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PLANT DISEASE MANAGEMENT FOR FIELD CROPS

The best way to ensure success of a disease-management program is to adapt it to the diseases expected and to use integrated disease-control measures. Among these measures are resistant or tolerant varieties, crop rotations, fungicides, nematicides, and suggested agronomic practices. The success of any one or all of these measures may depend on how carefully you scout your crops. Because periodic scouting increases the likelihood that disease controls will be applied properly, it can help prevent loss through disease and unnecessary use of pesticides.

Specific information for the control of the important diseases of corn, soybeans, wheat, and alfalfa can be found in Table 1 and in the following issues of *Report on Plant Diseases (RPD)*: no. 123, "Winter Wheat Disease Management Program"; no. 212, "Illinois Corn Disease Management Program"; no. 308, "Alfalfa Disease Management Program"; and no. 507, "Illinois Soybean Disease Management Program."

These and other issues of *RPD* are available from the Department of Crop Sciences, University of Illinois, N-533 Turner Hall, 1102 South Goodwin Avenue, Urbana, IL 61801. The cost per report is \$1.

FEDERAL AND STATE LAWS RESTRICTING PESTICIDE APPLICATION

The U.S. Environmental Protection Agency (US EPA) classifies pesticides for "general" or "restricted" use. Applying a restricted-use pesticide, whether as a commercial or private applicator, requires certification.

Commercial applicators include not only persons applying restricted-use pesticides for hire but also government personnel, chemical company representa-

tives, and others involved in demonstrational, regulatory, and public health pest control. Certification as a commercial applicator requires passing a written examination administered by either the Illinois Department of Agriculture or the Illinois Department of Public Health.

Private applicators who use restricted-use pesticides "for the purpose of producing any agricultural commodity on property owned or rented by [the applicator] or as exchange labor (no compensation) on the property of another" must also be certified by passing an examination.

Educational training programs for farmers (private applicators) and commercial pesticide applicators are conducted by University of Illinois Extension to prepare persons for certification. The actual certification and the issuing of permits or licenses are handled by the Illinois State Department of Agriculture.

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, benomyl) and is not capitalized. The *trade name* is a specific company's product name and is capitalized (for example, Benlate). Often, multiple trade names exist for products containing the same active ingredient. In such cases, the specific company product names have been replaced by the term *many*. Also, many product combinations and formulas are available. Consult your local Extension office or agrichemical dealer for

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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.

Table 1. Condensed disease-control recommendations for field crops

Crop, disease	Fungicide or nematicide		Comments
	Common name	Trade name	
ALFALFA			
Seed rots and seedling blights	captan metalaxyl mefenoxam thiram	many Allegiance FL, Apron FL Ridomil Gold EC many	Seed treatment is not usually necessary with high-quality seed.
Bacterial wilt, Phytophthora root rot			Resistance should be strongly considered when choosing a variety.
Leaf spots, spring blackstem, and anthracnose	copper hydroxide	Kocide	Cut forage in a timely manner to maximize yields and minimize leaf loss. Grow adapted, resistant varieties.
Crown and root rots			Maintain proper fertility and soil pH. Avoid cutting or grazing during the last 5 to 6 weeks of the growing season. Control insect pests.
Verticillium wilt			Seed treatment with thiram is suggested to prevent seed transmission. This disease is a problem only in stands that are more than 3 years old. Resistant varieties should also be considered.
Sclerotinia white mold			Spring planting, deep and clean plowing where possible, using 3- or 4-year rotations with nonlegume crops, and avoiding excessively lush growth may reduce disease severity. Chemical controls are not available.
BARLEY			
Seed rots, seedling blights, loose smut	captan carboxin mefanoxam metalaxyl PCNB terbuconazole + thiram thiram triademenol	many Vitavax Apron XL LS Allegiance FL, Apron FL many Raxil-thiram many Baytan 30	Seed treatment is strongly suggested. Carboxin is required for loose smut control. Metalaxyl controls only Pythium seedling blight in barley.
Barley yellow dwarf virus			Plant winter barley after the fly-free date and spring barley as early as possible.
CLOVER			
Anthracnose diseases			Grow adapted resistant varieties.
Crown and root rots			Same as for alfalfa.

