

4

PLANT DISEASE MANAGEMENT FOR FIELD CROPS

Yield and quality of field crops in Illinois are affected by disease each year. The damage from crop diseases can be minimized by implementing optimal management practices. Disease-management programs should use integrated disease-control measures that focus on the specific diseases known to occur in a particular area. Disease-management tactics include using resistant or tolerant crop varieties, crop rotations, fungicides, and appropriate agronomic practices. This chapter emphasizes information on fungicides, which in most cases should be used only in conjunction with other disease-control measures or after such measures have been implemented.

The success of disease-control measures may depend on how carefully crops are scouted and how accurately the disease is diagnosed. Periodic scouting increases the likelihood that disease controls will be applied properly and at the time when they are most effective, and it can help prevent economic loss from disease and unnecessary use of fungicides.

Additional information for the management of important diseases of corn, soybeans, wheat, and alfalfa can be found in Table 1 and in the following issues of *Report on Plant Disease (RPD)*: no. 123, "Winter Wheat Disease Management Program"; no. 212, "Illinois Corn Disease Management Program"; no. 308, "Alfalfa Disease Management Program"; no. 507, "Illinois Soybean Disease Management Program"; and no. 1002, "Characteristics of Fungicides Used in Field Crops." These and other issues of *RPD* on specific diseases are available on the Web at <http://www.ag.uiuc.edu/~vista/pubs.html>.

DISEASE DIAGNOSIS

Accurate diagnosis of a disease is a critical initial step for successful disease management. Several different diseases or other plant health problems cause similar symptoms on plants, and an accurate diagnosis is required to choose the best disease-control measures. Many fungicides have specific activity against only certain types of plant pathogens, and their incorrect use wastes time and money. Diligent effort should be made to ensure that diseases are diagnosed accurately. Plants should be collected for diagnosis as soon as disease symptoms are noted. It can be very difficult to accurately diagnose a disease after the plants are dead and dry. The University of Illinois can help with disease diagnosis. Samples can be sent to the Plant Clinic in Urbana for a thorough diagnosis; call (217) 333-0519, or visit the Web site at <http://plantclinic.cropsuiuc.edu/>. Samples can also be taken to a University of Illinois Extension office to use the Distance Digital Diagnosis System.

ALWAYS READ THE LABEL BEFORE USING A PESTICIDE

The pesticide names used in this publication include both the common, or coined, chemical names and representative trade names. The *common name* is the active ingredient (for example, metalaxyl) and is not capitalized. The *trade name* is a specific company's product name and is capitalized (for example, Allegiance FL). Often, multiple trade names exist for products containing the same active ingredient. In

The information in this chapter is provided for educational purposes only. Product trade names have been used for clarity, but reference to trade names does not imply endorsement by the University of Illinois; discrimination is not intended against any product. The reader is urged to exercise caution in making purchases or evaluating product information.

Label registrations can change at any time. Thus the recommendations in this chapter may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions. Purchase only enough pesticide for the current growing season.

such cases, the specific company product names have been replaced by the term *many*. Different product combinations and formulas are frequently available. Consult your local agrichemical dealer or Extension office for additional information. **Before making any pesticide-application decision, refer to the most recent product label for application rates, days to harvest, and other information.** The information on a pesticide label can change at any time and may have changed since this chapter was published. According to the Illinois Pesticide Act, a license is required for anyone who purchases or applies restricted-use pesticides. These products clearly state the words "restricted use" on the label. In addition, anyone applying general-use pesticides in the course of employment must have a license. See Chapter 14 for more information about licensing requirements for pesticide application in Illinois.

FUNGICIDE GUIDELINES

COMMON FUNGICIDE TERMS

A variety of terms is used to describe the mobility and activity of fungicides. Examples include protective-contact, local penetrant, local systemic, translocated, preventive, and curative. Further characterization of the fungicides is shown in Table 3.

Protective-contact fungicides. These products remain on the surface of plant foliage, protecting it from infection for some period. They do not enter the plant tissue. Uniform spray coverage is vital. The length of protection depends on many factors. As with any pesticide, either rainfall or irrigation within a few hours after application may wash away much of the pesticide and greatly reduce the protective value. Even after drying on the plant surface, residues continue to be eroded via rain, dew, vaporization, sunlight, etc., thus reducing protection. Furthermore, as the plant tissues expand or are replaced, new tissue is left unprotected. For these reasons, protective-contact fungicides must be reapplied more often than systemic fungicides. The addition of a spreader-sticker adjuvant to the spray mix may help improve coverage and slow residue loss. As always, carefully read both the fungicide and the adjuvant label to ensure that the proposed tank mix is legal and safe for the crop.

Local penetrant and systemic fungicides. These products are absorbed into the plant. Some are fairly mobile within the plant, while others are not. Local penetrant (sometimes called local systemic) fungicides are absorbed into the immediate area of application but are not translocated far from the site of uptake. They serve to prevent the development of disease at and near the site of absorption. Systemic fungicides are more mobile than local penetrants.

However, the systemic fungicides currently available in the field-crops market display only upward/outward mobility in the plant. This upward/outward movement is sometimes referred to as acropetal or apoplasmic translocation.

Curative vs. preventive activity. Fungicides can also be classified according to *when* they act upon the pathogen. Preventive fungicides prevent the infection by and establishment of the pathogen. All fungicides offer some degree of preventive activity. Because protective contact fungicides do not enter the plant, it stands to reason that they provide only preventive activity.

