Challenges and opportunities for enhancing maize adaption to stressful environments

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Agriculture is highly vulnerable to variations in weather such as flooding, drought, and high-temperatures. Increased frequency of these stresses due to climate change will negatively impact crop yields and increase the probability that future production environments will be challenged by multiple stresses that vary in timing and intensity. With these emerging threats to agriculture, plant scientists are called to identify and deploy new genes and physiological mechanisms that contribute to crop resilience. Additional efforts are needed to integrate or stack multiple climate adaptation traits into new cultivars. Recent studies in maize showed that genotype by environment interactions for heat and drought stresses are complex and efforts to combine multiple stress tolerance into a single genotype can be challenging. Successful crop improvement efforts for multiple stress tolerance will require a clear understanding of component traits and how they impact plant growth and development. Comparative analyses of crops that exhibit unique adaptation characteristics may also provide insight into how traits can be combined and optimized in elite cultivars. Studies in maize and sorghum suggest that some adaptation traits such as late-season drought tolerance appear to be under similar genetic control in each crop. Plant breeders for one crop may substantially benefit from lessons learned in another crop. Although recent advancements in plant breeding and biotechnology are making substantial contributions to engineering plants with tolerance to abiotic stresses, more research is needed to understand the genes and mechanisms that can be used to develop crop plants adapted to diverse climatic conditions.