MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 14-2017
2017 ANNUAL REPORT

Title: Determining Environmental Management Schemes to Influence the Development of Poor Seed Quality in Maturity Group IV and V Soybean

Project Leader: Tom Allen – tallen@drec.msstate.edu

BACKGROUND AND OBJECTIVES

Maintaining seed quality remains important for Mississippi soybean farmers. In some instances, environmental conditions that precede harvest can result in substantial seed quality losses. The specific conditions associated with seed quality losses tend to include a warm and extremely humid environment immediately prior to and during physiological maturity (R8).

In general, the specific environmental conditions required for seed quality losses to occur happen when inclement weather delays harvest beyond R8. However, it is likely that several key environmental conditions must be met for seed rot to occur, especially on a large number of acres. Even though reduced seed quality may not be an annual occurrence, the economic losses associated with large reductions in seed quality can be excessive. During 2008 and 2009, unfavorable environmental conditions occurred for an extended period of time immediately preceding and during R8. In addition, environmental conditions that occurred on a much smaller area during the 2017 season resulted in some quality losses. In all three of those years, the unfavorable environment resulted in severe economic losses due to poor seed quality attributed to fungal seed rot. In 2008, the period of time that delayed harvest was much shorter and therefore a greatly reduced amount of loss was experienced throughout the Miss. soybean production system. However, the period of conducive environment was greatly increased during 2009 and this subsequently increased the seed rot experienced at the end of the season.

Fungi are the most common group of organisms that result in losses of seed quality. Numerous fungi can cause seed rot, but require a conducive environment, damage to the developing soybean seed (e.g., insect damage), and numerous additional factors that may predispose the plant to a reduction in seed quality.

The premise behind this particular project began as a result of observations made during 2009. Environmental conditions that immediately preceded harvest remained warm and extremely wet for an extended period of time. In most cases, soybean harvest was delayed beyond an acceptable period of time by as much as six weeks, but delays differed among geographic locations.

During the harvest delays experienced during 2009, numerous ag-related professionals observed a general reduction in seed quality that was blamed predominantly on Phomopsis seed decay (PSD). However, previous research conducted on the soybean mycoflora suggests that, even though species of *Phomopsis* can be some of the worst seed rotting fungi given a conducive environment, additional fungi may be involved in what can be considered to be a seed rot complex that involves numerous fungi. Since numerous fungi are likely involved in the soybean seed rot complex, determining a specific management alternative becomes increasingly difficult. Managing one particular fungus or situation requires one to initially determine what the specific causal organism is behind the seed rot issue.

The objectives of the proposed research involve creating an environment conducive for soybean seed rot in a MG IV soybean in a situation with a controlled environment.

REPORT OF PROGRESS/ACTIVITY

OBJECTIVE 1. Create an environment conducive to the development of seed rot in MG IV soybean varieties.
To complete this specific objective, overhead irrigation was applied in each of the environments (shelters) having the ability for this particular input (two of the three shelters; one with covering and one without). Overhead irrigation was initiated in the two shelters on August 23 which would have been prior to the inoculation that was conducted on September 7 for the purposes of providing humidity for the infection of soybean plants.

Over a period of eight weeks, a total of 28 irrigation events were used for the purposes of initiating seed rot in the soybean plots planted under the shelters (Table 1). In all, greater than 187 hours of moisture was applied to the *Phomopsis*-inoculated, non-inoculated, and fungicide sprayed (either with Domark or Quadris) soybean plants within the overhead irrigated shelters. Therefore, based on this particular objective, two overhead irrigated shelters were compared to a non-overhead irrigated shelter and two sets of plots without a shelter with one receiving no furrow irrigation and one receiving furrow irrigation for a total of five different environments.

Table 1. Number of irrigation events, dates applied, and total period of time for each irrigation event (in minutes) for the purposes of producing seed rot in a soybean delayed harvest situation.

