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

Project # 56-2020

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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.

Objective 2: Screen high-yielding commercial varieties and flood tolerant germplasm for flood response.

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

Report of Progress/Activity

Breeding (~200) lines from Missouri, Arkansas, and North Carolina were planted on May 29th to evaluate yield stability, growth and metabolism. We evaluated ~20 physiological parameters related to light capture in five commercial varieties under flooded and non-flooded conditions. A majority of physiological parameters showed no significant response to flood; however, it does appear that in Asgrow varieties the antenna size of photosystem two seems to be reduced. This is in agreement with previous research I have done on soybean under flood. This is likely a protective mechanism to prevent damage to the photosynthetic apparatus. This response is related to anecdotes of flooded soybean doing better under cloudy conditions, relative to hot, sunny days. We should

harvest our plots the week of October 19th. Breeding (~200) lines from Missouri, Arkansas, and North Carolina were planted on May 29th to evaluate yield stability, growth and metabolism.

We harvested on Oct. 29. Data has been released to Dr. Pongyen Chen of the University of Missouri and a publication is in the works. The annual flooding research team meeting occurred on January 14th. We have added an extension and, economic, and seed quality component to the project. This will be a collaborative effort through the new water center in Stoneville, MS. Genotype by environment data on flood rating is being compiled for a publication by Dr. Leandro Mozzoni of the University of Arkansas.

Seed has been purchased and the field is being prepped for the growing season. Data have been analyzed and there is considerable site-to-site variation in flood-tolerance rating. That being said, within each site, there is evidence for stability of several lines across testing sites. A manuscript is in preparation.

Objective 2: Screen high-yielding commercial varieties and flood tolerant germplasm for flood response.

Five elite lines were planted in a randomized study. Flood was imposed on a subset from July 15-21st (6 days). Plots will be rated for injury on the 27th of July. Flood was imposed on a subset from July 15-21st (6 days). Plots were rated for injury on the 27th of July. Generally, plots in a raised bed system rated lower for flood injury. No cultivar effect was observed for flood damage. Data from this study is being evaluated. The annual flooding research team meeting occurred on January 14th. We have added an extension and, economic, and seed quality component to the project.

Seed has been purchased and the field is being prepped for the growing season. Commercial lines in this study yielded similarly across all treatments. Generally, we observed an ~27% yield advantage for raised beds, when compared to flat planting.

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

This objective was embedded within objective 2. Initial results show that beds result in increased emergence, relative to flats. Additionally, flood treatments took less time to dewater in a bed system. Generally, plots in a raised bed system rated lower for flood injury. No cultivar effect was observed for flood damage.

For this portion of the project, collaborators are now interested in the role rescue nitrogen and seed size play. Generally, raised beds seem to be a superior method when evaluating flooding. A proposal is being prepared for United Soybean Board. Seed has been purchased and the field is being prepped for the growing season. Commercial lines in this study yielded similarly across all treatments. Generally, we observed an ~27% yield advantage for raised beds, when compared to flat planting.