

Using spectral reflectance for indirect selection and Genome-wide association study of drought tolerance in Winter wheat

Shiferaw A. Gizaw

Department of Crop and Soil Sciences Washington State University Pullman, WA 99164

PhD Candidate (Dr. Arron Carter's lab)

ABSTRACT

Spectral reflectance technology is an emerging throughput alternative to study physiological traits that are related to drought adaptation and yield potential. This study was conducted to evaluate drought responses and phenotypic associations of yield determining spectral reflectance indices (SRIs), and identify the underlying quantitative trait loci (QTL) in Pacific Northwest (PNW) winter wheat germplasm. To this effect, a total of 402 genotypes (87 hard and 315 soft) were phenotyped under water deficit and optimum conditions in 2012 and 2013. Genotype and environment had significant effect on grain yield, stay green and various SRIs ($p < 0.001$). Variation in soil moisture and thermal time cumulatively explained 86% of total yield variation across environments. Normalized difference vegetation index (NDVI), anthocyanin reflectance index (ARI), normalized chlorophyll pigment ratio index (NCPI), photochemical reflectance index (PRI), normalized water index (NWI), green normalized vegetation index (GNDVI) and simple ratio (SR) showed consistent pattern of drought response and strong phenotypic correlation with grain yield ($p < 0.001$). The variation in drought tolerance that was explained by SRIs ranged from 55 to 84 % ($p < 0.001$). SRI-derived estimates of stay green showed moderate to strong correlations with flag-leaf senescence indicating the possibility of using this approach in canopy-level estimation of stay green. A genome-wide association study was conducted for these traits using 3,526 bi-allelic SNP markers (from 9K iSelect assay), 3 to 4 principal components, and relatedness matrix in mixed linear model. A total of 89 SNP markers were significantly associated with one or more SRIs ($p < 0.01$) at least in six of the seven trials. The QTL for SRIs on chromosome 3A, 4A, 5B, and 7A were co-localized with stay green and drought tolerance loci, and were not associated with phenology.

Keywords: Reflectance indices, drought tolerance, winter wheat, genome-wide association