Physiology of Salinity Stress in Almond

Project Leaders: Patrick Brown[1], Steve Grattan[2]
[1]Department of Plant Sciences, UC Davis, One Shields Ave., Davis, CA 95616 (530) 752-0929, phbrown@ucdavis.edu
[2]Department of Land Air and Water Resources, UC Davis, One Shields Ave., Davis, CA 95616 (530) 752-4618, srgrattan@ucdavis.edu

PROJECT SUMMARY

Objectives:

- Compare selected rootstocks and cultivars in different combinations with respect to salinity tolerance.
- Assess the relative importance of osmotic stress, Na toxicity and Cl toxicity as components of salinity stress in almond.
- Elucidate the physiological mechanisms conferring different levels of salinity tolerance to different rootstocks and cultivars.
- Investigate the interactions between mineral nutrients and toxic salt ions and the possibility of using mineral nutrients to improve salinity tolerance of almond.
- Devise monitoring strategies to help almond breeding programs for salinity tolerance in future.

Background and Discussion:

Almond is classified as a salt sensitive crop and salinity is increasing in all almond growing regions of California. California is prone to salinization due to low and irregular precipitation, high evapotranspiration rates and use of irrigation waters with a substantial salt content. Soil salinization will become a greater problem as availability and quality of irrigation water is reduced.

The effects of salinity stress on plant growth and metabolism are multifaceted. Salinity can impose an osmotic stress on plants by lowering the water potential. In addition over time, the salt ions accumulate to toxic levels in plant tissues and become directly detrimental. At toxic concentrations, Na and Cl ions interfere with metabolic processes and cause molecular damage and oxidative stress. High levels of these potentially toxic ions can also cause nutritional issues by interfering with the availability, uptake and mobility of essential minerals. As perennials, trees are more likely to be sensitive to specific ionic toxicities than non-woody species.

Both Na and Cl toxicities are observed in tree crops, and the primary cause of toxicity may change depending on the species. Salt-tolerant genotypes can exclude toxic ions from their leaves by limiting the root uptake of these ions and/or storing them in their woody tissues. Reduced growth and foliar injury symptoms that appear first in older leaves as marginal necrosis are typical for salt-stressed plants.

There is limited information on the mechanisms that affect almond performance in saline environments and the relative importance of osmotic stress and ionic toxicity in the short and long term. From field observations, we know that there is significant variation among the available almond rootstocks and cultivars with respect to salinity tolerance. However, this variation has not been studied in a carefully designed experimental setup, and the physiological basis for these differences is not understood.

In this study based on observations and preliminary research, Nemaguard, Hansen536, Empyrean1 and Viking were chosen as the rootstocks while Nonpareil, Mission, Monterey and Fritz were chosen as the cultivars. In spring 2014, young, grafted trees were planted in 7-gal pots filled with calcined clay (Turface™) as growth medium. In addition to the differences between the rootstocks and cultivars, the effects of different salts (NaCl vs. KCl vs. Na_2SO_4) and extra mineral nutrients (Ca, K and nitrate) are being studied at 3 different salinity levels.

Tree growth is monitored regularly by a novel method based on digital image processing. The concentrations of essential minerals, Na and Cl are periodically measured in leaf and trunk samples. Evapotranspiration measurements and carbon isotope analysis are used to assess the osmotic stress. Additional data are collected including foliar injury ratings, trunk diameter and chlorophyll measurements.

Project Cooperators and Personnel: Umit Baris Kutman, UC Davis

For More Details, Visit

- Poster location 58, Exhibit Hall A + B during the Almond Conference; or on the web (after January 2015) at Almonds.com/ResearchDatabase
- Related projects: 14-HORT4-Duncan; 14-HORT10-Gradziel; 12-HORT16-Aradhya/Ledbetter