Effects of Abscisic Acid on Corn (*Zea mays*) grown under Salinity and Flooding Conditions

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Introduction

Corn (*Zea mays*), also known as maize, is a staple crop that plays a pivotal role in the global agricultural economy, serving as a fundamental source of food, feed, and biofuel. The cultural significance of corn spans many civilizations, with its origins tracing back to ancient Mesoamerica over 7,000 years ago. The U.S. is the largest producer of corn globally, with an annual production exceeding 14 billion bushels, and Iowa stands as the leading corn-producing state.

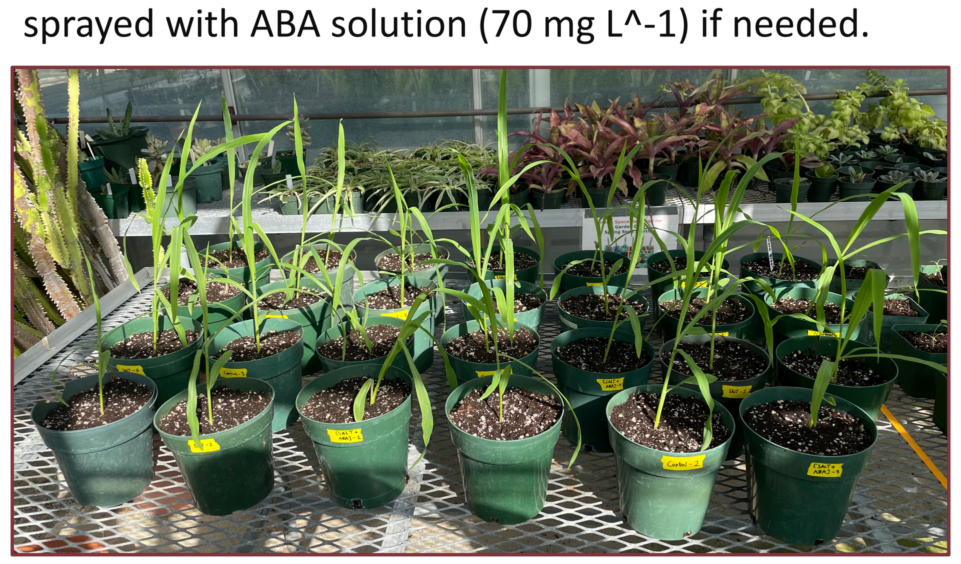
Corn exhibits remarkable adaptability to diverse climatic conditions, making it a versatile crop across different agricultural zones. However, it thrives best in well-drained, fertile soils with adequate moisture levels. Corn is sensitive to drought conditions, relying heavily on consistent rainfall or irrigation for optimal growth and yield. Additionally, it requires substantial nutrient input, particularly nitrogen, to support its rapid growth and high productivity.

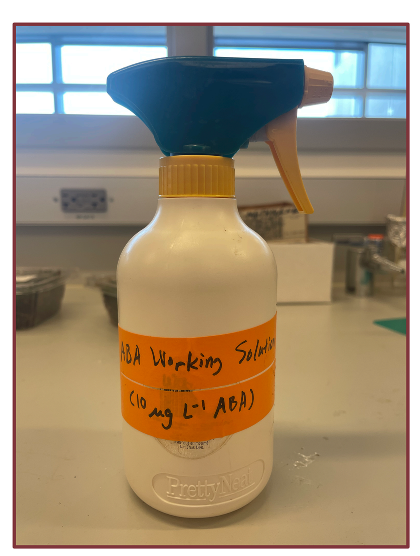
Recently, rising sea levels on accounts of climate change have posed a significant threat of saltwater intrusion to agricultural lands, including those like Corn fields. A research study by Ohio State University in 2018 found that rising sea levels led to saltier soil conditions in Bangladesh, resulting in the likely movement of nearly 200,000 coastal farmers inland (Chen, 2018).

Abscisic acid (ABA) is a plant hormone that assists in plant response to environmental stress, by regulating several biochemical and physiological processes. In this study, we explored the role of ABA in assisting the Corn plants' growth and productivity against the effects of salinity and flooding conditions. The results indicated that the ABA treatment was able to boost the productivity in control plants, in addition to reducing water loss through transpiration. Overall, ABA was likely to have assisted in the prevention of more detrimental effects of salinity in the growth and development of corn plants through boosts in photosynthesis while promoting water use efficiency.

