Small Grains

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Disease Mangement Practices for Small Grains

Plant pathogens and the disease they cause, although endemic to region, do not have to extract their toll each year from the prudent and alert small grains producer. There are a number of cultural and management practices that when employed will significantly reduce the economic impact from disease.

The practices may include the use of: **Sanitation** - burial of pathogen-infested residues by tillage or plow down or the use of "burn down" herbicides to destroy volunteer small grains in double-cropped soybeans after harvest; **Rotation** - avoid presence of pathogens by not following corn with wheat or barley or following wheat with wheat; **Planting date** - avoid pathogen or reduce the infection period by avoiding early planting; **Seed bed preparation and balanced fertility** - provide good seed to soil contact and fertility to promote vigorous plant stands; **Good quality, disease-free seed** - promote healthy, vigorous seedling development; **Adapted, disease resistant cultivars** - produce plants able to resist disease attack; **Seed treatment fungicides** - depending on fungicide this will protect developing seedlings from a number pathogens; **Seed treatment insecticide** - depending on the insecticide fall barley yellow dwarf infections can be prevented; **Foliarly applied fungicides** - fungicides can protect the yield established when management practices and cultivar resistance fail to prevent economically significant losses from occurring.

Table 3.10 - Effectiveness of Management and Cultural Practices on Diseases of Wheat

Diseases	Sanitation	Crop rotation	Planting date	Balanced fertility	Disease free seed	Resistant cultivars	Fungicide Seed	Fungicide Foliar	Insecticide Seed
Powdery mildew	-		2[1]	3	-	1	1	1	-
Leaf rust	-	-	3	-	-	1	3	1	-
Leaf and glume blotch	2	2	-	-	2	3	2	1	-
Tan spot	2	2	-	-	-	3	-	2	-
Loose smut	-	-	-	-	1	-	1	-	-
Head scab[2]	1	1	-	-	-	-	-	-	-
Take-all	2	1	3	3	-	-	-	-	-
Barley yellow dwarf	-	-	1	-	-	2	-	-	1
Wheat spindle streak	-	-	2	-	-	1	-	-	-
Wheat streak mosaic virus	1	2	-	-	-	-	-	-	-

[1]1 = highly effective; 2 = moderately effective; 3 = slightly effective; and - = no effect in reducing disease.

[2]Seed infested with the head scab fungus will produce weak seedlings that are prone to seedling blight. A fungicide seed treatment may be of some benefit if germination rates are acceptable. Scabby seed does not produce head-scabbed plants.

Table 3.11 - Effectiveness of Management and Cultural Practices on Diseases of Barley

Diseases	Sanitation	Crop rotation	Planting date	Balanced fertility	Disease free seed	Resistant cultivars	Fungicide Seed	Fungicide Foliar	Insecticide Seed
Covered smut	-	-	-	-	1[1]	2	1	-	-
Loose smut	-	-	-	-	1	2	1	-	-
Powdery mildew	-	-	2	3	-	1	2	1	-
Leaf rust	-	-	2	-	-	1	3	1	-
Barley scald	1	1	-	-	-	1	-	1	-
Net blotch	1	1	-	-	-	1	2	1	-
Head scab[2]	1	1	-	-	-	-	-	-	-
Barley stripe	2	3	-	-	1	2	1	-	-
Barley yellow dwarf	-	-	2	-	-	1	-	-	1

[1]1 = highly effective; 2 = moderately effective; 3 = slightly effective; and - = no effect in reducing disease.

[2]Seed infested with the head scab fungus will produce weak seedlings that are prone to seedling blight. A fungicide seed treatment may be of some limited benefit if germination rates are acceptible. Scabby seed does not produce head scabbed plants.

Seed and Seedling Diseases

Fungicide seed treatments, properly applied, are highly recommended and can be considered inexpensive stand establishment insurance. Seed treatments minimize losses from seed decay, seedling blights, and seed- and soil-borne diseases. Slurry applications or commercial liquid applications provide the best adhesion and most uniform coverage and, thus, provide the most effective control. Recent problems with loose smut control have been attributed to poor fungicide coverage and higher levels of smut in seed that is treated. Hopper box treatments have not been providing the necessary coverage to ensure control.

Table 3.12 - Seed Treatment Fungicides for Small Grains

Crop	Disease	Fungicide Common name	Fungicide Trade name	Remarks
Barley, Oats, Rye, Wheat	Seed decay and seedling blights, including the scab fungus (seed treatments do not control the head blight phase of scab disease)	captan captan captan captan thiram thiram	Captan 30-DD Captan 300 Captan 400 Captan 400DD Thiram-50WP Gustafson 42-S	Thiram formulations are not registered for oats. Vitavax formulations, Raxil-Thiram, and Terra-Coat LT-2 are not registered for rye. Use according to instructions on label. Do not use treated seed for feed or food.
		carboxin	Vitavax	Not for use on rye
		carboxin + captan	Vitavax 20-20	Not for use on rye
		carboxin + thiram	Vitavax 200	Not for use on rye
		difenconazole + mefanoxam	Dividend XL RTA	For wheat use only. Apply 5.0-10.0 fl oz /100 lb of seed.
		difenconazole + mefanoxam	Dividend Apron XL-LS	For wheat use only. Apply 0.5 - 1.0 fl oz/100 lb of seed.
		difenconazole + mefanoxam	Dividend Extreme	For wheat and triticale only. Apply 1.0-4.0 fl oz/100 lb of seed.
		PCNB	Gustafson LT-2N	Not for use on rye
		tebuconazole + thiram	Raxil-Thiram	Not for use on rye

Table 3.12 - Seed Treatment Fungicides for Small Grains (cont.)

