Mississippi Corn Promotion Board
2019 Progress Report

Project Title:	Evaluating Corn Hybrids for Drought and Waterlogging
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Project Summary

Our research is rooted in the importance of establishing vigorous, even crop stands early in the growing season to lay the foundation for a successful crop to be harvested at the end of the year. The development of vigorous root systems and expansive photosynthetic machinery (plant canopy) are crucial as we push to increase yields, build stress tolerance, and increase the efficiency of crop inputs. Strong early season growth establishes the capacity for plants to better tolerate environmental stress (drought, heat, flooding, ext.) and biotic stress (insects, pathogens, weeds, ext.) throughout the growing season; this growth also establishes plants' ability to efficiently uptake water and nutrients. Waterlogging (flooding) and drought are prevalent issues faced by Mid-South producers due to erratic weather events experienced throughout the growing season. Waterlogging in cropping operations reduces root growth, nutrient uptake, photosynthesis, canopy development, and, ultimately, grain yield. Damage is not only due to an excess of water, but a lack of oxygen in the soil; this means damage can occur even when visual ponding is not visible on the soil surface. Drought is a syndrome that affects corn at all growth stages and is particularly detrimental during reproductive stages. Drought during crop establishment reduces plant height and canopy size. Excessive drought also affects root growth and nutrient uptake. If present during reproductive stages, drought limits kernel production and reduces grain fill.

To mitigate environmental stress, producers have two primary options:

1) Select best management practices to minimize stressful conditions on the crop

2) Select varieties with the best tolerance and genetics optimized to the conditions experienced in specific operations.

Our research addresses both options from a fundamental research standpoint. Our projects help bring awareness and understanding of how these stresses affect corn, the thresholds before irreversible damage occurs, and the benefits of best management. Our research establishes methods and tools to provide new differentiation between hybrids beyond yield not previously available through variety trials. This methodology could be expanded in the future to include a larger number of hybrids and even applied to other crops. Also, this research places a unique emphasis on roots, an area largely ignored by modern crop research.

Project Results/Outcomes

For the past three years, we have executed and replicated four experiments toward our goal of unraveling the effects of waterlogging and drought on corn growth and development. Each stress was divided into two projects: one investigating multiple stress levels on a single hybrid, another differentiating the response between various high yielding corn hybrids from the Mississippi Variety Trial list. Waterlogging and drought both significantly affected all corn growth and developmental traits. As drought stress occurred, plants were shorter and canopies were thinner following a decrease in photosynthesis. Root architecture dramatically changed: roots grew deeper, with less branching. Under waterlogged conditions, plant growth was hindered following a reduction in soil oxygen content. Soil oxygen rapidly declined until reaching zero after approximately six days. Above ground plant material experienced many symptoms of drought stress, despite an overabundance of water. Root growth became thinner and shallower.

Project Results

In the studies analyzing response among multiple hybrids, the effects of stress occurred as expected, but differed depending on the hybrid. Flood Stress and Drought Stress response indices are being developed to visualize how responses varied among the hybrids.

Future Plans:

2020 is the final year of funding for this project. Data is being compiled and analyzed for reports. Individual projects will be replicated as needed for this growing season, depending on the consistency of the data. Results will be compiled into both extension bulletins and academic papers for dissemination.

Expanded Study:

Resources from this grant provided by the MCPB are being combined with other sources of funding (USDA-NIFA) to broaden the scope of this study to include the effects of temperature (low and high) and nitrogen. Studies designed identically to the projects above have been completed and are in the data analysis stage. The investment in this project by the MCPB will produce results beyond the scope of the original proposal, benefitting both researchers and producers.

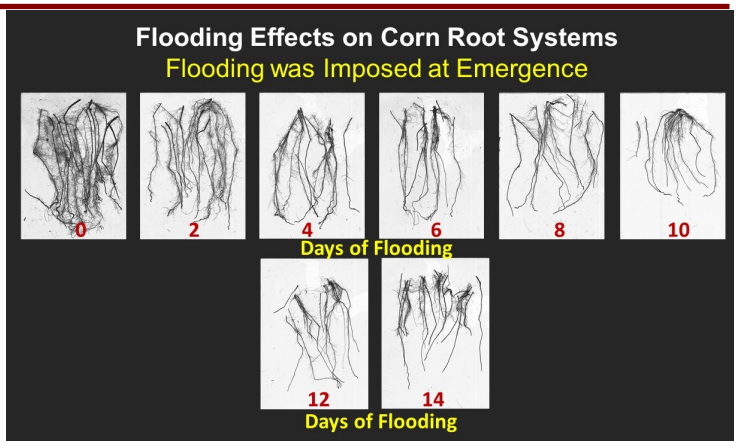

Fig.1 (*above*) depicts the effects of waterlogging on root growth. As waterlogging duration extended, roots grew thinner and shallower following a decline in soil oxygen content.

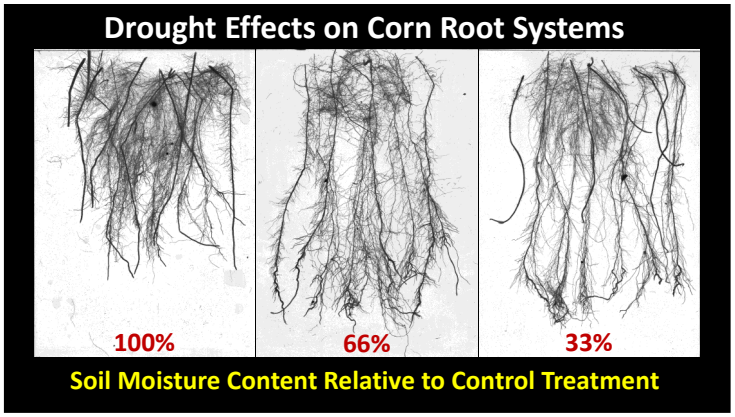

Fig. 2 (*above*) depicts the effects of drought on root growth. Total root volume, surface area, and number declined under drought, but root architecture dramatically changed. Roots grew deeper with less later branching as they mined for water and nutrients deeper in the soil.

Project Impacts/Benefits

Researchers: Data from these projects help pinpoint the exact mechanisms affected by environmental stress, especially roots that have not been studied to a great extent. Published results will establish baseline knowledge for future research projects to expand. **Producers:** Data and results published in the form of extension bulletins will provide knowledge about how these stresses are impacting their crop and the value of efficient management strategies and tolerant varieties. Classification of stress tolerance among hybrids with proven high yield potential provides an additional resource for producers to use when selecting optimal hybrids for their operation.

Project Deliverables

In 2019, results were presented in both oral and poster form at the American Society of Agronomy National Annual Meeting in San Antonio, TX, and the American Society of Plant Biology Annual Meeting in San Jose, CA. One academic paper and one extension publication have been drafted.

In 2020, we plan to finalize the project and publish results in 2-4 extension publications and 2-4 academic journals. Results will also be disseminated at several national and international meetings.

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