Resistance

Inheritance of Adult Plant Resistance to Crown Rust in an Accession of *Avena sterilis*

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ABSTRACT


An accession of *Avena sterilis*, Canadian Avena (CAV) accession 1387, which originated from Israel, was susceptible in the seedling stage, but resistant in the adult plant stage to six races of *Puccinia coronata*. Crosses of resistant derivatives of CAV1387 with the susceptible *A. sativa* lines RL3069 or Sun II resulted in *F₂* segregation ratios of 1 resistant:2 moderately resistant:1 susceptible plants. It was concluded that the adult plant resistance in CAV1387 was conferred by a single partially dominant gene, designated as *Pc-69*. This gene confers effective field resistance to the races of *P. coronata* that occur in western Canada.

Additional key words: genetics of crown rust resistance, post-seedling resistance.

Accessions of *Avena sterilis* L. collected from the Middle-East and North Africa have provided many genes which confer resistance to the crown rust fungus, *Puccinia coronata* Cda., beginning in the seedling plant stage (5,11,18). Resistance which is effective only in the adult plant stage has also been reported to occur in *A. sterilis* (5,17), but there is no information on its mode of inheritance. Adult plant resistance is also a component of resistance to *P. coronata* in some cultivars of *A. sativa* L. (3,7,10,14). The cultivar Victoria contained two factors, *Vc₁* and *Vc₂*, for adult plant resistance (15), which have been designated as genes *Pc-27* and *Pc-28*, respectively (11). Adult plant resistance was also found in cultivars Santa Fe and Ukraine (16), but it is not known if it is the same as that in Victoria.

This paper describes the inheritance of adult plant resistance in one accession of *A. sterilis*.

MATERIALS AND METHODS

Test races of *P. coronata*. The virulence characteristics of the six races of *P. coronata* used in this study are shown in Table 1. The races are designated by Winnipeg accession (CR) numbers, and the equivalent "standard" race numbers (12) are included for comparison.

The *A. sterilis* parent. Accessions of *A. sterilis* were initially screened with races CR12 and CR37 in the seedling stage and with CR25 in the adult plant stage. All adult plant tests were carried out by inoculating and evaluating the flag leaves for infection type (13). The critical Victoria contained two factors, *Vc₁* and *Vc₂*, for adult plant resistance (15), which have been designated as genes *Pc-27* and *Pc-28*, respectively (11). Adult plant resistance was also found in cultivars Santa Fe and Ukraine (16), but it is not known if it is the same as that in Victoria.

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families. The BC₁F₂ progeny were to be used to analyze the mode of inheritance of the resistance in CAV1387, but due to extensive leaf necrosis the populations were too small for genetic analysis. Then eight resistant plants (infection type :2+, each from a different backcross family from the above test were selected and selfed to the *F₂* generation. In each generation, plants were tested for resistance in both the seedling and adult stages to obtain plants that were homozygous resistant. Selected resistant *F₂* plants were then used for further crossing and for tests for resistance in the field.

The CAV1387/ Frazer BC₁F₂ plants were crossed using the line RL3069 (Rodney 0*2/C19139//2* Fraser) as the male parent. The line RL3069 is susceptible (infection type 4-4 on the seedling and flag leaves) to the known races of *P. coronata*, but carries gene *Pg-a* (synonymous with gene *Pg-12*+) for resistance to *P. graminis* f. sp. *avenae* (6). The line RL3069 was used to enable the isolation of *P. coronata* from *P. graminis* f. sp. *avenae*.

A further cross using one of the eight above parental lines was made using the cultivar Sun II as the male parent. Cultivar Sun II reacts with infection type 4 to the known races of *P. coronata* in both the seedling and flag leaf stages.

In all tests, the *F₂* progeny from the above crosses were grown in a growth cabinet at 18 C and an 18-hr photoperiod. The flag leaves were inoculated with fresh urediospores of race CR46 of *P. coronata*, the plants were incubated overnight at 100% relative humidity, then continued growth in the growth cabinet as above. The infection types were scored 14 days after inoculation.

