The Breeding Behavior of Yield and Related Variables in Alfalfa.

III. General and Specific Combining Ability

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THE basic problems in alfalfa breeding were reviewed in 1942 by Tysdal et al. (15). These investigators noted that the highest yielding of 28 single crosses exceeded the average yield of the check varieties by 39%. The average of the top ten hybrids was 15% above the yield of the commercial variety checks. Furthermore, when the hybrids were compared in the field, certain ones showed much more hybrid vigor than others, indicating good combining ability for some lines and relatively poor combining ability for others.

Bolton (1) also noted differences in combining ability for forage yield in both inbred and open-pollinated groups in alfalfa. Open-pollinated sources of material appeared to be as productive of good hybrids as were inbred lines. He suggested that open-pollinated sources would be preferred over the inbred sources, because of their greater ability to produce seed, an important attribute of parental clones.

Tysdal and Kieselbach (14) and Tysdal and Crandall (13) showed that alfalfa synthetics, based on general combining ability measured from polycross progeny testing, were highly productive. Wilsie and Skory (17) suggested that for maximum improvement specific combining ability should be determined also. A positive correlation between general and specific combining ability was shown (17).

The yield of polycross progenies of parental clones of alfalfa, all high in general combining ability, showed little relationship with average synthetic yields of 18 derived synthetics (11). Davis (3), however, tested three 4-cline alfalfa combinations and concluded that yield of such synthetics could be predicted from polycross progeny tests.

Wilsie (16) reported an F₁ single cross that yielded 81% above the higher-yielding inbred parent. Davis and Panton (4) noted that the yield of the best of six single crosses was 36% higher than the expected yield of the synthetic of the four parental clones. Reports such as these emphasize the need for breeding methods that will make more effective use of hybrid vigor in the development of new alfalfa varieties.

Morley et al. (12) noted that alfalfa strains differed in combining ability for winter and summer growth rates. Differences between strains for combining ability were usually more evident in winter than in summer growth. However, a Canadian creeping-rooted strain had a high combining ability for summer growth but was poor in combining ability for winter growth. Heinrichs (9) has developed strongly creeping-rooted lines of alfalfa in a breeding program whose purpose was to improve seedling vigour and fall growth, since these characters are of considerable importance in the establishment and establishment of alfalfa nurseries. The broad sense heritability estimates for these variables increased or decreased according to growth period and previous treatments. Multiple correlation coefficients (n=30) were obtained between yield per plant, natural plant height, long stem length, and number of nodes per plant. The ratio of total dry matter yield per plant demonstrated the use of these measurable variables to predict yield per plant in spaced-alalfa nurseries. Estimates of general and specific combining ability for dry matter yield per plant and for other characters are presented.

MATERIALS AND METHODS

Four parental types, previously described as a diallel manner and established in two replications each in F₁ families and S₁ families. Of the four parents, P₁ and P₂ were upright and P₃ and P₄ were prostrate in growth. The yield per plant, natural plant height, number of nodes, and length of the longest stem were recorded at establishment, 1958, and on May 28, July 10, and August 15 following the year following establishment. The harvest of leaves was determined for the July 10 harvest.

Associations between years, harvest dates, and characters were presented in an earlier paper (6). The data represent the July 10, 1959, harvest.

Single plant correlations (n=165) were available in all possible combinations for P₁ × P₂ cross. Partial regression coefficients were obtained from the matrix analysis to arrive at a predictive equation for yield per plant based on related variables.

Mean square estimates for general and specific combining ability as well as reciprocal effects were derived from diallel analysis as proposed by Griffing (10). This method has been used for analysis of general and specific combining abilities in alfalfa (12) and of seedling vigor and fall growth habit in alfalfa (2). It is assumed that this technique developed for diploid organisms could also be applied to the tetraploid alfalfa.