Inheritance of Resistance to Fusarium Wilt of Flax in Dakota Selection 48-94

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The flax varieties grown on the largest acreage in desert areas of California are susceptible to Fusarium wilt (Fusarium oxysporum f. lini (Bolley) Snyder and Hansen). These varieties are Punjab (C.I. 20), now relatively unimportant, and Punjab 47 (C.I. 1115) and Imperial (C.I. 1114), both selections of Punjab. Although wilt has not caused serious economic loss, the disease is increasing, and some fields are infested to a point where susceptible flax varieties can no longer be grown.

Coincident with efforts to find resistant materials in local and introduced varieties (10, 11), a breeding program has been underway to develop resistant varieties by hybridization and backcrossing. Dakota (C.I. 1071) selections have been used rather extensively in this program. This report includes data obtained from crosses of one of these selections with Punjab, Punjab 47 and a second Dakota selection.

LITERATURE REVIEW

The literature would indicate that the inheritance of resistance to Fusarium wilt in flax is complex. Tisdale (13) and Burnham (5) concluded that the inheritance of resistance could not be explained on the basis of a few genes. In a study of F₂ lines from a cross of Dakota with an Indian variety, Chu and Culbertson (6) found several lines with wilt resistance equal to that of Dakota, but none as susceptible as the Indian variety.

In some crops, genes for resistance to Fusarium wilt have been identified. Wade (14) found that resistance to wilt in canning peas was due to a single dominant gene. Resistance to near-wilt in the same crop was shown by Hare, et al. (8) to be due to a second dominant gene. In cabbage, high resistance was reported by Walker (15) to be due to a single dominant gene, though Anderson (1) found that moderate resistance was not simply inherited. This moderate resistance was believed to be due to several genes that were cumulative in effect and not dominant. One variety of cabbage was shown by Blank (3) to consist of some plants with a high type of resistance, and the rest with moderate resistance. A single dominant gene was found by Bohn and Tucker (4) to give resistance to wilt in tomatoes. Fahmy's data (7) for cotton suggested that a single dominant gene was responsible for resistance, though Smith (12) reported that resistance in sea-island cotton was due to two dominant pairs of factors. The difference in resistance of three varieties of watermelon was considered by Bennett (2) to be due to a number of genetic factors which were cumulative in their effect.

MATERIALS AND METHODS

Dakota 48–94 is a highly wilt-resistant selection of Dakota that stems back to a single plant in 1948. Each of the four crosses of this study was made between a single plant of this selection and single plants of the wilt-susceptible varieties Punjab, Punjab 47 and Dakota 48–90. Dakota 48–90 is a single plant selection of Dakota. The segregating generations and parental materials that were included in wilt tests through the period 1949 to 1954 are listed in table 1. One test was grown on naturally infested soil referred to above, and one on the Goat Ranch, also in San Mateo County. Inoculum, a suspension of spores, was applied directly to the row before covering the seed with soil. Previous work (11) describe the technique of inoculation in more detail.

All tests were grown in greenhouse flats. Each was sown to 12 rows, with 2 of them parent varieties and 10 to 15 rows of F₁ progeny obtained from each cross. In two tests, only one row per parent was used. In one test, 10 rows were obtained in a row, and 100 seedlings were obtained in each test. In the other test, 2 rows were used, and 100 seedlings were obtained in each test.

The number of wilted seedlings in each row was frequent intervals, and such seedlings pulled. When wilt was expressed in percent of the total number of seedlings. The percentage wilt in tests was due to two complementary genes, though those that were dead or showing obvious symptoms of wilt was expressed in percent of the total number of seedlings.

With the exception of materials inoculated with clone 33-1, the conclusion of a test found most plants either healthy or definitely affected by wilt. Consequently, a delay of 3 to 6 weeks after the susceptible check variety had succumbed was made to obtain about 50 seedlings in each test.

RESULTS

Punjab × Dakota 48–94

Seven F₂ rows and 180 F₃ lines from a cross with Dakota 48–94 were grown in comparison tests on naturally infested soil. The distribution of F₂ rows, F₃ rows, and F₃ lines (F₂ progenies) among infection classes is given in table 1. Slightly more than 30% of the F₃ lines were highly susceptible, and a small but distinct group appeared to be as resistant as Punjab 48–94. The remaining lines were distributed over the wilt range, but there was a well marked group of 11 to 40% wilt, and another not so well marked group of 41 to 75% wilt. The latter was like the F₂ population.

The behavior of these materials suggested that the wilt resistance of Dakota 48–94 was due to two complements which have been termed Fₙₐ and Fₙ₁, but not the "A gene" and "B gene" for the purposes of this paper. This hypothesis would assume that the genotype of Dakota 48–94 is AABB, and of Punjab aabb. The behavior of different genotypes obtained in tests

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Wilt resistance</th>
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<tbody>
<tr>
<td>AABB</td>
<td>0%</td>
</tr>
<tr>
<td>AaBb</td>
<td>11%–40%</td>
</tr>
<tr>
<td>AAbb</td>
<td>41%–75%</td>
</tr>
<tr>
<td>aabb</td>
<td>100%</td>
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