Gooseberry Mite Infestation Decreases the Cold Hardiness of Dormant Black Currant Flower Buds

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Additional index words. Ribes nigrum, Cecidophyopsis grossulariae, abiotic and biotic stress, cold tolerance, ice nucleation, freeze damage

Abstract. Black currant (Ribes nigrum L.) cultivars with heavy, light, and no gooseberry mite (Cecidophyopsis grossulariae Collinge) infestation levels (MIL) were tested for cold hardiness by visually determining the bud injury rating (BIR) after laboratory freezing in Jan. 1998. Lightly mite-infested cvs. Blackdown and Risager, usually thought of as less cold hardy than their Nordic counterparts (Brennan, 1996). The black currant (Ribes nigrum L.) cultivars tested were chosen for these reasons. The first laboratory trial (Expt. 1) contrasted freezing damage of heavily infested buds of ‘StorKlas’ with that of lightly infested buds of ‘Blackdown’ and ‘Risager.’ In an additional trial (Expt. 2), freezing injury of noninfected ‘StorKlas’ buds from Pennsylvania and British Columbia were contrasted with heavily and lightly mite-infested buds of Oregon-grown ‘StorKlas.’

Materials and Methods

Four black currant cultivars with a range of mite infestation levels (MIL) and cold hardness ratings were chosen for laboratory freezing. Western European currant cultivars are generally much less winter hardy than their Nordic counterparts (Brennan, 1996). The English ‘Blackdown’ and the German ‘Risager’, which had low levels of mite infestation, were chosen for these reasons. The Swedish ‘StorKlas’ and Finnish ‘Brödtorp’, two cultivars generally regarded as very cold hardy (Brennan, 1996; Trajkovski, 1991), which were heavily mite-infested in the Corvallis field collection, were also chosen. In addition, dormant stems of ‘StorKlas’ without mite infestation were obtained from Pennsylvania and British Columbia, Canada. Cold hardiness was assessed by rating the bud injury of these cultivars after laboratory freezing trials during Jan. 1998.

In mid-Dec. 1997, a severe infestation of the gooseberry mite was observed in the Ribes field planting at the U.S. Dept. of Agriculture, Agricultural Research Service, National Clonal Germplasm Repository in Corvallis, Ore. The identity of the mite was confirmed through morphological (Amrine et al., 1994) and molecular tests (Fenton et al., 1993). The mite was observed within dormant buds of >50 genotypes of R. nigrum L., R. rubrum L., R. uva-crispus L., R. oxyacanthoides L., and R. ×nidigrolaria Bauer (unpublished data). Mite infestation levels were genotype dependent; some cultivars were heavily infested but others were not.

Gooseberry mite infestation could affect the cold hardiness of the dormant buds. Interaction between pathogenic and environmental stresses to woody plants has been reported. The reduction of freezing tolerance of woody plants by microbial infection has been documented in peach [Prunus persica (L.) Batsch.] (Daniell and Krewer, 1984; Chang et al., 1989) and apple (Malus ×domestica Borkh.) (Zawadzka, 1988). Noninjurious freezing stress can predispose woody plants, such as dogwood (Cornus stolonifera Michx.) and Euonymus alatus (Thunb.) Sieb., to injury by canker-causing bacteria (Schoenefeiss, 1979; Schoenefeiss and Wene, 1977). In red raspberry (Rubus idaeus L.), freezing injury was increased by previous damage from two-spotted spider mite (Tetranychus urticae Koch) (Doughty et al., 1972). The objective of our study was to determine the effect of gooseberry mite infestation on the bud cold hardiness of several black currant cultivars.
age before the freezing tests, initial BIR was determined. On 22 Jan., nodal samples of heavily mite-infested ‘StorKlas’ and ‘Brödtorp’ were collected and rated without laboratory freezing to determine baseline BIR.

