Impact of Reduced Lignin or Ferulate Crosslinking on Fitness of Temperate Grasses

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Breeding for increased forage quality is an effective mechanism to add value to a forage cultivar targeted for livestock agriculture. Reduced lignin concentration and reduced ferulate crosslinking (etherified ferulates, EthFA) within the cell wall are two mechanisms that have been proposed to increase fiber digestibility of forage grasses. Divergent-lignin and divergent-EthFA genotypes of three species (orchardgrass, reed canarygrass, and smooth bromegrass) were created by selection and repeated evaluation to confirm that their phenotypic classification was consistent and repeatable. A total of 24 genotypes were used to generate three eight-parent full-diallel sets of crosses. Within each species, two genotypes were selected with the most extreme values of low lignin, high lignin, low EthFA, or high EthFA. Across species and genotypes, the divergence in EthFA was approximately 20% of the mean and the divergence in lignin was approximately 12% of the mean. Both of these differences had large and significant impacts on fiber digestibility. Crosses and parents were established in a replicated field study and used to measure forage yield on a three-cut management system. Diallels were analyzed for general and specific combining ability (GCA and SCA) effects and reciprocal effects. The impact of high vs. low lignin or high vs. low EthFA was evaluated by making paired comparisons of parental means and GCA effects.

Selection for reduced EthFA led to reductions of 47, 30, and 31% for forage yield of orchardgrass, reed canarygrass, and smooth bromegrass, respectively. All six low-EthFA parents had significant negative GCA effects, averaging -1.51 Mg/ha across the three species. The greatest impacts of reduced EthFA were on the first harvest, which is when most stem production occurs (-0.79 Mg/ha for first harvest compared to -0.38 and -0.34 Mg/ha for the second and third harvests, respectively). Previous research has shown that reduced EthFA of these parental genotypes results in significant reductions in stem:leaf ratio, suggesting that reduced EthFA impairs cell wall development that is critical for stem growth.

Selection for reduced lignin concentration led to average reductions of 5, 20, and 11% for forage yield of orchardgrass, reed canarygrass, and smooth bromegrass, respectively. The impact of reduced lignin concentration was not consistent for either parents or crosses. Only four of the six parents had significantly reduced lignin concentration and only two of six parents had significant negative GCA effects. Selection for decreased lignin concentration appears to be a viable approach for increasing digestibility of these three species without significant negative impacts on forage yield.