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Plant Pathology Fact Sheet

Fungicide Use in Wheat

Donald E. Hershman
Extension Plant Pathologist

Background

Disease management is a key component of high-yielding wheat production. In most years, it simply is not possible to produce high wheat yields without paying attention to disease control. Most diseases are best managed through the use of multiple tactics, both proactive (e.g., crop rotation, delayed and/or staggered planting plates, use of resistant varieties of varying maturities, proper fertility, and application of seed treatment and/or foliar fungicides) and reactive (e.g., application of foliar fungicides and timely harvest). Fungicides are just one tool in the disease management arsenal; however, growers often place too much emphasis on this one tool.

This fact sheet discusses the pros and cons of fungicide seed treatments and foliar fungicide applications, as well as presents information on making the most appropriate fungicide use decisions. Research and experience tells us that the use of seed treatment and foliar fungicides are usually necessary to maximize wheat profitability in Kentucky. This said, there are some years where treatments are not needed and do not pay.

Making unnecessary fungicide applications is bad for both economic and environmental reasons. Thus, it is in everyone's best interest to make applications when they are needed, but only when needed. This is the target of this publication.

Fungicide Seed Treatments

Seed treatment fungicides are used on nearly all wheat seed purchased in Kentucky. Stands and yields are not always improved when fungicide-treated seed is planted, but the cost of fungicide and treating is relatively low compared to the potential benefits. Think of seed treatments as a form of low cost crop insurance; it is there when you need it.

Getting and keeping a good stand is a key component of high-yielding wheat. Typically, achieving excellent stands is not that difficult in Kentucky as long as high quality seed is used, and planting date and planting method are consistent with University of Kentucky recommendations. We have conducted a great many seed treatment fungicide tests over the years and we rarely see a significant impact on spring stands, tiller counts, disease control, or yield. Occasionally, we see significant stand improvements in the fall, but these rarely carry over into the spring.

Role of Seed Treatment Fungicides

The above notwithstanding, seed treatment fungicides do play a significant role in Kentucky wheat production. Actual growing conditions throughout Kentucky are much more varied than what we are able to test experimentally. Thus, field situations commonly occur, which we cannot duplicate experimentally, that make treating seed a wise choice. For example, dry soil conditions in early fall frequently cause a delay in planting while producers wait for soil moisture conditions to improve. Under these circumstances, it is not uncommon for wheat to be planted well after the recommended planting date for an area. In addition, many times soil conditions in November become hostile to germinating wheat and young seedlings. Under these conditions, germinating seed and young seedlings may need the benefit of a seed fungicide. Even when planting date is optimal, stands can be compromised if seeds are planted too deep or too shallow, if planting equipment is not properly calibrated and functioning, or if soil conditions turn cool and wet earlier in the fall than normal. In these cases, seed treatment fungicide may help you attain and retain acceptable stands even when conditions favor a number of common soil- and seed-borne fungi (e.g., *Fusarium, Pythium, Rhizoctonia, Septoria*, *Stagonospora*, etc.).

Another significant role of seed treatment fungicides is to assist with stand establishment when the seed has reduced germination and/or vigor. For example, stocks of high germination/high vigor seed are usually very limited in the fall following a big Fusarium head blight (FHB) year. In these years, growers frequently have to settle for seed with lower than desired germination rates (e.g., 70%) and vigor. As long as seed is within acceptable tolerances for both germination and vigor, fungicide seed treatments can make the difference between achieving acceptable stands or not. Note: this does not apply to severely damaged seed that may contain a lot of tombstones (dead seed) or has suffered serious mechanical damage.

Historically, loose smut has been a serious problem in wheat, but this is no longer the case. Like the near eradication of polio in the human population, it is now very rare for loose smut and related diseases to cause significant damage in most wheat producing states. Good seed production practices and certification standards have played a major role in helping to achieve this status. However, the regular use of certain seed treatment fungicides capable of eradicating the smut fungus in seed has also been extremely important. The increased occurrence of loose smut would be all but certain if growers quit using seed treatment fungicides, many of which are highly effective against this disease.

