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Advances in Salinity Tolerance and Phytophthora Detection

For many years, the California Avocado Commission's (CAC's) avocado rootstock breeding, run through the University of California, Riverside (UCR), focused exclusively on finding Phytophthora tolerant rootstocks. However, as time has passed, salinity has become an increasing problem for our industry, perhaps even surpassing Phytophthora in importance.

To address this growing problem, the Commission funded a four-year project with Dr. Peggy Mauk, subtropical horticulture specialist at UCR, and cooperators Drs. Mary Lu Arpaia, David Crowley and Donald Suarez (U.S. Department of Agriculture (USDA) Salinity Lab, Riverside), starting in the 2012-2013 fiscal year to evaluate the salinity tolerance of a number of University of California and South African rootstocks.

The trees in the trial were planted in April 2011 and were originally intended to be used for a Phytophthora trial that never came to fruition. Given the large variety of rootstocks in the block and the industry's need, it was repurposed for a salinity trial. The rootstocks in the block are PP4, PP14, PP24, PP40, PP45 and Thomas (UCR selections), R0.05, R0.06, R0.07, R0.16, R0.17, and R0.18 (South African selections), and Dusa as the industry standard control. All are grafted with Hass scions.

Example trees of the UCR rootstock selection PP40 after 10 months of treatment with saline (left) or fresh (right) water. The rootstock shows good tolerance to salinity with only mild leaf burn symptoms. Photo credit: Peggy Mauk, UCR.

During 2013, the block's irrigation system was modified to accommodate fresh and saline water treatments and salinity treatments began in November 2013. The saline treatment was increased slowly over about a three-month period to avoid shock, reaching the final saline treatment level of EC 1.5 dS/m total salts with 175 ppm chloride in January 2014. Control fresh water has an EC of about 0.67 dS/m total salts and a chloride content of about 40 ppm.

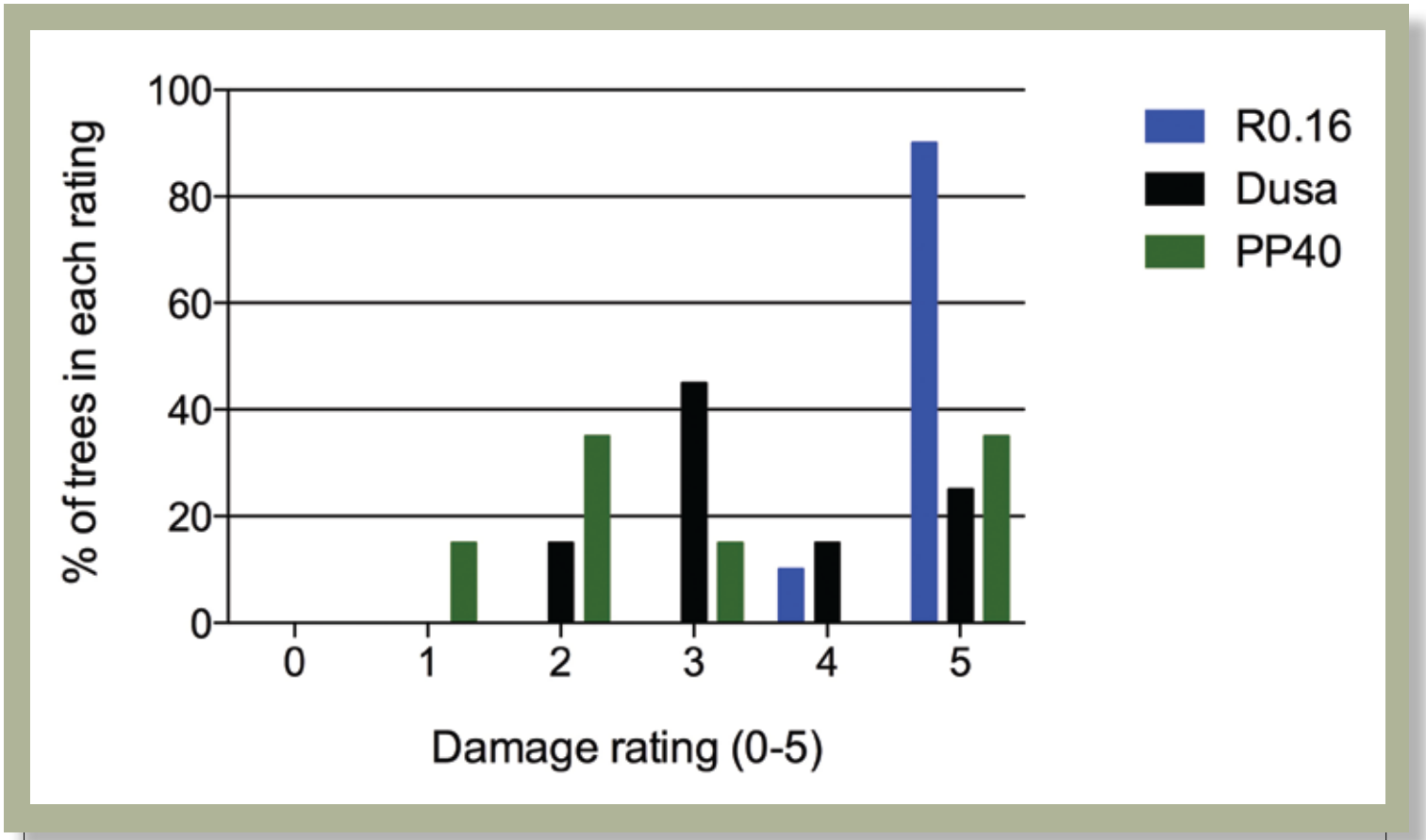
Throughout 2014, the trees were evaluated by measuring rootstock trunk diameter, canopy volume, leaf burn, yield and flowering, as well as physiological parameters of photosynthesis, transpiration rate and stomatal conductance. In addition, leaf, soil and water analyses were performed.

