Improving chilling tolerance in chickpea using genomics and computational approaches

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Chickpea (*Cicer arietinum L.*) is one of the most important legume crops, grown primarily as a protein source. Low temperature (chilling) stress significantly impacts the yield and profitability of chickpeas, particularly during the reproductive growth stage. The development of chilling-tolerant chickpea varieties is a priority for growers and breeding programs in areas where chilling stress is prevalent. This requires developing methods to measure chilling stress tolerance and selective breeding to improve it while keeping yield and other desirable traits intact. Our research aims to investigate the genetic architecture of chilling tolerance using Genome-Wide Association Studies (GWAS) and understand the efficacy of genomic selection (GS) to breed for improved tolerance. About 270 lines were phenotyped at Dale, Western Australia over two years using a novel ‘pod marking’ method to assess pod viability, which serves as an indicator of cold tolerance. Pod viability is defined as the ratio of viable pods (those filled with grain) during the chilling period (average daily temperature below 13°C) to the total number of pods, with a higher ratio indicating greater tolerance.

GWAS analysis indicated pod viability is a moderately complex trait governed by a few major and many minor genes. This was further confirmed by moderate (0.25) narrow sense heritability (0.25) for the trait. Moderate genomic prediction accuracy (0.39 ±0.06) was obseved for pod viability from 10-fold cross validations, providing evidence for the reliability of GS to guide selection decisions.

Both the novel screening method for chilling tolerance and genomics-assisted breeding are being used to accelerate breeding toward the development of chickpea varieties with improved chilling tolerance.