Seed Treatment Products

There is currently a long list of seed treatment fungicides available for use on wheat. Some of these fungicides have a broad spectrum

of disease control activity and others have very specific uses. Many products contain multiple active ingredients in order to control the greatest range of seed and soil-borne fungi. TABLE 1 lists common names some of the more widely used fungicides and the diseases they control. Contact your local farm supply dealer or agricultural chemical salesperson for more specific information on available products. The vast majority of newer products are effective at very low use rates and, consequently, can only be applied by certified applicators. Hopper box treatments are still available, but their use has been considerably reduced in recent years.

FOLIAR FUNGICIDES

The role of foliar fungicides is to manage certain common foliar and head diseases caused by fungi. Target diseases include leaf, stripe, and stem rust; powdery mildew; speckled leaf blotch; Stagonospora leaf and glume blotch; tan spot; and Fusarium head blight (i.e., head scab). "Leaf blotch complex" is a general term often used when multiple leaf blotch/spot fungi are affecting leaves at the same time. Other diseases, such as take-all and diseases caused by viruses or bacteria, are not controlled by fungicides.

STAGONOSPORA LEAF AND GLUME BLOTCH (LEFT), LEAF RUST (RIGHT) AND POWDERY MILDEW (BOTTOM) ARE COMMON FOLIAR AND HEAD DISEASES IN KENTUCKY.

Since the first printing of this publication (1996), foliar fungicide use in Kentucky has gone mainstream. In 1996, only about 20% of producers had ever applied a foliar fungicide to wheat. At present, fungicides are used by most producers interested in achieving high yield, high quality. There is no doubt that producers will at least recover the cost of fungicide and application in most years. However, as indicated earlier, fungicides are not needed every year. Unfortunately, the current trend is to apply fungicides on a calendar (growth stage) basis and not according to actual need. This is often the expedient thing to do, especially when wheat prices are high. However, in the long run, this approach to wheat production is not sustainable. Specifically, scheduled applications, while easier to plan for and implement, are in direct opposition to established good farming practices. Fungicides should certainly be used when needed, but there are many good reasons to keep the sprayer in the barn in some years.

The main role of foliar fungicides is to protect crop yield potential from losses caused by specific fungal diseases. Fungicides vary in their effectiveness against these target diseases (TABLE 2). Fungicides do NOT give a "yield bump". Rather, they protect yield potential that is already built into the crop. This may seem like a minor point, but it is actually quite important. If you understand this principle, you will appreciate why fungicides do not always result in higher yields compared to untreated crops.

The bottom line is this: if disease pressure is great enough to reduce crop yields, then fungicides may help protect the crop from potential losses. However, if disease conditions are light such that no or nominal yield loss is possible, than applying a fungicide would not result in either a yield or economic advantage. It's that simple. But if one believes that fungicides can actually

increase yields (a.k.a., yield bump), then they might be tempted to apply a fungicide under any and all disease situations.

Making Fungicide Spray Decisions

The best and most sustainable approach is to base fungicide spray decisions on results of field scouting and to consider the following factors that impinge on a crop's risk for diseases:

- Variety "disease package" (varieties that resist – or at least are not highly susceptible – to common diseases are much less likely to respond to a fungicide).
- Dense canopy (thick crops have reduced light penetration and air circulation in the canopy, and both of these favor development of foliar and head diseases).
- Early planting date and mild fall and winter (increases the risk of fall infections – like leaf rust – that may carry over into the spring.
- Diversity of varieties planted (diversity reduces the chances that a single disease will cause widespread damage and yield losses on a farm).
- High nitrogen fertility (enhances plant susceptibility to certain diseases).
- Disease-favorable weather forecast.
- Field history of disease (provides insight as to which diseases are most likely to be a problem).
- Disease activity in current crop (active diseases often get worse over time if conditions remain favorable).

