Growth and Physiological Responses of Maize to Water Stress

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Introduction

- In arid and semi-arid regions, proper irrigation is required to achieve high yield and quality of crops.
- Maize (*Zea mays* L.) is one of the most important crops grown for food, biofuel, feed, and fodder worldwide.
- Maize is more susceptible to water stress during early reproductive stages of development. Water deficit usually occurs during a period of high air temperature and drought and can cause severe yield reduction.

Objectives

The objective of this study was to investigate the effect of water-stress on physiological attributes, growth, and yield of maize grown in an arid environment.

Materials and Methods

Location

The University of Wyoming Powell Research and Extension Center (PREC), WY, USA.

Treatments and design

- The hybrid 'P8107HR' corn was grown under four levels of irrigation (100ETc = **T1**, 80ETc = **T2**, 60ETc = **T3**, and no water from V9 to R3 stages = **T4**) managed with an on-surface drip irrigation system. ETc = reference evapotranspiration x crop coefficient.
- The study design was a completely randomized design with three replications.
- An infrared gas analyser (LI-6400XT) was used to obtain photosynthesis (*A*), stomatal conductance (*gs*), transpiration (*E*), and intrinsic water use efficiency (*iWUE*) from August 10 to August 28, 2014 when maize was at its maximum water requirements (V14 – R2) stage.
- Aboveground biomass, canopy height, leaf area index (*LAI*), specific leaf area (*SLA*), and water use efficiency (*WUE*) were determined at harvest.
- Data was analyzed using SAS.

Results and Discussion

Yield and growth response

- Total dry matter yield was greatly affected by water stress, resulting in 50% reduction compared to control (7,961 for T4 vs. 15,981 kg ha^{-1} for T1) (Figure 1 A).
- Canopy height decreased as water stress increased (Figure 1 B). Similar pattern was also observed for the *LAI* (Figure 1 C). However, *SLA* increased with water deficit reaching its maximum for T4 (Figure 1 D).
- *WUE* was high under T3 treatment and low for the T4 treatment suggesting that maize plants under water stress from V9 to R3 growth stage fail to minimize their water loss and keep high level of carbon assimilation and biomass accumulation (Kebede et al., 2014) (Figure 1 E).

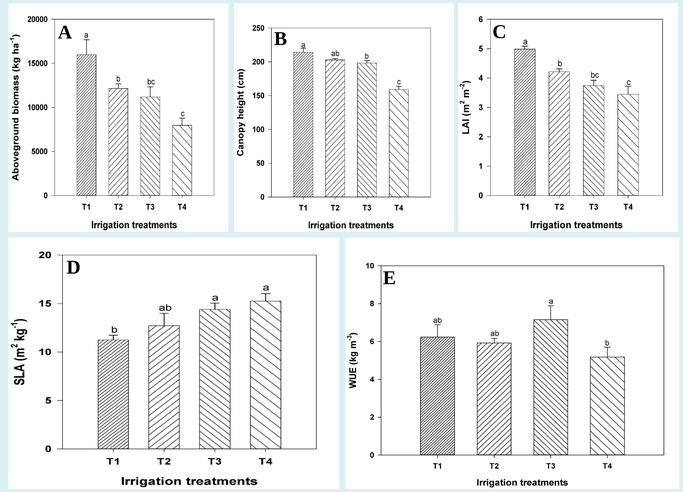

Figure 1. Growth response of maize to different irrigation levels.

Physiological attributes

- Photosynthesis and transpiration were greatly affected by water deficit; both were maximum for 100ETc and minimum for T4 (Figure 2 A&B). This could be the result of low stomatal conductance due to water stress (Farooq et al., 2009).
- The highest level of stomatal conductance was observed under 100ETc (Figure 2 C). In *iWUE*, although no differences were observed among irrigation levels, there was an increasing trend of *iWUE* with increasing water deficit (Figure 2 D). This indicates that the late vegetative growth stages might be the most critical period for gas exchange under water stress (Kebede et al., 2014).

Gas exchange measurements using the LI-COR 6400 at PREC, WY.

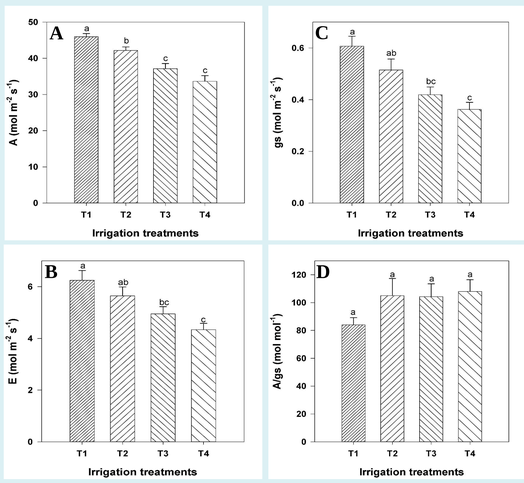

Figure 2. Physiological response of maize to different irrigation levels.

Conclusion

Results showed that water stress during a period of high water requirements at V9-R3 stage affects maize ability to perform gas exchange, and thus influencing aboveground biomass yield and *WUE*. Irrigation levels seem to be a key factor affecting maize growth and physiology.

Acknowledgments

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References

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Kebede, H., Sui, R.X., Fisher, D.K., Reddy, K.N., Bellaloui, N., Molin, W.T., 2014. Corn yield response to reduced water use at different growth stages. Agricultural Sciences 5, 1305-1315.