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MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 56-2017 (YEAR 1)
2017 ANNUAL REPORT

Title: Evaluation of the Effects of Flooding on Soybean Growth, Recovery, and Yield

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BACKGROUND

Flooding ranks as the second largest stress (following drought) that causes economic losses to US agriculture. Soil flooding for periods as short as two days on 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 flooding 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 recent years, these predictions are evidenced 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 flooding. Dr. Grover Shannon screened 350 lines for flood tolerance at the early reproductive stage and found susceptible lines lost yield at about 2 times the rate of tolerant lines in 2005. Two genes were identified through previous United Soybean Board (USB)-supported projects, and these have been utilized to develop flood-tolerant germplasm and varieties.

Agricultural management is another strategy to protect yield under stress; however, little research has been done to study the impacts of best management practices on yield sustainability of soybeans that experience flooding stress.

OBJECTIVES

Objective 1: Characterize germplasm and identify genes for flood tolerance.

Objective 2: Develop high-yielding and flood-tolerant germplasm and varieties in MGs III to V.

Objective 3: Evaluate the effects of flood timing and duration, and management practices on yield and seed quality and composition.

REPORT OF PROGRESS/ACTIVITY

A soybean flooding study was planted May 12, 2017. Floods were applied at the V4 and R2 growth stages. The floods were held on soybeans for 24 and 72 hours once they were established. Gas exchange measurements were taken directly after the removal of a flood using a LiCor 6800 gas analyzer. The measurements were taken 14 days after soybeans had recovered. These data were used to quantify the effect of flooding of soybean respiration.

Flood timing and duration produced effects on soybean respiration rates. Compared to unflooded soybeans, a flood occurring at the R2 growth stage reduced respiration by 27%, while a flood occurring at the V4 growth stage reduced respiration by 46%. A flood duration of 24 hours reduced respiration by 17% compared to unflooded soybeans; a flood duration of 72 hours reduced respiration by 31%.

Soybean seed yield was negatively affected by flooding during this experiment, and variety had an effect on yield. Overall, Pioneer 45T74X variety yielded 8% better than Asgrow 47X6 variety and university variety checks.

An interaction between flood timing and duration was observed. A flood occurring at the V4 growth stage and lasting 72 hours reduced soybean yield by 6% compared to soybeans not flooded. Flood timing and the use of raised beds produced an effect on soybean seed yield. A yield boost was observed from soybeans planted on beds and experiencing a flood at the R2 growth stage. Soybeans planted on flat ground and flooded at the R2 growth stage yielded significantly less than soybeans planted on beds. This observation suggests that the use of raised beds in flood-prone areas is a management practice to consider to reduce the negative effects of flooding.

First year data have proved that flooding can produce negative effects on soybean growth and yield. Variety effects suggest that soybeans grown in our region should be screened for flooding tolerance. Raised beds proved beneficial for soybeans being flooded at the R2 growth stage, while soybeans flooded at the V4 growth stage were no different than the unflooded checks.

Extreme differences were not observed during this experiment. Perhaps this was because the extremely favorable growing season for soybeans in our area following the flooding events may masked some of the expected differences.

Figure 1.

