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Canola pre-breeding for heat stress tolerance in Australia

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Background:

Extreme heat events are occurring more frequently in Australia. Heat tolerance is not known to exist in Australian canola cultivars. This project seeks heat tolerance in a diverse *Brassica napus* population which was created through a Grains Research and Development Organisation (GRDC)-funded project based on collaboration between Australia, China and India.

Objective:

In a GRDC-funded national project, we evaluated the diverse *B. napus* population for heat tolerance in a controlled heat screening facility (HSF) at UWA, portable heat chambers (PHC) in the field at NSW DPI, and in national field trials. The objective was to identify heat tolerance in the HSF and PHC and to validate heat tolerance in national field trials.

Methods:

Single plants of 322 diverse canola genotypes were assessed for heat tolerance in the HSF at UWA in control and heat-stress treatments for 7 days from first open flower. There were two sowing times (early and late) in 2020 and 2021. Heat tolerance was measured based on 8 yield-related traits, including yield on the main stem, yield on the whole plant and whole plant biomass at harvest. The percentage change from control to heat treatment and stress tolerance index were used to measure the relative level of heat tolerance in each genotype.

Following selection in the HSF, 16 genotypes were evaluated in the PHC to assess heat tolerance under field conditions. Heat treatment was applied for 8 days from first flower to simulate a heat wave in the field.

The most promising lines were validated in national field trials in 2020, 2021 and 2022.

Regular irrigation was applied in all trials to avoid any confounding effect of drought stress. Multiple times of sowing were used to ensure that genotypes were exposed to high temperature stress at flowering at one or more sowing times.

Genome wide association study (GWAS) was used to identify QTLs and genes with putative functions related to heat stress in the population.

Results:

Several putative heat tolerant and sensitive lines were identified in the HSF, and then evaluated in the PHC where results were consistent with the HSF.

Field trials at several environments in southern Australia validated heat tolerance in several genotypes which were previously selected for heat tolerance in the HSF and PHC.

GWAS identified 162 significant marker-trait associations (MTAs) for heat tolerance, among which 62 MTAs showed $\geq 5\%$ phenotypic variance explained for different traits. Each QTL contributed to heat tolerance based on one or more yield-related traits. Candidate genes, once their functions are confirmed, may be used for improving heat tolerance in canola breeding programs.

Conclusions:

Heat stress tolerance was identified in a diverse canola population in the HSF at UWA, PHC at NSW DPI, and in national field trials. Heat tolerant germplasm and molecular markers will be offered to Australian canola breeders with the goal to improve heat tolerance in commercial canola cultivars.