



Current Report

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Foliar Fungicides and Wheat Production in Oklahoma

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Question: How are the growth stages of wheat described?

Answer: The Feekes' scale (Figure 1) is commonly used to describe the growth stages of wheat. This scale describes the growth stages of wheat numerically, and is commonly used to indicate the recommended timing of pesticide applications.

Question: How much damage can a foliar disease such as leaf rust cause on wheat?

Answer: A foliar disease such as leaf rust causes the most damage when it is severe at heading, flowering or milk, and not as damaging at soft dough or later (Table 1).

Question: When should I apply a fungicide?

Answer: All the fungicides listed in Tables 2 and 3 can be applied up to growth stage 10.5 (heads completely emerged but

Table 1. Approximate percent loss of yield caused by leaf rust at combinations of leaf rust severity and growth stage of wheat.

Growth stage	Severity (%) of leaf rust on the flag leaf				
	10	25	40	65	100
Flowering	10	15	20	30	35
Milk	2	5	8	14	20
Soft dough	1	3	4	7	10
Hard dough	1	1	1	3	5

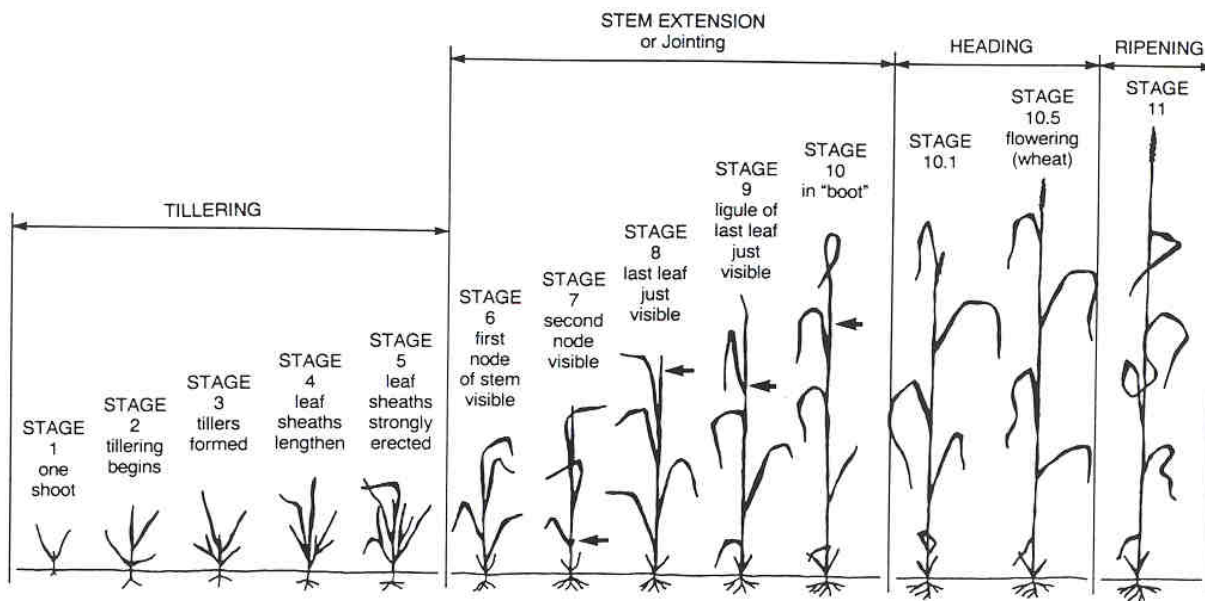


Figure 1. The Feekes scale of wheat development.

Large, E.C. 1954. Growth stages in cereals: Illustration of the Feekes' scale. Plant Pathology 3:128-129.

not yet flowering) or in a few cases, up to growth stage 10.5.4 (flowering completed; kernel watery ripe; see Table 3). In most years, the optimum period for application is from growth stages 9 (flag leaf fully emerged) to 10.5 (heads fully emerged) because application in this range most likely provides protection during the critical times of flowering and milk (Table 1).

Question: What fungicides are available for use in Oklahoma?

Answer: Many fungicides currently are labeled for use on wheat. A comparison of the relative effectiveness of these fungicides is presented in Table 3. REMEMBER to consult the label for the most current and accurate information.