Crop	Disease	Fungicide Common name	Fungicide Trade name	Remarks
Barley	Loose smut *(Ustilago nuda),* Covered smut *(Ustilago hordei)*	carboxin carboxin carboxin carboxin + captan carboxin + thiram tebuconazole + thiram	Vitavax Vitavax 34 Vitavax 75W Vitavax 20-20 Vitavax 200 Raxil-Thiram	Use according to instructions on label. Must be applied as a slurry treatment for complete coverage.
	Covered smut *(Ustilago hordei)*	PCNB	Terra-Coat LT-2	Use according to instructions on the label. Should be applied as a slurry treatment for complete coverage.
	Barley stripe *(Helminthosporium gramineum)*	imazalil	Gustafson Flo-Pro IMZ	Use according to label instructions.
Oats	Loose smut *(Ustilago avenae)*, Covered smut*(Ustilago kolleri)*	carboxin carboxin carboxin + thiram	Vitavax Vitavax 34 Vitavax 200	Use according to instructions on label. Must be applied as a slurry treatment for complete coverage.
	Loose smut *(Ustilago avenae)*	PCNB + tebuconazole + thiram	Terra-Coat LT-2 Raxil-Thiram	Use according to instructions on the label. Should be applied as a slurry treatment for complete coverage.
Wheat	Loose smut *(Ustilago triticina)*	carboxin	Vitavax	Use according to instructions on label.
		carboxin carboxin + captan carboxin + thiram	Vitavax 34 Vitavax 20-20 Vitavax 200	Must be applied as a slurry treatment for complete coverage.
		difenconazole + mefanoxam	Dividend XL RTA	Apply 50.-10.0 fl oz/100 lbs of seed.
		difenconazole + mefanoxam	Dividend Apron XL-LS	Apply 0.5-1.0 fl oz/100 lbs of seed.
		difenconazole + mefanoxam	Dividend Extreme	Apply 1.0 fl oz/100 lbs of seed.
		tebuconazole + thiram	Raxil-Thiram	
		triadimenol	Baytan 30 Flowable	This material is only registered for application by certified seed condition ers and is not available for farmer application. Rate is 0.75-1.5 fl oz/100 lb of seed. **Caution:** Treated seed should not be planted late in the planting season or planted more than 1.5 inches deep. Use accord- ing to label instructions.
	Common bunt or stinking smut *(Tilletia caries)*	carboxin carboxin carboxin + captan carboxin + thiram	Vitavax Vitavax 34 Vitavax 20-20 Vitavax 200	Use according to instructions on label. Must be applied as a slurry treatment for complete coverage.

Table 3.12 - Seed Treatment Fungicides for Small Grains (cont.)

Crop	Disease	Fungicide Common name	Fungicide Trade name	Remarks
Wheat (cont.)	Common bunt or stinking smut *(Tilletia caries) (cont.)*	PCNB	Gustafson LT-2N	
		tebuconazole + thiram	Raxil-Thiram	
		difenconazole + mefanoxam	Dividend XL RTA	Apply 5-10 fl oz/100 lbs of seed.
		difenconazole + mefanoxam	Dividend Apron XL-LS	Apply 0.5-1.0 fl oz/100 lbs of seed.
		difenconazole + mefanoxam	Dividend Extreme	Apply 2.0 fl oz/100 lbs of seed.
	Common root rot complex *(Helminthosporium sativum* and *Fusarium* spp.*)*	imazalil	Gustafson Flo-Pro IMZ	Use according to label instructions.
		difenconazole + mefanoxam	Dividend XL RTA	Apply 5.0-10.0 fl oz/100 lbs of seed.
		difenconazole + mefanoxam	Dividend Apron XL-LS	Apply 0.5-1.0 fl oz/100 lbs of seed.
	Powdery mildew *(Erysiphe graminis* f.sp. *tritici)*	tridimenol	Bayton 30 Flowable	This fungicide will prevent the over wintering of powdery mildew and leaf rust in susceptible cultivars. Rate is 1.5 fl oz/100 lb of seed. It is only registered for application by certified seed conditioners and is not available for farmer application. **Caution:** Treated seed should not be planted late in planting season or planted more than 1.5 inches deep. Use according to label instructions.
		difenconazole + mefanoxam	Dividend Extreme	Apply 4.0 fl oz/100 lbs of seed.
	Leaf rust *(Puccinia triticina)*	difenconazole + mefanoxam	Dividend XL RTA	Apply 0.5-1.0 fl oz/100 lbs of seed.
		difenconazole + mefanoxam	Dividend Apron XL-LS	Apply 0.5-1.0 fl oz/100 lbs of seed.
				Dividend formulations provide a degree of fall season powdery mildew, leaf rust, and leaf and plume blotch control in winter wheat. For full season control, foliar fungicides may be required in the spring on cultivars that are susceptible to moderately susceptible to powdery mildew.

Table 3.13 - Effectiveness of Seed Treatments in the Management of Wheat and Barley Diseases

Seed treatment product(s)	Product rate (fl. oz./CWT)	Pythium pre-emergence damping-off	Wheat loose smut	Wheat early season powdery mildew	Wheat seedborne scab	Wheat early season stagonospora	Barley loose smut	Barley stripe
Baytan 30 + Captan 400	1.25 + 2.0	G	E	E	F	G	E	G
Baytan 30 + Thiram 42S	1.25 + 3.3	G	E	E	F	G	E	G
Dividend Extreme	2.0	E	E	F	F	G	NR	NR
Dividend Extreme	4.0	E	E	G	F	G	NR	NR
Dividend XL	0.5	E	VG	P	P	F	NR	NR
Dividend XL	1.0	E	E	F	F	G	NR	NR
Flo-Pro IMZ	0.25 – 0.5	-	N	N	F	-	N	E
Raxil + Thiram	3.5	G	E	F	G	G	E	G
Raxil MD	5.0	E	E	F	F	G	E	G
Raxil XT	0.16[1]	E	E	F	F	G	E	G
Vitavax 200	3.0 – 4.0	G	G	P	G	N	G	F

E = excellent, VG = very good, F = fair, P = poor, N = no control, NR = not registered, - = information not available.