Some systemic and local penetrant fungicides have "curative" properties, meaning the fungicide has the ability to stop the progress of infections that may have occurred a few hours or days before the application. This "kick-back" or "reach-back" characteristic is useful when responding to infection episodes. However, the effectiveness of even curative fungicides is diminished when an applicator waits too long and disease severity becomes too high.

SEED TREATMENTS

The greatest benefits of fungicide seed treatments are often found where seed is of low quality due to damage or fungal infestation, where the seedbed is sufficiently cool and wet to delay germination or emergence, and where low seeding rates are used. Fungicide seed treatments are not a substitute for high-quality seed and do not improve the performance of seed that is low in quality due to mechanical damage or physiological factors. Treated seed of low quality usually does not produce stands or yields equal to untreated high-quality seed. Therefore, only seed of high quality should be considered first for planting.

The checklist for soybean seed treatments (Table 4) is designed to assist in determining the need for seed treatments, especially for control of damping-off pathogens. Selection of the proper seed treatment is very important because certain fungicides may be effective for controlling only specific pathogens, such as *Phytophthora* and *Pythium*.

FOLIAR TREATMENTS

Foliar fungicide treatments may reduce losses due to disease in soybean, corn, and small grains. Foliar sprays of fungicides may maintain yields and seed quality when conditions are favorable for disease development. The use of fungicides should be based on expected disease severity and is most economical for seed-production fields.

The checklist in Table 5 may be used to determine if fungicide controls for pod and stem blight, anthrac-

nose, stem canker, Septoria brown spot, Cercospora leaf blight, or frog-eye leaf spot are warranted. If the checklist is used to determine whether disease severity warrants spraying and fungicides are applied correctly, maximal benefits should be achieved. Refer to Table 2 for Asian soybean rust fungicide recommendations.

Foliar fungicides can be applied to corn to control leaf blights, gray leaf spot, and common and southern rust diseases. The use of fungicides is generally justified only when disease is prevalent within 1 to 2 weeks of tasseling. Infections that begin 1 to 2 weeks after tasseling or later may not cause economic losses and therefore may not warrant a fungicide. Risk factors such as crop rotation and tillage practices (for example, no-tilled corn-on-corn), hybrid susceptibility, and weather conditions all play a role in disease development. Observation of these risk factors, along with scouting, will help in making fungicide application decisions for corn.

Foliar fungicides can be applied to small grains (primarily wheat) to control Fusarium head blight (scab), rusts, Septoria diseases, leaf blights, and tan spot. When inadequate rotations have been used and weather is wetter than normal, these diseases are most damaging from emergence of the flag leaf to early milk stage. Fungicides may increase yields, seed weight, and quality, and reduce deoxynivalenol (DON) toxin levels in harvested grain. Decisions about using fungicides to control foliar diseases should be based on the amount of disease at the emergence of the flag leaf. The Fusarium head blight risk-assessment tool is available to help make fungicide-application decisions for management of Fusarium head blight; this information is on the Web at <http://www.wheatscab.psu.edu>.

Spray adjuvants (surfactants) help disperse fungicides and improve coverage. If an adjuvant is compatible with the product, it can be added to the spray mix. Adjuvants are especially helpful for corn and small grains. Achieving the best fungicide coverage possible results in better disease control. It is important to use the correct nozzle type and orientation, droplet size, and spray volume to achieve the best coverage and disease control possible for the specific crop and disease. Refer to Chapter 10 for more information regarding application equipment.

DISEASE REACTIONS OF FIELD-CROP VARIETIES RECOMMENDED FOR ILLINOIS

Disease incidence and severity vary from one locality to another and from year to year depending on disease resistance in the crop, the weather and soil

conditions, previous disease, and races of the pathogens present. For information on suggested disease-resistant crop varieties, consult your seed dealer; local Extension office; or the Department of Crop Sciences, University of Illinois, AW-101 Turner Hall, 1102 S. Goodwin Ave., Urbana, IL 61801. For soybean variety selection, disease resistance, and other information, resources are available on the Web at the Varietal Information Program for Soybeans (VIPS) site: <http://web.aces.uiuc.edu/VIPS/newIndex.cfm>. Information on wheat variety disease resistance is available at the University of Illinois Variety Testing Program site: <http://vt.cropsci.uiuc.edu/>.

NEMATICIDE APPLICATION

Granular nematicides/insecticides registered for use on corn and sorghum may be used as in-furrow or band treatments, depending on the product label. Follow the manufacturer's suggestions on application methods. Nematicides should be used only where soil analysis shows high numbers of parasitic nematodes above a threshold value. Follow soil-sampling instructions in RPD no. 1100, "Collecting and Shipping Soil Samples for Nematode Analysis." Nematicides are not designed to replace crop rotation or the use of resistant crop varieties in a management program. Successful nematode management is based upon an integrated approach that may include pesticides. Pesticides alone do not provide adequate control and may produce environmental problems.

RECOMMENDED PLANT DISEASE WEB RESOURCES

<http://www.ag.uiuc.edu/~vista/pubs.html>

Publications on agriculture and horticulture topics written by University of Illinois faculty and staff. This site contains issues of *Report on Plant Disease*.

<http://www.pesticidesafety.uiuc.edu>

Pesticide safety education, including information on pesticide applicator training and safe and effective use of pesticides.

