Parent Selection in Breeding Strawberries Resistant to Twospotted Spider Mites

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Abstract. Mite resistance of strawberry, Fragaria × ananassa Duch., based on the ability to support low populations of the twospotted spider mite, Tetranychus urticae Koch, was assessed in the progeny of 15 crosses at two locations. The best parents were Washington State University selections 72-83M, 75-7-5 and 75-53-7 and the poorest parents were the susceptible cultivars 'Totem' and 'Rainier'. General combining ability estimates for mite resistance were higher than specific combining ability estimates. Heritability estimates, based on parent/offspring regression, were high and ranged from 0.62 to 0.92. These observations suggest that additive genetic factors play a major role in the inheritance of mite resistance.

Twospotted spider mite resistance in strawberry can be assessed by evaluating leaf damage symptoms (2, 7) or by determining the mite populations supported (5, 8). Mite resistance based on leaf injury ratings was shown to be a heritable trait (2, 3, 7) and such resistance was either dominant or partially dominant (2, 3). Kishaba et al. (5) concluded that the support of low mite populations was under genetic control and that 'Lassen' and its derivatives generally had high resistance. Previously, we selected twospotted spider mite resistant clones which, under both greenhouse and field conditions support less than 10% of the mite populations found on susceptible cultivars (8). Our objectives were to show the importance of additive gene action in the transfer of this resistance to seedling populations and to identify the best parents for use in breeding.

Fifteen strawberry crosses (Table 1) were made involving 3 cultivars, 'Linn', 'Rainier' and 'Totem', and 5 Washington State University (WSU) selections, 72-83M, 75-7-5, 75-41-7, 75-53-17, and 75-57-3. The WSU selections have shown high levels of resistance while 'Rainier' and 'Totem' have been susceptible (7). 'Linn' has shown a moderate level of resistance (Shanks and Barritt, unpublished data).

Eighteen seedlings from each cross and 5 to 8 plants of each parent clone were planted in the field at Puyallup, Washington, in a completely random design in May, 1978. Each seedling was allowed to produce a matted row plot 1 m in length. Plants were periodically sprayed with carbaryl to kill predators and thus encourage the build up of mite populations. For mite counts one leaflet was removed from each of 5 fully expanded trifoliate leaves of medium age from each plot on May 17, May 31, June 15, and July 2, 1979.

In May, 1978 at Vancouver, Washington, 20 seedlings from each cross were planted in 15-cm² pots and maintained through a normal fruiting cycle in a greenhouse. No supplemental light was used and temperatures were kept near ambient by using exhaust fans (6). Estimates of natural mite infestations in the greenhouse were made by counting the mites on 5 leaflets per plant on April 30, May 24 and June 6, 1979.

All mite counts were transformed, using log (X + 1), and the data for all dates were combined prior to completing a) an analysis of variance to test the significance of the differences among progeny means, b) a Gilbert (4) analysis to determine significance of specific (SCA) and general combining ability (GCA) and to provide parental values, and c) a parent/offspring regression (Puyallup data only) to estimate heritability (1).

At both Puyallup and Vancouver, significant differences in mite counts occurred between crosses (Table 1). The 3 most resistance crosses at each location had 72-83M as one parent and 75-7-5, 75-41-7 or 75-53-17 as the other parent. The progenies which supported the highest mite populations had either 'Totem' or 'Rainier' as parents. The rankings of crosses at each location were close (r = 0.775, n = 15).

Genotypic parent assessments (Table 2), based on progeny evaluations, showed that 72-83M transmitted the highest level of mite resistance and that 'Totem' and 'Rainier' transmitted the lowest level of resistance. The rankings of parent clones at each location were close (r = 0.883, n = 8). Of the 3 cultivars, 'Linn' transmitted the highest level of resistance and was equal in this respect to the 2 mite resistant selections, 75-53-17 and 75-41-7.

Analyses of variances of progeny data showed that at each location GCA was highly significant and that SCA was much lower, although still significant (Table 3).

Heritability estimates based on parent/offspring regression at Puyallup were
Table 3. Analyses of variance of progeny data for twospotted spider mite resistance evaluated in a greenhouse at Vancouver and in the field at Puyallup. Washington.