[1]Raxil XT is a WP formulation. The rate is oz./CWT.

Table 3.14 - Small Grains: Seed-treatment Guidelines

Crop	Management	Cultivar susceptibility to powdery mildew	Fungicide(s) trade name	Remarks
Wheat	High or expected yield >70 bu/A	Susceptible	Baytan 30 + Captan or Baytan 30 + Thiram	May not provide full season control of mildew. Plant Baytan-treated seed no more than 1.5 inches deep. See rates in efficacy table above. Loose smut control is excellent and damping-off control is adequate.
	High or expected yield >70 bu/A	Moderately susceptible	Baytan 30 + Captan or Baytan 30 + Thiram Dividend XL (1.0-2.0 fl. oz./CWT) Dividend Extreme (2.0-4.0 fl. oz./CWT)	See Baytan remarks above. Mildew protection with Dividend tends to decline earlier in the spring than with Baytan. The 2.0 fl. oz. rate of Dividend is more effective against mildew.
	High or expected yield >70 bu/A	Moderately resistant or Resistant	See Remarks	Powdery mildew control with seed treatments is not required. Select any of the products on the efficacy table for loose smut and damping-off control.

Table 3.14 - Small Grains: Seed-treatment Guidelines (cont.)

Crop	Management	Cultivar susceptibility to powdery mildew	Fungicide(s) trade name	Remarks
Wheat (cont.)	Moderate or expected yield 50 to 70 bu/A	Moderately susceptible or Susceptible	Baytan 30 + Captan or Baytan 30 + Thiram Dividend XL (1.0-2.0 fl. oz./CWT) Divident Extreme (2.0-4.0 fl. oz./CWT)	Powdery mildew control with seed treatments can produce a yield response in disease favorable years. See Baytan comments above. Mildew protection with Dividend tends to decline earlier in spring than with Baytan. The 2.0 fl. oz. rate of Dividend is more effective against mildew.
	Moderate or expected yield 50 to 70 bu/A	Moderately resistant or Resistant	Any Raxil formulation Dividend XL (0.5-1.0 fl. oz./CWT) Dividend Extreme (2.0 fl. oz. CWT) Any Vitavax formulation	With this combination of control and resistance, the higher level of mildew protection is not warranted.
	Low or expected yield <50 bu/A	Any level	See Remarks	Select products primarily for loose smut and damping-off control.
Barley and Oats	N/A	N/A	See Remarks	Select products primarily for loose smut and damping-off control.

Control of Barley Yellow Dwarf in Small Grains

Barley yellow dwarf is the most widely distributed and destructive of the viral diseases that affect wheat. Symptoms of barley yellow dwarf are often confused with various nutritional or non-biological disorders. Leaf discoloration induced by the virus infection typically ranges from shades of yellow to red and sometimes purple, especially extending from the leaf tip to the base and from the leaf margin to the mid-rib. Seedling infections reduce yields most. Plants infected in the fall of the year may not survive the winter or are severely stunted and discolored when growth resumes in the spring. These diseased plants often occur in circular patches within the field. These patches are associated with the feeding and colonization by the aphid vectors in the fall and early spring. Grain yields from such plants have been shown to be reduced by 30 to 35 percent in experimental plots in Virginia. The virus can be transmitted by more than 20 species of aphids. (five species of which are known to occur in Virginia). The virus persists in small grains (barley, oats, rye, and wheat), in corn, and in over 80 species of perennial and annual grasses. The spread of this virus is entirely dependent on the activity of the aphid vectors. The environmental conditions that favor barley yellow dwarf epidemics are cool temperatures (50˚ to 65˚ F) with rainfall that favors wheat and grass growth as well as aphid reproduction and movement. Infections can occur throughout the season and are most abundant where high populations of aphids survive the winter. The leaf discoloration symptoms indicating virus infection develop within about two weeks of inoculation at temperatures between 65˚ to 70˚ F. When infections occur at temperatures above 85˚ F, symptoms do not develop.

The best means of control in barley is to select cultivars that are resistant to the virus and not to plant early in the season. Wheat cultivars range from highly susceptible to moderately susceptible. Planting later in the season will reduce the risk from fall infections of barley yellow dwarf, but this may not be enough in some years. A seed treatment insecticide has been shown to be highly effective in preventing fall barley yellow dwarf infections and significantly reducing spring infections as well.

When barley yellow dwarf has been common in a field and culture is directed towards higher yields then a seed treatment insecticide may be economically beneficial.

Table 3.15 - Control of Barley Yellow Dwarf Virus in Wheat and Barley

Disease	Insecticide common name	Trade name	Formulated rate per CWT seed	Remarks
Barley yellow dwarf	Imidacloprid	Gaucho 480	1.0 fl oz	Do not feed or graze animals on treated areas for 45 days after planting.
	thiamethoxam	Cruiser 5FS	0.75-1.33 fl oz	

Control of Wheat Spindle Streak Virus (Wheat Yellow Mosaic)

Wheat spindle streak virus is common in some fields in Virginia. Symptoms are typically expressed in leaves as yellow-green mottling with parallel dashes or streaks with tapered ends—hence the name wheat spindle streak. The virus is transmitted to wheat by a soil-borne fungus, *Polymyxa graminis,* which, in the absence of wheat, is associated with the roots of grassy weeds and other monocot crops (e.g., barley, corn, millet, rye, sorghum, etc.). Most significant infections take place during cool, wet periods in the fall. Often large areas of a field may be affected. Infection does not occur at temperatures above 68˚F. The optimal temperature for symptom expression is between 48˚ and 55˚F. The earlier in the life of the wheat plant that infection occurs, the more severe the symptom expression. During cool spring conditions, the yellow spindle streaks may become necrotic. Affected plants may be mildly stunted and produce fewer tillers and seeds per head.