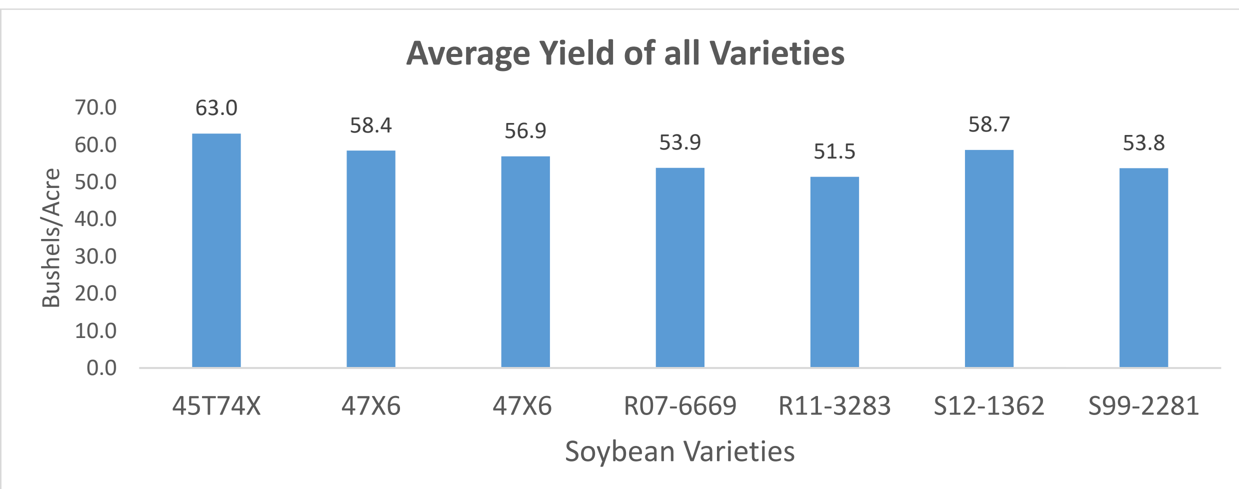

Figure 1 illustrates the overall yield of soybeans used in the trial. Seed yields were good across the board. Extreme differences were not seen; however, the 2017 growing season was highly favorable for soybean production.

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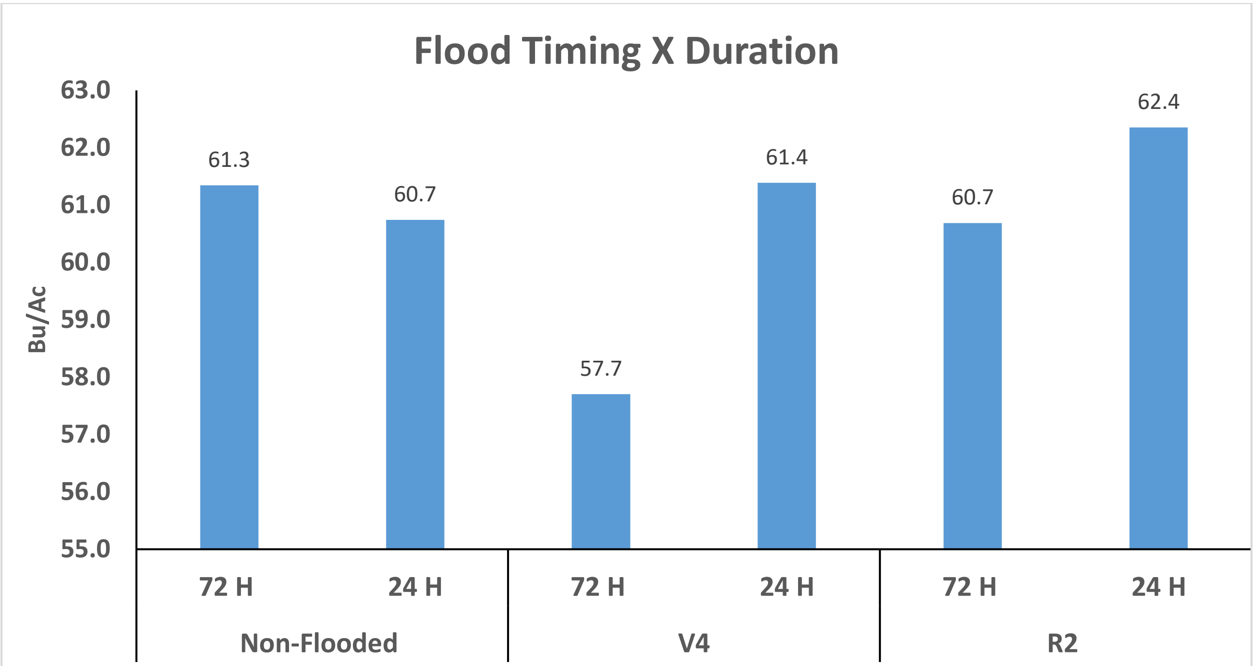
Figure 2.



Soybeans were flooded for two different durations at two different growth stages. Figure 2 illustrates that a flood lasting for 72 hours at the V4 growth stage can decrease yield. Compared to the unflooded soybeans, flooding for 24 hours at the R2 growth stage resulted in a slight yield increase.

Figure 3.