The goal of scouting is to assess the crop at critical growth stages for 1) incidence and severity of fungal diseases targeted by foliar fungicides, 2) crop yield potential, and 3) to determine if some other pest or disease has compromised crop health to the point where applying a fungicide is not prudent. Crops with low yield potential (i.e., less than 50 bushels per acre) are not good candidates for fungicide application because of the limited potential to recoup input costs. In Kentucky, fungicides applied during or immediately following head emergence typically give the best yield response against common yield-robbing diseases, such as leaf rust and Stagonspora leaf/glume blotch. However, earlier applications may be necessary in some years to protect against speckled leaf blotch, stripe rust, tan spot, or powdery mildew. This is why scouting is essential!

Fungicides for Managing Fusarium Head Blight (FHB)

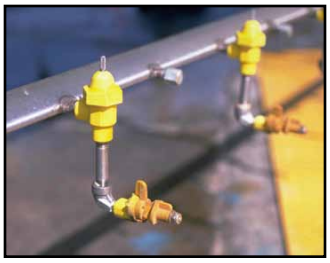
Fungicides can provide acceptable levels of disease control when FHB conditions are light. However, fungicides rarely provide acceptable results on FHB-susceptible varieties when FHB pressure is moderate to high. Much more consistent and reliable results are achieved when FHB is managed using fungicides in conjunction with the best available FHB-resistant varieties. Fungicides targeting FHB should be applied at early anthesis (beginning of flowering) for best results. This can create a tension when other diseases, such as leaf blotch complex or leaf rust, are gaining momentum in the crop prior to head emergence.

Most of the time, this is not a serious issue and applications made for FHB also do an excellent job against other late-season fungal diseases. But occasionally, situations develop where a producer may need to decide which target diseases are the highest priority. Depending on the decision made, either FHB suppression or control of other leaf and head diseases could be compromised.

One tool than cat help determine if FHB is likely to be a problem is the on-line FHB Risk Map Tool, housed on the Wheat Fusarium Head Blight Prediction Center maintained by Pennsylvania State University. This tool, which includes a commentary of FHB risk specific for Kentucky, estimates the risk that at least a moderate FHB epidemic will occur. If a target disease other than FHB is building in the crop, consulting this tool will help establish if the FHB risk is low, moderate, or high. If moderate or high, it may be prudent to wait until at least full head emergence to make a fungicide application. On the other hand, if the FHB risk is low, making an application at heading would be the way to go.

Application of Foliar Fungicides

It is important to note that best disease control results using foliar fungicide are achieved when attention is paid to the details of application. Fungicide labels usually indicate a range of acceptable application volumes and if an adjuvant (e.g., surfactant) can be considered.



Typically, it is not too difficult to obtain excellent coverage of leaves in the upper crop canopy (flag and flag-1) since leaves are horizontally-oriented structures and in the direct line of the downward applied fungicide. It is much more difficult to obtain excellent coverage of the vertically-oriented heads since most of the fungicide misses the heads and ends up on leaves. Research has shown that enhanced fungicide coverage of heads can be achieved by angling nozzles towards the grain heads, preferably at a 30-degree angle from the horizontal. This nozzle orientation will also result in good coverage of leaf tissue. Of course, the above configuration applies to ground application, but a great many acres of wheat in Kentucky are treated aerially, either by fixed-wing aircraft or helicopter. Aerial application of fungicides can provide results as good as ground application, but the tolerances for achieving excellent coverage aerially are more challenging than they are for ground application. Application speed, spray equipment set-up and function, height of application, physical impediments to spraying (like power lines, trees, etc.), applicator skill, etc., can all impact the results of both aerial and ground application. However, inconsistencies tend to be magnified during aerial applications because of the considerably higher speeds involved.

