B-137

Identification of genomic regions and germplasm to improve drought tolerance in soybean

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Drought stress causes the greatest soybean yield losses in rain-fed U.S. growing areas among abiotic stresses. Since less than ten percent of U.S. soybean acreage is irrigated, combating this stress requires soybean plants which possess physiological mechanisms to tolerate drought for short periods. One such trait, slow canopy wilting, is observed when leaf wilting and loss of petiole turgidity are slower to appear during drought stress, and may lead to yield improvement. Additionally, quantifying carbon isotope composition is a surrogate measurement for water use efficiency in C3 plants. In this study, a panel of over 200 genetically diverse soybean lines genotyped with the SoySNP50K BeadChip was evaluated for these traits in repeated field experiments. Canopy wilting was visually scored at two locations (Athens, GA and Salina, KS) in 2015 and 2016 after extended periods of drought stress, and leaf samples analyzed for carbon isotope composition were collected at one location (Athens, GA) over two years. Substantial variation in canopy wilting was observed across environments, with more severe wilting occurring in Athens, GA in both years. Values for δ13C ranged from -24 to -30 ‰, with a correlation between years of r = 0.74. BLUP values for canopy wilting and carbon isotope composition across and within environments were calculated and used as the phenotypes for genome-wide association analyses. Several putative new genomic regions associated with both traits were identified in addition to confirmation of regions elucidated in previous mapping studies. New germplasm with slow canopy wilting across environments and high water use efficiency were also identified. The genomic regions and germplasm discovered through this research can be used to better understand these physiological traits, and be incorporated into elite germplasm to improve soybean drought tolerance.