In This Issue

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Fungal Diseases that Can Impact Soybean Pod and Seed Quality

Author: Darcy Telenko

There are a number of fungal soybean diseases that can greatly impact seed quality. In Indiana, the most common are Phomopsis seed decay (*Phomopsis* spp.), Cercospora purple seed stain (*Cercospora kikuchii*); Frogeye leaf spot on seed (*Cercospora sojina*); Anthracnose (*Colletotrichum* spp.); Downy mildew (*Pernospora manshurica*); and various other secondary fungal invaders of injured pods including *Alternaria, Fusarium, Cladosporium, and Penicillium.*

The tables below provides several descriptive characteristics to begin the diagnostic process and choose appropriate management recommendations. It is important to note, however, that although Purple Seed Stain is easily identified by the ‘signature’ purple symptom on the seed, accurate diagnosis of most of the fungal diseases on seed requires microscopic assistance offered by the Purdue Plant and Pest Diagnostic Laboratory (PPDL). The diversity of symptoms that can be observed on diseased soybean seed is shown in the example in Figure 1. In this image, all of the discolored seed were incubated and microscopically confirmed to be infected with the frogeye leaf spot pathogen *C. sojina*.

Disease infected seed can have reduced storability, decreased germination, loss of seed weight and reduced meal and oil quality. Optimum storage conditions to limit fungal growth includes 1. Seed free from fungi or other pests, 2. Clean seed without organic or other waste material, 3. Less than 12% moisture, and 4. Cool uniform storage temperature.

Management options to minimize diseases on soybean seed:

1. Start with clean seed (pathogen free) and use resistant varieties when available.
2. Fungicide options –
    1. Seed treatments can help reduced seed to seedling disease transfer.
    2. Foliar fungicides can help reduced the risk to pod and seed infection by some fungi.
2. Tillage and crop rotation – bury the inoculum from disease-infested residue and further reduced the inoculum by planting a non-host the next season.
3. When at threshold levels, control pests, such as bean leaf beetle, and other insects that injure the pod, opening the door to fungal infection (see https://extension.entm.purdue.edu/newsletters/pestandcrop/article/discolored-and-shriveled-soybean-seeds-who-done-it/)

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Figure 1. A diverse range of symptoms observed from *Cercospora sojina* (frogeye leaf spot) infection on seed. (*Photo Credit: Gail Ruhl, PPDL*).

Table 1. Characteristics and management options for fungal diseases of soybean that affect seed quality.

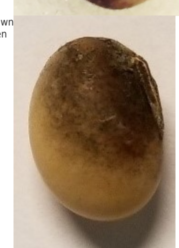
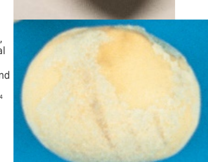
					Management Options		Available Rotation		
Disease	**Pathogen**	**Pod Symptoms**	**Seed Symptoms**		**Seed-borne**	**Resistance**	**Crops**	**Tillage**	**Fungicide**
Anthracnose	*Colletotrichum* spp.	Irregularly shaped, brown areas. Small black fruiting bodies (acervuli) that produce spine-like structures may also form on infected tissue	Brown to black or small, irregular gray areas with black specks[1]		Yes	No	Corn, non-legumes	Yes	Foliar fungicides
Cercospora Blight/Purple Seed Stain	*Cercospora kikuchii*	Dark lesions, may not always be present	Pink to dark - purple discoloration of seed coat[2]		Yes	Yes, but only leaf blight not seed stain	Corn; small grain; alfalfa	Yes	Foliar for leaf blight stage
Frogeye	*Cercospora sojina*	Circular to oval lesions that are red-brown to black	Reddish-brown lesions -often on ends of seed[3]		Yes	Yes	Corn, small grains	Yes	Seed treatment and foliar options
Downy Mildew	*Pernospora manshurica*	No external symptoms, internal whitish, fluffy mass	Small and lighter seed, crusty fungal growth on seed; dull and white in appearance[4]		Yes	Yes, but many races	Yes	Yes	
Phomopsis Seed Decay	*Phomopsis* spp/*Diaporthe* spp.	Black fungal specks (pycnidia) on infected tissue[4]	Cracked, shriveled, with chalky, white appearance[5]		Yes	Yes –early maturity greater risk	Corn; wheat	Yes	Seed treatment and foliar options

Table 2. Stem diseases that might lead to contaminated seed lots.

