Understanding Factors that Influence the Efficacy of Seed Treatments for Soilborne Pathogens in Corn and Soybean

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As of the May 3rd Wisconsin Crop Progress report (Source: USDA-NASS), 51% of corn and 8% of soybean acres were planted around the state. Although weather conditions have been quite favorable for planting, soil temperatures continue to fluctuate (Figure 1). Seed and seedling diseases of corn can occur in localized areas every year and, if fields are not routinely inspected after planting, can cause hidden yield loss. Fungicide seed treatments are a standard disease management practice in corn production and are becoming a much more common practice for soybean production. With the increasing cost of seed, numerous questions have been raised regarding the need and use of fungicide (and nematicide) seed treatments. Disease scouting is important in order to make the most informed choice for controlling seed and seedling pathogens present in your field.

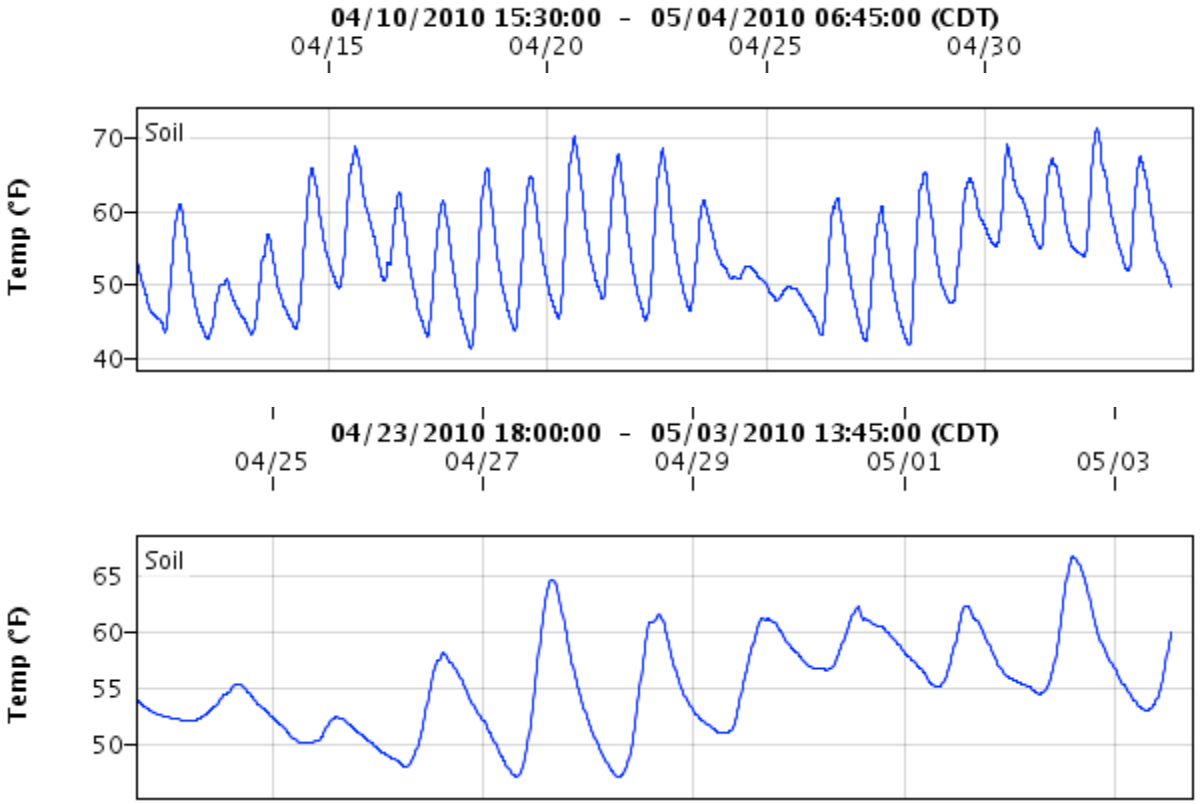

Figure 1. Soil temperatures at Arlington (upper: 4/10 to 5/4) and Lancaster (lower: 4/24 to 5/4), WI. Temperatures were obtained from approximately 4" depth.

Symptoms of corn and soybean seedling disease. Seedling diseases result in lower plant populations and also reduced vigor, which directly translates to yield loss. This is often more important for corn as soybeans can compensate for lower plant stands through lateral growth. However, as many soybean producers have reduced their seeding rates in 2010 due to increase seed costs, seed treatment fungicides may be an option to maintain desired final plant populations at harvest.