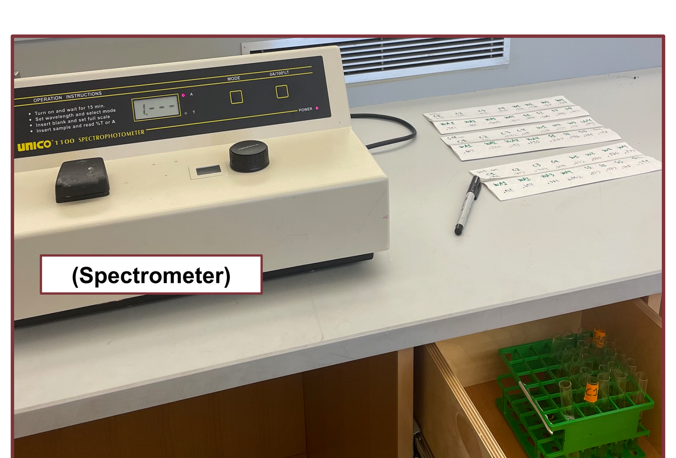
Materials & Methods

The first experiment consisted of 20 corn plants being treated with 4 separate treatments (with 5 replicates each) to mirror the respective conditions: 1) Control (di-water), 2) Control + ABA, 3) Salt (salt water), and 4) Salt + ABA. Each replicate was given either di-water or salt water (8.667 g of sodium chloride per 1L.) and sprayed with ABA solution (70 mg L^-1) if needed.





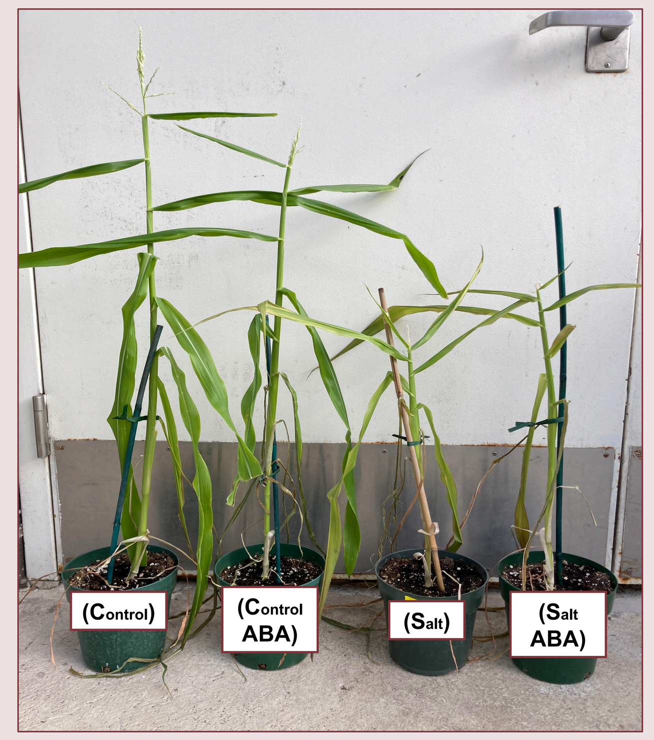
The Corn plants were observed and treated in the greenhouse for eight weeks. Every week, the number of leaves and the length of the 2nd, 6th, or 11th leaf (based on whether the leaf not able to be accurately measured anymore, i.e., the 2nd leaf died by week 5)



Soluble protein contents in the Corn plants and Leaf Photoreceptors (Chlorophyll and Carotenoids) were quantified through Spectrometers. The soil water retention content was tracked from 11/22/23 to 12/13/23 through a Soil Moisture Sensor.

