The Influence of Salinity and Rootstock on Avocado Seedling Growth

Progress Report

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Abstract
Rootstock differences influence the salt tolerance of fruit trees and vine crops because of varietal differences in absorption and transport of sodium and chloride. The influence of salinity and Mexican-Guatemalan parentage rootstock on Mass seedling growth is under study at Brokaw Nurseries, Saticoy. Eight rootstock varieties (Clonals: Borchard, G755c, Duke 7, Huntalas, G6, Lula 3, and Duke 6; and the nonclonal Walter Hole) grafted to Hass were grown to an age of 1.5 years at three salinity levels (2.9, 3.6, and 4.5 dS/m) in sand media.

Seedling height, quality, and trunk diameter were measured five times after seedling establishment and salinization of the growth media. The chloride and sodium content of leaves, stems, and roots were also measured.

For the 4.5 dS/m salinity treatment, Borchard performed the best: the final height was 2.3 times that at the beginning of the experiment. G755c was next best: the corresponding height increase was 1.7 times. Salinity had little effect on the growth of Borchard and G755c, whereas growth decreased with salinity for Duke 7, Huntalas, Walter Hole, Lula 3, G6, and Duke 6. The latter two were unable to survive at 4.5 dS/m.

Chloride content for leaves ranged from 0.1 to 0.6 percent and from 0.05 to 0.5 percent for stems. Growth, G, decreased with increasing chloride content, Cl, in the leaves and stems. The regression equation for leaves was \( G = 3.95 - 11.0 \text{ Cl} + 11.2 \text{ Cl}^2 \) (\( r^2 = 47 \) percent), where growth is expressed as the ratio of plant height at the end of the experiment divided by that at the beginning. Chloride content is expressed as a percent of the dry weight. For stems, the corresponding equation was \( G = 3.5 -12.7 \text{ Cl} + 17.5 \text{ Cl}^2 \) (\( r^2 = 70 \) percent). Sodium content in the leaves was low (overall average = 0.05%), as compared to 0.45% in the stems. In contrast to chloride, growth and stem sodium content were not correlated (\( r^2 = 27 \) percent).
Introduction

A study of rootstock and salinity effects on growth of Hass seedlings is underway at Brokaw Nursery in Saticoy. This project characterizes the salt tolerance of Hass on primarily Phytophthora root rot resistant clonal rootstocks, and on the partitioning of sodium and chloride within the plant. Prior investigators (1, 2, 3, 5, 6, 7, 8, 10, 11, 12) have demonstrated the general influence of rootstock on avocado salt tolerance. The most common mechanism of tolerance appears to be reduced transport of chloride (1, 2, 4, 8) and exclusion of sodium (6, 9) by the rootstock, although exceptions are known (3). This report is a preliminary summary of data obtained during the first experiment conducted between 6/82 and 10/83. Another experiment is currently underway with Borchard, G755a, G755b, G755c, Duke 7, Toro Canyon, and Huntalas rootstocks.

Methods

Clonal rootstocks budded to Hass were planted in three sand tanks. After establishment under nonsaline conditions, each tank was irrigated with water of a specific salinity. The salinity levels were 2.9, 3.6, and 4.5 dS/m. Irrigation with low angle spray emitters occurred several times each day. Sufficient water was applied so the salinities of the applied and drainage waters were equal.

Six seedlings per rootstock were planted in each sand tank at randomly selected locations. Initial plant measurements of height, trunk diameter, and quality were made before the sand media was salinized. These measurements were repeated quarterly, and samples of old and new leaves were taken for sodium and chloride analysis. After about one year of growth under saline conditions, the seedlings were harvested. The roots, stem, leaves, and meristem of each surviving plant were analyzed for sodium, chloride, and boron. In addition, one seedling of each rootstock and salinity treatment was analyzed for nitrogen, phosphorus, potassium, calcium, magnesium, sulfate, manganese, zinc, iron, and copper.