<http://www.ipm.uiuc.edu/bulletin/index.php/>

The online *Pest Management and Crop Development Bulletin* contains pest-management information for diseases, insects, and weeds in Illinois.

<http://web.aces.uiuc.edu/VIPS/newIndex.cfm>

The Varietal Information Program for Soybeans site contains information on disease-resistance ratings, as well as other traits for soybean varieties.

<http://vt.cropsci.uiuc.edu>

The University of Illinois Department of Crop Sciences Variety Testing Program contains information on disease-resistance ratings of wheat and alfalfa varieties, as well as performance data from soybean, corn, small grain, and forage crop variety trials conducted each year across the state.

<http://www.ipm.uiuc.edu/>

The University of Illinois's integrated pest management (IPM) site.

<http://cropdisease.cropsci.uiuc.edu/>

Basic information to help users recognize, understand, and manage field crop diseases in Illinois.

<http://www.apsnet.org/>

The American Phytopathological Society's Web site contains extensive information on plant diseases and their control, as well as a catalog of publications on plant diseases.

<http://www.plantmanagementnetwork.org/>

The Plant Management Network's Web site contains resources for the applied plant sciences. Results from fungicide efficacy trials and variety screening trials for disease resistance can be found here.

<http://www.cdms.net/>

Current pesticide labels and material safety data sheets.

<http://www.greenbook.net>

Information on pesticides, including current pesticide labels and material safety data sheets.

<http://plantclinic.cropsci.uiuc.edu/>

The Web site for the University of Illinois Plant Clinic describes services offered, fees, and directions for submission of plant samples for diagnosis.

<http://www.wheatcab.psu.edu>

The Fusarium head blight risk-assessment tool. This tool can be used to help determine the risk of Fusarium head blight (scab) occurring in different areas of Illinois and other wheat-producing states.

<http://www.sbrusa.net>

The Pest Information Platform for Extension and Education (PIPE) Web site contains information about soybean rust observations in the United States.

<http://soybeanrust.org>

The Illinois soybean rust information center and Illinois sentinel plot system Web site contains information on soybean rust disease and spore observations in Illinois and information on scouting and managing this disease.

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SOYBEAN RUST FUNGICIDE DECISION GUIDELINES

These guidelines were developed by the North Central and Eastern Regional Association of State Agricultural Experiment Station Directors (NCERA-208) Soybean Rust Committee, with the help of land-grant university Extension plant pathologists.

For many of the soybean production regions in North America, the decision to make fungicide applications for management of soybean rust is based on risk. Several factors are involved in the risk of soybean rust moving into an area: incidence and severity of rust in areas to the south, wind patterns that can move the spores of the soybean rust fungus over long distances, regional and local weather, and growth stage of the soybean crop. To determine the risk level of a specific state or province, check with local Extension specialists and the "state commentary" on the PIPE Web site (www.sbrusa.net). An example of a low-risk situation is that of soybean rust in 2006, in which dry conditions in the Gulf Coast states prevented buildup of soybean rust spores early enough to impact the crop in the northern United States and Canada. An example of a moderate-risk situation is a scenario in which soybean rust has been found on soybean in a neighboring state or region but has not yet been detected in your area. Another example of a moderate-risk situation is soybean rust has built up to significant levels in one or more southern states, the long-range forecast is for storm fronts to pass through those areas in the next 2 weeks, and weather is predicted to be suitable for soybean rust in your area. An example of a high-risk situation is soybean rust has been identified in a sentinel plot, commercial soybean field, or kudzu patch in your state or province; and weather conditions are predicted to favor rust development.

Fungicides available for management of soybean rust have different properties that allow them to protect against and control soybean rust. Although all fungicides work best if applied prior to disease onset, some fungicides may also have some "post-infection" properties (aka "curative" or "kick-back" properties). The most effective fungicide classes currently available for soybean rust management are the strobilurin (QoI, quinone-oxidoreductase-inhibiting, aka Group 11) and the triazole (DMI, demethylation-inhibiting, aka Group 3) fungicides. In general, the triazole fungicides have better movement within the soybean plant and have better "post-infection" properties than the strobilurin fungicides. Strobilurin fungicides tend to have longer residual activity than triazole fungicides

and may provide better control of other foliar and stem diseases of soybean. Some pre-mix and co-pack products are available that contain both a strobilurin and a triazole fungicide, and strobilurin and triazole fungicides can be tank-mixed as well.

SOYBEAN RUST APPLICATION RECOMMENDATIONS

VEGETATIVE GROWTH STAGES

Current data indicate that fungicide applications are not needed in the early vegetative growth stages for soybean rust control. Applying a fungicide just prior to soybean flowering (R1) may be prudent if disease risk is high. This is especially true for late-planted crops and/or very late-maturing varieties that may develop a large canopy before flowering.

R1 (beginning of flowering) through R5 (beginning seed) reproductive stages. Soybean rust develops most rapidly during soybean reproductive growth stages. The first fungicide application should be made before rust has appeared on more than 10 percent of the leaflets in the canopy. At an incidence this low, each rusted leaflet may have only one or very few pustules, and the disease is difficult to detect without careful scouting. An application of a fungicide when the level of disease is greater than 10 percent incidence may protect newly emerging leaves but may not result in a yield benefit. Prior to applying fungicide to a given field, the field should be checked for the presence and level of rust in the field, as well as other foliar and stem diseases. If other foliar and/or stem diseases are present, then some adjustment of fungicide mix may be needed. Check with local Extension specialists for specific state/province recommendations at this level of disease and for presence of other foliar diseases in the area. In some areas, multiple applications may be needed, depending upon the growth stage when the disease is first detected and the subsequent environmental conditions. Consecutive applications of stand-alone strobilurin or triazole fungicides should not be made, due to the concern of fungicide resistance developing in the soybean rust pathogen. Refer to fungicide labels for specific directions and restrictions.