Results

Figure 1 Corn Plant Conditions after Different Treatments (labelled below)



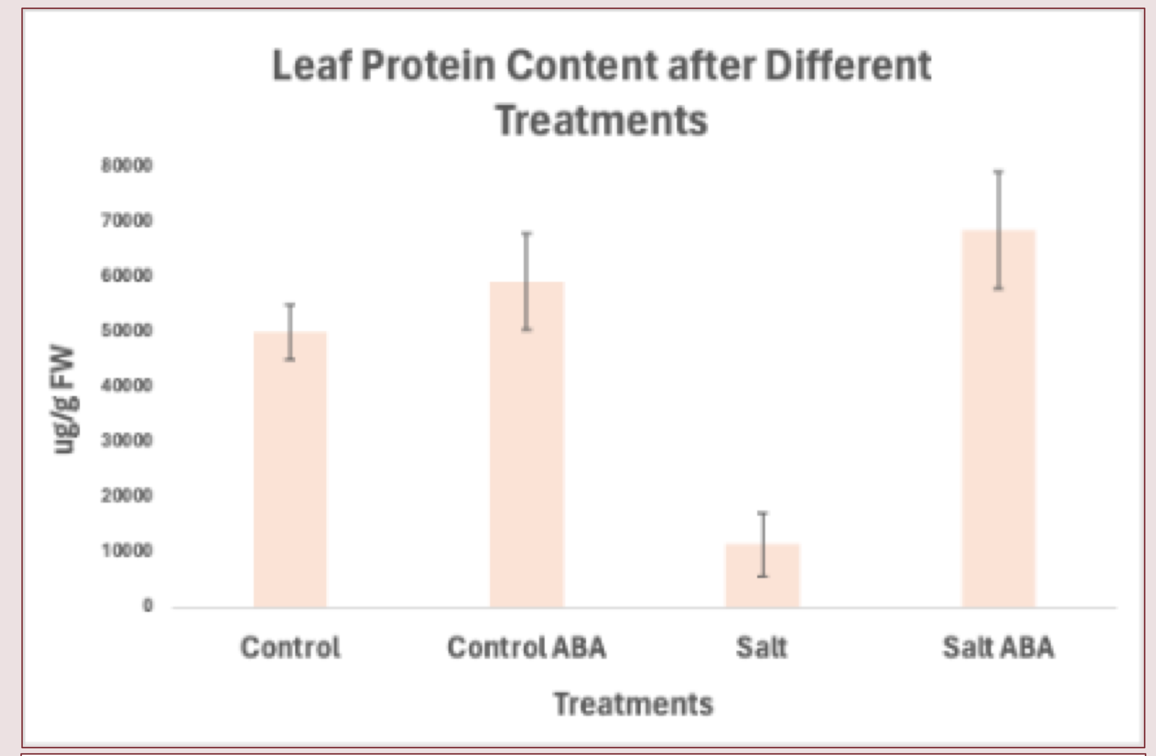