The chi-square test was applied to determine goodness-of-fit to theoretical segregation ratios. The original CAV1387 parent and the recurrent parents were included as controls in all tests.

TABLE 1. Key to the isolates of *Puccinia coronata* used to screen for adult plant resistance in *Avena sterilis* and to test segregating populations of *A. sterilis* accession CAV1387/ *A. sativa* crosses

<table>
<thead>
<tr>
<th>Winnipeg accession no.</th>
<th>Standard race no.</th>
<th>Effective/ineffective host resistance (Pc)b genes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR12</td>
<td>264</td>
<td>38,39,45,46,47,48,50,54,55,62,63/35,40</td>
</tr>
<tr>
<td>CR20</td>
<td>295</td>
<td>35,38,40,45,46,47,48,54,55,62,63/50</td>
</tr>
<tr>
<td>CR25</td>
<td>305</td>
<td>35,38,50,56,62,63/39,40,45,46,47,58,54,55</td>
</tr>
<tr>
<td>CR32</td>
<td>210</td>
<td>35,38,39,40,45,46,47,48,50,54,55,62,63/</td>
</tr>
<tr>
<td>CR37</td>
<td>230</td>
<td>35,38,39,40,45,46,47,48,50,54,55,62,63/</td>
</tr>
<tr>
<td>CR46</td>
<td>326</td>
<td>35,38,39,40,45,46,47,48,50,54,55,62,63/</td>
</tr>
</tbody>
</table>

bSimons and Michel (12).

The *Pc*-genes in this table, all derived from *A. sterilis* (Simons, et al 11), are used to identify the Winnipeg (CR) isolates of *P. coronata*.
TABLE 2. Segregation for resistance to race CR46 of Puccinia coronata of F2 populations from crosses between Avena sterilis accession CAV1387-derived resistant lines (CAV1387/A. sativa Fraser BC1:F2) and the susceptible A. sativa line RL3069 or Sun II

<table>
<thead>
<tr>
<th>Crosses</th>
<th>Infection type and no. of plants</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CAV1387-derivatives/RL3069a</td>
<td>1:2:3</td>
<td>205</td>
<td>437</td>
<td>235</td>
<td>1.2:1</td>
</tr>
<tr>
<td>CAV1387-derivatives/Sun II</td>
<td>1:2:3</td>
<td>32</td>
<td>54</td>
<td>29</td>
<td>1.2:1</td>
</tr>
</tbody>
</table>

*The results involving RL3069 are summarized from crosses with eight CAV1387/Fraser derivatives and those involving cultivar Sun II are from one of the above derivatives.

RESULTS AND DISCUSSION

The results from the crosses of all eight resistant lines (derived from CAV1387/Fraser) with RL3069 segregated similarly, and the results (Table 2) are a summary of all eight crosses. The progeny segregated into three classes in a ratio of 1 resistant (infection types 12:2 moderately resistant (infection types 3-3):1 susceptible (infection types 3-4)) plants (P = 0.30-0.50). If the resistant and moderately resistant classes are combined, the resulting segregation was 652 resistant:235 susceptible plants, which is a good fit to a 3:1 segregation ratio (P = 0.50-0.70). These results indicate that the resistance is conferred by a single partially dominant gene, with the heterozygous plants accounting for the intermediately resistant infection types.

The cross of one of the resistant parents, which had also been crossed with RL3069, and with cultivar Sun II also resulted in an F2 segregation ratio of 1 resistant:2 moderately resistant:1 susceptible plants (P = 0.70-0.80, Table 2). Combining the resistant and moderately resistant classes resulted in 86 resistant:29 susceptible plants (P = 0.50-0.70). These results confirm those from the RL3069 Sadanaga, K., Sebesta, J., and Thomas, H. 1978. Oats: A standardized pathogen population (8,9). The effectiveness of gene Pe-69 and its ease of transfer make it a good candidate for combination with other seedling resistance genes to provide an enhanced broadly-based resistance to crown rust.

LITERATURE CITED