R6 (full seed) and later. The benefits of applying a fungicide at late growth stages are uncertain. In addition, many fungicides have preharvest-interval restrictions that do not allow applications past R6. Refer to fungicide labels for specific directions and restrictions, and check with local Extension specialists for specific state/province recommendations.

Table 1. Disease-control guidelines for field crops (see product labels for specific, current information)

Crop, disease	Fungicide or nematicide		Comments and recommendations
	Common name	Trade name	
ALFALFA			
Seed rots and seedling blights	captan fludioxinil mefenoxam metalaxyl thiram	many Maxim XL Apron XL LS, Ridomil Gold EC Allegiance FL and LS, Apron FL many	Seed treatment is often helpful, even with high-quality seed.
Bacterial wilt, Fusarium wilt Phytophthora root rot Aphanomyces root rot			Resistant varieties should be planted.
Leaf spots, spring blackstem, and anthracnose	copper hydroxide	Champ Kocide	Cut forage in a timely manner to reduce leaf loss and maximize yield and quality. Studies have shown inconsistent benefits of using foliar fungicides. Choose varieties with resistance to anthracnose.
Crown and root rots			Maintain proper fertility and soil pH. Avoid harvesting or grazing too often during the last 5 to 6 weeks of the growing season. Control insect pests.
Verticillium wilt			This disease is most often a problem in stands over 3 years old. Plant resistant-varieties.
Sclerotinia crown and stem rot			Use the most resistant varieties, and plant in the spring. The use of 3- or 4-year rotations with nonlegume crops and deep plowing where possible may reduce disease severity.
BARLEY			
Seed rots, seedling blights, loose smut	azoxystrobin captan carboxin fludioxonil imazalil mefenoxam metalaxyl PCNB tebuconazole + thiram thiram triadimenol triticonazole	Dynasty many Vitavax Maxim XL, FS many Apron XL LS Allegiance FL and LS, Apron FL many Raxil-thiram many Baytan 30 Charter	Seed treatment is strongly suggested.

Table 1. Disease-control guidelines for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments and recommendations
	Common name	Trade name	
BARLEY (CONT.)			
Barley yellow dwarf virus			Plant winter barley after the Hessian fly-free date and spring barley as early as possible.
CLOVER			
Anthracnose diseases			Grow resistant adapted varieties.
Crown and root rots			Same as for alfalfa.
Seed rots, seedling blights, and Sclerotinia			Same as for alfalfa.
CORN			
Seed rots and seedling blights	azoxystrobin captan carboxin fludioxonil mefenoxam metalaxyl thiram trifloxystrobin	Dynasty many Vitavax Maxim 4FS Apron XL LS Allegiance many Trilex	Sow injury-free, plump seed in noncompacted soils that are at least 50°F. Prepare the seedbed properly and place herbicide, fertilizer, insecticide, and seed correctly. Fungicide seed treatments are commonly used. Dynasty will be applied only in combination with mefenoxam and fludioxonil.
Northern leaf blight	azoxystrobin	Quadris	Plant resistant hybrids. Chlorothalonil is registered only for seed corn and sweet corn. Begin applications when conditions favor disease development, and repeat at 4- to 7-day intervals or as required to maintain control.
Southern leaf blight	chlorothalonil	Bravo	
Northern leaf spot	mancozeb	Dithane M-45, Manzate 200, Penncozeb	
	propiconazole	Tilt PropiMax EC	
	propiconazole + azoxystrobin	Quilt	
	propiconazole + trifloxystrobin	Stratego	
	pyraclostrobin	Headline	
Gray leaf spot	azoxystrobin propiconazole	Quadris Tilt PropiMax EC	Gray leaf spot is usually most damaging in no-till continuous corn. Fields located in low-lying areas or areas subject to frequent fogs, high humidity, or irrigation are prone to disease. Plant tolerant or resistant hybrids and use crop rotation and tillage where feasible.
	propiconazole + azoxystrobin	Quilt	
	propiconazole + trifloxystrobin	Stratego	
	pyraclostrobin	Headline	
Common rust and southern rust	azoxystrobin chlorothalonil propiconazole	Quadris Bravo Tilt PropiMax EC	Same as for leaf blights and spots. Quadris and Stratego are labeled for control of common rust (<i>Puccinia sorghi</i>) only.
	propiconazole + azoxystrobin	Quilt	
	propiconazole + trifloxystrobin	Stratego	
	pyraclostrobin	Headline	