Figure 2 Protein Content of Corn Plant's Leaves after Different Treatments

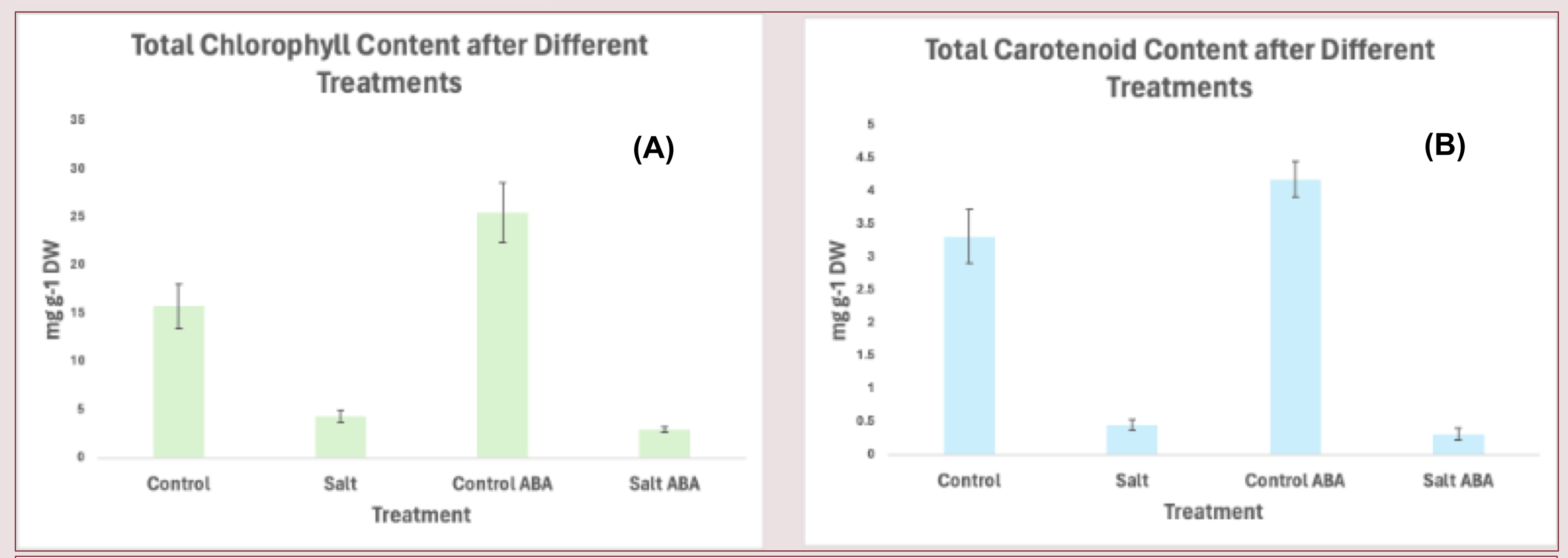
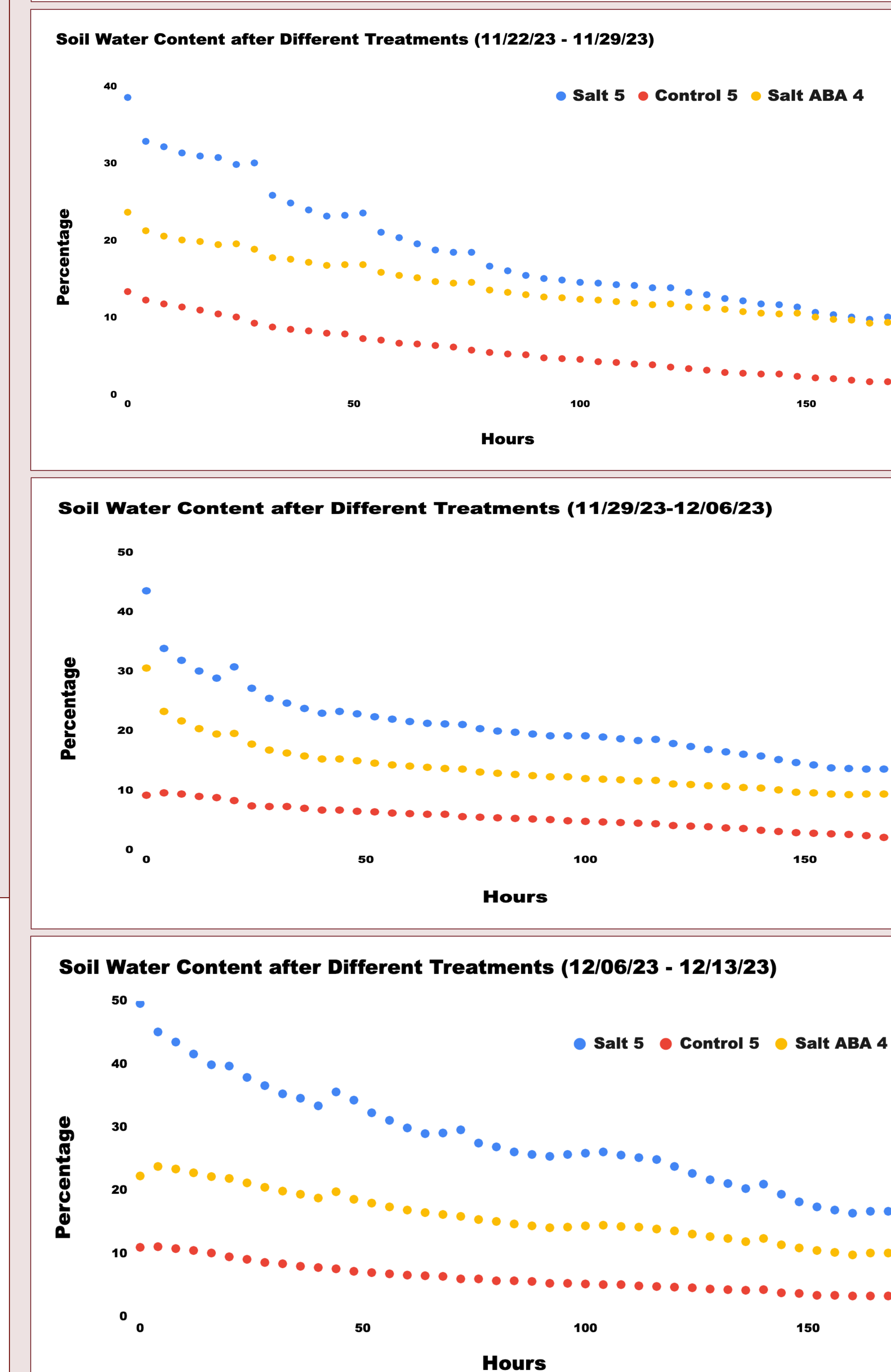


