REPORTS & NOTES


Genetic Immunity to Apple Mildew Incited by Podosphaera leucotricha

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Abstract. A source of immunity to apple mildew, Podosphaera leucotricha (Ell.&Ev.) Salm., derived from a Malus species, when crossed with susceptible cultivars, conferred immunity to 50% of its progeny in greenhouse and field tests. Reciprocal crosses indicated a nuclear gene. A greenhouse method for large-scale screening is described.

Few genetic sources of high resistance or immunity to apple mildew are known. For greatest breeding efficiency, the character should be sexually transmitted, and should be dominant, simply inherited, and stable. Even those cultivars usually considered highly resistant may, under weather conditions highly favorable to the organism, show undesirable susceptibility (8, 10). Immunity thought to be under single gene control was reported by Knight and Alston (4), but later their hypothesis was revised to account for 2 different genes plus modifiers (2, 5, 11).

Progeny data indicate that the resistance observed in cultivars of the dessert apple is under polygenetic control (1, 8, 9). The value of this resistance for breeding purposes is diminished by the several years of field screening often necessary to determine the degree of resistance as well as its stability under varying weather conditions (6, 7, 8). Simply inherited and stable immunity, reliably identifiable at an early plant age in large populations would materially advance progress in breeding for mildew resistance.

In the fall of 1972, greenhouse tests for mildew resistance identified a single plant grown from open-pollinated seed of 'Starking Delicious' as highly resistant. This plant was propagated and tests were continued over the following 2 years in both the greenhouse and the field. On the basis of its complete freedom from mildew infection throughout the series of tests, it was judged to be immune. The distinct foliar lobes, fruit diameter of only 3 cm, and astringent flavor indicated its pollen parent was a Malus species.

Propagated trees of this mildew-immune selection (MIS) first bloomed in 1975. MIS was crossed with 'Pricilla' as seed parent, and reciprocally with 'Jonathan'. 'Pricilla' was selected due to its relatively low susceptibility to apple mildew and for its genetic immunity to apple scab incited by Venturia inaequalis (Cke.) Wint. 'Jonathan' was chosen for its known high susceptibility to apple mildew and its strong tendency to transmit this character to its progeny. Techniques for pollen collection and controlled crossing were described earlier (3).

Seeds from controlled pollinations were extracted in late Sept., dried for 72 hr, and either stratified at 2 to 3°C or held dry in poly bags at ca–17°C. For spring screening tests, seeds were stratified 90 days or more in a mixture of 3 horticultural grade vermiculite: 2 ground peat, (by vol) and were germinated in this mixture. After germination and production of 1 or 2 true leaves, the seedlings were transplanted to sterilized soil in plant bands. Seeds for fall tests were held frozen until at least 90 days before the desired time of germination, then stratified in poly bags of moist finely ground peat at ca 6 to 7°C. The seeds were washed from the peat and planted in plant bands of sterilized soil.

Inoculum for spring greenhouse screening was obtained from heavily-infected 2 or 3 yr old apple seedlings dug the preceding fall, held over winter at 2 to 3°C, and replanted in pots of soil in the greenhouse. New foliage became infected as it was produced, providing abundant spores. For fall greenhouse tests, infected shoots were excised from plants in the field, and held in vessels of water close to and about 0.5 m above the young seedlings being tested. The inoculum sources were shaken lightly at least once daily to release spores. After sporulating infections became visible on susceptible seedlings, the entire test planting was fanned twice daily to spread inoculum to all plants. Spores were also transferred by brush from heavily sporulating infections to plants not showing infection.

In early June, 1976, all seedlings still alive from the spring test were transplanted outdoors close to heavily mildew-infected apple seedlings.

In both spring and fall greenhouse tests, sporulating infections were visible on susceptible foliage within 6 to 7 days after inoculation. Infection spread rapidly over the entire test plantings, result-

Fig. 1. Mildew immune (left) and susceptible (right) siblings from 'Jonathan' x a mildew immune seedlings, spring greenhouse test of 1976.

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The combination of this genetic system with the simple screening test should materially aid incorporation of apple mildew immunity into new forms of the cultivated apple.

### Table 1. Segregation of mildew immune:susceptible apple seedlings from controlled crosses in greenhouse tests of spring and fall, 1976.

<table>
<thead>
<tr>
<th>Progeny</th>
<th>Immune</th>
<th>%</th>
<th>Susceptible</th>
<th>%</th>
<th>X² (1:1)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pricilla × MIS² (spring test)</td>
<td>42</td>
<td>50.6</td>
<td>41</td>
<td>49.4</td>
<td>0.012</td>
<td>&gt;0.9</td>
</tr>
<tr>
<td>Pricilla × MIS (fall test)</td>
<td>82</td>
<td>50.3</td>
<td>81</td>
<td>49.7</td>
<td>0.006</td>
<td>&gt;0.9</td>
</tr>
<tr>
<td>Jonathan × MIS (spring test)</td>
<td>43</td>
<td>54.4</td>
<td>36</td>
<td>45.6</td>
<td>0.620</td>
<td>&gt;0.3</td>
</tr>
<tr>
<td>MIS × 'Jonathan' (spring test)</td>
<td>27</td>
<td>52.9</td>
<td>24</td>
<td>47.1</td>
<td>0.882</td>
<td>&gt;0.3</td>
</tr>
</tbody>
</table>

²MIS = mildew-immune selection.

### Table 2. Field incidence of apple mildew infection, June to Oct., 1976, on seedlings which showed immune or susceptible reactions in previous greenhouse test.

<table>
<thead>
<tr>
<th>Progeny</th>
<th>Greenhouse immune (no.)</th>
<th>Field infected (no.)</th>
<th>Greenhouse susceptible (no.)</th>
<th>Field infected (no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pricilla × MIS²</td>
<td>42</td>
<td>0</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Jonathan × MIS</td>
<td>43</td>
<td>0</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>MIS × Jonathan</td>
<td>27</td>
<td>0</td>
<td>17</td>
<td>17</td>
</tr>
</tbody>
</table>

²MIS = mildew-immune selection.

y Fewer susceptible seedlings were field tested than shown in Table 1 due to the death of some plants by destruction of foliage in the greenhouse test.

The combination of this genetic system with the simple screening test should materially aid incorporation of apple mildew immunity into new forms of the cultivated apple.

### Literature Cited


### A Scarfskin-like Disorder of Apples

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**Additional index words. Malus domestica**

For about 20 years we have noticed a disorder on fruits of apple (*Malus domestica* Borkh.) in our orchards that appears near harvest as red color development. This disorder usually begins on the upper (stem end) inside cheek as a finely stippled whitish area ranging from a trace to the whole fruit being covered and produces a milky appearance with greatly reduced red color. In severe outbreaks the cuticle becomes slightly roughened but usually the surface is smooth. The disorder has become a serious economic concern especially in 'Rome Beauty' grown in sandy soils. The disorder lowers the grade because affected fruit (>15% of surface covered) is classified by the U.S. Federal-State Inspection Service as a "smooth russet" defect.

This disorder resembles "scarfskin" described by Beach in 1905 (1) "as a dull or clouded appearance to a red skin as in 'Sweet Winesap' or 'Black Gilliflower'." It also resembles the characteristic whitish-grey areas found in 'Stayman Winesap'. In 1959 Dayton (2) reported that these light areas in 'Stayman Winesap'.

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**2** Manager.