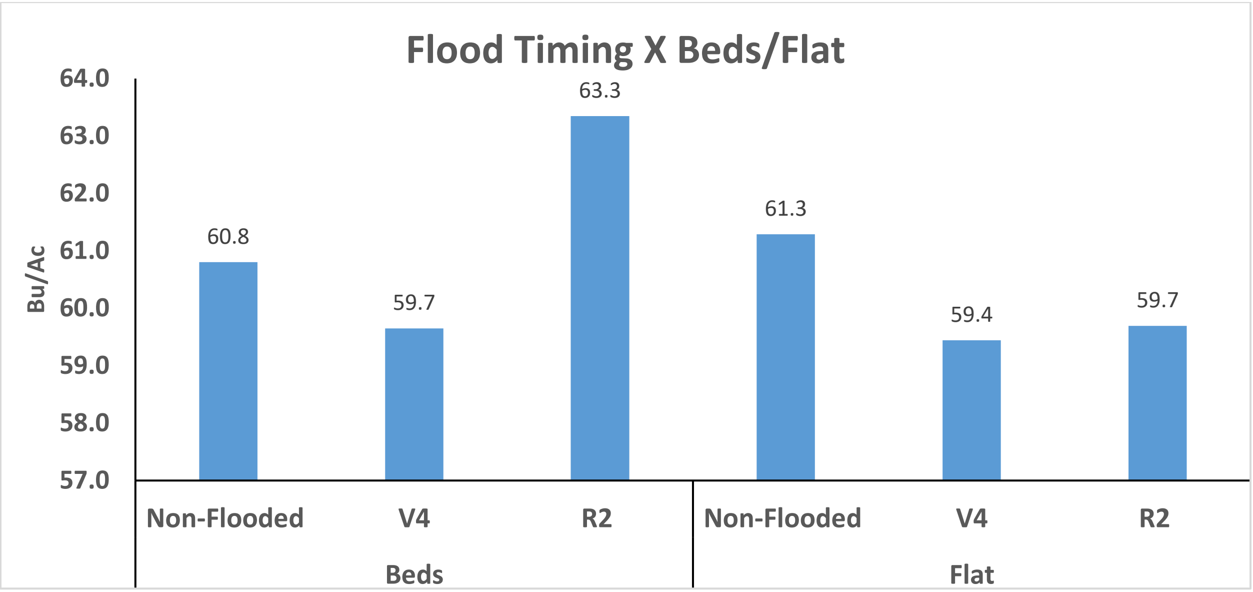


Figure 3 shows the effects of a flood occurring at different growth stages of soybeans planted flat or on raised beds. The difference is at the R2 growth stage, where soybeans planted on beds outperformed the flat-planted soybeans. Soybeans planted flat or on raised beds and flooded at the V4 growth stage were no different from each other, suggesting that early-flooded soybeans have time to recover from the effects of flooding.

Figure 4.