Table 1. Condensed disease-control recommendations for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments
	Common name	Trade name	
CLOVER (CONT.)			
Seed rots and seedling blights			Same as for alfalfa.
CORN			
Seed rots and seedling blights	captan carboxin fludioxonil mefanoxam metalaxyl thiram	many Vitavax Maxim 4 FS Apron XL LS Allegiance FL, Apron FL many	Sow injury-free, plump seed in soils that are at least 50°F. Prepare the seedbed properly and place herbicide, fertilizer, insecticide, and seed correctly. Fungicide-plus-insecticide seed treatments are commonly used.
Helminthosporium leaf diseases Northern leaf blight Southern leaf blight Northern leaf spot	chlorothalonil mancozeb	Bravo Dithane M-45, Manzate 200, Penncozeb	Plant resistant hybrids. Chlorothalonil is registered only for corn grown for seed and sweet corn. Begin applications when conditions favor disease development, and repeat at 4- to 7-day intervals or as required to maintain control. Do not apply within 14 days of harvest. Do not apply to sweet corn to be processed. Do not feed fodder or forage to livestock.
	propiconazole	Tilt	Do not apply Tilt to field and seed corn after silking. Limit applications to a total of 16 oz per acre per season. Do not harvest seed corn, popcorn, or field corn for forage within 30 days of application. Do not apply to sweet corn within 14 days of harvest. Do not harvest sweet corn for forage within 14 days of application.
Gray leaf spot	propiconazole	Tilt	Most damaging in no-till, continuous corn, and where corn follows corn. Fields located in low-lying areas or areas subject to frequent fogs, high humidity, or irrigation can also be damaged. Plant tolerant or resistant hybrids and use crop rotation and tillage where feasible.
Common rust and southern rust	chlorothalonil	Bravo	Same as for Helminthosporium leaf diseases.
Stewart's disease			Plant resistant hybrids or use insecticides to control flea beetles when necessary.
Goss's bacterial wilt and leaf blight			Plant resistant hybrids. Clean plowdown and 2-year crop rotations also give control. Use clean plowdown only where erosion is not a problem.

Table 1. Condensed disease-control recommendations for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments
	Common name	Trade name	
CORN (CONT.)			
Anthracnose, Physoderma brown spot, eyespot, yellow leaf blight			Plant resistant or tolerant hybrids. Practice crop rotation or clean tillage where soil-erosion considerations allow.
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. A nitrogen stabilizer may be helpful where nitrogen loss is expected. Maintain adequate phosphorus and potassium fertility for the rate of nitrogen used. Control corn borers and corn rootworms. Scout fields at 30 to 40% moisture for lodging potential. Walk a zig-zag pattern through the field, pushing random plants about 5 in. 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.
Nematodes Dagger Lance Ring Root-knot Root-lesion Spiral Sting Stubby-root Stunt	ethoprop terbufos	Mocap Counter	Use nematicidal rates of these materials only when soil tests indicate economic populations of nematodes. Eliminate pH, fertility, hardpan, soil insects, and other diseases as possible limiting factors before using nematicides. Use crop rotation where appropriate. For needle nematode control, avoid small grains in rotations and control grassy weeds. More than one genera of plant-parasitic nematode may be present in a field. Identification of nematodes should be done before selecting rotation.

Table 1. Condensed disease-control recommendations for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments
	Common name	Trade name	
CORN (CONT.)			
Needle (see comments)			
OATS			
Seed rots and seedling blights	captan carboxin mefanoxam metalaxyl PCNB thiram triademenol	many Vitavax Apron XL LS Allegiance FL, Apron FL many many Baytan	Seed treatment is strongly suggested for control of smut diseases.
Barley yellow dwarf			Grow resistant varieties. Plant susceptible varieties as early in the spring as possible.
Crown rust			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 mancozeb PCNB thiram	many Dithane M-45, Manzate 200, Penncozeb many many	Fungicide seed treatment is strongly suggested. Plant in soils at least 60° to 65°F.
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>)	captan carboxin mefanoxam metalaxyl PCNB thiabendazole thiram	many Vitavax Apron XL LS, Ridomil Gold Allegiance FL, Apron FL many TBZ many	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 heavy crop residue (reduced tillage or no-till). Plant in soils that are at least 55°F. Apron XL LS and Allegiance FL control <i>Pythium</i> and <i>Phytophthora</i> .

