

Salinity Management

---

**Salinity-Chloride Interactions  
Effects on Yield**

*David Crowley*      *Mary Lu Arpaia*  
*UC Riverside*      *Kearney Agricultural Center*

*Cooperators: Gary Bender – UCCE, Ben Faber – UCCE, Mary Bianchi – UCCE,  
Daryl Nelson - Fruit Growers Laboratory*

---

Avocado yields are decreased by chloride toxicity and soil salinity throughout California avocado orchards but there is little information on the extent to which different rootstocks can be used to improve tree performance under saline conditions. This research is aimed at the development of a production function model that can be used to predict the impacts of irrigation water chloride content and salinity (EC) on avocado yields. The model further evaluates the effects of different soil chemical and physical properties, water chemistry, and rootstocks on the accumulation of chloride in the leaf tissue, as well as the effects of salinity and chloride on root growth. Data are being collected from 10 orchards that span the major avocado production areas from San Diego to San Luis Obispo. Our modeling approach involves the use of an artificial neural network (ANN) program that enables us to separate out very complex interactions that cannot be detected using traditional statistical procedures. When completed, this research will allow us to provide a simple, user friendly program that growers can access via the internet to predict how different water qualities will affect their yields for Hass avocado produced on each of the different main rootstocks that are now being used in California.

In the 2009 annual report, we provided our results on use of this modeling approach for predicting root growth, but did not have yield data due to the poor fruit yields for almost all growers that year. This past year was particularly important as we have now been able to analyze the first full data set that includes yield data. The output from the first full run of the model with yield data was provided in the midyear report, and revealed that chloride and salinity strongly affect avocado yields and provided quantitative equations that can be used to determine the effects of both factors (EC and chloride) on yields, as well as their interactions. The model was also able to examine the effects of plant nutritional status on yields under saline conditions, and this varies for different rootstocks and soils. Because these models must be trained with real data in order to generate the equations, it is essential to include several years to generate a model that can be used with high accuracy. Under the time line of this project, we will be able to include yield data for 2011 to further strengthen and test the model, after which we will determine whether it can be used with good confidence or still requires further data.

At the time of this report, we have now collected all of the leaf and soil samples that will be used for our next modeling run. These samples are being analyzed by Fruit Growers Laboratory, and the data that are being returned are being organized and analyzed following the same procedures that we used last year. The next run of the model will be available in the midyear report for 2011, which will also

enable to test another application of the model for a time series analysis. The latter application evaluates how yields vary over time and the extent to which we may be able to predict changes in yield from year to year. In other words, we may also be able to predict how variations in yield that are caused by alternate bearing are affected by salinity, chloride, soil type, rootstock, and plant nutritional status.

Along with our salinity research supported by the CAC, we have also been able to leverage additional funding to conduct studies on the potential value of soil inoculants for improving drought and salinity tolerance in avocado. One project that was funded by the CONICYT program with UC-MEXUS was carried out by Dr. Macario Bacilio who initiated a field study using sap flow measurements in the field to measure how changes in root growth using soil inoculants may affect water use efficiency. Dr. Bacilio also carried out a large greenhouse experiment with avocado seedlings that evaluated root growth in soils with different organic amendments and a soil inoculant (BioSoil) that is being marketed for use in fruit orchards. The premise for this research is use of bacterial inoculants that contain a gene encoding an enzyme called ACC deaminase, which suppresses the production of stress ethylene in the plant rhizosphere. This volatile gas is produced by plant roots under stress conditions and signals the plant roots to stop growing. By lowering the production of ethylene with these bacterial inoculants, it may be possible to improve root growth and water use efficiency under saline conditions. This same line of research is also being supported by a grant from the Kearney Foundation of Soil Science, and a postdoctoral research associate who is an expert on this topic will join our team in January 2011. The salinity project supported by the CAC has thus enabled us to carry out other complimentary research that may be of value to avocado growers.

In addition to the midyear report that shows how the model works and the types of output that are generated, we have also presented our research at several venues including a grower meeting in Temecula (Grangetto's Farm and Garden supply), and at international meetings with other scientists working on the same topic but different crops in other countries. Three seminars were given by Crowley in China at the top agricultural university in Beijing (China Agricultural University), at Nanjing Agricultural University, and at the UCR-CAS (Chinese National Academy of Sciences) Institute of Arid Land Ecology in Xinjiang China, where researchers are similarly using a neural network modeling approach for crop function models. Our research has been very well received and is at the forefront of research aimed at development of production function models for examining the effects of salinity on crop yields. In the coming year, Crowley will provide a series of talks on this research at grower meetings in Santa Barbara, Ventura, and San Diego counties.

In summary, 2010 has been an important year for providing a full proof of concept for the modeling approach we are using to examine the effects of salinity and chloride on avocado yields. We are on schedule in our sampling and data analysis, and look forward to the further improving and refining our crop production function as the new data set becomes available in the spring of 2011. Based on the results to date, we believe we should have a very useful tool that can be applied for predicting crop yields under different salinity conditions, and the extent to which this can be affected by different rootstocks and fertilization management. Readers are encouraged to examine the midyear report for further details on preliminary results generated from the first model run using yield data.