Disease	Pathogen	Pod Symptoms	Seed Symptoms		Management Options Available				
					Seed-borne	Resistance	Rotation Crops	Tillage	Fungicide
Sclerotinia Stem Rot	*Sclerotinia sclerotiorum*	Water-soaked, tan to white bleached stem tissue	Presence of black sclerotia in infected tissue can contaminate seed during harvest[2]		Seed lot contamination	moderate	Corn; small grains for 2-3 years	Bury >8 inches	Foliar can reduce disease severity

Image credit: [1]University of Missouri Extension. [2]Purdue Plant Pest Diagnostic Lab. [3]Darcy Telenko, Purdue University. [4]Courtesy J. B. Sinclair – ©APS. Reproduce, by permission, from Hartman, G. L. et al. eds. 2015. Compendium of Soybean Diseases and Pests, 5th ed. American Phytopathological Society, St. Paul, MN. [5]Albert Tenuta. Reproduced, by permission, from Mueller, D. et al. eds. 2016. A Farmer's Guide to Soybean Diseases. American Phytopathological Society, St. Paul, MN.

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Corn Grain Test Weight

Author: Bob Nielsen

Among the top 10 most discussed (and cussed) topics at the Chat 'n Chew Cafe during corn harvest season is the grain test weight being reported from corn fields in the neighborhood. Test weight is measured in the U.S. in terms of pounds of grain per volumetric "Winchester" bushel. In practice, test weight measurements are based on the weight of grain that fills a quart container (37.24 qts to a bushel) that meets the specifications of the USDA-FGIS (GIPSA) for official inspection (Fig. 1). Certain electronic moisture meters, like the Dickey-John GAC, estimate test weight based on a smaller-volume cup. These test weight estimates are reasonably accurate but are not accepted for official grain trading purposes.

Fig. 1. A standard filling hopper and stand for the accurate filling of quart or pint cups for grain test weight determination. (Image: www.seedburo.com).

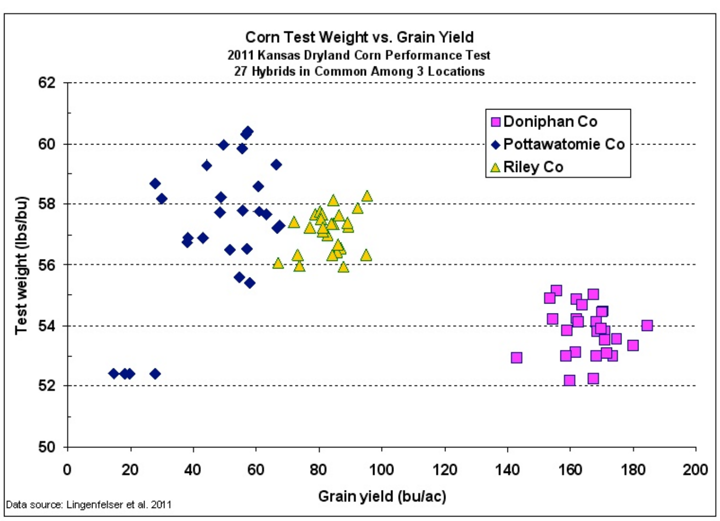

Fig. 2. Corn grain test weight versus grain yield for 27 hybrids grown at 3 Kansas locations (Lingenfelser et al, 2011).

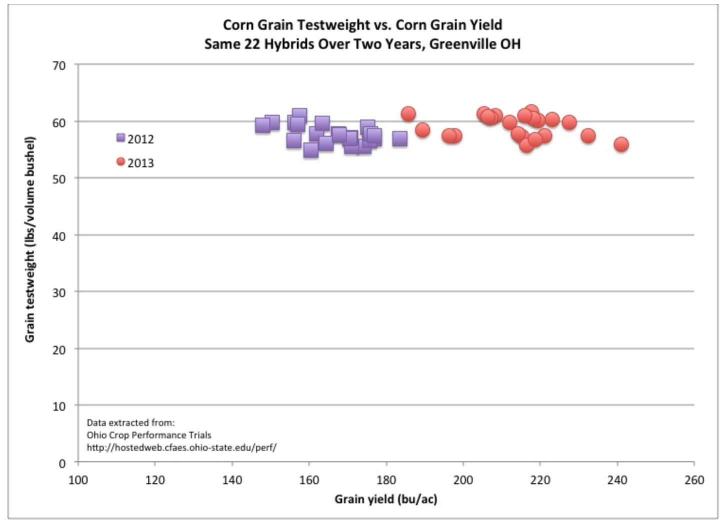

Fig. 3. Corn grain test weight versus grain yield for 22 hybrids grown at Greenville, OH in 2012 (drought) and 2013 (ample rainfall).