Since the fruit harvested in 2014 was set and developed prior to the application of the salinity treatments, there were no differences in yield between control and salinity treatments.

Leaf tissue analyses prior to salinization showed that there was a range of leaf chloride concentrations among the rootstocks (from 77 to 227 mmol/kg dry weight). This indicates that some of the rootstocks are chloride excluders (low leaf chloride concentration) and others are chloride accumulators (high leaf chloride concentration). Leaf burn was evaluated in February and October 2014 by rating each tree on a scale of 0 (no burn) to 5 (tree defoliated). In February (six weeks after full salinization), there were no ratings above 3 and there was no difference between salinized and control trees. However, by October there were significant differences among rootstocks in the salinized treatment, with rootstocks from both UCR and South Africa performing well and poorly. A sample of these data are shown in the accompanying figure on page 32.

After just one year of saline treatment, this trial is yielding very valuable data, and it appears that there are some rootstocks in the development pipeline with considerably better salt tolerance than is currently available. Larger scale trials will need to be conducted to make sure these tolerant rootstocks yield well, are otherwise horticulturally "good," and perform well under a variety of conditions, but there is reason to be optimistic.

As mentioned above, Phytophthora, along with salinity, is one of the top issues faced by our industry. Many growers know they have Phytophthora in their grove, but few, if any, have committed the time and money to conduct an extensive soil sampling to know the full extent of



Salinity damage ratings for Hass trees grafted on three different rootstocks 10 months after the initiation of salinity treatments. The South African rootstock R0.16 showed poor salinity tolerance with 95percent of trees showing defoliation, whereas Dusa and the UCR selection PP40 showed considerably better salinity tolerance with most trees having only mild leaf burn.

the disease in their grove. That's because traditional Phytophthora analysis requires the collection of a soil sample, which is then sent to a lab for analysis by Polymerase Chain Reaction (PCR). That analysis requires a high level of technical expertise to extract DNA from the soil sample and expensive lab equipment, resulting in a cost of about $50 per sample. Thus, many growers base their Phytophthora treatment on the recognition of visual symptoms, but visual symptoms are not exclusive to Phytophthora and treatments may be applied unnecessarily.

A cheaper, faster method of Phytophthora detection would be a tremendous benefit to avocado growers, and in 2012 Dr. Frank Martin, plant pathologist, USDA Salinas, proposed just that. Dr. Martin had been involved in developing detection methodology for *Phytophthora ramorum*, the cause of sudden oak death, and proposed to extend that knowledge to help with Phytophthora detection in avocado.

Prior to working specifically on avocado Phytophthora, Dr. Martin's lab had worked to develop species specific molecular primers and probes for the detection of all 96 described species of Phytophtora by PCR. In his work on avocado, Dr. Martin worked with a technology known as Twist Dx, which does not require DNA extraction. The equipment needed is portable and the assay can be completed in as little as 20 minutes, which makes Phytophthora detection faster, cheaper and easier for avocado growers.

Dr. Martin has successfully translated the PCR technology for *Phytophthora cinnamomi* and *P. mengei* diagnosis to the Twist Dx technology. The unit that his lab has worked with costs about $4,500, but there are other companies entering the market and other units are available for as little as $2,500. Given the simplicity of sample processing, the short time required and the availability of low cost equipment, this diagnostic technology now has the potential to be used directly in the field by pest control advisors, extension personnel and other diagnosticians. And each and every grower has the potential to know the full extent of Phytophthora infection in their grove to improve tree health management.

The Commission is actively working to determine the best path forward to transfer this technology to the field to help the avocado industry. Dr. Martin's technology will be demonstrated at the upcoming Pine Tree Field day on March 25, 2015 at 10 a.m.