Table 1. Condensed disease-control recommendations for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments
	Common name	Trade name	
SOYBEANS (CONT.)			
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 resistant to moderately resistant.
Sclerotinia white mold	thiophanate-methyl	Topsin-M	Rotate with nonlegume crops. Plant moderately resistant varieties in fields where disease has been present before. Burial of infected residues is recommended where white mold is a recurring problem. Tillage operations are suggested <i>after</i> the following corn crop to help conserve soybean residues. Corn is not affected by white mold. Residue burial is <i>not</i> recommended where erosion can be a problem. Fungicides must be directed into the lower canopy for control. Seed treatments with TBZ fungicides have been shown to reduce potential for seedborne distribution. TBZ is not labeled as a foliar treatment.
Phytophthora root rot	mefanoxam metalaxyl	Apron XL LS, Ridomil Gold Allegiance FL, Apron FL	Plant varieties with race-specific or field resistance (tolerance). Race-specific resistance provides immunity to specific races. In some areas, races of the <i>Phytophthora</i> fungus are present that can attack this type of resistance. Varieties with field tolerance are tolerant after two sets of trifoliolate leaves develop. However, they are very susceptible to the seedling-blight phase of the disease. Varieties with field tolerance should be protected in the seedling stage with Apron XL LS or Allegiance-FL fungicide applied as a seed treatment. A band or in-furrow treatment with Ridomil Gold at planting may be helpful.
Soybean cyst nematode (SCN)	aldicarb	Temik	Maintain proper soil fertility. Rotate with non-host crops, such as corn, small grains, red clover, and alfalfa, and with SCN-resistant soybean varieties. A sample rotation following SCN-damaged soybeans: corn followed by an SCN-resistant variety followed by corn. Monitor SCN populations by taking soil samples after the third year. If populations are below the level for damage, consider a high-yielding, susceptible soybean variety to reduce the buildup of a

Table 1. Condensed disease-control recommendations for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments
	Common name	Trade name	
SOYBEANS (CONT.)			
Soybean cyst nematode (cont.)			different race. If populations are above the damage level, plant a variety with a different source of resistance, or plant a nonhost crop and repeat soil sampling. Nematicides are suggested only where crop rotations are not possible and resistant varieties are not readily available. See <i>Report on Plant Diseases</i> no. 501 for more information.
Root-lesion nematode	aldicarb	Temik	No soybean varieties are resistant to root-lesion nematodes, so crop rotation and nematicides are the most practical approaches to control. These approaches are discussed in <i>Report on Plant Diseases</i> no. 1103, "Lesion Nematodes."
Dagger	carbofuran	Furadan 4F	
Lance			
Root-knot			
Spiral			
Sting			
Stubby-root			
Stunt			
Sudden death syndrome			Some varieties appear to be more resistant than others. Plant more than one variety where sudden death syndrome has been a problem. Early planted beans are more commonly 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	benomyl chlorothalonil thiophanate-methyl	Benlate Bravo Topsin-M	Suggested when disease conditions warrant (see Table 3). Two applications of fungicide are suggested for maximum yield and seed quality. One late application at higher labeled rates improves seed quality. Scout fields to determine the need for late applications. Use three applications of Bravo in areas with a history of moderate to severe disease intensity. Do not graze or feed treated soybean vines to livestock. Observe days-to-harvest limit, which varies by product.
WHEAT			
Seed rots, seedling blights, loose smut, and bunt (stinking smut)	captan carboxin metalaxyl mefanoxam thiabendazole thiram triadimenol	many Vitavax Allegiance FL, Apron FL Apron XL LS TBZ many Baytan	Seed treatment is strongly suggested. Higher labeled rates of carboxin are required for bunt control. Thiram or captan alone does not control loose smut.