Fungicide Efficacy for Control of Wheat Diseases

The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) has developed information on fungicide efficacy for control of certain foliar diseases of wheat (TABLE 2, revised April 6, 2011) 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 2 includes most widely marketed products, and is not intended to be a list of all labeled products.

Applying Fungicides with Herbicides

Periodically, fungicide manufactures probe the market to see if ultra-early to early applications of fungicides (i.e., stem elongation to flag leaf emergence) will be accepted and used by producers. Part of the

lure in this approach is that many producers already apply herbicides and/or insecticides at early growth stages, so adding the fungicide is relatively inexpensive. In many cases, fungicide manufacturers recommend reduced fungicide rates when their products are applied early, so this sweetens the pot. In most soft red winter wheat states, early applications are not sold as a replacement for later applications, but rather, in addition to later applications. In some parts of the country, such as the Pacific Northwest, this strategy can pay off since wheat frequently does have significant disease pressure prior to flag leaf extension. However, this is a rare situation in Kentucky. We tested early applications during the late 1980s and again during 2007 to 2011 with little success. In most cases, disease pressure did not build up until well after the fungicide was applied. In these instances, the fungicide was not there when it was needed. In other cases, disease never did build up, so the applications were not needed in the first place. Fungicide manufacturers frequently market early applications as a way to "short circuit" a disease epidemic before it gets started. This sounds good, but in most instances, things don't pan out the way the early application programs are sold. All things considered, there appears to be little justification for applying any foliar fungicide prior to flag leaf extension in all but the rarest cases in Kentucky.

TABLE 1. ACTIVITY OF COMMON SEED TREATMENT FUNGICIDE ACTIVE INGREDIENTS.*

Fungicide	Activity Summary
Carboxin	Modest control of general seed- and soil-borne pathogens; excellent control of loose smut.
Difenoconazole	Moderate control of general seed- and soil-borne pathogens, very good control of Fusarium seed rot and seedling blight, and excellent control of loose smut. Minor control of early powdery mildew and rust and good control of seedling blights caused by *Stagonospora* and *Septoria*.
Fludioxonil	Provides excellent control seed borne *Fusarium* as well as several soil borne pathogens, with the exception of *Pythium*.
Mefenoxam and Metalaxyl	Provides protection from *Pythium*, but other classes of seed and soil-borne pathogens are not controlled.
Pyraclostrobin	When combined with triticonazole, provides protection against *Rhizoctonia*, *Fusarium*, common root rot (*Cochliobolus*), dry seed decay (*Penicillium*), common bunt and loose smut.
Tebuconazole	Similar to difenoconazole, except provides no control of fall powdery mildew. Provides protection from *Rhizoctonia* for a limited time following seeding.
Thiram	Moderate activity against various many common seed- and soil-borne fungi.
Triadimenol	Similar to difenoconazole, but provides excellent control of fall powdery mildew and very good control of fall infections of leaf rust or stripe rust. In high mildew areas, can often be used as a replacement for foliar fungicide sprays for mildew in early spring (up to head emergence). Very good control of Fusarium seed rots and seedling blights. Excellent control of loose smut. Moderate activity against many common seed- and soil-borne fungi.
Triticonazole	Provides excellent control of smuts and very good control of seed borne *Fusarium* and several soil borne pathogens with the exception of *Pythium*.

*Consult with your chemical salesperson and/or ag supply dealer for product trade names. Most commercially-available seed treatment products are comprised of multiple active ingredients.

TABLE 2. EFFICACY OF FUNGICIDES FOR WHEAT DISEASE CONTROL BASED ON APPROPRIATE APPLICATION TIMING.