Table 1. Disease-control guidelines for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments and recommendations
	Common name	Trade name	
CORN (CONT.)			
Stewart's disease (a bacterial disease)			Plant resistant hybrids. Insecticides and insecticide seed treatments may be used to control flea beetles when necessary.
Goss's bacterial wilt and leaf blight (a bacterial disease)			Plant resistant hybrids. Clean plowdown and 2-year crop rotations also give control. Use clean plowdown only where erosion is not a problem.
Anthracnose, eyespot	azoxystrobin propiconazole propiconazole +azoxystrobin propiconazole +trifloxystrobin	Quadris Tilt, PropiMax EC Quilt Stratego	Plant resistant or tolerant hybrids. Practice crop rotation or clean tillage where soil-erosion considerations allow. Quadris and Headline are labeled for control of anthracnose leaf blight and eyespot. Propiconazole (PropiMax and Tilt), Quilt, and Stratego are labeled for control of eyespot but not anthracnose.
Physoderma brown spot, yellow leaf blight	pyraclostrobin	Headline	See management for anthracnose and eyespot.
Crazy top and sorghum downy mildew			Plant resistant or tolerant hybrids. Improve drainage in affected area. Control wild cane to reduce sorghum downy mildew inoculum.
Viral diseases			Plant resistant hybrids. Control johnsongrass to reduce overwintering source of maize dwarf mosaic and maize chlorotic dwarf viruses.
Stalk rots (charcoal, <i>Diplodia</i> , <i>Fusarium</i> , <i>Gibberella</i> , <i>Nigrospora</i> , anthracnose)			Plant hybrids with good stalk rot resistance and stalk strength. Maintain adequate nitrogen, phosphorus, and potassium fertility. Control corn borers and corn rootworms. Scout fields at 30 to 40% moisture for lodging potential. Walk a zigzag pattern through the field, pushing random plants about 5 inches from the vertical. If more than 10 to 15% lodge, schedule the field for early harvest.
Storage molds <i>Aspergillus</i> spp. <i>Penicillium</i> spp.	propionic acid		Grain treated with an acid grain preservative may be used only for animal feed. Store undamaged corn at 15 to 15.5% moisture from fall until spring, then dry to 13% for long-term storage. Grain damaged by field molds, insects, and the like should be dried to 13 to 13.5% moisture at harvest. Watch stored grain for heating, musty odor, crusting, or other signs of storage mold activity. Control stored-grain insects. Make sure the combine is adjusted to avoid damage to grain. Remove fines and foreign material before storage.

Table 1. Disease-control guidelines for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments and recommendations
	Common name	Trade name	
CORN (CONT.)			
Nematodes	ethoprop	Mocap	Use nematicidal rates of these materials only when soil tests indicate populations of nematodes are above threshold. Eliminate pH, fertility, hardpan, soil insects, and other diseases as possible limiting factors before using nematicides. More than one genus of plant-parasitic nematode may be present in a field. Identification of nematodes should be done before selecting rotation. Use crop rotation where appropriate. For needle nematode control, avoid small grains in rotations and control grassy weeds.
Dagger	terbufos	Counter	
Lance			
Ring			
Root-knot			
Root-lesion			
Spiral			
Sting			
Stubby-root			
Stunt			
Needle			
OATS			
Seed rots and seedling blights	captan carboxin fludioxonil mefenoxam metalaxyl PCNB tebuconazole + thiram thiram triadimenol	many Vitavax Maxim 4FS Apron XL LS Allegiance FL and LS, Apron FL many Raxil-thiram many Baytan 30	Seed treatment is strongly suggested for control of smut diseases. Carboxin, PCNB, tebuconazole, and triadimenol have efficacy against smut diseases.
Barley yellow dwarf			Grow resistant varieties. Plant susceptible varieties as early in the spring as possible.
Rusts	propiconazole	PropiMax Tilt	Plant resistant varieties. Fungicides applied for <i>Septoria</i> and <i>Helminthosporium</i> also aid in crown rust control.
SORGHUM			
Seed rots, seedling blights, and smuts	captan fludioxonil mancozeb mefenoxam PCNB thiram	many Maxim 4FS Dithane M-45, Manzate 200, Penncozeb Apron XL many many	Fungicide seed treatment is strongly suggested. Plant in soils at least 60° to 65°F.

Table 1. Disease-control guidelines for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments and recommendations
	Common name	Trade name	
SORGHUM (CONT.)			
Nematodes	aldicarb terbufos	Temik Counter	Apply only where soil analysis indicates an economic nematode population. Eliminate pH, fertility, hardpan, soil insects, and other diseases before using nematicides. Crop rotation may be practical only after identifying the nematodes involved.
SOYBEANS			
Seed rots and seedling blights (primarily <i>Fusarium</i> , <i>Pythium</i> , <i>Phytophthora</i> , and <i>Rhizoctonia</i>)	azoxystrobin azoxystrobin + metalaxyl <i>Bacillus pumilis</i> captan carboxin fludioxonil mefenoxam metalaxyl PCNB thiabendazole thiram trifloxystrobin	Dynasty SoyGard Yield Shield many Vitavax Maxim 4FS Apron XL LS Allegiance FL and LS many TBZ many Trilex	Plant high-quality seed germinating more than 70% in a cold germination test. Seed treatment is recommended when seed of unknown quality due to fungal infection must be planted, delays in emergence are anticipated, seed is planted to produce seed, reduced seeding rates are used, or seed is planted into wet soil or heavy crop residue (reduced tillage or no-till). Plant in soils that are at least 55°F. Apron XL L and Allegiance FL control <i>Pythium</i> and <i>Phytophthora</i> .
Charcoal rot			Plant full-season varieties as early as possible. Avoid excessive seeding rates and maintain optimal fertility. Deep fall plowing may be beneficial where soil erosion concerns allow.
Brown stem rot			Rotate, using 2 years of corn where brown stem rot has been a problem. Plant varieties labeled tolerant, resistant, or moderately resistant. Control soybean cyst nematode.
Sclerotinia white mold	<i>Coniothyrium minitans</i> tetraconazole thiophanate-methyl	Contans WG Domark 230 ME Topsin-M	Rotate with nonlegume crops. Plant moderately resistant varieties in fields where disease has been present before. Corn and small grains are not affected by white mold. Fungicides must be directed into the lower canopy for control. Some fungicide seed treatments have been shown to reduce potential for seedborne distribution. A biological control product (Contans WG) contains a fungus that can destroy sclerotia of the white mold fungus in the soil.