Those seedlings that do emerge may have rotten root or stem tissue, resulting in decreased plant vigor and plant death. *Pythium* and *Fusarium* spp. are the most common fungi associated with seed and seedling disease in corn. In soybean, several pathogens can cause seedling diseases, including *Phytophthora sojae*, *Pythium* spp., *Rhizoctonia solani*, *Fusarium* spp., and to a lesser extent *Phomopsis longicola*. From 2003 to 2005, reduction in soybean yield due to these different soilborne pathogens was estimated to be 5 million bushels in Wisconsin (Figure 2). This represented approximately 3 to 5% of annual production in the state. Nationwide, it has been estimated that approximately 275 million bushels of soybean have been lost due to seedling diseases between 2000 and 2008.

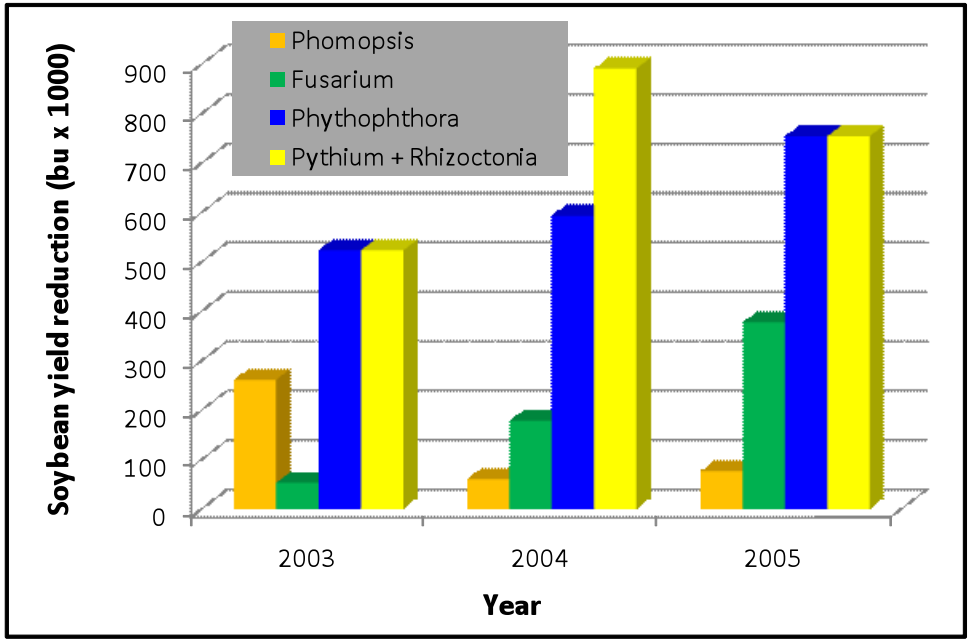

Figure 2. Estimated reduction in soybean yield in Wisconsin due to most important seedling diseases between 2003 and 2005 (Source: Wrather & Koenning, 2006).

Besides lower plant populations, above-ground symptoms of *Pythium* infection include dark, slimy lesions on seedling roots or hypcotyl tissue, root rot and yellowed, stunted leaves (White, 1999; Hartman, et al., 1999). *Fusarium* symptoms include tan or reddish-brown lesions that can cause shriveling of the root or hypocotyl tissue and root rot. Symptoms are sometimes accompanied by signs of the

pathogen, including pink or purple colored mycelium. *Rhizoctonia solani* can also cause seeding disease, with symptoms typified by distinct reddish-brown, sunken lesions and plant lodging due to root decay. *Phomopsis longicola* infection causes seed decay and pre- or post-emergence damping off. *Phytophthora* symptoms include pre- and post-emergence damping off, and root and stem rot of seedlings. For further information about early-season soybean diseases, please consult the following.

Environmental conditions favoring corn and soybean seedling diseases. Corn and soybean germinate and emerge quickly at temperatures above 68 °F. Although seeds can imbibe water at temperatures above freezing, seed metabolism and therefore germination and emergence are greatly retarded at temperatures below 55 °F. Additionally, cell damage that occurs when seeds imbibe very cold water can predispose seeds to seed rotting pathogens. It is during this delay in germination and emergence that seed and seedling pathogens can cause problems. Very wet soil conditions are required for *Pythium* and *Phytophthora* infection, while *Fusarium* and *Rhizoctonia* are favored by only wet soil conditions, and *Phomopsis* prefers dry soil. Cool temperatures favor both *Pythium* (50 to 60 °F) and *Fusarium* (59 °F) (Munkvold and O'Mara, 2002; Table 1), as well as *Phytophthora* in soybean. *Rhizoctonia solani* and *Phomopsis longicola* are generally favored by higher soil temperatures and can infect seedlings under a wide temperature optimum (*R. solani* - 46 to 82 °C) (White, 1999). A recent article from the UW-Extension Soybean Agronomy program discusses soybean emergence and the use of growing degree-units.