Table 1. Condensed disease-control recommendations for field crops (cont.)

Crop, disease	Fungicide or nematicide		Comments
	Common name	Trade name	
WHEAT (CONT.)			
Seed rots, seedling blights, loose smut, and bunt (stinking smut) (cont.)	difenaconazole PCNB tebuconazole + thiram	Dividend many Raxil + thiram	Green forage may not be grazed until 55 days after planting. For Dividend-treated seed, do not plant a rotation crop for 30 days after wheat harvest.
Septoria leaf blotch, Septoria glume blotch, Helminthosporium leaf blight, Pyrenophora tan spot	azoxystrobin benomyl mancozeb propiconazole triademefon	Quadris Benlate Dithane M-45, Manzate 200, Penncozeb Tilt Bayleton	Plant resistant varieties. Apply fungicide when disease conditions warrant. Do not make more than 3 applications of mancozeb, and do not apply within 26 days of harvest. Bayleton is limited to 16 oz of material per acre per season and has a 21-days-to-harvest restriction. Rotational crops (corn, soybeans, sorghum, and small grains) cannot be planted for 35 days following the last application of Bayleton. Do not allow livestock to feed or graze on treated plant materials. Quadris is not labeled for <i>Helminthosporium</i> .
Leaf rust and stem rust	azoxystrobin propiconazole	Quadris Tilt	One application of Tilt per season is permitted at flag-leaf emergence (Feekes's stage 8). To avoid possible illegal residues, do not apply after this stage. Do not graze or feed livestock the treated forage or cut the green crop for hay or silage. After harvest, the straw may be used for bedding or feed. Quadris is not labeled for stem rust.
	triadimefon	Bayleton	See previous entry for this product.
Powdery mildew	azoxystrobin propiconazole triadimefon	Quadris Tilt Bayleton	Plant resistant varieties.
Viral diseases Wheat streak mosaic, wheat soilborne mosaic			Plant resistant or tolerant varieties. Plant after the fly-free date. Control volunteer wheat in and around production fields.
Barley yellow dwarf mosaic, wheat spindle streak mosaic			Gaucht insecticide seed treatment may help reduce barley yellow dwarf virus by controlling aphids.
Take-all			Plant after the fly-free date. Use ammonium form of nitrogen fertilizer. Use crop rotations of 2 to 3 years between wheat crops where possible.

additional information. Before making any pesticide-application decision, refer to the most recent label for rates, days to harvest, and other information.

FUNGICIDE APPLICATION

Aircraft are the best vehicles for applying foliar fungicides to agronomic crops. Some aircraft may not be equipped or calibrated to do this job. It is therefore important to select an aerial applicator who is familiar with disease control and whose aircraft has been properly calibrated for uniform, thorough coverage of all aboveground plant parts. With the equipment now available, a reasonable job of applying fungicides requires a minimum of 5 gallons of water carrier per acre. Superior coverage may be obtained with more water, but the cost may be prohibitive. Conversely, a lower volume (less than 3 to 4 gallons per acre) gives correspondingly poorer control. Five gallons of water can be applied uniformly using about 30 to 70 properly spaced nozzles, depending on the aircraft. The nozzles should be D-8 to D-12, hollow cone, with no. 45 or 46 cores. The final decisions on nozzle number, size, swath width, and placement depend on the air-speed, pressure, and volume desired. Droplet size is also important. Ideally, droplets should be 200 to 400 microns in size for thorough and uniform coverage.

ADJUVANTS

If a spray adjuvant (surfactant) is compatible with the product label, add it to the spray mix. Adjuvants help disperse fungicides and improve coverage. They are especially helpful for corn and small grains. Some commonly available surfactants are Bio 88, BioFilm, DuPont Spreader Sticker (liquid), NuFilm P, NuFilm 17, Plyac, Regulade, Triton AG-98, Triton B-1956, and Triton CS-7.