Table 1. Disease-control guidelines for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments and recommendations
	Common name	Trade name	
SOYBEANS (CONT.)			
Phytophthora root rot	mefenoxam metalaxyl	Apron XL, Ridomil Gold Allegiance	Plant varieties with race-specific or field resistance (tolerance). Race-specific resistance with Rps genes provides immunity to specific races. In some areas, races of the <i>Phytophthora</i> fungus are present that can attack this type of resistance. In this case, varieties with field tolerance should be planted. All varieties should be protected in the seedling stage with Apron XL LS or Allegiance FL fungicide applied as a seed treatment.
Nematodes			
Soybean cyst nematode (SCN)			Use SCN-resistant varieties. The same resistant soybean varieties should not be grown in the same field twice. Monitor SCN populations by taking soil samples. Maintain proper soil samples. Maintain proper soil fertility. Rotate with nonhost crops, such as corn or small grains.
Root-lesion Dagger Lance Root-knot Spiral Sting Stubby-root Stunt			No soybean varieties are resistant to root-lesion nematodes, so crop rotation and nematicides are the most practical approaches to control.
Sudden death syndrome (SDS)			Some varieties have partial resistance to SDS. Plant more than one variety where SDS has been a problem and stagger planting dates. Early-planted soybeans are frequently more severely damaged than later-planted ones. Vary maturity by planting more than one maturity group or use different maturities within a single group. Infection is influenced by cool and wet weather. Control soybean cyst nematode.
Pod and stem blight, anthracnose, stem canker, Septoria brown spot, Cercospora leaf blight, purple seed stain, frogeye leaf spot	azoxystrobin chlorothalonil propiconazole propiconazole + azoxystrobin propiconazole + trifloxystrobin pyraclostrobin tetraconazole thiophanate-methyl	Quadris Bravo Tilt Quilt Stratego Headline Domark Topsin-M	Plant resistant varieties if available. Fungicides may be warranted when conditions are favorable for these foliar diseases (see Table 3). Fungicides are not labeled for control of stem canker. Domark and Tilt are not labeled for control of pod and stem blight, and Tilt is not labeled for control of Cercospora blight. Do not graze or feed treated soybean vines to livestock.

Table 1. Disease-control guidelines for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments and recommendations
	Common name	Trade name	
SOYBEANS (CONT.)			
Soybean rust	See Table 2 for soybean rust fungicides.		Check state reports and soybean rust observations in the United States at http://www.sbrusa.net/ . Refer to the soybean rust fungicide decision guidelines (Table 2).
WHEAT			
Seed rots, seedling blights, loose smut, and bunt (stinking smut)	azoxystrobin captan carboxin difenoconazole difenoconazole + mefenoxam fludioxinil imazalil mancozeb mefenoxam metalaxyl mefenoxam PCNB tebuconazole + thiram thiabendazole thiram triadimenol triticonazole	Dynasty Captan Vitavax Dividend XL Dividend Extreme Maxim XL many Grain Guard Apron XL LS Allegiance FL and LS, Apron FL Apron XL LS many Raxil-thiram TBZ many Baytan 30 Charter	Seed treatment is strongly suggested. Thiram or captan alone does not control loose smut. A number of products contain various combinations of these fungicides. Many different fungicidal products are available for treatment of wheat seed, and this list is intended to provide examples of products available.
Septoria leaf blotch, Stagnospora glume blotch, Helminthosporium leaf blight, Pyrenophora tanspot	azoxystrobin mancozeb propiconazole propiconazole + azoxystrobin propiconazole + trifloxystrobin prothioconazole pyraclostrobin	Quadris Dithane M-45, Manzate 200, Penncozeb Tilt Quilt Stratego Proline Headline	Plant resistant varieties. Apply fungicide when disease conditions warrant. Quadris is not labeled for <i>Helminthosporium</i> .
Leaf rust, stripe and stem rust	azoxystrobin propiconazole propiconazole + azoxystrobin propiconazole + trifloxystrobin prothioconazole pyraclostrobin triadimenol	Quadris Tilt Quilt Stratego Proline Headline Baytan 30	Product labels should be consulted for allowable number of applications and growth stage (Feekes' stage) when last application is allowed. Proline is not labeled for control of stripe rust.

Table 1. Disease-control guidelines for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments and recommendations
	Common name	Trade name	
WHEAT (CONT.)			
Powdery mildew	azoxystrobin	Quadris	Plant resistant varieties.
	propiconazole	Tilt	
	propiconazole + azoxystrobin	Quilt	
	propiconazole + trifloxystrobin	Stratego	
	pyraclostrobin	Headline	
	triadimenol	Baytan 30	
Take-all			Plant after the Hessian fly-free date. Use ammonium form of nitrogen fertilizer. Use crop rotations of 2 to 3 years between wheat crops where possible.
Fusarium head blight (scab)	prothioconazole	Proline	Choose resistant varieties and plant varieties with different maturities. Wheat planted into corn or wheat stubble may be at a higher risk for scab. Consult the Fusarium head blight risk-assessment tool at http://www.wheatscab.psu.edu to determine if your area is at risk for scab.
Viral diseases			
Wheat streak mosaic, wheat soilborne mosaic			Plant resistant or tolerant varieties. Plant after the Hessian fly-free date. Control volunteer wheat in and around production fields.
Barley yellow dwarf, wheat spindle streak mosaic			Insecticide seed treatments may help reduce barley yellow dwarf virus by controlling aphids.