Fungicide(s)												
Class	Active ingredient	Product	Rate/A (fl. oz)	Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust[5]	Head scab	Harvest Restriction
Strobilurin	Azoxystrobin 22.9%	Quadris 2.08 SC	6.2 - 10.8	F(G)[1]	VG	VG	E	E[2]	E	VG	NL	45 days
	Fluoxastrobin 40.3%	Evito 480 SC	2.0 – 4.0	G	--[3]	--[3]	--[3]	--[3]	VG	--[3]	NL	40 days
	Pyraclostrobin 23.6%	Headline SC	6.0 - 9.0	G	VG	VG	E	E[2]	E	G	NL	Feekes 10.5
Triazole	Cyproconazole 8.9%	Alto 100 SL	3.0 - 5.5	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	30 days
	Metconazole 8.6%	Caramba 0.75 SL	10.0 - 17.0	VG	VG	--[3]	VG	E	E	E	G	30 days
	Propiconazole 41.8%	Tilt 3.6 EC[4]	4.0	VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5
	Prothioconazole 41%	Proline 480 SC	5.0 - 5.7	3	VG	VG	VG	3	VG	VG	G	30 days
	Tebuconazole 38.7%	Folicur 3.6 F[4]	4.0	G	VG	VG	VG	E	E	E	F	30 days
	Prothioconazole19% Tebuconazole 19%	Prosaro 421 SC	6.5 - 8.2	G	VG	VG	VG	E	E	E	G	30 days
Mixed mode of action	Metconazole 7.4% Pyraclostrobin 12%	TwinLine 1.75 EC	7.0 – 9.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5
	Propiconazole 11.7% Azoxystrobin 7.0%	Quilt 200 SC	14.0	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5
	Propiconazole 11.7% Azoxystrobin 13.5%	Quilt Xcel 2.2 SE[5]	14.0	--[3]	VG	--[3]	--[3]	--[3]	VG	--[3]	NL	Feekes 10.5
	Propiconazole 11.4% Trifloxystrobin 11.4%	Stratego 250 EC	10.0	G	VG	VG	VG	VG	VG	VG	NL	35 days
	Tebuconazole 22.6% Trifloxystrobin22.6%	Absolute 500 SC	5.0	G	--[3]	--[3]	--[3]	--[3]	E	--[3]	NL	35 days

[1] Efficacy categories: NL=Not Labeled and Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent. Efficacy designation with a second rating in parenthesis indicates greater efficacy at higher application rates.

[2] Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred

[3] Insufficient data to make statement about efficacy of this product

[4] Multiple generic products containing the active ingredients propiconazole and tebuconazole may also be labeled in some states. Products including tebuconazole incude: Embrace, Monsoon, Muscle 3.6 F, Onset, Orius 3.6 F, Tebucon 3.6 F, Tebustar 3.6 F, Tebuzol 3.6 F, Tegrol , and Toledo. Products containing propiconazole include: Bumper 41.8 EC, Fitness, Propiconazole E-AG, and PropiMax 3.6 EC.

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.

Additional Resources

The University of Kentucky publications listed below are available at County Extension offices, as well as on the Internet.

- Comprehensive Guide to Wheat Management in Kentucky, ID-125
http://www.ca.uky.edu/agc/pubs/id/id125/id125.htm

- Kentucky Integrated Crop Management Manual for Small Grains, IPM-4 (2009)
http://www.uky.edu/Ag/IPM/manuals/ipm4smgr.pdf

- Kentucky Plant Disease Management Guide for Small Grains, PPA-10c (1993)
http://www.ca.uky.edu/agc/pubs/ppa/ppa10c/ppa10c.pdf

- No-Till Small Grains Production in Kentucky, ID-136 (2000)
http://www.ca.uky.edu/agc/pubs/id/id136/id136.htm

- Wheat Head Blight Prediction Center (Pennsylvania State University)
http://www.wheatscab.psu.edu/

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Photos by Donald Hershman, University of Kentucky (spray jets, pg. 1 & fungal diseases, pgs. 3 & 4); Howard F. Schwartz, Colorado State University, Bugwood.org (wheat, pg. 1 & aerial applicator jets, pg. 5); and Joseph Berger, Bugwood.org (wheat seed, pg. 2)
