

Genomic approaches to enhance adaptive plasticity to cope with soil constraints amidst climate change in wheat

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Abstract

Climate influences on below-ground plant traits seldom receive due attention. Climate change is varying the availability of resources, soil physical properties, rainfall events, soil mineral weathering and leaching intensity which collectively determines soil physical and chemical properties. Soil constraints – acidity (pH<6), salinity(pH[?]8.5), sodicity and dispersion (pH>8.5) are major causes of wheat yield loss in arid and semi-arid cropping systems. To cope with changing environment, plants employ adaptive strategies such as phenotypic plasticity; a key multifaceted trait, to promote shifts in phenotypes. Adaptive strategies are complex, determined by key functional traits and Genotype × Environment interactions. The understanding of molecular basis of stress tolerance is particularly challenging for plasticity traits. Advances in sequencing and high-throughput genomics technologies has identified functional alleles in gene-rich regions, haplotypes, candidate genes, mechanisms and in silico gene expression profiles at various growth developmental stages. Our review focuses on favourable alleles for enhanced gene expression, QTLs and epigenetic regulation of plant responses to soil constraints including heavy metal stress and nutrient limitations. A strategy is then described for quantitative traits in wheat by investigating significant alleles, functional characterization of variants, followed by gene validation using advanced genomic tools and marker development for molecular breeding and genome editing. Also, the review highlights the progress of gene editing in wheat, multiplex gene editing and novel alleles for smart control of gene expression. Integration of these genomic technologies will be effective to enhance plasticity traits and stabilizing wheat yields on constrained soils in the face of climate change.

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