Table 2. Foliar fungicides available for control of rust on soybean in Illinois (as of 9/14/07)

Trade name	Active ingredient(s)	FRAC code(s) ^a	Rate per acre	PHI ^b	Label status ^c	Section 18 expiration	Company
Alto	cyproconazole	3	4 fl oz	30 days	section 18	4/19/09	Syngenta Crop Protection
Caramba	metconazole	3	8.2–9.6 fl oz	30 days	section 18	4/19/09	BASF Corporation
Domark 230 ME	tetraconazole	3	4–5 fl oz	not after R5	section 3	N/A ^d	Valent USA
Folicur	tebuconazole	3	3–4 fl oz	30 days	section 18	11/10/07	Bayer CropScience
Laredo EC	myclobutanil	3	4–8 fl oz	28 days	section 3	N/A	Dow AgroSciences
Laredo EW	myclobutanil	3	4.8–9.6 fl oz	28 days	section 3	N/A	Dow AgroSciences
Orius	tebuconazole	3	3–4 fl oz	30 days	section 18	11/10/07	Mahteshim-Agan
Punch	flusilazole	3	3–4 fl oz	30 days	section 18	6/15/10	DuPont
Tilt	propiconazole	3	4–6 fl oz	up to R6	section 3	N/A	Syngenta Crop Protection
Topguard	flutriafol	3	7 fl oz	21 days	section 18	5/11/10	Cheminova
Uppercut	tebuconazole	3	3–4 fl oz	30 days	section 18	11/10/07	DuPont
Headline	pyraclostrobin	11	6–12 fl oz	21 days	section 3	N/A	BASF Corporation
Quadris	azoxystrobin	11	6–15.5 fl oz	14 days	section 3	N/A	Syngenta Crop Protection
Headline SBR	tebuconazole + pyraclostrobin	3, 11	5.8–7.8 fl oz	30 days	section 18	11/10/07	BASF Corporation
Quadris Xtra	cyproconazole + azoxystrobin	3, 11	4 fl oz	30 days	section 18	4/19/09	Syngenta Crop Protection
Quilt	propiconazole + azoxystrobin	3, 11	14–20.5 fl oz	21 days	section 3	N/A	Syngenta Crop Protection
Stratego	propiconazole + trifloxystrobin	3, 11	7–10 fl oz	21 days	section 3	N/A	Bayer CropScience
Bravo Ultrex	chlorothalonil	M	0.9–2.2 lb	42 days	section 3	N/A	Syngenta Crop Protection
Bravo WeatherStik	chlorothalonil	M	1–2.25 pt	42 days	section 3	N/A	Syngenta Crop Protection
Echo 720	chlorothalonil	M	1–2.5 pt	42 days	section 3	N/A	Sipcam
Echo 90 DF	chlorothalonil	M	0.9–2 lb	42 days	section 3	N/A	Sipcam
Equus 720 SST	chlorothalonil	M	1–1.6 pt	42 days	section 3	N/A	FarmSaver
Equus DF	chlorothalonil	M	1.5–2.2 lb	42 days	section 3	N/A	FarmSaver

^aFRAC codes developed by the Fungicide Resistance Action Committee. Fungicides with the same code have the same site of action. For more information, go to <http://www.frac.info>.

^bPHI = preharvest interval.

^cSection 18 emergency exemptions are good for the state of Illinois only, and products with section 18 exemptions can be applied only for soybean rust control. A copy of the section 18 emergency exemption use directions must accompany the applicator.

^dN/A = not applicable.

Table 3. Fungicide Resistance Action Committee (FRAC) Group, fungicide names, resistance risk, and mobility for fungicides used in Illinois field crops^a

FRAC Group code and name [target site of action]	Common name	Trade names	Resistance risk	Mobility
1. methyl benzimidazole carba- mites [mitosis: B-tubuline assembly]	thiabendazole	LSP, in Rival	high	systemic (upward)
	thiophanate- methyl	Topsin-M	high	systemic (upward)
3. demethylation inhibitors (DMI) [C14-demethylation in sterol biosynthesis]	difenoconazole	Dividend	medium	systemic (upward)
	imazalil	Flo-Pro IMZ, in Raxil MD Extra	medium	systemic (upward)
	myclobutanil	Laredo	medium	systemic (upward)
	propiconazole	Bumper, PropiMax, in Quilt, in Stratego, Tilt	medium	systemic (upward)
	tebuconazole	Folicur, in Gaucho XT, Orius, in Raxil	medium	systemic (upward)
	tebuconazole	Domark	medium	systemic (upward)
4. phenylamides [RNA polymerase I]	mefenoxam (= metalaxyl-M)	Apron XL LS, in Maxim XL, Ridomil Gold	high	systemic (upward)
	metalaxyl	Allegiance	high	systemic (upward)
7. carboximides [complex II in fungal respiration (succinate- dehydrogenase)]	carboxin	in Prevail, Vitavax	medium	systemic (upward)
11. quinone outside inhibitors (QoI) [complex III of fungal respiration: ubiquinol oxidase, Qo site in mito- chondria]	azoxystrobin	Dynasty, Protégé, Quadris, in Quilt, in SoyGard	high	systemic (upward)
	pyraclostrobin	Headline	high	local penetrant
	trifloxystrobin	in Stratego, Trilex	high	local penetrant

Table 3. Fungicide Resistance Action Committee (FRAC) Group, fungicide names, resistance risk, and mobility for fungicides used in Illinois field crops^a (cont.)

