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Exploring soybean germplasm for drought and agronomic-related traits using true breeding values

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True breeding values (TBVs) can be used to select parental genotypes in a breeding programs. Here, we used the results from genome wide association studies (GWAS) of drought related traits including canopy temperature (CT), canopy wilting (CW), carbon isotope ratio ( $\delta^{13}\text{C}$ ), oxygen isotope ratio ( $\delta^{18}\text{O}$ ), ureide concentration (UR), nitrogen derived from atmosphere (NDFAs), and nitrogen concentration (N), measured from our research along with several traits from GRIN including early-seed shattering (ESS), late-seed shattering (LSS), height (Ht), lodging (LG), oil (OL), protein (PR), seed weight (SW), stem termination (ST), and yield (Y). From GWAS results, we identified favorable alleles and average allelic effect of significant markers associated with these traits.

Accessions (373) used for GWAS can be considered a training set and rest of accessions in germplasm collection can be considered a validation set. True breeding values of the validation set were calculated by using these favorable alleles and their average allelic effect. Over 14,000 accessions from the germplasm collection have phenotypic data for agronomic traits. From phenotyped accessions, two traits, ST and SW, which are not affected greatly by environmental variation and sampling error, were used to check the accuracy by correlating actual phenotype and TBVs. We observed highly significant positive correlations between actual phenotype and TBVs for ST ( $r = 0.60$ ) and SW ( $r = 0.56$ ). Based on TBVs, we found that the expected correlations between agronomic traits such as yield were significantly correlated with height ( $r = 0.50$ ) and oil ( $r = 0.56$ ), and negatively correlated with protein ( $r = -0.23$ ), early seed shattering ( $r = -0.68$ ), late seed shattering ( $r = -0.48$ ), and seed weight ( $r = -0.37$ ). Similarly, we observed the expected correlations between drought-related traits including a positive correlation between CW and CT ( $r = 0.60$ ), and positive correlation of  $\delta^{13}\text{C}$  with CW ( $r = 0.53$ ) and CT ( $r = 0.67$ ). Extreme drought-tolerant accessions were identified, which can be used as potential parents in a breeding program.