Proceedings of the California Avocado Research Symposium, October 30, 2004. University of California, Riverside. California Avocado Commission. Pages 108-111.

Salinity Tolerance in Avocado

Continuing Project: Year 7

Project leader: David Crowley (951-787-3785), e-mail crowley@mail.ucr.edu
Department of Environmental Sciences, UC Riverside
Cooperating Personnel: Woody Smith, Gary Bender, and Mary Lu Arpaia

Benefit to the Industry

This project is aimed at evaluation and recommendation of rootstocks that are useful for production of avocado on saline soils. Rootstocks identified as salinity tolerant and that also meet criteria with respect to productivity and Phytophthora resistance from other related projects will be recommended for commercial release. Rootstocks with high salinity tolerance are also being incorporated into the breeding program. Results of this research will allow growers to use irrigation water having a higher salinity content than is currently permissible for avocado production.

Objectives

1) Compare salinity tolerance and chloride uptake for Hass scions grafted on currently used rootstocks and newly developed rootstocks identified from research in Israel.
2) Breeding and development of new avocado rootstocks for commercial release.

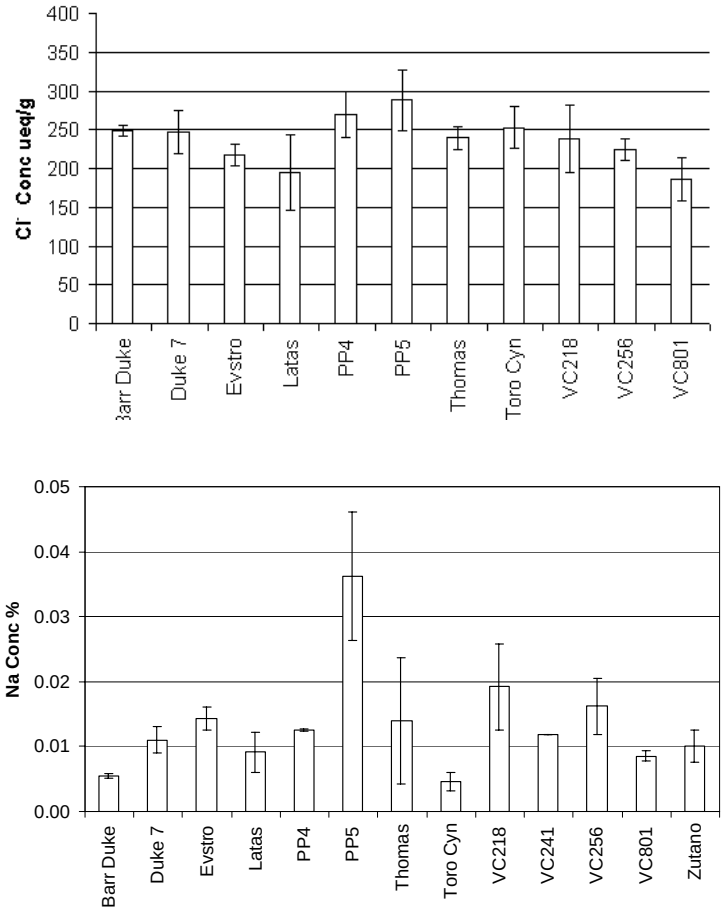
Summary

In the 2004 project year, our main efforts were directed toward the establishment of a new field experiment that will test several of our best salinity tolerant rootstocks and several new releases from Israel. The experiment was established in June at the Stehly Ranch near Valley View, California, and will compare 11 different rootstocks that were grafted with Hass scions (Duke 7, Spencer, Parida, VC44, VC207, VC 801, VC218, PP14 (Uzi), PP 16 (Rio Frio), PP24 (Steddom)). Irrigation water at the Stehly Ranch is highly saline with an average EC of 2.5 and chloride levels of approximately 300 ppm. In our previous screening trials at this site, we have identified several rootstocks that have superior salinity tolerance, and that produce vigorous trees. Many of these same trees are being evaluated for productivity at a variety of locations in experiments managed by Dr. John Menge, who is assessing yield and Phytophthora resistance for trees grown over a range of soil conditions. The field trial at the Stehly ranch represents the most extreme salinity conditions that avocado growers will normally encounter.

In addition to the new field experiment, we are continuing to monitor an earlier field experiment at the Stehly ranch, which contains 5 year old trees, and a new set of trees that were replanted in 2003 to replace those lost by frost. The replant in the original site

was set up to compare additional rootstocks that were not included in the original experiment. Results of our leaf analyses for the original trees are provided in Figure 1.

Figure 1. A. Leaf chloride (top) and leaf sodium concentrations (bottom figure) in Hass scions grafted on to rootstocks evaluated in Field Experiment I at Stehly Ranch. Leaves samples collected in Sept 2003.