Results

Both rootstock and salinity influenced plant vegetative quality as evaluated by the Brokaw employee responsible for the project. The numerical ranking and corresponding vegetative characteristics were:

1. dead plant
2. severely stressed plant—almost dead
3. stressed plant
4. healthy plant, but not currently growing
5. vigorously growing plant.
Figure 1 illustrates the range of rootstock and salinity effects on vegetative quality for three rootstocks. Salinity had little influence on Borchard and may have enhanced vegetative quality (Fig. 1a). Salinity effects on G755c were also small (Fig. 1b). Vegetative quality of Duke 6 decreased throughout the experiment for the two higher salinity treatments; the highest salinity treatment was lethal (Fig. 1c).

Figure 2 illustrates the influence of rootstock on seedling growth for the 4.5 dS/m
treatment. Only the results for seedlings which survived this treatment are shown. The
parameter for growth, relative growth, is the ratio of plant height at the time of
measurement divided by the initial height before salination. Borchard and G755c grew
considerably more than the other varieties during the first 280 days of treatment. Only
Borchard and Duke 7 grew during the last 80 days (July-Oct).

Salinity levels had little effect on the relative growth of Borchard and G755c (Table 1).
Relative growth of Duke 7 was reduced in the 4.5 dS/m treatment. Relative growth of
the other varieties at 3.6 dS/m was less than that at 2.9 dS/m. It follows that the
threshold for salinity effects ranges from about 4.5 dS/m (or possibly greater for
Borchard and G755c) to less than, or equal to, 2.9 dS/m for Huntalas, G6, Lula 3, and
Duke 6. The published threshold salinity is 1.3 dS/m. These data suggest this threshold
could be increased about threefold by rootstock selection, or breeding, or both.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Salinity [dS/m]</th>
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<tbody>
<tr>
<td></td>
<td>2.9</td>
<td>3.6</td>
</tr>
<tr>
<td>Borchard</td>
<td>2.3</td>
<td>2.8</td>
</tr>
<tr>
<td>G755C</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Duke 7</td>
<td>2.9</td>
<td>3.1</td>
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<tr>
<td>Huntalas</td>
<td>1.6</td>
<td>1.3</td>
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<td>Walter Hole</td>
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<td>G6 PT</td>
<td>2.2</td>
<td>1.9</td>
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<tr>
<td>Lula 3</td>
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<td>1.4</td>
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<tr>
<td>Duke 6</td>
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<td>1.1</td>
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<tr>
<td>Average</td>
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<td>1.8</td>
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</table>

Chloride and sodium contents of roots, stems, and leaves provide insight into partitioning of
these ions in the plant and their influence on plant growth. Chloride content for leaves
ranged from 0.1 to 0.6 percent and from 0.05 to 0.5 percent for stems. Relative growth, \( G \),
decreased with increasing chloride content, \( Cl \), in the leaves and stems. The regression
relationship between growth and leaf chloride content was

\[
G = 4.0 - 11.0 C1 + 11.2 C1^2 \quad (r^2 = 47\%)
\]

The corresponding equation for stem chloride content was

\[
G = 3.5 - 12.7 C1 + 17.5 C1^2 \quad (r^2 = 70\%)
\]
The corresponding data are shown in Fig. 3. Sodium content in the leaves was low (overall average = 0.05%), as compared to 0.45% in the stems. In contrast to chloride, growth and stem sodium content were not correlated. The regression relationship between growth and stem sodium was

\[ G = 1.82 + 1.84 \text{Na} - 3.28 \text{Na}^2 \quad (r^2 = 27 \text{ percent}). \]

**Conclusions**

Absorption and transport of chloride and sodium by existing rootstocks vary considerably and affect seedling growth. Chloride content of the scion stem may be a suitable indicator of rootstock effects on the growth (salt tolerance) of young seedlings. The results indicate salt tolerance of avocados can be improved considerably through breeding and selection of rootstocks.

**Acknowledgements**

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**Literature Cited**
