The Genetic Gain Pattern Indicates Additive Gene Effects Controlling Alfalfa Stem Digestibility

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Low fiber digestibility in alfalfa stems can limit dry matter intake and energy availability in ruminant animal digestion. Breeding for improved stem fiber digestibility could increase net digestible biomass yield. Previously, alfalfa (Medicago sativa L.) plants were identified for a breeding program based on either low or high rapid (16-h) and low or high potential (96-h) in vitro neutral detergent fiber digestibility (IVNDFD) of plant stems. Two cycles of bidirectional selection for plants with low or high stem 16-h IVNDFD and low or high stem 96-h IVNDFD were carried out. The resulting populations were evaluated for herbage biomass, leaf to stem ratio, IVNDFD, and detergent fiber components in field trials with plants harvested at three maturity stages. The 96-h IVNDFD trait was highly heritable (H^2 = 0.71) with a genetic gain rate of 5.05% per selection cycle. The patterns of continuous increase of stem fiber digestibility from each cycle of selection for high 16-h and high 96-h IVNDFD digestibility and a decrease in digestibility from each cycle in the low 16-h and low 96-h populations suggested that additive gene effects may control stem fiber digestibility. The non-unidirectional change of digestibility from the high x low and low x high populations indirectly affirms the additive gene effects. Divergent selection did not alter leaf to stem ratio nor other plant morphological traits. Selection for stem IVNDFD was a highly effective strategy for developing alfalfa cultivars with improved nutritional quality.