were mainly responsible for the observed responses to heat.

As described above, plants were grown at 1520 m from root cuttings of the same trees from which leaves were collected for the experiments shown in Fig. 1 and 2. Leaf samples were obtained from these 2 year old trees and tested in the manner described above. The heat tolerance of leaves from each clone was greater for trees growing at 1520 m than for those at the field sites (Fig. 3 vs. 2). Killing time at 48°C increased from 35 to 60 min for leaves of TC trees and from 40 to 130 min for those from RV trees. Leaves of DG trees grown at 1520 m were especially heat tolerant; 50% electrolyte leakage was not observed in 3 hr at 48°C. Differences between the 2 year old plants and those of the same ecotype growing at higher elevations could be related to physiological age. However, in most cases heat tolerance increases with age (4), so it seems more likely that growth at the warmer site was responsible for the greater tolerance observed.

Pronounced ecotype differences were retained during the 2 years at 1520 m (Fig. 3). The heat tolerance of the 3 clones was well correlated to their sites of origin. Therefore, although the aspen used in this study showed some capacity for adaptation, genetic differences persisted. As pointed out by Hopkins (3), an increase in elevation of 122 m in-duced 50% electrolyte leakage from immersed leaf discs during a 20 min exposure. The cellular features responsible for the ecotype differences reported here could influence whole plant response to sublethal but prolonged high temperatures. The time-temperature interaction is of critical importance in the expression of heat injury (4). These observations emphasize in fact that the site of origin is an important factor to consider in the successful landscape utilization of native plant material.

Literature Cited


Relationship between Guard Cell Length and Ploidy in Vaccinium

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Additional index words. Vaccinium elliotti, V. darrowi, V. arboreum, V. stamineum, V. fuscatum, V. myrsinoides, V. ashei

Abstract. Guard cells tended to be shortest for diploid species and longest for hexaploids, but there was so much plant-to-plant variation both within ploidy levels (diploid, tetraploid, hexaploid) and within species that guard cell length was not a reliable indicator of ploidy level of individual plants.

Tetraploid and hexaploid Vaccinium species have evolved from diploid species through allopolyploidy and possibly through autoploidy (2, 3). Chromosome number determination is a prerequisite to the efficient use of a blueberry plant in breeding, because plants can be hybridized readily if they have the same chromosome number (1, 2, 6), but cross only with difficulty if they differ in ploidy. Crosses between diploids and tetraploids typically produce few hybrids, and those produced are mostly tetraploid (6, 9). Tetraploid x hexaploid crosses, although easier to make, give partially-fertile pentaploids (5, 7).

Chromosomes can readily be counted from meiotic or premeiotic flower buds in Vaccinium. An indication of ploidy also can be obtained by assessing a plant's fertility when crossed with known diploid, tetraploid, and hexaploid parents. Both procedures require mature flowering plants. Chromosome counts from blueberry shoot tips and root tips are tedious.

Chandler (4) found that large differences in stomate size could be used to separate tetraploid and octoploid plants obtained by colchicine treatment of highbush blueberry seedlings. Differences in stomate size also have been used to separate plants of differing ploidy in many species including Bromus (10) and Triticum (8).

The fact that guard cell length is easy to measure in blueberries and can be measured on non-flowering plants makes guard cell length an attractive possibility for estimating ploidy level. The purpose of this study was to determine whether or not stomate size is a reliable indicator of ploidy level among plants of various blueberry species and hybrids.

Seed was collected from native populations of 6 Vaccinium species: diploids V. elliotti Chapman, V. darrowi Camp, V. stamineum L. and V. arboreum Marsh; the tetraploid (V. fuscatum Ait); and hexaploid (V. ashei Reade). All seed collections came from...
Table 1. Mean guard cell length of 7 seedling and 8 adult blueberry populations.

<table>
<thead>
<tr>
<th>Population</th>
<th>Ploidy</th>
<th>Mean</th>
<th>SE</th>
<th>Range</th>
<th>Mean</th>
<th>SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. elliottii</td>
<td>2x</td>
<td>14.0a</td>
<td>.28</td>
<td>12.5-15.6</td>
<td>12.2a</td>
<td>.25</td>
<td>11.2-13.6</td>
</tr>
<tr>
<td>V. darrowi</td>
<td>2x</td>
<td>14.2a</td>
<td>.24</td>
<td>11.9-15.7</td>
<td>14.0b</td>
<td>.39</td>
<td>12.4-15.9</td>
</tr>
<tr>
<td>V. stamineum</td>
<td>2x</td>
<td>14.5a</td>
<td>.32</td>
<td>12.4-17.2</td>
<td>14.5c</td>
<td>.33</td>
<td>13.1-16.6</td>
</tr>
<tr>
<td>V. arboreum</td>
<td>2x</td>
<td>16.1b</td>
<td>.44</td>
<td>12.9-21.8</td>
<td>13.3ab</td>
<td>.39</td>
<td>11.7-14.7</td>
</tr>
<tr>
<td>V. fuscatum</td>
<td>2x</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>16.8de</td>
<td>.58</td>
<td>13.3-19.5</td>
</tr>
<tr>
<td>V. fuscum</td>
<td>4x</td>
<td>16.8b</td>
<td>.40</td>
<td>12.1-19.1</td>
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</tr>
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<td>Commercial</td>
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</tr>
<tr>
<td>hybrids</td>
<td>4x</td>
<td>17.9c</td>
<td>.28</td>
<td>16.0-20.4</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>V. myrsinites</td>
<td>4x</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>17.2e</td>
<td>.75</td>
<td>13.8-20.0</td>
</tr>
<tr>
<td>V. ashei</td>
<td>6x</td>
<td>20.0d</td>
<td>.60</td>
<td>15.4-25.2</td>
<td>15.8cde</td>
<td>.51</td>
<td>13.8-18.2</td>
</tr>
</tbody>
</table>

*Mean of 20 plants for seedlings and 10 plants for adults.

Among adult plants, guard cell length also increased with ploidy, except that hexaploid *V. ashei* had smaller cells than the tetraploids *V. fuscum* and *V. myrsinites* (Table 1) and diploid *V. darrowi* was not significantly different from tetraploid *V. fuscum*.

Differences in environment, plant age, and leaf age could account for the disparity in guard cell length between adults and seedlings. The discrepancy between seedling and adult *V. ashei* may have had a genetic component because the adult population came from 1 site in north-central Florida, whereas the seedlings were a composite from north-central Florida, northeast Florida, and southeast Georgia.

These results indicate that guard cell size in blueberries has little value as an indicator of chromosome number of individual plants in genetically-diverse populations. The distinct differences in guard cell size between tetraploid and octaploid plants obtained from colchicine-treated seedlings of single crosses in Chandler's study (4) were not found between diploid, tetraploid, and hexaploid plants of different blueberry species.

**Literature Cited**