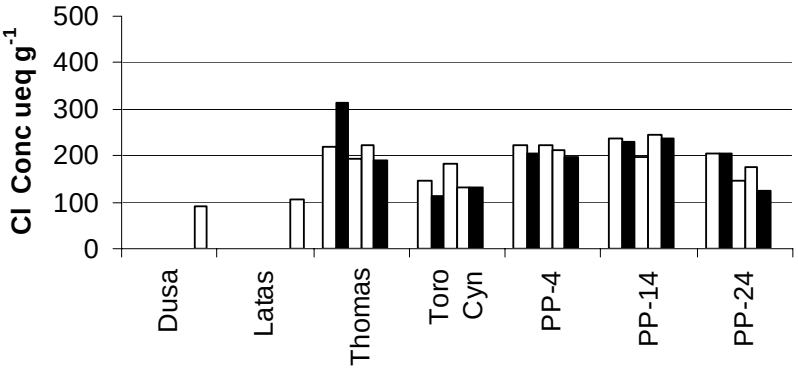


The leaf tissue analyses for the rootstocks are in agreement with previous 3 years of data that demonstrate that there are significant differences in the leaf chloride and sodium contents of different avocado rootstocks. The best rootstocks with respect to low chloride are VC801, and Merensky I (Latas) and Merensky II (Evstro). The best rootstocks for restricting sodium uptake were VC 801 and Merensky I. Analyses were also conducted for calcium, potassium, and trace metals (data not shown). Leaf sodium content was directly correlated with a low potassium content ($r^2=0.25$ $P=0.08$), such that trees containing low sodium also contained lower potassium concentrations, and thus may need increased potassium fertilization. Leaf potassium and calcium concentrations were inversely related ($R^2 = 0.78$ $P>0.001$). These data suggests that potassium fertilization may be beneficial on high calcium soils, although this needs to be confirmed experimentally in a fertilizer trial. Leaf iron contents were similar for all rootstocks (range 70 to 80 ppm), with the exception of Thomas which had low leaf iron content (55 ppm). Leaf zinc concentrations ranged between 32 to 45 ppm, which is sufficient. There were no significant differences between the rootstocks with respect to zinc contents.

All of the superior rootstocks identified above along with the Duke 7 control are included in the new trial along with several new releases and the remaining VC salt tolerant varieties from Israel that have come out of quarantine. Among the rootstocks from UCR is one designated PP16 (Rio Frio), which has been previously evaluated in a Phytophthora root rot trial in Escondido and was shown to have high yields and a particularly low chloride content in comparison to other rootstocks included in the trial. In contrast to our other salinity tolerant rootstocks that are West Indian, Rio Frio is a Guatemalan rootstock from the Zentmyer collection. Yield data for 4 year old trees in 2002 were 7000 lbs per acre in an area where the mean is typically closer to 3000 lbs per acre (John Menge, personal communication). Comparison of the chloride contents for Rio Frio with 14 other rootstocks indicate that scion on this rootstock contain three-fold less chloride than in scions grafted on to Duke 7, and two-fold less than in Merensky I (Latas), which is our best salinity tolerant rootstock to date under high salinity conditions.

In addition to the field experiment at the Stehly ranch in Pauma Valley, we are monitoring an experiment at the Dr. Pete Miller's Orchard in Carpinteria. In this experiment, we are comparing the salinity tolerance of 6 different rootstocks that are grafted both with Hass and with Lamb Hass scions, the latter which has been purported to be more salinity tolerant than Hass. The results of the leaf tissue analyses for these trees for samples collected in 2003 are shown in Figure 2. Contrary to the original hypothesis, there does not appear to be any significant difference in Hass and Lamb Hass with respect to leaf chloride contents when grown on the same rootstocks. The site was visited by Dr. Mary Lu Arpaia in summer 2004, and the trees were rated and photographed. Differences in tree vigor were noted among the rootstocks, but continued observations will be needed over the long term to determine if there are in fact differences in Hass and Lamb Hass performance on these rootstocks. Leaf samples for 2004 will be collected in late September/October 2004.

Figure 2. Comparison of leaf chloride concentrations for leaves of Hass and Lamb Hass scions grafted on to rootstocks differing in salinity tolerance. Hass (white bars) and Lamb Hass (black bars). Individual bars for each rootstock represent different composite samples from different blocks for the same rootstock. In blocks where the trees were too small (Dusa and Latas trees were planted later than the other rootstocks), no leaf samples were taken.



In February 2004, we planted the first seedlings in the high density screening plot at the Harlan Beck Orchard. This screening plot is being used for evaluation of seeds from our salt tolerance breeding blocks that are located on the UCR Agricultural Operations in Riverside. No fruit is being produced yet in these blocks; however, this first year we had seedlings from self crossed VC 44, 256, and 801 that we placed in the plot for evaluation. The trees are planted in a high density plot at 2 ft intervals with drip irrigation using saline irrigation water. Individual seedlings that perform particularly well under the high salt conditions will be removed and transplanted to the UCR Ag Ops for further evaluation and use in the salinity breeding blocks. In this manner, we will attempt to produce and improve new rootstocks that are even more saline tolerant than the best ones that we have available now.

Conclusions

Several rootstocks have now been shown to have superior ability to exclude chloride and sodium, and are anticipated to be released to growers in the near future. These include the Merensky I and II rootstocks, and VC 801. Identification of new rootstocks which can be incorporated into the breeding program is underway and will lead to future improvement in salinity tolerance. As water costs increase and growers rely increasingly on saline water for irrigation, this will permit use of higher salinity water with lesser damage to the trees and concomitant reductions in crop yield. In conjunction with the use of salinity tolerant rootstocks, continued research on irrigation management to optimize water use efficiency is critical to long term viability of the avocado industry in California.