ASSOCIATIONS BETWEEN PETAL COLOR OF FLAX AND SEVERAL QUANTITATIVE TRAITS

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Several qualitative characters of flax (Linum usitatissimum L.) have been shown to be associated with important quantitative traits. It is of interest to the flax breeder to learn of such associations, since qualitative characters may be used as selection criteria for improving associated quantitative traits. Before a qualitative character is used as a “marker” for identification of improved varieties, the degree of association between it and other traits should be known.

Significant associations have been reported (4, 6, 7) between the two loci that condition color of flax seed and important quantitative traits. A simply inherited chlorophyll mutant character has also been shown (4) to be associated with agronomic and seed characteristics of flax. A fourth locus that conditions anther color did not show associations with several important quantitative traits, but did exhibit small but significant associations with time of bloom and iodine value (3).

The objective was to determine whether a locus that conditions petal color of flax is associated with important quantitative traits. Comparisons were made of agronomic and seed quality characters of several lines that are isogenic except for the a locus and closely linked genes.

Most flax varieties have blue petals and blue anthers. However, when the recessive gene a is present in a homozygous condition, the petals and anther walls are nearly devoid of anthocyanin. The petals are white with a tinge of blue (2). The anthers are very light yellowish-blue. This character is easily discernible during the flowering period. No commercial varieties in the United States or Canada possess the a allele.

Materials and Methods

By “isogenic” pair is meant 2 lines having the same genotype, except for the locus under study and the chromosome segments closely linked to it. The average length of chromosome segment remaining linked to the a locus after 13 generations of selfing is estimated to be 8.3 cross-over units based upon formulas presented by Hanson (8).

“Isogenic” pairs were obtained from F2 rows segregating for the a locus. Each pair arose from a different F2 line from the cross “Redwood” × C.I. 1455. A high-oil introduction from India, C.I. 1455, has very light-blue to white petals and light yellowish-blue anthers which result from the a allele (1).

Seventeen “isogenic” pairs were compared at St. Paul, Minnesota, in 1964 in a split-plot design with 3 randomized blocks. Whole plots were “isogenic” pairs with subplots as individual lines. Subplots consisted of a single row 18 feet long with rows 2 feet apart. Characters studied and methods of evaluation were:

1) Maturity: number of days from sowing to first bloom, as to number of days from physiological maturity.
2) Seed weight: weight in milligrams of duplicate 100-seed samples from each subplot.
3) Plant height: height in inches from soil to uppermost part of plants.
4) Yield per acre (lb.): weight in pounds per acre of harvest of whole plot.
5) Oil content and iodine value: by method (5) on duplicate samples from each subplot.

Table 1. Means and average differences between blue- and white-petalled “isogenic” lines of flax for agronomic and yield characters.

<table>
<thead>
<tr>
<th>Character</th>
<th>Blue petals (AA)</th>
<th>White petals (aa)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days from sowing to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First bloom</td>
<td>52.2</td>
<td>52.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Full bloom</td>
<td>60.0</td>
<td>60.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Maturity</td>
<td>91.7</td>
<td>91.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Plant ht. (in.)</td>
<td>23.6</td>
<td>23.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Yield per acre (lb.)</td>
<td>1,018</td>
<td>1,023</td>
<td>5.0</td>
</tr>
<tr>
<td>Seed wt. (mg/100)</td>
<td>521.7</td>
<td>521.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Oil content (%)</td>
<td>41.78</td>
<td>41.84</td>
<td>0.05</td>
</tr>
<tr>
<td>Iodine value</td>
<td>163.1</td>
<td>163.2</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* Differences significant at 5% level; ** at 1% level.
† Indicates diversity of genetic background in which alleles are compared.

5) Oil content and iodine value: by method (5) on duplicate samples from each subplot.

Results and Discussion

The white-petalled lines averaged 0.2 day earlier in reaching first and full bloom, respectively; both differences, though small, were significant. The blue-petalled lines may have been judged as earlier than the white-petalled lines because of the more floppy growth of the former. The two groups of lines differed significantly as to number of days from sowing to physiological maturity.

There were no significant differences between blue- and white-petalled lines in height, seed weight, oil content, or iodine value (Table 1). Apparently the “Redwood” × C.I. 1455 does not have pleiotropic effects on these characters. It is possible that genes closely linked to the a locus do affect these characters but were not segregating in the 17 pairs compared.

Differences were highly significant for 6 of the 8 characters measured. The dominant and recessive alleles at the a locus were segregating in fairly diverse genetic backgrounds.

The lack of any strong association between quantitative traits with petal color indicates that this character is a suitable “marker” for variety identification.

Literature Cited