IWYP International Wheat Yield Partnership
Research to Deliver Wheat for the Future

IWYP SCIENCE BRIEF

NUMBER 51 JULY 2024

Supported by GRDC Grains Research & Development Corporation | Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Validation of Targeted Genetic Improvement in Yield Potential and Water Use Efficiency in Wheat

Improving plant biomass and water use efficiency are key elements in elevating wheat grain yield in farmers' fields. Two previous IWYP research projects (IWYP39 and IWYP-AAFC3) used a transgenic and mutational approach to assess key target genes involved in yield enhancement (*AVP1*, *OsPSTOL1* and *OsNAS2*) and stomatal control and development (*TaOST1*, *TaSLAC1*, *TaYDA* and *TaMUTE*). In these projects collaborators from Australia, Canada, UK, USA and Mexico created and characterized lines of transgenic and mutant wheat with altered expressions of the genes of interest to understand the processes controlled by these genes and their effect on plant growth and grain yield. Plants over-expressing *AVP1* were found to better remobilize sugars from source to sink tissue leading to enhanced root and shoot biomass, and grain yield, while plants over-expressing *OsPSTOL1* had greater root biomass due to an upregulation of genes in nutrient uptake from the soil and higher grain yield. Though the majority of lines with mutations in *TaOST1*, *TaSLAC1*, *TaYDA* & *TaMUTE* had detrimental effects on stomata development and movement, some lines were identified which had better water use efficiency under drought conditions. Recent funding from the Grains Research and Development Corporation (GRDC; UOA2404-013RTX) in Australia is now facilitating the development of non-GMO optimizations of these genes aimed at delivering elite germplasm with these enhanced traits to breeding programs.

Planting field trials of GMO wheat at Dookie, Victoria, Australia in 2023.

Seed multiplication of non-GMO novel gene alleles in the glasshouse.

What Solutions have been Identified?

- Multiple seasons of GMO wheat field trials at two locations in Australia have shown that over-expression of *AVP1*, *OSPSTOL1* and *AVP1* & *OSPSTOL1* & *OSNAS2* results in 10-60% improvement in grain yield
- Novel high expression alleles of the wheat homologous of *AVP1* (*TaAVP2-D*) and *OsPSTOL1* (*TaPSTOL1-like*) genes have been identified from wheat cultivars and landraces
- Screening of cv. Cadenza and cv. Gladius EMS mutant wheat populations have identified lines with improved water use efficiency under greenhouse conditions
- A crossing program has introduced novel alleles into elite Australian cv. Sceptre to create non-GMO solutions for further characterization

What has been Transferred to the Wheat Improvement Pipelines

- Genetic markers for 2 *TaVP* alleles and one of the *TaPSTOL1*-like genes along with SNPs for all the mutants
- Non-GMO cv. Sceptre BC3 lines containing novel alleles of genes or unique mutations in genes to undergo greenhouse evaluation in 2024 with further trialing of GMO wheat lines to take place in the South Australia and Victoria areas
- Promising non-GMO cv. Sceptre lines with novel alleles to be trialed in up to 6 locations in the field in South Australia during the 2025 and 2026 seasons
- Breeders will assess a selection of the most promising lines in multiple environments around Australia in 2027