Control is affected by selecting wheat cultivars that are resistant. A list of wheat cultivar disease resistance and susceptibility is presented in Table 3.16.

Control of Wheat Streak Mosaic Virus

Wheat streak mosaic virus (WSMV) was observed for the first time in more than 25 years during the 2000 growing season. The incidence and severity of this disease depends on the environment, vector survival, distribution and frequency of volunteer wheat plants that serve as a source of virus and a haven for the vector, and wheat cultivar susceptibility. Symptoms of wheat streak mosaic virus typically appear in the spring. These symptoms can look very similar to wheat spindle streak caused by wheat spindle streak mosaic virus, which is vectored by the soil-borne fungus *Polymyxa graminis*. However, the field pattern of wheat streak mosaic is related to the distribution and activity of the vector, the wheat curl mite, *Aceria tulipae*. As the wheat crop develops, plants affected with WSMV are typically severely stunted with yellow mottled and streaked leaves. These yellow streaks are often seen as discontinuous dashes running parallel to the leaf veins. As the season progresses, plants affected and colonized by the curl mites may develop "leaf rolling." Leaves appear upright while the margins roll inward. This symptom of mite feeding looks like drought stress in the affected plants. Wheat streak mosaic symptoms tend to become more severe as the weather warms, and severely affected plants may produce sterile heads or die prematurely.

The wheat curl mite, Aceria tulipae, is the vector and the only means by which the virus is transmitted in nature. This mite thrives in lush young growth of wheat and other grasses. Thus, volunteer wheat in soybean fields harvested in the fall is a particularly good breeding ground for this mite and the virus. The wheat curl mite is approximately 0.03 mm long. It is invisible to the unaided eye and is easily dispersed by winds. The mite can develop from egg to adult in 8 to 10 days. It reproduces rapidly at temperatures ranging from 75˚ to 80˚F. Dry conditions also favor the mite's development. It can overwinter as an egg, nymph, or adult either in the crowns of wheat plants of other host grasses. This enables the mite to survive freezing temperatures for several months. Survival is even greater in mild winters. Although wheat is the preferred host for Aceria tulipae, many other species of grasses are hosts for both the mite and the virus. These include corn, oats, foxtail, barnyardgrass, and others. Volunteer wheat is the primary means by which the wheat curl mite populations and the wheat streak mosaic virus are maintained. In the absence of a host with live green leaves, the wheat curl mite will only survive for a few days.

Since there are no effective chemicals registered for control of the wheat curl mite, disease management should be directed toward removing host plants during the fall and winter months (e.g., volunteer wheat) to prevent the survival of the mite and the maintenance of the virus in or near the field. Cultivars can vary in their susceptibility to the virus, but at this time the resistance or susceptibility of soft red winter cultivars has not been adequately characterized.

Foliar Diseases

Control of foliar diseases of small grains begins with the selection of well-adapted, disease resistant cultivars. Chemical control of foliar diseases generally has been found to be non-economical unless a high yield potential may be realized. Maximum economic yield (MEY) management practices, especially high nitrogen fertility and narrow rows, increase both the yield and disease potential in a small grain crop. Use of Baytan seed treatment and/or foliar-applied fungicides under high yield management may be required to control foliar diseases and protect the higher yield potential of the crop. The use of Baytan seed treatment should be based on: a) use of high-yield management practices, especially higher nitrogen fertility levels, and b) powdery mildew susceptibility of wheat cultivar (S through MS reactions). Cultivars rated MR to MS may not respond dramatically to Baytan depending on seasonal conditions.The decision to protect yields with fungicides should be made when the expected yield is roughly greater than 70 bu/A (the cut-off depends on the cost of production and on potential market price) and when conditions are forecast to be favorable for continued disease development and stage of crop growth. Conditions for powdery mildew are characterized by temperatures between 60° and 75° F and periods of high relative humidity. Leaf rust develops most rapidly when temperatures are between 60° and 85° F and free moisture from showers or dew can be found on leaves from early evening until late morning hours. Septoria leaf and glume blotch is favored by wind blown rain, high relative humidity, and temperatures between 68° and 82° F. The disease characteristically moves upward from infected lower leaves in the plant canopy. Use disease threshold information in the "Remarks" section of Foliarly applied fungicides for disease control in small grains as a guide to knowing when and if to spray.

