Inheritance of Leaf Color in Broadleaf Birdsfoot Trefoil

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STUDIES of leaf color inheritance have been reported for several crops. Content of leaf protein, intensity of green coloration, and chlorophyll content have been directly correlated. Thus intensity of leaf greenness can be used as a measure of protein content. Chlorophyll and protein content of several crops are reported to be controlled by one or more genes. The purpose of this investigation was to determine the mode of inheritance of leaf color, as chlorophyll content, in broadleaf birdsfoot trefoil, Lotus corniculatus L.

LITERATURE REVIEW

The amount of chlorophyll in a leaf is considered indicative of its protein content. Smirnova (5) reported that dark green leaves in Medicago sativa contained 8% and in Trifolium pratense contained 1.4% more protein than did light green leaves. He considered the difference in protein contents of plants to be related to a difference in yield.

In sweet clover, Hartwig (3) found that the yellow cotyledon color was a simple dominant to green cotyledon, but the F2 seedling color usually resembled the maternal parent. Hann (2) and Oyster (1) have reviewed the mode of inheritance of Mendelian and non-Mendelian chlorophyll deficiencies in many species of plants. Mendelian inheritance includes single gene, disomic, and multiple mode of inheritance; non-Mendelian inheritance is considered to be under cytoplasmic influence.

As an example of a Mendelian type of inheritance, Sprague and Curtis (6) crossed 12 selfed lines of corn which ranged in chlorophyll content from 6.23 to 11.16 mg. per 100 cm². Their results suggested that chlorophyll inheritance in corn is controlled by a relatively small number of genes. The total chlorophyll content was related significantly to chlorophyll concentration, leaf area, and yields of total dry matter and shelled grain. Their studies showed also that the mean value for chlorophyll concentration and total chlorophyll of selfed lines was a reasonable index of yields of their hybrids.

An interesting example of the non-Mendelian inheritance of chlorophyll pigment are the corn studies of Rhoades (4). He found that plastids could be modified by a nuclear gene and that it was thereafter transmitted by cytoplasmic heredity. Strain (7) concludes that the total amount of chlorophyll in plants varies with the species, the environment under which the plants are grown, the genotype and the age of the plants when chlorophyll determinations are made.

The Viking variety of L. corniculatus and a dwarf form, var. arvensis Pers, hereafter designated as Arvensis, were used in these studies. Two plants of variety Viking, V₁ and V₂, and one plant of Arvensis, A₁, were selected for genetic studies on the leaf color. V₁ and V₂ are noted for the deep green color of their foliage while A₁ had light green foliage. These three plants and their clones retained their leaf color differences both in the greenhouse and in the field during the 3-year observation period.

A₁ and V₁ were crossed reciprocally and their progenies grown to maturity in the greenhouse. These F₁ progenies are designated A₁V₁ and A₂V₁, respectively, depending on the direction of the cross. One of the F₁ plants, A₁V₁A₁, was backcrossed to both parents and the progenies of these crosses were also greenhouse cultured. V₁ was used in several crosses which will be considered in the discussion of the results of the above studies.

Evaluation of differences in leaf color of these plants was based on an estimate of crude chlorophyll content extracted with 10 ml. of 95% ethyl alcohol per 100 mg. fresh weight of leaflets. Calcium carbonate was added to the alcohol as a buffer to maintain a high pH because of the organic acids liberated. Since complete extraction with alcohol required about 5 days, vials containing the fresh leaflets and alcohol were left at room temperature on the first day but were placed in the refrigerator on the following 4 days. Thus the chemical and physical changes prior to colorimetric determination were minimized. At the end of this period, 8 ml. of chlorophyll extract was placed in a cuvette and read at 665 millimicrons in a Bausch and Lomb colorimeter. The ethyl alcohol-calcium carbonate solution was used as a blank.

When 4 months old, 10 analyses were made, each on cuttings of A₁ and V₁, and the F₁ plant of A₁V₁A₁. One analysis was made on each F₂ and each backcross plant. Even-age leaflets between the 6th and 12th nodes were selected. The number of leaflets required to make up 100 mg. of fresh weight varied from 3 to 6 for thick leafed V₁ to 35 to 40 leaflets for A₁. The F₁ hybrid and backcrosses required intermediate numbers of leaflets.

EXPERIMENTAL RESULTS

The mean value for 10 samples of F₁ plant A₁V₁A₁ was 6.37. This plant which possessed dark green leaves was used in the production of backcrosses. Frequency distribution of percent transmittance of the extracted chlorophyll solution and the mean value for each class are presented in Table 1.

Distinct differences exist between the means. The parental classes A₁ and V₁ show the greatest differences and the narrowest frequency distribution of percent transmittance. In the reciprocal F₁ populations both the means and the range in percent transmittance differ but little.

Means and ranges for the F₁ populations approached that of the Viking parent. The two backcross progenies differed in their mean values and frequency distribution.

The data suggest that dark green foliage color in plant V₁ is dominant over the light green foliage of plant A₁. When frequency distribution of the backcross generation was analyzed it was noted that out of 139 plants in the