ASSOCIATIONS BETWEEN ANther COLOR OF FLAX AND SEVERAL QUANTITATIVE TRAITS

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ASSOCIATIONS between qualitative characters and important quantitative traits are of interest to plant breeders. Significant associations may enhance or preclude the use of easily discernible characters as criteria for selecting superior genotypes. Qualitative characters may be incorporated in a breeding program to identify varieties, provided the characters are not significantly associated with undesirable quantitative traits. Such characters would be particularly useful to differentiate backcross-derived varieties.

Three loci of flax (Linum usitatissimum L.) have been shown to be associated with important quantitative traits. The yellow-seed character studied by Culbertson et al. (4, 5) is controlled by two recessive genes, h and g, which have pleiotropic effect on flower petals. The h gene was found to be significantly associated with maturity; height; seed yield; quality and quantity of oil in seed; test weight; and seed size. The g gene, which also conditions yellow seed color, was reported by Comstock et al. (2) to be associated with days to bloom; height; quality and quantity of oil in seed; seed weight; and seed germination. The bg gene, which conditions a yellow-green mutant character, was shown in the same report (2) to be associated with days to bloom; seed yield; quality and quantity of oil in seed; seed weight; and germination.

The present study sought to determine whether a locus that conditions anther color of flax is associated with important quantitative traits. Comparisons are made of agronomic and seed quality characteristics between lines that are isogenic except for the h locus and closely linked genes.

Most varieties with blue petals also have blue or light blue anthers. However, when the recessive gene h is present in a homozygous condition, the anther walls are devoid of anthocyanin and are orange-yellow (1). This character is easily discernible during the flowering period (Figure 1). It would give positive identification to a variety possessing it. Several blue-petaled, yellow-anthered accessions may be found in the United States Flax World Collection; but there are no blue-petaled commercial varieties with yellow anthers in North America.

By isogenic pair is meant 2 members having the same genotype, except for the locus under study and the chromosome segment closely linked to it.

We used isogenic pairs from F10 rows segregating for the h locus from a cross 'Redwood' × C.I. 1537. An introduction from India, C.I. 1537, has blue petals and yellow anthers. Then the bg gene, as confirmed by a test cross of C.I. 1537 to "Tammes type 2", C.I. 766.

For 22 isogenic pairs, compared at St. Paul, Minnesota, in 1963, we used a split-plot design with 3 randomized blocks. For whole plots of isogenic pairs, we used 2 rows 2-ft. apart and 18-ft. long. Subplots were made up of single rows of only one member of the isogenic pair. Characters studied, and procedures of evaluation, were:

1) Maturity: number of days from sowing to first bloom, full bloom, and physiological maturity.

2) Seed yield: 16-ft. section harvested from center of each subplot.

3) Plant height: distance from soil to uppermost part of plants.

4) Oil content and iodine value: by small sample method (3) on duplicate samples from each subplot.

The yellow-anther lines did not differ significantly from the blue-anther lines in number of days from sowing to first or full bloom; seed yield; or oil content (Table 1). The yellow-anther lines averaged 0.2 day earlier in reaching physiological maturity, and were 0.4 inch shorter. Both differences, though small, were significant. The mean iodine value of yellow-anther lines was 1 point less than the mean of blue-anther lines. These differences in maturity; height; and iodine value, though significant, are not considered of economic importance.

Differences were highly significant among the 22 pairs for all 7 characters measured. This indicates that the dominant and recessive alleles at the h locus were compared in fairly diverse genetic backgrounds.

The lack of any strong association of important quantitative traits with anther color shows that this qualitative character is a suitable "marker" for variety identification. Yellow-anther character is therefore being incorporated into 'Koto' flax, as part of a parallel backcross program to introduce several rust resistant genes into this variety. Improved 'Koto' will be identified by its blue petals and yellow anthers.

Literature Cited


Table 1. Means and average for differences between blue- and yellow-anthered lines of flax plant, seed, and yield characteristics.

<table>
<thead>
<tr>
<th>Character</th>
<th>Blue-anthered</th>
<th>Yellow-anthered</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>63.0</td>
<td>62.8</td>
<td>-0.2</td>
</tr>
<tr>
<td>Full bloom</td>
<td>71.3</td>
<td>71.1</td>
<td>-0.2</td>
</tr>
<tr>
<td>Maturity</td>
<td>104.9</td>
<td>104.6</td>
<td>-0.3</td>
</tr>
<tr>
<td>Plant height, inches</td>
<td>26.5</td>
<td>26.1</td>
<td>-0.4**</td>
</tr>
<tr>
<td>Test weight, lb.</td>
<td>560.2</td>
<td>560.8</td>
<td>-121.4</td>
</tr>
<tr>
<td>Oil content, %</td>
<td>39.45</td>
<td>39.51</td>
<td>-0.6</td>
</tr>
<tr>
<td>Iodine value</td>
<td>179.3</td>
<td>179.2</td>
<td>-1.0**</td>
</tr>
</tbody>
</table>

* Difference significant at 5% level; **Difference significant at 1% level.
† Diversity of genetic background in which alleles were compared.