Number	Month	Date	Duration (min)
1	August	23	485
2	August	24	360
3	August	25	539
4	August	29	420
5	September	5	330
6	September	8	495
7	September	11	420
8	September	18	420
9	September	19	420
10	September	20	390
11	September	21	420
12	September	22	150
13	September	27	435
14	September	28	345
15	September	29	483
16	October	2	413
17	October	3	435
18	October	4	428
19	October	9	410
20	October	14	320
21	October	18	300
22	October	19	420
23	October	20	520
24	October	23	435
25	October	26	450
26	October	27	285
27	October	30	365
28	October	31	375
		TOTAL	**11,268**

Objective 2. Determine the specific organisms (i.e., bacteria, fungi, yeasts) infecting pods and seed of soybean plants in the different treatment and environmental scenarios.

Due to the delayed planting in 2017, this objective was omitted. One of the major hurdles we have had to overcome on this particular project has been learning to grow a soybean crop under a reduced light and moisture setting. I think we learned a good deal about fine tuning the process so that we should irrigate and then plant the soybean crop so that we have some moisture present at the time of planting. Therefore, the majority of this proposed portion revolved around fine- tuning the nature of working under the shelters which can be quite difficult due to reduced moisture that can make planting and maintaining a stand quite difficult. Therefore, the majority of our efforts were related to:

a. Getting the shelters planted
b. Determine how the overhead irrigation was going to work
c. Glean as much information as possible from scaling things back to something more manageable.

Objective 3. Determine the impact of the applied environmental conditions and treatments on overall seed quality.

As outlined above, some of the original objectives were scaled back or altered to account for the delayed planting as well as some of the major issues with the shelters. Treatments for the 2017 season consisted of one half of each of two enclosed shelter receiving either:

-inoculation with a liquid *Phomopsis* formulation
-non-inoculated (no *Phomopsis* applied)
-fungicide treated:
    -5 fl oz/A of Domark
    -6 fl oz/A of Quadris

The *Phomopsis* treatment consisting of fungal conidia (provided by Dr. Susan Li, USDA-ARS, Stoneville, MS) was applied on two separate dates that consisted of an application of inoculum at R5.2 (on September 7) followed by a second inoculation two weeks later at R5.5 (September 21). Inoculations were made to the specified plots to receive fungal inoculum in 5 gallons of water using non-ionic surfactant (0.25% v/v). Each plot was sprayed for three entire passes to verify that the plant canopy was saturated with inoculum. In addition, fungicides were applied to the treated plots receiving the respective fungicide in a 15 gal/A total volume.

At physiological maturity, and following the overhead irrigation treatments that were added to the shelters following R8, the entire plot area (4 rows on 19" centers and 10' in length) was hand-harvested. Plants recovered from each plot were threshed, seed was captured and weighed (lb), and plot area was calculated to arrive at a total plot weight (bu/A). From the entire grain sample, three replicated 100 kernel weights were weighed and the entire grain sample was evaluated for overall damage (using a 0-9 scale). The observational scale used for assessing damage (or seed quality) was based on 0=no loss of quality, seed exhibiting a normal appearance, 5=reduced size, discolored seed, some fungal growth observed and 9=reduced size, extremely discolored seed, excessive fungal growth present on most grain. Observations of quality were made from each replicate (as described above) and averaged for each of the treatments (inoculated, non-inoculated and fungicide-treated) to determine the effect of fungal inoculum on overall seed quality within each environment.

Two different analyses were conducted on the data collection. Treatments within each shelter (environment) were analyzed to determine the effect of treatment within each environment. In addition, treatment was analyzed between environments to determine the effect of the treatment across a range of environments.

Taken as a whole, and when analyzed by treatment within environment (shelter), treatment did not result in a significant effect on yield, 100 kernel weight, or damage (0-9 scale) (data not presented). In addition, the statistical analysis determined that a treatment by environment interaction was not significant. The only significant differences between treatments were observed in Environment #4, which consisted of overhead irrigation with no plastic covering where the Phomopsis-inoculated and the Quadris-sprayed plots were significantly different than the non-treated as well as one another (p=0.0231) (data not presented).

