Acid Soil Adaptation Index: A Field Selection Approach for Improving Low pH Tolerance in Alfalfa

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Alfalfa production in the southeastern United States is significantly limited by low pH and aluminum toxicity brought on by acidic ultisols. Despite previous efforts to improve this trait, no tolerant cultivar is currently available, and the genetic basis of tolerance in alfalfa remains unclear. The current research focused on large scale field evaluation of a germplasm in low pH and high aluminum soils. 139 half-sib families derived from a selected, diverse panel of plant introductions have been evaluated for forage yield in a field with an adjusted pH of 6.37 and a field with a low pH=4.90 and exchangeable Al^{3+} concentration of 10.41 mg/kg in two replications at two locations. An Acid Soil Adaptability Index (ASAI) score (Howeler, 1991) was assigned to each half-sib family to identify unadapted (<1), well-adapted (>1), and very-well-adapted genotypes (>2). Dry matter yield (DMY) per plot was evaluated in Watkinsville, GA throughout the growing seasons of 2021, 2022, and 2023 and in Tifton, GA in 2023. A mixed model analysis of the results revealed significant interactions between year, location, and genotype, necessitating separate analysis for each year-location combination. Evaluation of ASAI scores across locations and years revealed 50 well-adapted and 7 very-well-adapted half-sib families in Tifton, 2023 and 57, 59, and 61 well-adapted and 8, 13, and 15 very-well-adapted genotypes in Watkinsville over 2021, 2022, and 2023, respectively. 24 half-sib families were consistently identified as well-adapted across all years and locations, implying significant genetic tolerance which can be used in cultivar development. The significant phenotypic variation displayed by this population can also be leveraged in genome wide association analysis (GWAS) to identify associations with molecular markers and genomic selection models to accelerate genetic gain for this complex trait.

Howeler, R. H. (1991). Identifying plants adaptable to low pH conditions. Plant-Soil Interactions at Low pH: Proceedings of the Second International Symposium on Plant-Soil Interactions at Low pH, 24–29 June 1990, Beckley West Virginia, USA