Question: What is the potential benefit from using a foliar fungicide?

Answer: More than 20 years of fungicide trials including years with little or no disease and several years with high disease pressure have documented an average yield increase of approximately 10 percent from using fungicides. Such an increase usually justifies fungicide use if the yield potential and price of wheat are high. Hence, consider the following to assist in deciding whether to apply a fungicide to control a foliar disease (Table 4):

- **Will a foliar fungicide help to regain yield?** The answer to this is “NO!” Foliar fungicides can only help protect the yield potential present at application.

Table 2. Effect of foliar fungicides on grain yield, test weight, and severity of wheat leaf rust and powdery mildew in a “low” foliar disease year (2014) and a “high” foliar disease year (2016).

	<i>Growth stage</i> ¹	<i>Yield</i>	<i>Test weight</i>	<i>Leaf rust</i>		<i>Powdery mildew</i>
				May 6	May 15	
Stillwater 2014 (no disease pressure)						
		bu/ac	lb/bu	-----% severity-----		
No treatment	----	53	58	0		0
Priaxor® @ 2 oz FB ²						
TwinLine® @ 7 oz	6 FB 10.3	58	58	0		0
Approach® @ 3 oz FB						
Approach Prima® @ 6.8 oz	6 FB 10.3	55	58	0		0
Twinline® @ 9 oz	10.3	53	58	0		0
Approach® @ 9 oz	10.3	53	58	0		0
Approach Prima® @ 6.8 oz	10.3	51	58	0		0
Folicur® @ 4 oz	10.3	54	58	0		0
Stratego YLD® @ 4 oz	10.3	56	58	0		0
Prosaro® @ 6.5 oz	10.3	54	58	0		0
Quilt Xcel® @ 10.5 oz	10.3	54	58	0		0
Alto® @ 3.5 oz	10.3	54	58	0		0
Tilt® @ 4 oz	10.3	56	58	0		0
LSD (p=0.05)		NS	NS	--		---
Stillwater 2016 (high disease pressure)						
		bu/ac	lb/bu	-----% severity-----		
No treatment	---	56	57	40	92	18
Nexicor® @ 3.5 oz FB						
Nexicor® @ 7 oz	6 FB 9	72	58	4	66	2
Approach® @ 3 oz FB						
Approach Prima® @ 6.8 oz	6 FB 9	69	58	9	65	1
Tilt® @ 4 oz	9	59	58	24	95	16
Folicur® @ 4 oz	9	63	58	6	73	21
Nexicor® @ 7 oz	9	66	58	9	69	13
Approach Prima® @ 6.8 oz	9	68	59	4	73	7
Trivapro® @ 13.7 oz	9	72	59	2	43	9
Quilt Excel® @ 10.5 oz	9	72	58	3	59	8
Alto® @ 5.5 oz	9	63	58	4	46	13
Absolute Maxx® @ 5 oz	9	72	59	2	59	10
Prosaro® @ 5 oz	9	64	58	4	49	10
LSD (p=0.05)	--	9	NS	9	19	8

¹ Growth stage 6 = first node visible; growth stage 9 = flag leaf fully emerged; growth stage 10.3 = heads about half emerged from the boot.

² FB=followed by.

Table 3. Management of Small Grain Diseases Fungicide Efficacy for Control of Wheat Diseases (April 2019).

The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) has developed the following information on fungicide efficacy for control of certain foliar diseases of wheat for use by the grain production industry in the U.S. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy is based on proper application timing to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. Table includes most widely marketed products, and is not intended to be a list of all labeled products. This information is provided only as a guide. It is the responsibility of the pesticide applicator by law to read and follow all current label directions. No endorsement is intended for products listed, nor is criticism meant for products not listed. Members or participants in the NCERA-184 committee assume no liability resulting from the use of these products.

