Multidimensional Role of Silicon in Mitigating Seasonal Risks for Improved Crop Production

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ABSTRACT

Abiotic stress factors such as drought and heat are the primary cause of grain yield reduction in a rainfed cropping system. Crop failures are predicted to increase in the coming years due to increasingly severe weather events. Drought and heat's individual and combined effects would disrupt plants' morpho-physiological, biochemical and molecular processes more than any other environmental stresses. Plant-available silicon (PAS) has been widely reported for its beneficial effects on plant growth and productivity and attenuating physiological and biochemical impairments caused by various abiotic stresses. We have done a series of control and field-based experiments to study the effect of PAS in mitigating drought (40±3% field capacity) and heat stress (36 °C for three days) at critical growth stages (stem elongation, pre-anthesis and early grain filling stage) in contrasting bread wheat cultivars. The results from different experiments showed that PAS application positively impacts wheat plants' growth and productivity. Overall, results have shown that PAS application led to a significant increase in plant growth, improved gaseous exchange, higher osmoprotectant concentrations and reduced proline levels under drought and heat stress compared to controls. Silicon application further improved the plant water relations and antioxidant activities for scavenging reactive oxygen species at the cellular level, which is linked with abiotic stress tolerance in wheat (Ashfaq et al., 2022). Silicon application also positively influenced the root functional traits to regulate moisture uptake ability for cooler canopy and enhanced photosynthesis under drought stress (Ashfaq et al., 2023 accepted). The studies suggest that PAS application can mitigate the detrimental effects of individual and combined drought and heat stress in wheat and potentially for other crops. These findings provide a foundation for future research investigating PAS-induced tolerance mechanisms in the wheat crop at the molecular level, evaluating its efficacy at the field level for different soil types and crops.

REFERENCES

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