2021 MSPB Final Report

Project # 56-2021

Evaluation of the Effects of Early Season Flooding on Soybean Growth and Yield, Physiology, and Economics

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BACKGROUND

Flooding ranks the second largest stress following drought causing economic losses to US agriculture. Soil flood for periods lasting as short as two days in clay soil, has been shown to reduce yields by as much as 27% during the early vegetative or early reproductive growth stage. Estimates of the average losses due to flood in the US are approximately $1.5 billion/year. Approximately 16% of US agricultural fields were previously reported to be affected by flood stress, including the 8 million acres of clay soil in the Mississippi Delta region that includes the states of Missouri, Tennessee, Arkansas, Mississippi and Louisiana. The National Aeronautics and Space Administration (NASA) weather simulation models predicted an alarming 30% increase in heavy precipitation events by the year 2030. In the recent years, these predictions are evident by seeing increased frequency of floods from hurricanes and extreme weather events than in previous decades. The sustainability of soybean production has been challenged by the increasing occurrence of heavy or frequent rains throughout soybean growth season.
Genetic variation in flood tolerance was observed in soybean germplasm and could be used to improve current varieties to prevent substantial production losses during flood. Dr. Grover Shannon screened 350 lines for flood tolerance at the early reproductive stage and found susceptible lines lost yield about 2 times the rate over tolerant lines in 2005. Two genes were identified through previous United Soybean Board (USB) supported projects to Nguyen and have been utilized to develop flood tolerant germplasm and varieties. While varieties for this breeding program have been evaluated in terms of yield response, a study of the mechanisms promoting flood tolerance has not been done.

PROGRESS/ACTIVITY

Objective 1: Characterize germplasm and identify physiological mechanisms related to flood tolerance.

Quarter 1: Breeding (~200) lines from Missouri, Arkansas, and North Carolina were planted on July 7 to evaluate yield stability, growth and metabolism.

Quarter 2: The hand planted breeding plots were allowed to grow until R3-R4 growth stage and were flooded for 12 days. Flood evaluations were recorded on September 29, 2021.

Quarter 3: All breeding lines were terminated once evaluations were completed. Yield was not evaluated.

Quarter 4: Objective complete. This data (excel file with raw data is attached) showed promising results for enhancing flood tolerance in soybean. Dr. Leandro Mozzoni, formerly with the University of Arkansas, had compiled this data and is currently working on a manuscript regarding variation in flooding tolerance for advanced breeding lines while working for Bayer Crop Science as a soybean breeder. Advanced lines showing enhanced flood tolerance are being moved forward for further selection by Drs. Henry Nguyen and

Pengyin Chen of the University of Missouri. Multiple germplasm releases were underway as per discussion in our last team meeting.

Objective 2: Evaluate the effect of rescue nitrogen application to mitigate flood damage.

Quarter 1: We modified this objective based on a conversation with Dr. Henry Nguyen to include one cultivar under a twin row production. We planted on June 1 and will flood on the week of August 2. The graduate student responsible for objectives 2 and 3 resigned effective May 1, 2021 due to mental health issues.

Quarter 2: The field this was planted in (field 15, DREC) had residual herbicide effects from a rice study the previous year. The portion with damage was planted on flats. Initially, we thought this was similar to previous years where we have seen poor stand establishment when planting on flat ground. After discussing this effect with the farm manager, he mentioned that the effect follows the plot pattern of the rice study from the previous year. We decided not to include data from the plat-planted portion since we could not be certain this was due to our treatment effects.

Dr. Chastain left MS State effective July 1 for a position at the Sustainable Water Management Research Unit with the USDA. The project was turned over to Dr. Gurpreet Kaur.

Flooding of the remaining portion of the study was conducted at the R2-3 stage for 11 days. One week after dewatering, flood ratings were taken in all plots. Data evaluations scored the average flood rating to be a 5.5 on a 0-9 scale (0= no damage, 9=plant death) suggesting there are potential varieties with moderate tolerance to flooding at this specific growth stage. (Table 1)

Excessive rainfall eliminated rescue nitrogen treatments, therefore the data is not being presented.

Quarter 3: Plots were harvested on October 21, 2021. Seed samples were collected and sent for quality and composition analysis (**data attached)**

Quarter 4

Dr. Gurpreet Kaur has signed an agreement with the University of Missouri to become new faculty effective as of August 1.

Objective 3: Evaluate the effect raised beds have on yield when flooding occurs, relative to flat planting for elite commercial varieties.

Quarter 1: This objective was embedded within objective 2. Initial results show that beds result in increased emergence, relative to flats. Plots were planted on June 1, 2022.

Quarter 2: The field this was planted in (field 15) had residual herbicide effects from a rice study the previous year. The portion with damage was planted on flats. Initially, we

thought this was similar to previous years where we have seen poor stand establishment when planting on flat ground. After discussing this effect with the farm manager, he mentioned that the effect follows the plot pattern of the rice study from the previous year. We decided not to include data from the plat-planted portion since we could not be certain this was due to our treatment effects.

Flooding of the remaining portion of the study was conducted at the R2-3 stage for 11 days. One week after dewatering, flood ratings were taken in all plots. Yield was not significantly reduced when plots were flooded compared to no flood; however, numerically on average flood reduced yield by 4%(Table 1).

Quarter 3: Plots were harvested on October 21, 2021

Quarter 4: Objective complete

Discussion

Germplasm screening for flood tolerance was successful for all field sites in this study. North Carolina, Arkansas, and Missouri research teams completed their trials and consistent tolerance to flood was found in several breeding lines. Publication of results and germplasm release is forthcoming.

The final year of this study was hit with multiple setbacks, as discussed above. Environmental conditions delayed planting and carryover effects from previous trials affected objectives 2 and 3. The field this was planted in (field 15) had residual herbicide effects from a rice study the previous year. The portion with damage was planted on flats. Initially, we thought this was similar to previous years where we have seen poor stand establishment when planting on flat ground. After discussing this effect with the farm manager, he mentioned that the effect follows the plot pattern of the rice study from the previous year. We decided not to include data from the plat-planted portion since we could not be certain this was due to our treatment effects.

Impacts and Benefits to Mississippi Soybean Producers

-End Products–Completed or Forthcoming

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Dr. Chastain is preparing a manuscript on the effects of planting on raised beds versus flat planting based on data obtained in previous years of this study. In addition, a manuscript related to the physiological response to flooding at the V2 and R1 stage for field planted soybean is in preparation.

Table 1. Average evaluations for soybean flooded and non-flooded fields trials during 2021 at Stoneville, MS

	Flooded	**Non-flooded**
Rating	5-6	0
Yield (bu/acre)	44	46
Protein	37	41
Moisture	11	11
Oil	24	22