NEMATICIDE APPLICATION

Granular nematicides/insecticides registered for use on corn, sorghum, and soybeans 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 an economic problem. They are not designed to replace crop rotation and the use of resistant crop varieties in a management program. Successful nematode management is based upon a combination approach that may include pesticides. However, pesticides alone do not provide adequate control and may produce additional environmental

problems. Follow soil-sampling instructions in RPD no. 1100, "Collecting and Submitting Soil Samples for Nematode Analysis."

FUNGICIDE GUIDELINES

SEED TREATMENTS

The greatest benefits of fungicide seed treatments are found where low seeding rates are used, where seed must be used that is of reduced quality due to fungal infection, and where seed is planted in a seedbed in which delays in germination or emergence are likely.

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 does not produce stands or yields equal to untreated high-quality seed. Therefore, only seed of high quality should be considered for planting.

The checklist for soybean seed treatments (Table 2) is designed to assist in determining the need for seed treatments, especially for control of damping-off fungi. Selection of the proper seed treatment is very important because certain fungicides have the specificity for controlling only *Phytophthora* and *Pythium*.

FOLIAR TREATMENTS

Foliar fungicide treatments may reduce losses in soybeans from Septoria brown spot, Cercospora leaf blight, purple seed stain, anthracnose, pod and stem blight, and stem canker. These diseases are most damaging when the weather is warm (70° to 80°F) and wet from early pod fill to maturity. Foliar sprays of fungicides may increase yields 10 to 15 percent, increase seed quality, and reduce disease losses when such fields are planted to soybeans the next year. The use of fungicides should be based on expected disease severity and is most economical for seed-production fields. The six diseases just listed are *not* as severe in cool, dry seasons and where adequate rotations have been used.

The checklist in Table 3 may be used to determine if fungicide controls for the six diseases mentioned should be used. A key factor in this checklist is the presence of black specks (pycnidia) from the pod and stem fungus on fallen petioles. Only brown, fallen petioles should be assayed, and more than two-thirds to three-fourths of these petioles should show pycnidia. If growers use the checklist and apply fungicides correctly, maximal benefits should be achieved. Less than optimal benefits are achieved if fungicides are applied incorrectly or if disease severity does not warrant spraying.

Table 2. 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	2
Tolerant	4
Resistant to one or more races	1
Expected rainfall for 96 hours following planting	
Below normal	1
Normal	1
Above normal	3
Low areas of field remain flooded for 48 hours following 1 in. 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 3. Checklist to determine if foliar fungicide application should be made to soybeans

Risk factor	Points for <i>yes</i>
For a total score of 15 or more, application will probably mean increased yields and higher seed quality.	
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 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
<i>Your total score:</i> _____	

Foliar fungicides are also applied to small grains (primarily wheat) to control rusts, Septoria diseases, Helminthosporium leaf blights, and tan spot. When weather is wetter than normal, these diseases are most damaging from emergence of the flag-leaf to early milk stage. Foliar fungicides may increase yields and can increase both seed weight and quality.

The use of fungicides should be based on the amount of disease at the emergence of the flag leaf. The foliar diseases just listed are *not* as severe when the heading period is drier than normal and where adequate rotations have been used.

Foliar fungicides are applied to corn—primarily in seed-production fields—to control Helminthosporium leaf blights, gray leaf spot, and the two rust diseases. The use of fungicides is generally justified only when disease is prevalent within 2 weeks of tasseling. Infections 6 weeks after tasseling or later do not cause significant economic losses.

DISEASE REACTIONS OF FIELD CROP VARIETIES RECOMMENDED FOR ILLINOIS

Disease reactions may vary from one locality to another and from year to year, depending on the physiologic races of the pathogens present. For the latest information on suggested crop varieties, consult your Extension office or the Department of Crop Sciences, University of Illinois, AW-101 Turner Hall, 1102 South Goodwin Avenue, Urbana, IL 61801.

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