, and powdery mildew, 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. In general, overfertilization results in rapid canopy closure early in the season, which helps trap moisture within the canopy, and increases the likelihood for buildup of foliar pathogens, particularly powdery mildew and leaf blotches.

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, stripe rust, powdery mildew, Cephalosporium stripe, 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, stripe 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 winterkill 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 the use of resistant varieties and 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). Be certain that diseases are correctly diagnosed to ensure proper fungicide selection. If foliar diseases are present at significant levels 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) through 5-6 days past this point is the best time to apply a fungicide to control Fusarium head blight. Current fungicide recommendations for Fusarium head blight management can be found on the Scabsmart website (scabsmart.org). Fungicides that contain a strobilurin fungicide active ingredient (Aproach, Headline, Quadris) should never be applied at the 10.5.1 growth stage and in general should not be applied later than FGS 9.