Table 3.16 - Wheat Cultivars and Their Disease Reactions[1]

Cultivar	Powdery Mildew	Leaf Rust	Leaf and glume blotch	Wheat spindle steak mosiac	Barley yellow dwarf virus
AgriPro Crawford	R	NA	NA	MR-MS	NA
AgriPro Foster	MR-MS	MS-S	NA	NA	MS
AgriPro Hickory	MR-MS	S	MS	MS	S
AgriPro Mason	MR-MS	MR	MS	MS	NA
Century II S	S	MS	NA	NA	NA
DynoGro 424	S	R	MS	R	S
Featherstone 520	MS	MS	MS	MS	S
FFR 502W	MR	VS	MS	MS-S	S
FFR 518	MS	R	NA	NA	NA
FFR 520	MR	S	NA	NA	NA
FFR 522	S	R	NA	S	NA
FFR 523W	MS	MR	MS	S	S
FFR 525W	VS	MS-S	MS	S	S
FFR 535	MS	S	NA	MR-MS	NA
FFR 544W	MS	MR-MS	MS	NA	VS
FFR 550W	MR	MS	NA	MS	NA
FFR 555W	S	MS	MS	MS	VS
FFR 560	MS	MR	NA	NA	NA
FFR 566	MR	R	NA	NA	NA
FFR 568W	MS	S	MS-S	MR	S
Florida 302	MS-S	MR-MS	MS-S	VS	MS
Gore	MR-MS	MR	MS	MS	S
Hoffman 14	S	MS	MS	S	S

VS = Very Susceptible; S = Susceptible; MS = Moderately Susceptible; MR = Moderately Resistant; R = Resistant; NA = Data not available.

[1]Disease **reactions may change** with environmental conditions and the **composition of pathogen races**.

Table 3.16 - Wheat Cultivars and Their Disease Reactions[1] (cont.)

Cultivar	Powdery Mildew	Leaf Rust	Leaf and glume blotch	Wheat spindle steak mosiac	Barley yellow dwarf virus
Hoffman 57	MR	S	MS	R	MS
Hoffman 95	MS	MR-MS	MS	MS	S
Jackson	MR	S	MS	MS	MS
Madison	MR-MS	MS	MS	R	MR-MS
Massey	MR	VS	MS	R	MR
McCormick	MR	S	MR	NA	NA
NKCoker Brand 9025	S	R	NA	NA	NA
NKCoker Brand 9134	MS-S	MR	MS	MS	S
NKCoker Brand 9184	MS	R	NA	NA	NA
NKCoker Brand 9663	S	R	MS	MS	MS
NKCoker Brand 9704	MS	MR	MS	R	MS
NKCoker Brand 9733	S	MR	MS	S	MS
NKCoker Brand 9803	MS-S	MS	MS	MR-MS	MS
NKCoker Brand 9835	MS-S	R	MS	MR-MS	MS
Pocahontas	R-MR	MS	MS	S	VS
Pioneer Brand 2548	MS	MR	MS	VS	MS
Pioneer Brand 2550	MS-S	S	MS	S	MS
Pioneer Brand 2551	MS-S	MR	MS	S	MS
Pioneer Brand 2555	S	MS	MS	S	MS
Pioneer Brand 2566	S	MR	MS	NA	NA
Pioneer Brand 2580	MR	MR	MS	S	MS
Pioneer Brand 2643	MR-MS	MR-MS	MS	R	MS
Pioneer Brand 2684	MS	MR-MS	MS	MS-MR	MS
Pioneer Brand 2691	MR-MS	MR	MS	MS	MS
Pioneer Brand 26R24	MS	MS	NA	NA	NA
Pioneer Brand 26R38	MS	MS	NA	NA	NA
Pioneer Brand 26R46	MS	MS	NA	NA	NA
Roane	VS	MR-MS	MS	MS	S
Saluda	VS	MS	MS	VS	MS-S
Sisson	MR	S	MR	MR	NA
Tyler	S	VS	MS	MR	S
USG 3209	R-MR	S	NA	MS-S	NA
USG 3408	MR-MS	R	MR	S	NA
USG 3650	MR	S	NA	R	NA
Vigoro Tribute	R	R	MR	R	NA
Wakefield	VS	MS	MS	MS	VS

VS = Very Susceptible; S = Susceptible; MS = Moderately Susceptible; MR = Moderately Resistant; R = Resistant; NA = Data not available.

[1]Disease **reactions may change** with environmental conditions and the **composition of pathogen races**.

Table 3.17 - Barley Cultivars and Their Disease Reactions[1]

Cultivar	Powdery Mildew	Leaf Rust	Scald	Net Blotch	Barley Yellow Dwarf
Barsoy	S	VS	S	R	S
Boone	S	S	S	MR	MS
Callao	R	MS	MR-MS	MR	MR
Nomini	R	MS	MR-MS	MR	MR
Pumunkey	R	MS	MR-MS	MS	MR
Pennbar 66	R	MR	MR	MR	—
Pennco	R	MR	R	MS	MR
Starling	R	MR-MS	MR-MS	MS	MR
Sussex	R	S	MR-MS	MR	MR
Wysor	R	MR-MS	MR-MS	MR	MR

VS = Very Susceptible; S = Susceptible; MS = Moderately Susceptible; MR = Moderately Resistant; R = Resistant; NA = Data not available.

[1] Disease reactions may change with environmental conditions and the composition of pathogen races.

Table 3.18 - Foliarly Applied Fungicides for Disease Control in Small Grains

Crop	Disease	Fungicide Common name	Fungicide Trade name	Formulated Rate/Acre	Remarks
Wheat and Barley	Powdery mildew on wheat *(Erysiphe graminis* f.sp. *tritici)* and barley (*Erysiphe graminis* f.sp. *hordei*)	propiconazole propiconazole propiconazole + trifloxystrobin azoxystrobin + propiconazole	Tilt 3.6EC PropiMaxEC Stratego 250EC Quilt 200SC	4.0 fl oz 4.0 fl oz 10.0 fl oz 14.0 fl oz	Scout fields weekly from **Zadoks' growth stages** (GS) 30 through 59 (Feekes' GS 5 through GS 10.5) head emergence. Examine plants from 5 to 10 randomly selected areas within the field. Make application only when powdery mildew covers 5-10% of area of fully expanded upper leaves **(See Figure 3.2)**, but not before tillers have reached Zadoks' 31 (Feekes' GS 6) first joint **(See Figure 3.1),** except in the Tidewater region south of the James River. Do not apply more than 4.0 fl oz/A of Tilt or PropiMax EC per year. PropiMax cannot be applied after Zadoks' growth stage 37 (Feekes' GS 8). Tilt, Stratego, and Quilt may be applied up to Zadoks' GS 59 (Feekes' GS 10.5), head has emerged, but not yet flowering. Do not apply after GS 37 on barley. Do not graze or feed livesock treated forage or cut the green crop for hay or silage. After harvest straw may be used for bedding. Follow all label instructions.

