Mississippi Corn Promotion Board
2018 Progress Report

Evaluating Corn Hybrids for Drought and Waterlogging Stress During Early-Season

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Project Summary (Issue/Response)

Waterlogging (flooding) and drought are prevalent issues faced by producers due to erratic rainfall events in the US Mid-South. Cool weather and heavy rainfall complicate both planting and the establishment of robust, uniform crop stands as producers push to plant corn as early as possible. Warmer weather and extended periods without rainfall found later in the growing season can be detrimental to the critical reproductive and grain filling stages of corn. Development of vigorous root systems and advanced photosynthesis machinery (plant canopy) are crucial as we push to increase yields and stress tolerance in modern corn varieties. Due to its physical nature, root growth and development is difficult to study in corn. Insufficient information is available regarding corn root growth, especially in response to excessive and inadequate water levels.

Waterlogging in cropping scenarios is reported to cause reductions in root growth, nutrient uptake, photosynthesis, leaf area development, and yield. However, information referencing the effect of waterlogging on corn is limited. Even less information quantifying the effect of waterlogging on root growth and development is available. Intense rainfall and furrow irrigation increases the risk of waterlogged conditions occurring in fields. Waterlogging is not just an excess of water; it is a lack of oxygen in the soil. Our projects aim is not solely to examine the effect of flooding, but to investigate how oxygen levels in the soil effect corn growth, development, and physiology.

Drought stress is a syndrome that affects all stages of corn growth and is particularly detrimental during reproductive stages. Several studies have evaluated the effects of drought stress on corn production. However, finite data is available referencing variation among popular corn hybrids in response to drought. In addition, the mechanisms influencing drought tolerance are not fully understood.

Project Results/Outcomes

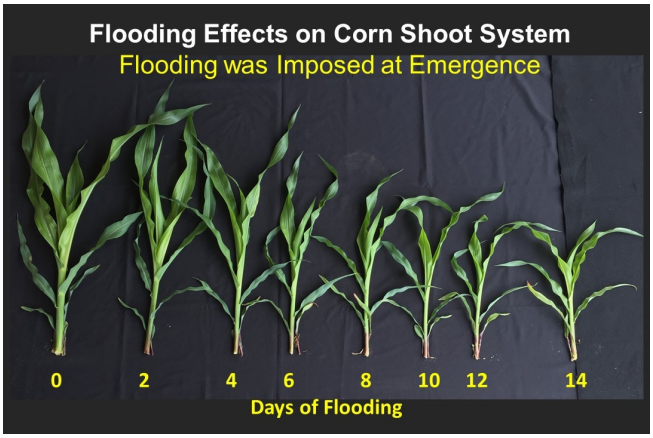
Over the past year, we have completed two projects. One project focused on the variation in response to drought stress among 19 popular Mississippi grown corn hybrids. The other project focused on the effect of multiple durations of flooding on corn. Both experiments were conducted outdoors, in pots filled with a sand-soil media mix. Each experiment was replicated twice to ensure results were consistent. Our drought study aimed to assess soil moisture stress tolerance among 19 commercially available corn hybrids during early vegetative growth. Hybrids from a wide variety of retail seed companies common to Mississippi's production systems were selected. Plants were subjected to three different soil moisture treatments. The control was fully irrigated three times per day, and the two treatments' soil moisture levels were maintained at approximately 66% and 33% of the control. Most shoot, root, and physiological traits decreased as soil moisture levels decreased. Responses also varied between hybrids.

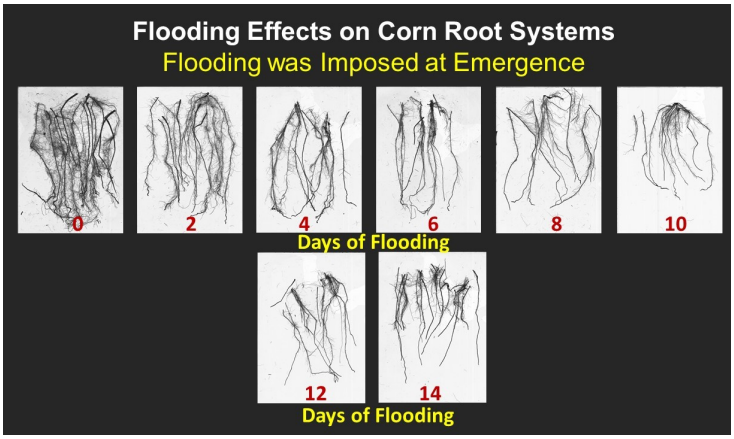
Project Results

Drought response indices were created for each measured trait by dividing treatment values by the corresponding control value, thus expressing the stress effect on a scale of 0 to 1. A Cumulative Drought Response Index was developed by summing individual drought response indices for each trait. This index was used to classify hybrids into tolerance groups.

In our flooding experiment, plants were subjected to periods of flooding between 0 and 14 days. Plants were irrigated and flooded with Hoagland's nutrient solution, ensuring no nutrient stress was present while still isolating the stress created from waterlogged conditions. Soil oxygen levels were continuously monitored and significantly decreased as flood duration increased. Oxygen levels eventually reached zero when continuously flooded. As flood treatments were terminated, soil oxygen levels quickly rose as pore space was drained of water. When flood duration increased, shoot and root growth significantly decreased. Flooding also had a significant impact on physiological parameters.

Understanding and quantifying the effect waterlogging has on early season growth is essential, as weakened plants are more susceptible to both pests (plants, insects, and disease) and environmental stresses (drought, heat, etc.).





Project Impacts/Benefits

Our projects have the potential to influence both the scientific community as well as producers involved in dryland and irrigated corn production.

Impacts of our experiments on flooding include supplementing producers' understanding of the potential damage caused by waterlogging and the importance of well-drained soils with high porosity. Our studies on drought will determine critical soil water potential levels, potentially aiding producers' decisions involving irrigation and water management. The experiments targeting hybrid response variation in both flooding and drought stress can assist producers' selection of successful, productive hybrids.

Project Deliverables

Results generated from these projects have been presented during the following conferences: The Mississippi Academy of Sciences, The Southern Branch of the ASA, and the ASA International Annual Meeting. Presentation awards were achieved at all three meetings including multiple first place finishes in both oral and poster presentations. We plan to publish our findings in multiple scientific journals. An extension article is already underway to distribute information to producers explaining the effects of flooding on corn in the mid-south. We plan to distribute this article before the spring planting season. In the future, we plan to produce an additional extension article highlighting the effects of drought on corn production in the mid-south.

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