World Academy of Science, Engineering and Technology
International Journal of Biotechnology and Bioengineering
Vol:12, No:10, 2018

Screening of Wheat Wild Relatives as a Gene Pool for Improved Photosynthesis in Wheat Breeding

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Abstract : The rate of genetic progress in wheat production must be improved to meet global food security targets. However, past selection for domestication traits has reduced the genetic variation in modern wheat cultivars, a fact that could severely limit the future rate of genetic gain. The genetic variation in agronomically important traits for the wild relatives and progenitors of wheat is far greater than that of the current domesticated cultivars, but transferring these traits into modern cultivars is not straightforward. Between the elite cultivars of wheat, photosynthetic capacity is a key trait for which there is limited variation. Early screening of wheat wild relative and progenitors has shown differences in photosynthetic capacity and efficiency not only between wild relative species but marked differences between the accessions of each species. By identifying wild relative accessions with improved photosynthetic traits and characterising the genetic variation responsible, it is possible to incorporate these traits into advanced breeding programmes by wide crossing and introgression programmes. To identify the potential variety of photosynthetic capacity and efficiency available in the secondary and tertiary genepool, a wide scale survey was carried out for over 600 accessions from 80 species including those from the genus Aegilops, Triticum, Thinopyrum, Elymus, and Secale. Genotype data were generated for each accession using a 'Wheat Wild Relative' Single Nucleotide Polymorphism (SNP) genotyping array composed of 35,000 SNP markers polymorphic between wild relatives and elite hexaploid wheat. This genotype data was combined with phenotypic measurements such as gas exchange (CO_2, H_2O), chlorophyll fluorescence, growth, morphology, and RuBisCO activity to identify potential breeding material with enhanced photosynthetic capacity and efficiency. The data and associated analysis tools presented here will prove useful to anyone interested in increasing the genetic diversity in hexaploid wheat or the application of complex genotyping data to plant breeding.

Keywords : wheat, wild relatives, pre-breeding, genomics, photosynthesis
Conference Title : ICAGPB 2018 : International Conference on Agricultural Genomics and Plant Breeding
Conference Location : Tokyo, Japan
Conference Dates : October 08-09, 2018