Table 3.18 - Foliarly Applied Fungicides for Disease Control in Small Grains (cont.)

Crop	Disease	Fungicide Common name	Fungicide Trade name	Formulated Rate/Acre	Remarks
Wheat	Leaf and glume blotch (*Stagonospora nodorum)* and Tan spot (*Pyrenophora tritici-repentis)*	mancozeb mancozeb mancozeb mancozeb mancozeb mancozeb mancozeb	Dithane M45 Dithane F45 Dithane DF Manzate 200 Manzate DF Penncozeb Penncozeb DF	2.0 lb 1.6 qt 2.0 lb 2.0 lb 2.0 lb 1.5-2.0 lb 1.5-2.0 lb	These fungicides are protectant types that must be applied before infection to provide a barrier to prevent infection. Make first application when flag leaf is fully emerged (Feekes' stage 10 or Zadoks' 45) and repeat when grain head is visible about 10-12 days later. Do not make last application within 26 days of harvest. Livestock may not graze in treated areas within 26 days of last treatment. Penncozeb is only registered for use on wheat.
Wheat and Barley	Leaf rust *(Puccinia triticina and P. hordei)*	propiconazole propiconazole	Tilt 3.6EC PropiMax EC	4.0 fl oz 4.0 fl oz	Scout fields weekly from **Zadoks' growth stages** (GS) 30 through 59 (Feekes' GS 5 through GS 10.5). Examine plants from 5 to 10 randomly selected areas within the field. Make application only when rust pustules cover 1-3% of area of fully expanded upper leaves **(See Figure 3.1)**, but not before first joint (Feekes' GS 6 or Zadoks' GS 31), except in Tidewater region south of the James River. **(See Figure 3.1)**. Do not apply more than 4.0 fl oz/ A of Tilt or PropiMax EC per year. PropiMax cannot be applied after Zadoks' growth stage 37 (Feekes' GS 8). Both Tilt and Stratego may be applied up to Zadoks' GS 59 (Feekes' GS 10.5), head has emerged, but not yet flowering. Do not apply after Feekes' 8 or Zadoks' 37 on barley. Do not graze or feed livestock treated forage or cut the green crop for hay or silage. After harvest the straw may be used for bedding or feed. Follow label instructions for additional precautions.

Table 3.18 - Foliarly Applied Fungicides for Disease Control in Small Grains (cont.)

Crop	Disease	Fungicide Common name	Fungicide Trade name	Formulated Rate/Acre	Remarks
Wheat and Barley (cont.)	Leaf rust *(Puccinia triticina and P. hordei)* (cont.)	pyraclostrobin	Headline 2.09EC	6.0-9.0 fl oz	Headline should be integrated into an overall disease man- agement strat- egy that includes proper selection of cultivars with disease tolerance, removal of plant debris in which inocu- lum overwinters, and plant residue management. **Resistance manage- ment:** Do not make more than two application/A/year. Determina- tion of treatment threshold: Scout fields weekly from Zadoks' growth stages (GS) 30 through 69 (Feekes' GS 5 through 10.53). Examine plants from 5 to 10 randomly selected areas within the field. Make application only when rust pustules cover 1% to 3% of area of fully expanded upper leaves (**See Figures 3.1 and 3.2**). Do not apply to barley after Zadoks' GS 55 (Feekes' GS 10.3). Do not apply to wheat after Zadoks' GS 69 (Feekes' GS 10.53). Do not harvest hay within 14 days of application.
Wheat	Leaf rust *(Puccinia triticina)*	azoxystrobin propiconazole + trifloxystrobin	Quadris 2.08SC Stratego 250EC	6.2-10.8 fl oz 10.0 fl oz	Quadris, Stratego, and Quilt should be integrated into an overall disease management strategy that includes proper selection of varieties with dis- ease tolerance, proper timing and placement of irrigation, removal of plant debris in which inoculum over- winters, plant residue management, and crop rotation. **Resistance man- agement:** Do not make more than two applications of Quadris or Stratego/A/ year. **Application directions:** Quadris or Stratego should be applied prior to or in the early stages of disease development. Applications may be made at any time immediately after jointing (Feekes' 6 or Zadoks' 31) up to late head emergence (Feekes' 10.5 or Zadoks' 59). A crop oil concen- trate adjuvant may be added at 1.0% v/v to optimize efficacy. Do not apply later than Feekes' growth stage 10.5 (Zadoks' 59). Do not harvest treated wheat for forage. Do not apply more than 0.77 quarts product/A/season (0.4 lb ai/A). Do not apply within 14 days of harvest for hay. Do not apply within 45 days of harvest for grain and straw.
		azoxystrobin + propiconazole	Quilt 200SC	14.0 fl oz	

Table 3.18 - Foliarly Applied Fungicides for Disease Control in Small Grains (cont.)