<table>
<thead>
<tr>
<th>Source</th>
<th>Vancouver</th>
<th>Puyallup</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>Mean square</td>
</tr>
<tr>
<td>General combining ability</td>
<td>8</td>
<td>1.498</td>
</tr>
<tr>
<td>Specific combining ability</td>
<td>36</td>
<td>0.247</td>
</tr>
<tr>
<td>Within family residual</td>
<td>837</td>
<td>0.092</td>
</tr>
</tbody>
</table>

"**Significant at 5% (*) or 1% (**) level.

0.82 ± 0.41 on May 31, 0.92 ± 0.16 on June 5, and 0.62 ± 0.16 on July 2.

Visual injury to strawberry foliage has not been a reliable indicator of spider mite populations (7). Mite counts, rather than visual injury ratings, were used in this study because significant physiological stress occurs in strawberry leaves at mite population levels below those that caused visible injury (6).

Mite resistance based on the ability to support relatively low mite populations in strawberry is a highly heritable trait and rapid progress toward improved resistant lines should be possible if parents are selected on the basis on their phenotypes. Since heritability was high and GCA variance also was high in comparison with SCA variance, nonadditive variance components, such as dominance and epistasis, played minor roles in the transfer of mite resistance. Based on parental relationships of resistant clones Kishaba et al. (5) concluded that support of low mite populations was a heritable trait. Chaplin et al. (2, 3) suggested that dominance plays a role in mite resistance. However, they measured leaf injury rating, a trait that differs substantially from the mite population trait recorded here and might be expected to have a different type of inheritance.

Literature Cited


Cull Losses in Western Sweet Cherries at Retail and Consumer Levels in Metropolitan New York

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Abstract. Retail and consumer level losses of western sweet cherries (Prunus avium L.) studied in metropolitan New York during 1977-80 were 9.9 and 12.0%, respectively. More loss was observed in store-prepackaged consumer samples than in consumer samples obtained from bulk displays. Half of the loss at each level resulted from parasitic diseases and a third from physiological disorders. The remaining loss was caused by mechanical injuries.

An average of 6,800 MT of sweet cherries are delivered fresh to the metropolitan New York market annually, with the Far West supplying more than 90% (5). The current emphasis on appearance and quality, by both merchants and consumers, has had a significant impact on the acceptance and culling standards of this commodity at the retail level. The practice of precooling cherries at shipping points in the Far West and the use of refrigeration at practically all stages in the marketing chain have greatly enhanced the preservation of quality in sweet cherries. A consequence of this development has been an upgrading of the quality most sweet cherry buyers will accept.

As a continuance of our study of market losses of major fresh fruit and vegetable crops (1, 2, 3), we present our findings on the nature and extent of sweet cherry losses at the retail and consumer levels in metropolitan New York. This information is useful to the trade and to field and market researchers in developing commercially feasible measures to reduce losses.

Data on 'Bing' and 'Lambert' sweet cherry cultivars was obtained through weekly visits to 8 or 9 food chain and independently-operated supermarkets in metropolitan New York during the June to August marketing periods for western cherries in 1977-80. Values for retail store losses were obtained twice weekly in 7 to 9 stores, at least 2 each in low, middle, and high income areas. Values for consumer level losses were determined from consumer-grade samples purchased during a visit to these stores each week. Store clerks, for the most part, culled the cherries before and while the fruits were displayed during the test periods, although occasionally the culling was done by USDA personnel. The retail culls usually consisted of moldy, discolored, crushed, leaky or soft cherries. Consumer-grade samples were held for 1-3 days at 4°C before the cherries were examined for rots and other defects sufficiently severe to warrant discarding. Identification of the nature of spoilage or waste in retail stores and in consumer samples was made by macroscopic examination in the store or laboratory, and by microscopy, and culture or isolation of microorganisms from rotten cherries.

In the 4 marketing seasons of 1977-80, our cooperating retail stores displayed 14.24 MT of sweet cherries during the test periods (Table 1). Of this amount 1,416 kg, or 9.9%, were culled. Our consumer samples weighed 275 kg and at the end of the consumer holding period,