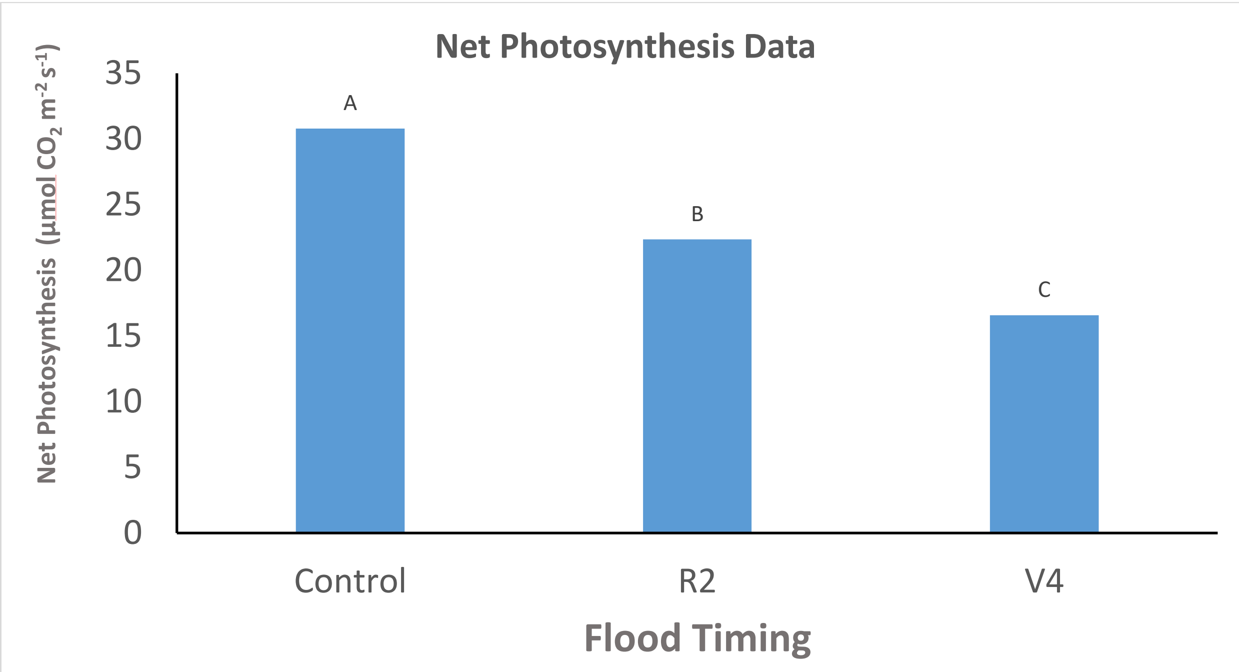
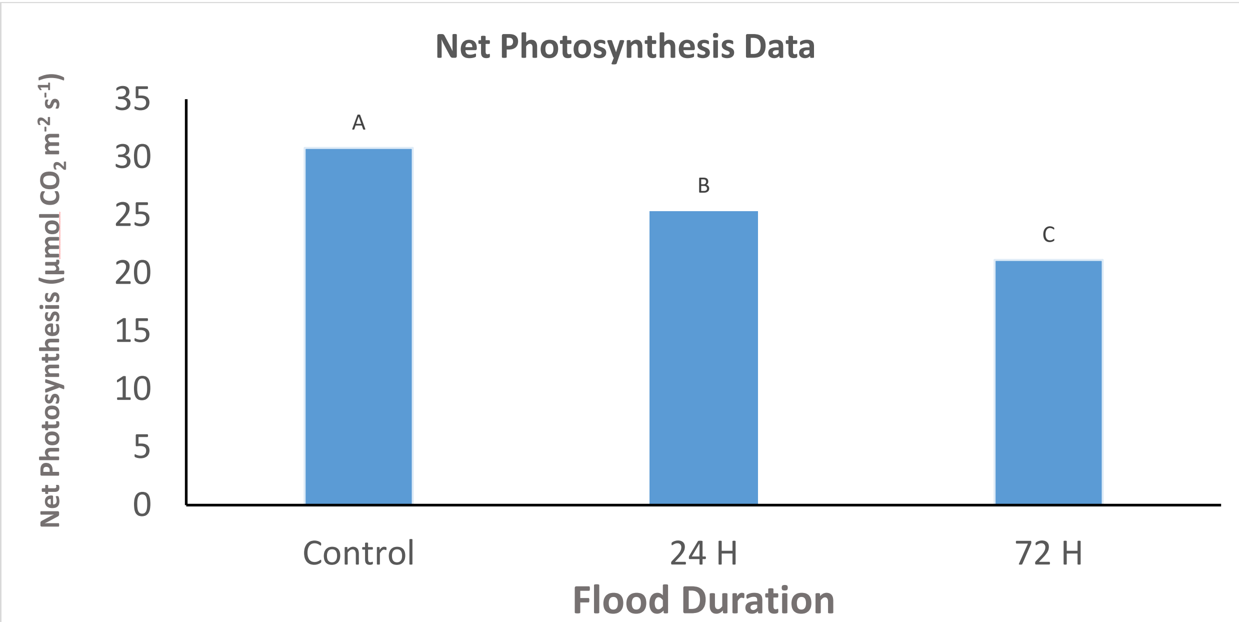


Figure 4 illustrates photosynthesis data collected from flooded soybean and compare the effects of flooding at different growth stages. Compared to the unflooded soybeans, an older soybean (R2) was able to photosynthesize more than a soybean flooded at an early stage (V4).

Figure 5.



Figures 5 shows photosynthesis data collected from flooded soybean, and compares unflooded soybean (control) to soybean flooded for 24 and 72 hours. A decrease in photosynthesis was measured as the flood duration increased.