Crop	Disease	Fungicide Common name	Fungicide Trade name	Formulated Rate/Acre	Remarks
Barley and Rye	Barley scald (*Rhynchosporium secalis*), Net blotch *(Pyrenophora teres),*	propiconazole propiconazole	Tilt 3.6 EC PropiMax EC	4.0 fl oz 4.0 fl oz	Scout fields weekly from Zadoks' growth stages (GS) 30 through 37 (Feekes' GS 5 through GS 8).
Wheat	Leaf and glume blotch*(Stagonospora nodorum)* and Tan spot *(Pyrenophora tritici-repentis)*	propiconazole propiconazole propiconazole + trifloxystrobin azoxystrobin + propiconazole	Tilt 3.6 EC PropiMax EC Stratego 250EC Quilt 200SC	4.0 fl oz 4.0 fl oz 10.0 fl oz 14.0 fl oz	Determination of treatment threshold: Scout fields weekly from Zadoks' growth stages (GS) 30 through 59 (Feekes' GS 5 through GS 10.5) head emergence. For leaf and glume blotch collect main tillers from 10 plants from 10 randomly selected areas within the field. Examine the appropriate indicator leaf (see Figure 3) from each tiller and record the number of indicator leaves with one or more lesions. If 25% of the 100 indicator leaves have one or more lesions, then a fungicide application is indicated. Do not apply more than 4.0 fl oz/ A of Tilt or PropiMax EC per year. PropiMax cannot be applied after Zadoks' growth stage 37 (Feekes' GS 8). Both Tilt and Stratego may be applied up to Zadoks' GS 59 (Feekes' GS 10.5), head has emerged, but not yet flowering.
		azoxystrobin	Quadris 2.08SC	6.2-10.8 fl oz	Quadris should be integrated into an overall disease manage- ment strategy that includes pro- per selection of varieties with disease tolerance, proper timing and placement of irrigation, removal of plant debris in which inoculum overwinters, plant residue management, and crop rotation. Resistance manage- ment: Do not make more than two applications of Quadris per acre per year. Application direc- tions: Quadris should be applied prior to or in the early stages of disease development. Applica- tions may be made at any time, immediately after jointing (Feekes' 6 or Zadoks' 31) up to late head emergence (Feekes' 10.5 or Zadoks' 59). A crop oil concentrate adjuvant may be added at 1.0% v/v to optimize efficacy. Do not apply later than Feekes' growth stage 10.5 (Zadoks' 59). Do not harvest treated wheat for forage. Do not apply more than 0.77 qts product/ A/season (0.4 lb ai/A). Do not apply within 14 days of harvest for hay. Do not apply within 45 days of harvest for grain and straw.

Table 3.18 - Foliarly Applied Fungicides for Disease Control in Small Grains (cont.)

Crop	Disease	Fungicide Common name	Fungicide Trade name	Formulated Rate/Acre	Remarks
Wheat (cont.)	Leaf and glume blotch*(Stagonospora nodorum)* and Tan spot *(Pyrenophora tritici-repentis) (cont.)*	pyraclostrobin	Headline 2.09EC	6.0-9.0 fl oz	Headline should be integrated into an overall disease manage- ment strategy that includes proper selection of cultivars with disease tolerance, removal of plant de- bris in which inoculum overwin- ters, and plant residue manage- ment. **Resistance management:** Do not make more than two appli- cations/A/year. Determination of treatment threshold: Scout fields weekly from Zadoks' growth stages (GS) 30 through 69 (Feekes' GS 5 through 10.53). For leaf and glume blotch collect main tillers from 10 plants from 10 randomly selected areas with- in the field. Examine the appro- priate indicator leaf (**See figure 3.3**) from each tiller and record the number of indicator leaves with one or more lesions. If 25% of the 100 indicator leaves have one or more lesions, then a fungicide application is indicated. Do not apply to after Zadoks' GS 69 (Feekes' GS 10.53). Do not harvest hay within 14 days of application.

Table 3.19 - Efficacy of Foliarly Applied Fungicides to Manage Wheat Diseases in the Mid-Atlantic Region

Active ingredient	Fungicide trade name	Powdery mildew	Leaf rust	Stagonospora leaf and glume blotch	Tan spot	Fusarium head blight (Head scab)
Azoxystrobin	Quadris 2.08 SC	F	E	VG	E	P
Mancozeb	Dithane M-45, Penncozeb	P	P-F	P-F	P-F	P
Propiconazole	Tilt 3.6 EC, PropiMax 3.6 EC	VG	VG	VG	VG	P
Pyraclostrobin	Headline 2.09 EC	F	E	VG	E	P
Trifloxystrobin + 11.4% Propiconazole 11.4%	Stratego 250 EC	G	E	VG	VG	P
Azoxystrobin + 7% + Propiconazole 11/7%	Quilt 200SC	VG	E	VG	VG	NR

Effectiveness of foliarly applied fungicides is highly dependent on disease severity, disease-favorable weather, and timing of application. The above ratings are based on "head-to-head" comparisons under a best fungicide case scenario. Use decision guides to determine thresholds and when to apply products.
Key: E = excellent, VG = very good, G = good, F = fair, P = poor, and NR = not recommended.