The official minimum allowable test weight in the U.S. for No. 1 yellow corn is 56 lbs/bu and for No. 2 yellow corn is 54 lbs/bu (USDA-GIPSA, 1996). Corn grain in the U.S. is marketed on the basis of a 56-lb "bushel" regardless of test weight. Even though grain moisture is not part of the U.S. standards for corn, grain buyers pay on the basis of "dry" bushels (15 to 15.5% grain moisture content) or discount the market price to account for the drying expenses they expect to incur handling wetter corn grain.

Growers worry about low test weight because local grain buyers often discount their market bids for low test weight grain. In addition, growers are naturally disappointed when they deliver a 1000 bushel (volumetric bushels, that is) semi-load of grain that averages 52-lb test weight because they only get paid for 929 56-lb "market" bushels (52,000 lbs ÷ 56 lbs/bu) PLUS they receive a discounted price for the low test weight grain. On the other hand, high test weight grain makes growers feel good when they deliver a 1000 bushel semi-load of grain that averages 60 lb test weight because they will get paid for 1071 56-lb "market" bushels (60,000 lbs ÷ 56 lbs/bu).

These emotions encourage the belief that high test weight grain (lbs of dry matter per volumetric bushel) is associated with high grain yields (lbs. of dry matter per acre) and vice versa. However, there is little evidence in the research literature that grain test weight is strongly related to grain yield.

Hybrid variability exists for grain test weight, but does not automatically correspond to differences in genetic yield potential. Grain test weight for a given hybrid often varies from field to field or year to year, but does not automatically correspond to the overall yield level of an environment.

Similarly, **grain from high yielding fields does not necessarily have higher test weight than that from lower yielding fields**. In fact, test weight of grain harvested from severely stressed fields is occasionally higher than that of grain from non-stressed fields, as evidenced in Fig. 2 for 27 corn hybrids grown at 3 locations with widely varying yield levels in Kansas in 2011. Another example from Ohio with 22 hybrids grown in common in the drought year of 2012 and the much better yielding year of 2013 also indicated no relationship between yield level and grain test weight (Fig. 3).

Conventional dogma suggests that low test weight corn grain decreases the processing efficiency and quality of processed end-use products like corn starch (U.S. Grains Council, 2018), although the research literature does not consistently support this belief. Similarly, low test corn grain is often thought to be inferior for animal feed quality, although again the research literature does not support this belief (Rusche, 2012, Simpson, 2000, Wiechenthal Pas et al., 1998). Whether or not low test weight grain is inferior to higher test weight grain may depend on the cause of the low test weight in the first place.

Common Causes of Low Grain Test Weight

During the 2009 corn harvest season in Indiana (late crop maturation, late harvest), there were more reports of low test weight corn grain than good or above average test weights. There were primarily six factors that accounted for most of the low test weight grain in 2009 and four shared a common overarching effect.

Grain Moisture

First and foremost, growers should understand that **test weight and grain moisture are inversely related**. The higher the grain moisture, the lower the test weight AT THAT POINT IN TIME. As grain dries in the field or in the dryer, test weight naturally increases as long as kernel integrity remains intact. Test weight increases as grain dries partly because kernel volume tends to shrink with drying and so more kernels pack into a volume bushel and partly because drier grain is slicker which tends to encourage kernels to pack more tightly in a volume bushel. Therefore in a year like 2009 with many of the initial harvest reports of grain moisture ranging from 25 to 30% instead of the usual starting moisture levels of about 20 to 23%, it should not be surprising that test weights were lower than expected.

Hellevang (1995) offered a simple formula for estimating the increase in test weight with grain drying. In its simplest form, the equation is (A / B) x C; where A = 100 – dry moisture content, B = 100 – wet moisture content, and C = test weight at wet moisture content. The author does not say, but I suspect this simple formula is most applicable within a “normal” range of harvest moistures; up to moistures in the mid- to high 20’s.

Example: Dry moisture = 15%, Wet moisture = 25%, Test weight at 25% = 52 lbs/bu.