FRAC Group code and name [target site of action]	Common name	Trade names	Resistance risk	Mobility
12. phenylpyrroles [MAP protein kinase in osmotic signal transduction]	fludioxonil	Maxim 4FS, in Maxim XL	low to medium	contact-protective
14. aromatic hydrocarbons (chlorophenyls, nitroanilines) [lipid peroxidation (proposed)]	PCNB	in Prevail, Terra-Coat LT-2N, in Vitavax-PCNB	low to medium	contact-protective
M3. dithiocarbamates [multisite contact activity]	mancozeb	Dithane, Manzate, Penncozeb	low	contact-protective
	maneb	in Enhance Plus	low	contact-protective
	thiram	Thiram, in many products	low	contact-protective
M4. phthalimides [multisite contact activity]	captan	Captan, in many products	low	contact-protective
M5. chloronitriles (phthalonitriles) [multisite contact activity]	chlorothalonil	Bravo, Echo, Equus	low	contact-protective

^aFungicide labels change frequently; check product labels and consult with manufacturers for current registration and crop use information.

Table 4. Soybean seed-treatment checklist for reducing early-season stand losses due to damping-off

Risk factor	Points for <i>yes</i>
Rainfall for the 7-day period before planting	
Below normal	2
Normal	1
Above normal	4
Seedbed preparation	
Conventional tillage	1
Rough surface (conservation tillage)	2
No-till	4
Germination at time of planting is less than 85% in a warm test or less than 70% in a cold test (discard such seed if at all possible)	3
Previous soybean stand in field was reduced by damping-off	4
Level of resistance to Phytophthora root rot	
Susceptible	3
Tolerant	4
Resistant to one or more races	1
Expected rainfall for 6 days following planting	
Below normal	1
Normal	1
Above normal	3
Low areas of field remain flooded for 48 hours following 1 inch of rainfall	4
Seeding rate is less than 55 lb per acre	3
Field is planted to double-crop soybeans	3

Your total score: _____

< 7 points: Seed treatment probably will not be beneficial.

7–15 points: Seed treatment may be beneficial if weather conditions do not favor rapid germination and growth.

> 15 points: Seed treatment will be beneficial to stand development.

Table 5. Checklist to determine if foliar diseases may be a problem in soybeans and if foliar fungicides should be considered

Risk factor	Points for <i>yes</i>
Rainfall, dew, and humidity up to early bloom and pod set	
Below normal	0
Normal	2
Above normal	4
Soybeans were grown in the field last year	3
Chisel-plow, disk, or no-till was used	1
Pycnidia (black specks) are visible on more than two-thirds of brown, fallen petioles, and Septoria brown spot is obvious on the lower leaves	2
Early-maturing variety (not full-season)	2
Soybeans are to be used or sold for seed	6
Yield potential is better than 35 bushels per acre	2
Seed quality at planting time is less than 85% germination in a warm test	1
Other conditions favor disease development (weather forecast with a 30-day period of greater-than-normal rainfall and a field history of disease)	3

Your total score: _____

For a total score of 15 or more, uncontrolled disease may decrease yields and lower seed quality.

Table 6. Soybean rust fungicide-decision guidelines

Crop stage	Soybean rust status (Risk determined by national, regional, and local activity and disease forecast.)					
	Rust absent			Rust present		
	Soybean rust risk ^a			Barely detectable in lower canopy ^b		Easy to detect in mid- to upper canopy
	<i>Low</i>	<i>Moderate</i>	<i>High</i>	<i>First applica- tion</i>	<i>Second applica- tion (if needed)</i>	
Vegetative (stages before flowering)	Fungicide application not recommended soybean rust control.					Yield benefit from fungicide application is uncertain. ^d
R1 (beginning of flowering) through	Do not spray.	Strobilurin	Premix, tank mix, co-pack Triazole	Premix, tank mix, co-pack, or Triazole	Triazole or premix, ^c tank mix, or co-pack	
R5 (beginning seed)	Do not spray.	Triazole Premix, tank mix, co-pack	Triazole			Check with local Extension specialists for specific guidelines.
R6 (full seed) to R8 (full maturity)	Generally, fungicide application is not recommended. Yield responses beyond R6 are uncertain and many fungicide labels specify that applications be made prior to R6. Check with local Extension specialists for specific recommendations for your state or province.					

^aDetermine risk by staying current with information from Extension specialists, trusted industry contacts, and/or crop consultants for the region and state. View the Soybean Rust PIPE Web site (www.sbrusa.net) frequently for updates.

^bSoybean rust incidence less than 10%.

^cPremix, tank-mix, or co-pack fungicide should contain the full rate of the triazole fungicide component.

^dApplication of a fungicide at this level of disease may protect newly emerging leaves but may not result in a yield benefit. Check with local Extension specialists for recommendations specific to our state or province.