Active Ingredient	Fungicide(s)										Harvest Restriction
	Product	Rate/A (fl. oz)	Powdery mildew	Stagonospora leaf/ glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head Scab ¹	
Strobilurin	Picoxystrobin 22.5%	Approach SC	G ¹	VG	VG ²	VG	E ³	VG	VG	NL	Feekees 10.5
	Pyraclostrobin 23.6%	Headline SC	G	VG	VG ²	E	E ³	E	G	NL	Feekees 10.5
Triazole	Metconazole 8.6%	Caramba 0.75 SL	VG	VG	--	VG	E	E	E	G	30 days
	Tebuconazole 38.7%	Folicur 3.6 F ³	NL	NL	NL	NL	E	E	E	F	30 days
	Prothioconazole 41%	Proline 480 SC	--	VG	VG	VG	VG	VG	VG	G	30 days
	Prothioconazole 19%	Prosaro 421 SC	G	VG	VG	VG	E	E	E	G	30 days
	Tebuconazole 19%	Tilt 3.6 EC ⁵	VG	VG	VG	VG	VG	VG	VG	P	Feekees 10.5.4
Mixed mode of action ⁶	Tebuconazole 22.6%	Absolute Maxx SC	G	VG	VG	VG	VG	E	VG	NL	35 days
	Trifloxystrobin 22.6%	Absolute Maxx SC	G	VG	VG	VG	VG	E	VG	NL	35 days
	Cyproconazole 7.17%	Approach Prima SC	VG	VG	VG	VG	E	VG	--	NR	45 days
	Picoxystrobin 17.94%	Approach Prima SC	VG	VG	VG	VG	E	VG	--	NR	45 days
	Prothioconazole 16.0%	Delaro 325 SC	G	VG	VG	VG	VG	VG	VG	NL	Feekees 10.5 35 days
	Trifloxystrobin 13.7%	Delaro 325 SC	G	VG	VG	VG	VG	VG	VG	NL	Feekees 10.5 35 days
	Pydiflumetofen 13.7%	Miravis Ace SE	VG	VG	VG	VG	VG	VG	VG	G ⁷	Feekees 10.5.4
	Propiconazole 11.4%	Miravis Ace SE	VG	VG	VG	VG	VG	VG	VG	G ⁷	Feekees 10.5.4
	Fluopyroxad 2.8%	Nexicor EC	G	VG	VG	E	E	E	VG	NL	Feekees 10.5
	Pyraclostrobin 18.7%	Nexicor EC	G	VG	VG	E	E	E	VG	NL	Feekees 10.5
Fluoxastrobin 14.8%	Preemptor SC	--	--	VG	VG	E	E	--	NL	Feekees 10.5 and 40 days	
Flutriafol 19.3%	Preemptor SC	--	--	VG	VG	E	E	--	NL	Feekees 10.5 and 40 days	
Mixed mode of action ⁶	Fluxapyroxad 14.3%	Priaxor	G	VG	VG	E	VG	VG	G	NL	Feekees 10.5
	Pyraclostrobin 28.6%	Priaxor	G	VG	VG	E	VG	VG	G	NL	Feekees 10.5
	Propiconazole 11.7%	Quit Xcel 2.2 SE ⁵	VG	VG	VG	VG	E	E	VG	NL	Feekees 10.5.4
	Azoxystrobin 13.5%	Quit Xcel 2.2 SE ⁵	VG	VG	VG	VG	E	E	VG	NL	Feekees 10.5.4
	Prothioconazole 10.8%	Quit Xcel 2.2 SE ⁵	VG	VG	VG	VG	E	E	VG	NL	Feekees 10.5.4
Mixed mode of action ⁶	Trifloxystrobin 32.3%	Stratego YLD	G	VG	VG	VG	VG	VG	VG	NL	Feekees 10.5 35 days
	Benzovindiflupyr 2.9%	Stratego YLD	G	VG	VG	VG	VG	VG	VG	NL	Feekees 10.5 35 days
	Propiconazole 11.9%	Stratego YLD	G	VG	VG	VG	VG	VG	VG	NL	Feekees 10.5 35 days
Azoxystrobin 10.5%	Trivapto SE	VG	VG	VG	VG	E	E	VG	NL	Feekees 10.5.4 14 days	