When considered across environments, overhead irrigation played a role in reducing yield regardless of the specific treatment composition (*Phomopsis*-inoculated or fungicide) (Table 1). In addition, and as it relates to a similar situation regarding the effect of overhead irrigation, 100 kernel weights as well as observational damage (Table 2) were also reduced in environments where overhead irrigation was applied. Fungicide treatment was beneficial by increasing yield as compared to the non-treated in some environmental situations; however, fungicide application did not result in complete eradication of damage nor overwhelmingly increase yield (Table 1) or 100 kernel weights (Table 2).

Table1. Yield based on specific treatments across multiple environments from the 2017 rainout shelter project conducted in Stoneville, MS.

	Yield (bu/A)			
	Non-treated	*Phomopsis*-inoculated	Domark (5 fl oz/A)	Quadris (6 fl oz/A)
Shelter 1 (NO environment – NO furrow irrigation)	24.0 a	17.3	20.6 ab	16.0 ab
Shelter 2 (overhead irrigation w/plastic covering)	10.0 b	13.9	13.6 bc	15.4 bc
Shelter 3 (NO overhead irrigation w/plastic covering)	17.7 ab	16.7	11.5 a	23.5 a
Shelter 4 (overhead irrigation NO covering)	6.7 b	11.7	8.6 c	7.8 c
Shelter 5 (NO overhead irrigation no covering w/furrow irrigation)	18.1 ab	18.0	11.3 c	21.5 ab
p-value	0.0436	0.2757	0.0173	0.0065
CV	50.5	41.3	43.6	31.2
LSD	11.6	6.5	10.5	7.9

Table 2. 100 kernel weight based on specific treatments across multiple environments from the 2017 rainout shelter project conducted in Stoneville, MS.

	100 kernel weight (g)			
	Non-treated	*Phomopsis*-inoculated	Domark (5 fl oz/A)	Quadris (6 fl oz/A)
Shelter 1 (NO environment – NO furrow irrigation)	13.8 bc	14.5	12.9 bc	14.2 a
Shelter 2 (overhead irrigation w/plastic covering)	12.4 c	13.8	12.6 bc	14.3 a
Shelter 3 (NO overhead irrigation w/plastic covering)	15.9 ab	14.1	14.3 ab	14.5 a
Shelter 4 (overhead irrigation NO covering)	9.9 d	11.8	11.3 c	10.7 b
Shelter 5 (NO overhead irrigation no covering w/furrow irrigation)	16.4 a	15.5	16.3 a	15.1 a
p-value	0.0003	0.0142	0.0212	0.0423
CV	12.0	14.2	14.1	14.8
LSD	2.5	2.0	2.9	3.1

Table 3. Damage (on a 0-9 scale) considered as a component of quality based on grain observations and on specific treatments across multiple environments from the 2017 rainout shelter project conducted in Stoneville, MS.

	Damage (0-9 scale)			
	Non-treated	*Phomopsis*-inoculated	Domark (5 fl oz/A)	Quadris (6 fl oz/A)
Shelter 1 (NO environment – NO furrow irrigation)	4.7 ab	3.8 a	3.8	5.0 ab
Shelter 2 (overhead irrigation w/plastic covering)	5.3 ab	4.4 a	4.0	5.3 ab
Shelter 3 (NO overhead irrigation w/plastic covering)	1.5	1.3 b	2.0	1.3 c
Shelter 4 (overhead irrigation NO covering)	7.8	5.3 a	9.0	7.5 a
Shelter 5 (NO overhead irrigation no covering w/furrow irrigation)	2.3	1.9 b	3.8	2.5 bc
p-value	0.0311	0.0003	0.0868	0.0029
CV	61.34	54.6	69.1	44.1
LSD	4.1	1.8	4.8	2.9