To quantify the cold hardiness differential between heavily and lightly mite-infested buds, a modified Spearman-Karber T50 test statistic (Bittenbender and Howell, 1974) was applied to data from ‘Brödtorp’ frozen on 14 Jan. and ‘StorKlas’ frozen on 26 Jan.

Results and Discussion

Black currant buds with heavy mite infestation contained unusual tissues forming what appeared to be spherical blisters or eruptions, ≈100 μm in diameter. Other tissues in the region of heavy mite infestation appeared more turgid than their noninfested counterparts. The BIR of nonfrozen, heavily mite-infested ‘Brödtorp’ was 2.9; that of ‘StorKlas’ was 4.3 (Table 1). The results of the 8 Jan. freezing trial indicated that the “expected least cold hardy” cultivars, ‘Blackdown’ and ‘Risager’, did not suffer lethal bud damage at −35 °C (Table 2); however, the mite-infested ‘Brödtorp’ and ‘StorKlas’ showed freezing damage at −35 and −25 °C, respectively (Table 2), more than the BIR due to MIL alone (Table 1). These results suggest that mite infestation decreased the cold hardiness of ‘Brödtorp’ and ‘StorKlas’; however, no noninfested buds of these cultivars were available from Corvallis and had to be obtained from other locations. ‘StorKlas’ was available from central Pennsylvania, where winter minima are lower than that of Corvallis. Because this more severe climate could induce additional cold hardness, ‘StorKlas’ samples were also obtained from the maritime climate of Vancouver Island, B.C. The ‘StorKlas’ buds from neither Pennsylvania nor British Columbia had mites, and the sample buds of each remained undamaged by laboratory freezing to −35 °C (Table 3). Thus, these noninfested buds were more cold hardy than the infested ‘StorKlas’ buds from Corvallis, Ore. (Tables 2 and 3).

To quantify the differential bud injury for light and heavy mite infestation within a cultivar, a Spearman-Karber T50 test statistic (Bittenbender and Howell, 1974) was applied to the data for ‘Brödtorp’, frozen on 14 Jan., and ‘StorKlas’, frozen on 26 Jan. These data were chosen because sufficient numbers of heavily and lightly infested buds were available at the test temperatures. The data were adjusted by reducing the percentage of dead buds due to initial MIR, as presented in Table 1. The heavily mite-infested buds of ‘Brödtorp’ and ‘StorKlas’ had T50 values ≈10 °C higher than those that were lightly mite-infested (Table 4).

In conclusion, two heavily mite-infested cultivars, ‘Brödtorp’ and ‘StorKlas’, which were normally very cold hardy, were less cold hardy than the lightly infested cultivars ‘Blackdown’ and ‘Risager’ from the same location. Second, heavily mite-infested buds of ‘StorKlas’ were less hardy than lightly infested buds of this cultivar from Corvallis, Ore., and both were less hardy than noninfested buds of ‘StorKlas’ from Pennsylvania or British Columbia. Third, heavy mite infestation reduced the cold hardiness level for ‘Brödtorp’ and ‘StorKlas’ by ≈10 °C as determined by Spearman-Karber T50 analysis.

This study demonstrates that gooseberry mite infestation can alter the response of black currants to low-temperature stress. This conclusion parallels the observation of other pathogenic-environment interactions observed in peaches (Chang et al., 1989; Daniell and Krewer, 1984), apples (Zawadzka, 1988), dogwood (Schoeneweiss, 1979; Schoeneweiss and Wene, 1977), and red raspberries (Doughty et al., 1972). However, in these examples, and particularly in that of raspberries, the effect was indirect. The two-spotted mite injury caused premature defoliation or damage to the photosynthetic tissue during the summer and resulted in reduced starch and sugar reserves, which reduced cold hardiness (Doughty et al., 1972). In contrast with the above, and in addition to any indirect effects, we suspect that the gooseberry mite infestation within the dormant currant buds has a direct component; mite presence and the physiological changes, e.g., spherical blisters or eruptions caused by the mites, increase the number of ice nucleation sites, thus reducing the ability of buds to supercool and thereby avoid freezing injury.