Management practices to control corn and soybean seedling disease. If you still have fields to be planted to corn or soybean, it is important to monitor conditions that could favor development of seedling diseases, including excessive moisture and cool soil temperatures. Also, pay particular attention to planter calibration for optimal seeding depth. Tillage may also help to control disease, as crusted or compacted soil tends to favor seed and seedling disease by delaying emergence or damaging emerging seedlings.

Fungicide seed treatments are also a disease control option. Very little published data is available for efficacy of fungicides labeled for seed treatment in corn. In one Wisconsin reduced tillage study comparing no fungicide, captan, captan + Apron®, and Maxim® + Apron® treatments, plots with fungicide treated seed had 66% emergence while those with untreated seed had 34% emergence (Lauer, 1997). Additionally, all seed treatments increased grain yield by 50% over untreated control.

In soybean, results from Wisconsin in 2008 and 2009 have been variable. Results in 2008 indicated that there was not a uniform response to ApronMaxx® or CruiserMaxx® across locations. There was evidence of a soybean variety x seed treatment interaction indicating that for some varieties, there was a response to seed treatment fungicides. In 2009, results indicated that there was a response to the use of seed treatment fungicides across locations. Conditions were quite different between the two years and in 2009, cool and wet soil conditions may have led to an increase in early season seedling diseases. Regionally, Bradley (2008) found that there was a net economic return of $13/acre when using seed treatment fungicides in North Dakota.

Most hybrid corn seed, especially those with herbicide or insect resistance transgenic traits, come pre-treated with a seed treatment. However, as all active ingredients are not alike, it important that you select the right active ingredients to treat the pathogens that have historically caused problems in your fields (CDMS, 2010; Table 2). Active ingredients such as captan, thiram and carboxin have a general "fungicide, seed treatment" label, and are not labeled to target specific fungi. Others, such as fludioxonil, pyraclostrobin, and ipconazole are labeled to only control *Rhizoctonia* and *Fusarium* spp. while metalaxyl only controls oomycetes such as *Pythium* and *Phytophthora* spp. Costs of seed treatments will differ. For example, treatments considered "standard" will often be more inexpensive ($1.25 per 50 pounds of seed) while those considered a "specialty" seed treatment may cost $3.50 or more per 50 pounds of seed.

A comprehensive knowledge of disease problems both above and below ground is important to maximize yield. For nematodes that may affect corn, digging plants and carefully examining the roots can provide clues as to whether nematodes are a problem in your field. However, to fully determine if nematodes are the cause, submit a sample to the Plant Disease and Diagnostic Clinic. With the recent labeling of Activa Complete Corn, there is now available chemistry to combat corn nematodes.

Table 1. Summary chart of corn and soybean seedling pathogens and the environmental conditions that favor disease.

Pathogen	Crops affected		Environmental conditions favoring disease		
	Soybean	Corn	Warm, dry soil	Warm, wet soil	Cool, wet soil
Phytophthora sojae	X			X	
Pythium spp.	X	X			X
Fusarium spp.	X	X		X	X
Rhizoctonia solani	X	X		X	
Phomopsis longicola	X		X		

Table 2. Summary chart of current corn and soybean seed treatment active ingredients, examples of trade names, and the pathogens that they control.

Active Ingredient[1]	Trade name examples[2]	Crop[3]	*Rhizoctonia solani*	*Pythium* spp.	*Phytophthora* spp.	*Fusarium* spp.	nematodes
pyraclostrobin	Stamina, Acceleron DX-109[4]	Corn soybean	X	X		X	
metalaxyl, mefanoxam,	Acquire, Apron Maxx, Maxim XL, Acceleron DC-309, Inovate, Allegiance-FL, Apron XL, Activa Complete Corn,	Corn soybean		X	X		
abamectin	Activa Complete Corn, Activa Dual Corn						X
fludioxonil	Maxim XL, Activa Complete Corn, Maxim	Corn	X			X	

	4FS	soybean					
trifloxystrobin	Accerleron DC-709	corn	X			X	
azoxystrobin	Dynasty, Activa Complete Corn	corn	X	X		X	
harpin αβ protein	Acceleron HX-209	corn					X
ipconazole	Acceleron DC-509, Inovate	Corn soybean	X			X	
captan[4]	Captan Moly, Vitavax MDC	Corn soybean					
thiram[4]	Thiram technical	Corn soybean					
carboxin[4]	Vitavax MDC	soybean					

[1] Active ingredients may have synonyms, depending upon company.
[2] Consult the specific specimen label for further information about the different Acceleron technology and numbering.
[3] Specific trade names may be registered for corn, soybean or corn and soybean.
[4] General "fungicide, seed treatment" labeling.

A number of factors are important to fully understand the risk and cost-benefit for using seed treatment fungicides, including knowledge of previous crop histories and diseases, planting date, plant population, tillage, and environmental conditions during the early growing season.

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