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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 $G = 3.95 - 11.0\ Cl + 11.2\ Cl^2$ (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 $G = 3.5 -12.7\ Cl + 17.5\ Cl^2$ (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.

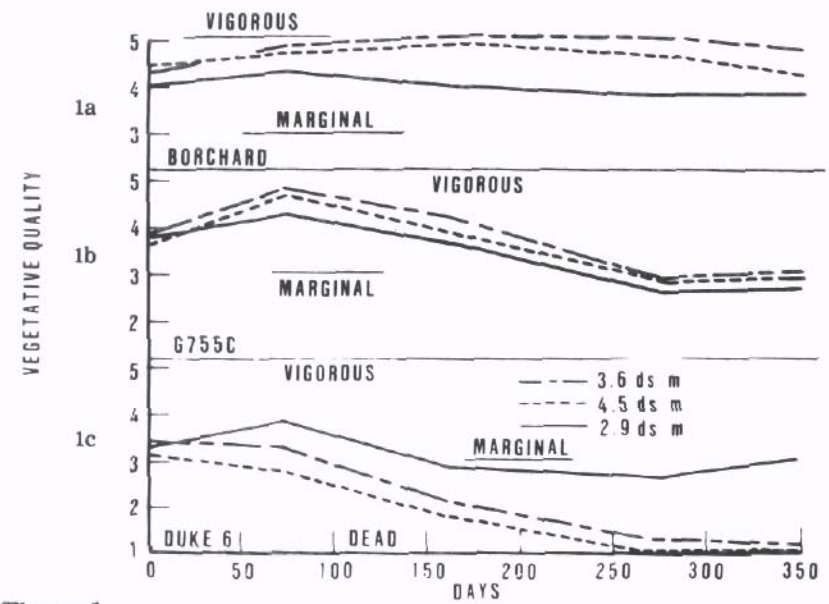

Figure 1.

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. la). 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).

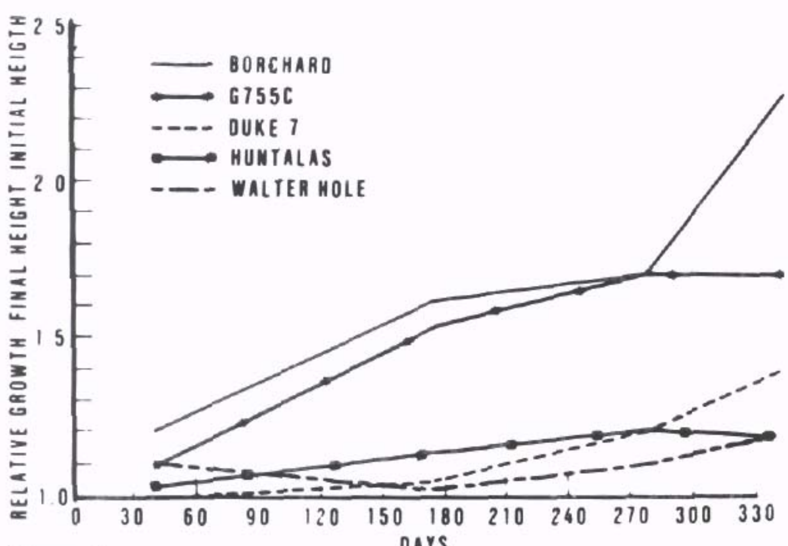

Figure 2.

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 1. Influence of Salinity treatment on final relative growth; plant height at the end of the experiment divided by initial height.

Variety	Salinity [dS/m]		
	2.9	3.6	4.5
Borchard	2.3	2.8	2.3
G755C	1.8	1.8	1.7
Duke 7	2.9	3.1	1.4
Huntalas	1.6	1.3	1.2
Walter Hole	1.3	1.0	1.2
G6 PT	2.2	1.9	—
Lula 3	2.3	1.4	1.0
Duke 6	2.0	1.1	—
Average	2.0	1.8	1.5