Figure 3 Chlorophyll **(A)** and Carotenoid (**B**) Content of Corn Plant after Different Treatments

Figure 4 Soil Water Content of Corn Plants from 11/22/23 to 12/13/23 after Different Treatments



Discussion and Conclusion

- After around 4 weeks, the Control and Control ABA plants (Figure 1) demonstrated significantly healthier developments compared to Salt and Salt ABA. This was evidenced by the former group exhibiting a higher leaf count, enhanced leaf length and thickness, and reduced chlorosis compared to the latter.
- Abscisic acid assisted the Control plants in their growth and functional capacities. This is observed as Control ABA (Figure 2) showed an increased concentration of soluble proteins compared to Control. Due to the elevated protein concentrations, the Control ABA plant exhibited enhanced enzymatic, structural, and functional capabilities.
- Abscisic acid assisted the Control plants in their ability to carry out photosynthetic activities. This is highlighted by higher Chlorophyll (Figure 3A) and Carotenoid (Figure 3B) content in Control ABA compared to Control. The increased levels of Chlorophyll and Carotenoids in the Control ABA plants indicates a notable improvement in their capability for photosynthesis.
- Corn plants with Salt Treatments had higher amounts of soil water content compared to the Control Treatment, indicating that they were unable to efficiently absorb enough water to aid in growth. However, Abscisic acid assisted the Salt plants in their ability to reduce the rate of water loss, likely through the closing of the stomata. Through the 3 weeks of observed water content (Figure 4), Salt was seen to have the most water content, followed by Salt ABA then Control. The mean water content remaining (calculated by averaging the 3 percentages at the last hour: 168) for Salt was 13.47, 9.63 for Salt ABA, and 2.37 for Control.
- **Therefore**, it can be concluded that Salt conditions definitively affect Corn plants' development and growth in a negative fashion in comparison to Control conditions (di-water). However, based on the real-time soil water retention data, the ABA-treated Salt plants had less uptake of salt treatments most likely through the closing of Stomata (reducing water loss through transpiration) or by altering roots. The ABA-treated Control plants also had greater amounts of Protein, Chlorophyll, and Carotenoid, indicating Abscisic Acid was able to boost the productivity by promoting enzymatic activities and photosynthetic efficiency.

Future Work

- Ongoing experiment observing the role of ABA in assisting Corn Plants' growth and productivity against the effects of flooding conditions
- Examining the extent of other plant hormones' effects on Corn Plants undergoing salinity treatments
- Applying a similar experiment but to other plants prone to similar flooding conditions like Wheat (*Triticum*)

Acknowledgements & Reference

- We would like to acknowledge the generous donation of the Soil moisture sensor by IoT Off-Grid
- Chen, J. "Coastal Climate Change, Soil Salinity and Human Migration in Bangladesh." Nature News, Nature Publishing Group, 22 Oct. 2018.