¹ Efficacy categories: NL=Not Labeled; NR=Not Recommended; P = Poor; F = Fair; G = Good; VG = Very Good; E = Excellent; -- = Insufficient data to make statement about efficacy of this product.
² Product efficacy may be reduced in areas with fungal populations that are resistant to strobilurin fungicides.
³ Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred.
⁴ Application of products containing strobilurin fungicides may result in elevated levels of the mycotoxin Deoxynivalenol (DON) in grain damaged by head scab.
⁵ Multiple generic products containing the same active ingredients also may be labeled in some states.
⁶ Products with mixed modes of action generally combine triazole and strobilurin active ingredients. Nexicor, Priaxor and Trivapto include carboxamide active ingredients.
⁷ Based on application timing at the beginning of anthesis (Feekees 10.5.1)

- **What is the yield potential of the wheat?** This should be 30 to 40 bushels per acre at a minimum, but can go up or down, depending on the price of wheat.
- **What is the price of wheat?** The higher the price, the more economical fungicide application becomes. See Table 4.
- **What is the growth stage of the wheat?** Foliar diseases do the most harm when infection is severe at stages such as heading, flowering and milk. So be sure to apply fungicide before disease is severe.
- **What about a split application of a fungicide?** For example, applying a reduced rate at an early growth stage (for example at GS 6 to 7) and then a full rate at GS 10 or so. Splitting the application of a fungicide may provide benefit for early season stripe rust or for diseases such as tan spot, septoria/stagonospora and powdery mildew that initiate from fungal inoculum on wheat residue left on the soil surface such as in no-till situations. A split application also may have benefit if a variety is extremely susceptible to these diseases and they are present in the late winter or early spring. However most data indicates that a single application from stages 9 to 10.5 is usually the most beneficial. If a split application is used, the first application should not be made with topdressing as the nitrogen needs to be applied prior to finding nodes at the base of tillers (GS 6 to 7) so the fertilizer moves into the root zone prior to jointing. Consider making the first (early) application a lower-cost generic, reserving the higher cost and more effective fungicides for a subsequent application, if needed. ALSO, take care to not exceed the maximum amount of a fungicide that can be applied in one season. Check the label to ascertain this.
- **What diseases are present?** Be sure which foliar fungal diseases are present. Stripe rust can be especially damaging because of its ability to quickly kill entire leaves. Hence, if you are considering a fungicide application to protect against stripe rust, it is critical to apply the fungicide before the appearance of rust pustules on the flag leaf.
- **What is the disease reaction of the variety?** Refer to the OSU Extension Fact Sheet PSS-2142 “Wheat Variety Comparison Chart,” available online at facts.okstate.edu or <http://www.wheat.okstate.edu/wheatmanagement/varieties/index.htm>. Some pathogens (e.g., the pathogen that causes wheat leaf rust) can adapt to resistance genes, and a resistant variety may become susceptible when a new race appears.
- **What is the weather forecast?** Hot and dry conditions inhibit further disease development and hasten ripening, while cool and moist conditions promote disease and lengthen the period of time for grain development and filling.

Table 4. The formulas below can be used to help determine the potential value of a fungicide application. This is a simple cost-benefit evaluation where the yield potential, the price of a bushel of wheat, and the cost of a fungicide can all be easily adjusted.

Potential increase		Estimated yield goal		Estimated selling price		Fungicide + app. cost ¹		Potential return on investment
Grain production scenario								
10%	X	30 bu/A	X	\$4.00/bu	–	\$8.00/A	=	+\$4.00/A
10%	X	50 bu/A	X	\$4.00/bu	–	\$8.00/A	=	+\$12.00/A
10%	X	30 bu/A	X	\$7.00/bu	–	\$16.00/A	=	+\$5.00/A
10%	X	50 bu/A	X	\$7.00/bu	–	\$16.00/A	=	+\$19.00/A
Same scenario for certified seed production								
10%	X	30 bu/A	X	\$15.00/bu	–	\$8.00/A	=	+\$37.00/A
10%	X	50 bu/A	X	\$15.00/bu	–	\$8.00/A	=	+\$67.00/A
10%	X	30 bu/A	X	\$15.00/bu	–	\$16.00/A	=	+\$29.00/A
10%	X	50 bu/A	X	\$15.00/bu	–	\$16.00/A	=	+\$59.00/A

¹ Fungicide costs can vary greatly depending on chemical used and application method.

The pesticide information presented in this publication was current with federal and state regulations at the time of printing. The user is responsible for determining that the intended use is consistent with the label of the product being used. Use pesticides safely. Read and follow label directions. The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Cooperative Extension Service is implied.

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