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

$$G = 4.0 - 11.0\ C1 + 11.2\ Cl^2\ (r^2 = 47\ \text{percent}).$$

The corresponding equation for stem chloride content was

$$G = 3.5 - 12.7\ C1 + 17.5\ Cl^2\ (r^2 = 70\ \text{percent}).$$

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

$$G = 1.82+1.84\ Na - 3.28\ Na^2\ (r^2 = 27\ percent).$$

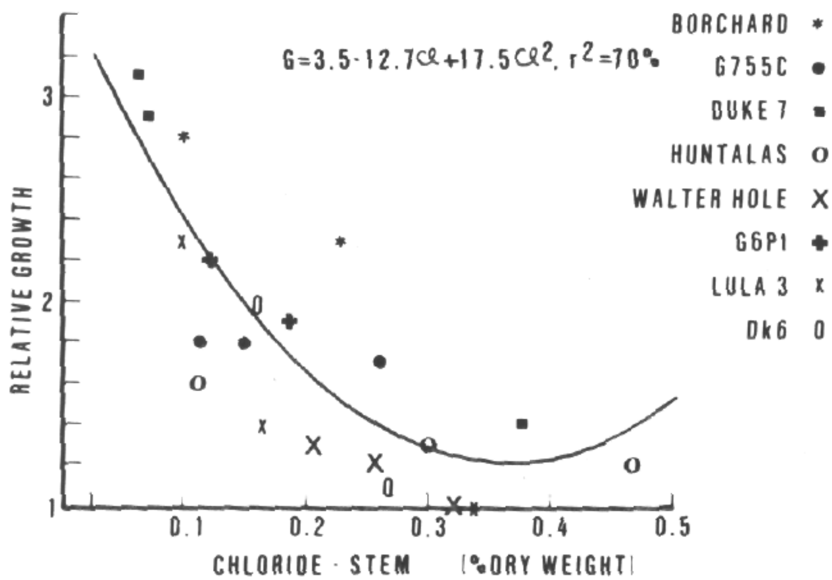

Figure 3.

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 resulta indicate salt tolerance of avocados can be improved considerably through breeding and selection of rootstocks.

Acknowledgements

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Literature Cited

Ben-Ya'Acov, A. D. Characteristics Associated with Salt Tolerance in Avocados Grafted on Mexican and West Indian Rootstocks. Proc. Inter. Hort. Cong. 18th (Tel Aviv) 1: 135. 1970.

Cooper, W. C. Salt Tolerance of Avocados on Various Rootstocks. Tex. Avo. Soc. Yrbk. 1951: 24-28.

Cooper, W. C., Peynado, A., Maxwell, N., Otey, G. Salt Tolerance and Cold Hardiness Tests on Avocado Trees. J. Rio Grande Valley Hort. Sci 11: 67-74.1957.

Downton, W. J. S. Growth and Flowering in Salt-Stressed Avocado Trees. Aust. J. Agric. Res. 29: 523-534. 1978.

Embleton, T. W., Matsumura, M., Storey, W. B., Garber, M. J. Chlorine and Other Elements in Avocado Leaves as Influenced by Rootstock. Amer. Soc. Hort. Sci, Proc. 80: 230-236. 1962.

Gustafson, C.D., Kadman, A., Ben-Ya'Acov, A. Sodium 22 Distribution in Arched Grafted Avocado Plants. Proc. 18th Inter. Hort. Cong. 1: 135.1970.

Haas, A. R. C. Effect of NaCl on Mexican, Guatemalan and West Indian Avocado Seedlings. Calif. Avo. Soc. Yrbk. 35:153-160. 1950.

Kadman, A. The Uptake and Accumulation of Chloride in Avocado Leaves and the Tolerance of Avocado Seedlings Under Saline Conditions. Proc, Amer. Soc. Hort. Sci. 83: 280-286. 1963.

Kadman, A. The Uptake and Accumulation of Sodium in Avocado Seedlings. Proc. Amer. Soc. Hort. Sci. 85:179-182. 1964.

Kadman, A. Experiments with Saline Resistant Vegetatively Propagated Avocado Rootstocks. Proc. 18th Int. Hort. Cong. 1: 136. 1970.

Patel, P. M., Wallace, A., Mueller, R. T. Salt Tolerance of Huntalas Compared with Other Avocado Rootstocks, Calif. Avo. Soc. Yrbk. 59: 78-85.1976.

Wallace, A., Shannon, L. M., North, C. P., Mueller, R. T. Glasshouse Studies on the Salt Tolerance and Growth of *Persea floccosa* as a Rootstock. Calif. Avo. Soc. Yrbk. 39: 179-183. 1955.