Estimated test weight at 15% moisture = ((100 – 15) / (100 – 25)) x 52 = (85/75) x 52 = 58.9 lbs/bu

An older reference (Hall & Hill, 1974) offers an alternative suggestion for adjusting test weight for harvest moisture that also accounts for the level of kernel damage in the harvested grain (Table 1). The table values are based on the premise that kernel damage itself lowers test weight to begin with and that further drying of damaged grain results in less of an increase in test weight that what occurs in undamaged grain. Compared to the results from using Hellevang’s simple formula, adjustments to test weight using these tabular values tend to result in smaller adjustments to test weight for high moisture grain at harvest, but larger adjustments for drier grain at harvest.

Table 1. Adjustment added to the wet-harvest test weight to obtain an expected test weight level after drying to 15.5 percent moisture.

Percent Damage	Grain Moisture at Harvest (Percent)							
	30	28	26	24	22	20	18	16
45	0.3							
40	0.7	0.2						
35	1.3	0.7						
30	1.8	1.3	0.8					
25	2.4	1.9	1.4	0.9	0.3			
20	3.1	2.6	2.0	1.5	1.0	0.5		
15	3.8	3.2	2.7	2.2	1.7	1.2	0.6	0.2
10	4.5	4.0	3.5	2.9	2.2	1.9	1.4	0.8
5	5.3	4.7	4.2	3.7	3.0	2.7	2.1	1.6
0	6.1	5.6	5.0	4.5	4.0	3.5	2.9	2.4

Stress During Grain Fill

Secondly, **thirdly**, and **fourthly**; drought stress, late-season foliar leaf diseases (primarily gray leaf spot and northern corn leaf blight), and below normal temperatures throughout September of 2009 all resulted in a significant deterioration of the crop’s photosynthetic machinery beginning in early to mid-September that “pulled the rug out from beneath” the successful completion of the grain filling period in some fields; resulting in less than optimum starch deposition in the kernels. **Fifthly**, early October frost/freeze damage to late-developing, immature fields resulted in leaf or whole plant death that effectively put an end to the grain-filling process with the same negative effect on test weight.

Ear Rots

Finally, ear rots (diplodia, gibberella, etc.) were widespread throughout many areas of Indiana in 2009. Kernel damage by these fungal pathogens results in light-weight, chaffy grain that also results in low test weight diseased grain, broken kernels, and excessive levels of foreign material. This cause of low test weight grain obviously results in inferior (if not toxic) animal feed quality grain, unacceptable end-use processing consequences (ethanol yield, DDGS quality, starch yield and quality, etc.), and difficulties in storing the damaged grain without further deterioration.

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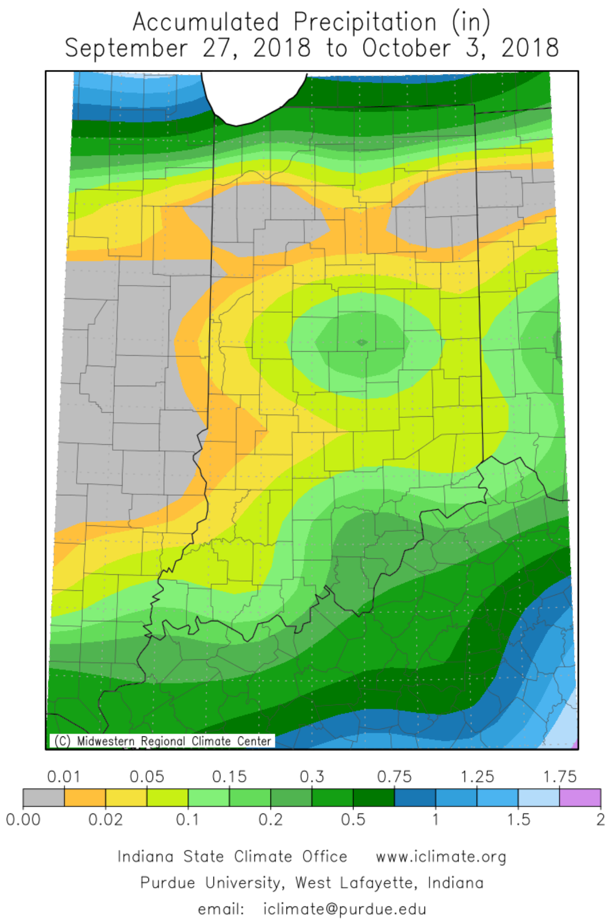
Accumulated Precipitation September 27-October 3, 2018



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Average Temperature from Mean September 27-October 3, 2018