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MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 14-2016 (YEAR 3)
2016 ANNUAL REPORT

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

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BACKGROUND AND OBJECTIVES

Maintaining seed quality remains important for Mississippi soybean farmers. The conditions required for seed quality losses generally occur when environmental conditions remain warm and extremely humid immediately prior to and during physiological maturity (R8). However, it is possible that several key environmental conditions must be met for seed rot to effectively occur.

Even though reduced seed quality may not be an annual occurrence, the economic losses associated with a large reduction in seed quality can be excessive in years when it occurs. In general, the specific environmental conditions required for seed quality losses to occur happen when inclement weather delays harvest beyond R8.

During 2008 and 2009, unfavorable environmental conditions occurred for an extended period of time immediately preceding and during R8. 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 occurred throughout the MS 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.

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 based on observations made during the 2009 soybean season. Immediately prior to harvest, environmental conditions remained warm and extremely wet for an extended period of time. In most cases, soybean harvest was delayed by as much as six weeks, but delays differed between geographic locations. During these harvest delays, 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 this research involved creating an environment conducive for soybean seed rot in MG IV soybean with the help of a controlled environment. In addition, laboratory analysis will be conducted to determine the specific mycofloral members of the complex involved in seed rot, as well as comparing several different environmental constraints on the mycological seed rot components. Results expected involve determining how shade and increased humidity/irrigation/moisture can result in soybean seed rot.

REPORT OF PROGRESS/ACTIVITY

Objective 1. Create an environment conducive for 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) with the capability for this input (two of the three shelters; one with covering and one without). Overhead irrigation was initiated in the two shelters on September 19 to provide moisture and humidity conducive for fungal inoculum to infect soybean plants.

Over a period of 6 weeks, a total of 22 irrigation events were used to initiate seed rot in soybeans planted under the shelters (Table 1). In all, more than 130 hours of moisture was applied to the *Phomopsis*-inoculated and non-inoculated soybean plants within the irrigated shelters. Therefore, based on this particular objective, two overhead irrigated shelters were compared to a nonirrigated shelter.

Table 1. Number of irrigation events, date 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	Period of time (min)
1	September	19	87
2	September	21	90
3	September	24	117
4	September	26	365
5	September	27	180
6	September	30	287
7	October	4	610
8	October	6	371
9	October	7	265
10	October	10	481
11	October	12	160
12	October	13	575
13	October	14	300
14	October	15	155
15	October	17	335
16	October	19	580
17	October	24	507
18	October	25	427
19	October	31	480
20	November	1	480
21	November	3	480
22	November	4	480
		TOTAL	**7,812**

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 2016, this objective was omitted. One of the major hurdles we have had to overcome on this 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 soil moisture present at planting. In 2016 we had to plant the shelters twice due to a poor stand following the first planting. We determined that a lack of soil moisture to effect germination and emergence was the biggest issue. Therefore, the majority of this proposed portion of the research was omitted so we could focus on:

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 2016 season consisted of one half of each of two enclosed shelters receiving either 1) inoculation with a liquid *Phomopsis* formulation, or 2) non-inoculated (no *Phomopsis* applied).

The *Phomopsis* treatment consisted of fungal conidia (provided by Dr. Susan Li, USDA-ARS, Stoneville, MS) applied on two separate dates--R5.2 on September 17, followed by two weeks later at R5.5 on October 1. Inoculations were made in 5 gallons of water using non-ionic surfactant (0.25% v/v), and each half of each inoculated shelter was sprayed for three entire passes to verify that plant tissues were saturated with inoculum until runoff. Inoculum was applied to two of the shelters—one of the covered shelters that could receive overhead irrigation and the other covered shelter that could not.

At physiological maturity, and following the overhead irrigation treatments, a 3-square-foot area was harvested from five separate sub-samples within each shelter. Samples were collected by removing the entire plant at the base of the soil line, bagging the entire sample, and e subsequently hand-threshing seed to capture the grain sample from each plot area. Each grain sub-sample was weighed and considered as a replicate. Therefore, for each treatment (*Phomopsis*-inoculated and non-inoculated), five replicate samples were averaged to arrive at a harvest weight (in grams) for each treatment.

In addition to determining the weight of each sub-sample, harvested grain was rated for quality. A modified 0-9 scale was used where 0=no loss of quality (seed exhibiting a normal appearance), 5 = reduced size with some discolored seed and some fungal growth observed, and 9 = reduced size with extremely discolored seed and excessive fungal growth present on most seed. Assessments of quality were made from each replicate (as described above) and averaged for each of the treatments (inoculated vs. non-inoculated) to determine the effect of fungal inoculum on overall seed quality within each environment.

Taken as a whole, inoculation with *Phomopsis* significantly affected harvested seed weight regardless of whether or not irrigation was applied to the soybean underneath the shelter (p=0.0078; inoculated or non-inoculated) (Table 2). The result of *Phomopsis* inoculation does suggest that the fungus can have a negative impact on weight of harvested grain. The result of environment (shelter) suggests that in fact the environment within the shelter, in this case in the form of overhead irrigation, did result in a reduction in grain weight.

Irrigation coupled with *Phomopsis*-inoculation resulted in a 50.3% decrease in weight of harvested grain in the irrigated shelter and a 29.6% reduction in weight of grain in the non-irrigated shelter. These data suggest that moisture does play a substantial role in reducing harvested grain weight, but that the fungus can substantially reduce harvested weight of grain in the absence of substantial moisture. However, taken with the overall grain rating (0-9), the greatest loss in quality was measured in the irrigated shelter regardless of inoculation with *Phomopsis* (p<0.0001), as treatment with the fungal inoculum was not observed to be significantly different (p=0.3748) when compared to the non-inoculated.

Determinations of poor seed quality, based on the 0-9 rating scale, were considered to be greater in the covered shelters (with plastic, environments 2 and 3) than in the shelter that did not have a plastic covering (environment 4). In fact, based on the data shown in Table 2 below, it appears that irrigation did not have as much of an effect on grain quality as the plastic covering of the shelter. Results from these shelters suggests that factors in addition to excessive moisture may play a large role in reducing seed quality in soybean production systems (e.g., shade, reduced light, overall stress as it relates to the growing conditions of the plastic, temperature). In general, seed quality had the greatest reduction in the non-irrigated environment, which suggests additional factors may play a role in overall seed quality.

Table 2. Yield results from the 2016 rainout shelter project conducted at Stoneville, MS.

No.	Environment	***Phomopsis* inoculum**	**Grain weight[a]**	**Grain rating**
			g	*0-9*
1	No shelter, no plastic, no overhead irrigation, furrow irrigated	-	-	-
2	Shelter, plastic, irrigated	Y	121.5	7.2
		N	244.3	6.8
3	Shelter, plastic, non-irrigated	Y	86.8	8.0
		N	123.2	8.0
4	Shelter, no plastic, overhead irrigation	N	484.1	3.5
5	No shelter, no plastic, no overhead irrigation, no furrow irrigation	-	-	-

[a] Environments numbered 1 and 5 were mistakenly harvested earlier than the rest of the plot area so comparisons could not be made between those environments.