The means by which gooseberry mites decrease the freezing tolerance of black currant buds will be investigated further. Whatever the underlying mechanism, these observations support the more general conclusion that a combination of biotic and abiotic stresses in the field can have a synergistic, negative impact on plant winter survival.

Table 2. Number of buds examined, test temperature, and mean bud injury ratings (BIR) and mean mite infestation levels (MIL), with SD, for black currant cvs. Brödtorp, StorKlas, Blackdown, and Risager, collected from Corvallis, Ore., and frozen in the laboratory on 8 Jan. 1998.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>No. buds examined</th>
<th>Test temperature (°C)</th>
<th>BIR (SD)</th>
<th>MIL (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brödtorp</td>
<td>10</td>
<td>−35</td>
<td>6.5 (2.9)</td>
<td>8.4 (1.6)</td>
</tr>
<tr>
<td>StorKlas</td>
<td>7</td>
<td>−35</td>
<td>8.9 (0.8)</td>
<td>10.0 (0.0)</td>
</tr>
<tr>
<td>Blackdown</td>
<td>5</td>
<td>−15</td>
<td>6.8 (2.5)</td>
<td>10.0 (0.0)</td>
</tr>
<tr>
<td>Risager</td>
<td>4</td>
<td>−35</td>
<td>2.5 (0.9)</td>
<td>1.5 (0.9)</td>
</tr>
</tbody>
</table>

See footnote z, Table 1.

See footnote y, Table 1.

Table 3. Number of buds examined, test temperature, and mean bud injury ratings (BIR) and mean mite infestation levels (MIL), with SD, for black currant cvs. Brödtorp, StorKlas, Blackdown, and Risager, collected from Corvallis, Ore., and Northumberland, Pa.; and Courtenay, B.C.; frozen on 26 Jan. 1998.

<table>
<thead>
<tr>
<th>Origin</th>
<th>No. buds examined</th>
<th>Test temperature (°C)</th>
<th>BIR (SD)</th>
<th>MIL (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oregon</td>
<td>26</td>
<td>−35</td>
<td>8.8 (1.7)</td>
<td>8.3 (2.8)</td>
</tr>
<tr>
<td>British Columbia</td>
<td>12</td>
<td>−35</td>
<td>1.0 (0.0)</td>
<td>1.0 (0.0)</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>12</td>
<td>−35</td>
<td>1.0 (0.0)</td>
<td>1.0 (0.0)</td>
</tr>
</tbody>
</table>

See footnote z, Table 1.

See footnote y, Table 1.
Table 4. Spearman-Karber T<sub>50</sub>,<sup>y</sup> with variances (S) for heavily and lightly mite-infested buds of black currant cv. Brödtorp, collected and tested on 14 Jan. 1998, and R. nigrum cv. StorKlas, tested on 26 Jan. 1998. These samples from Corvallis, Ore., were frozen in the laboratory to −15, −20, −25, −30, and −35 °C and were visually rated for bud injury.

<table>
<thead>
<tr>
<th>Mite infestation</th>
<th>Heavy</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivar</td>
<td>T&lt;sub&gt;50&lt;/sub&gt;</td>
<td>S</td>
</tr>
<tr>
<td>Brödtorp</td>
<td>−25.7</td>
<td>1.7</td>
</tr>
<tr>
<td>StorKlas</td>
<td>−23.1</td>
<td>1.4</td>
</tr>
</tbody>
</table>

<sup>y</sup>Spearman-Karber T<sub>50</sub> and variances were calculated separately for the heavily and lightly infested buds of each cultivar. Because not all buds survived the highest test temperature, a T<sub>0</sub> of −10 °C was assumed; the lowest test temperature did not kill all buds, thus a TL of −40 °C was assumed (Bittenbender and Howell, 1974).

<sup>z</sup>Heavy infestation was defined as ≥100 and light infestation as <100 mites per bud.

### Literature Cited