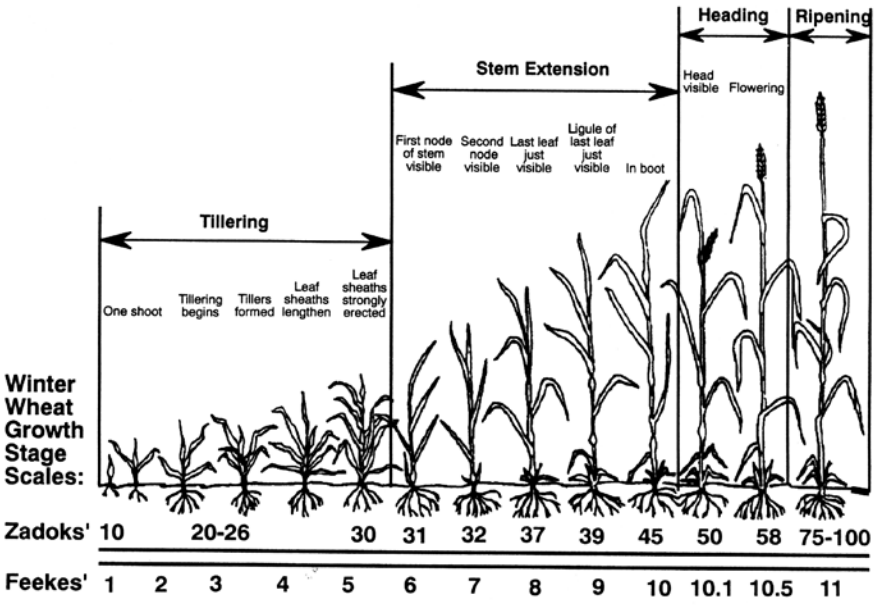

Fig. 3.1 Stages of growth of small grains.

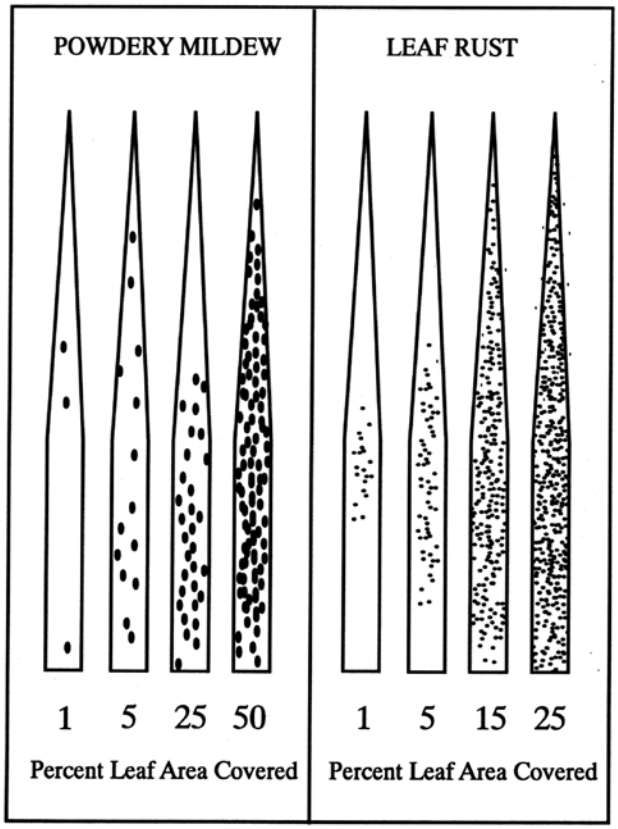

Fig. 3.2 Percent leaf area affected by powdery mildew and leaf rust. (After C. James. 1971. A Manual of Assessment Keys for Plant Diseases, *Canada Department of Agriculture, Publication No. 1458).*

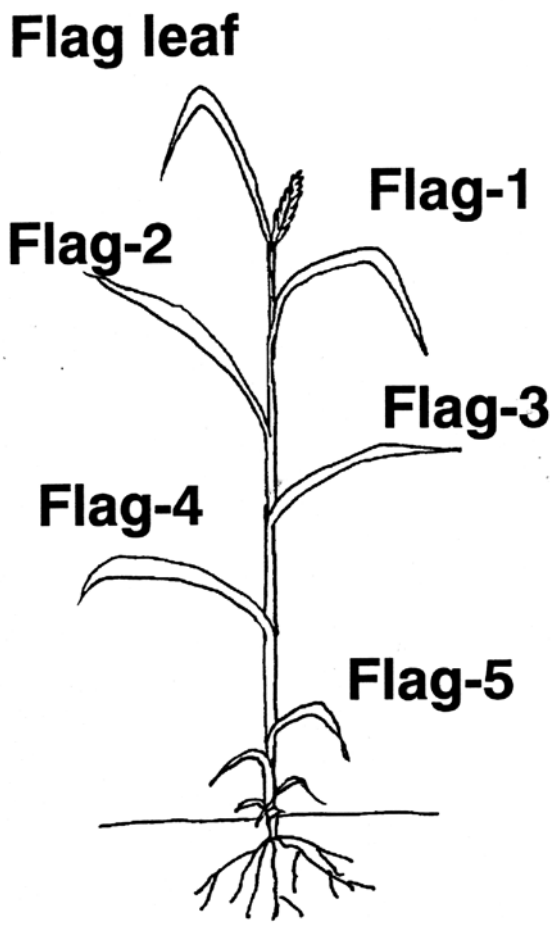

Fig. 3.3 Determination of treatment threshold for leaf and glume blotch in wheat.

Scout fields weekly from Zadoks' Growth stage 31 through 73 (Feeks' 6 through 11). Randomly select 10 locations within a wheat field. At each randomly selected location, examine and record number of indicator leaves out of ten main tillers with one or more leaf and glume blotch lesion(s). If 25% of the (100) indicator leaves in the field have one or more lesions then a fungicide application is indicated

Indicator Leaves are:

Flag-4 and **Flag-5** for Zadoks' Growth Stages 31-37 (Feeks' 6-8)

Flag-3 for Zadoks' Growth Stages 38-45 (Feeks' 8-10)

Flag-2 for Zadoks' Growth Stages 46-59 (Feeks' 10-10.51)

Flag-1 from Zadoks' Growth Stages 60-73 (Feeks' 10.52-11)