Physiology of Salinity Stress in Almond

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PROJECT SUMMARY

Objectives:

- Compare the salinity tolerance of selected rootstocks and cultivars in different combinations
- Understand the relative importance of water stress and Na and Cl toxicities as components of salinity stress
- Assess recovery treatments, carry-over effects and cumulative effects of salinity in multi-year experiments
- Elucidate the physiological mechanisms affecting salinity tolerance in almond
- Investigate the interactions between the mineral nutrients N and K and the toxic ions Na and Cl
- Understand the effects of non-uniform salinity in split-root systems to devise improved salt management strategies

Background and Discussion:

Almond is a salt-sensitive crop, and salinity is increasing in all almond-growing regions of California. California is prone to salinization due to low precipitation, high evapotranspiration rates and use of irrigation waters with high salt content.

As a multi-component stress, salinity may impose water stress on plants while the salt ions Na and Cl accumulate in tissues to cause toxic effects. These ions interfere with metabolic processes, cause molecular damage and oxidative stress, and may cause nutritional issues. Due to their cumulative nature, ionic toxicities tend to be more important for perennials than for annuals. The primary toxic ion depends on the species and conditions. Foliar injury symptoms appearing first in older leaves as marginal necrosis are typical for salt stress.

We have determined that there is substantial variation among almond cultivars and rootstocks in terms of salinity tolerance.

Nemaguard, the most common rootstock used for almond production in California, appears to be the most salt-sensitive rootstock among the tested ones; while Empyrean-1 and Viking exhibit superior tolerance. Among cultivars, Nonpareil is particularly salt-tolerant whereas Mission and Fritz are very sensitive.

At practically relevant EC levels (2-4 dS/m), well-irrigated almonds may not be significantly affected by salt-induced water stress. Specific ion toxicities are mainly responsible for salt damage to almond. Cl accumulates significantly faster than Na to toxic levels in leaves but is easily removed from the tree by the loss of affected leaves. In contrast, Na toxicity is less acute but more cumulative as woody tissues store significant levels of Na. In-season recovery treatments with high-quality water may minimize the carry-over effects of salinity in the next growing season.

Salt-tolerant rootstocks limit the amounts of Na and Cl that reach the scion. Interestingly, the Na and Cl exclusion capabilities of rootstocks seem to correlate. The salinity tolerance variation among the cultivars is mainly accounted for by the Na-storage capacities of the genotypes. This explains why differences disappear when the primary toxic ion is Cl. Excessively high levels of K aggravate Cl toxicity. The practical relevance of K-Na competition and salinity x nitrate interaction is currently under investigation.

Split-root experiments with non-uniform salt treatments showed that rootstocks limit their water uptake from the saline zone and absorb more water from the non-saline zone. Partial access to non-saline zone substantially reduces the total salt uptake of rootstocks. These findings may have important implications for salinity management in almond orchards.

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For More Details, Visit

- Poster location 45, Exhibit Hall A + B during the Almond Conference; or on the web (after January 2016) at Almonds.com/ResearchDatabase
- 2014 - 2015 Annual Reports CD (14-HORT20-Brown/Grattan); or on the web (after January 2016) at Almonds.com/ResearchDatabase
- Related projects: 15-HORT23-Drakakaki; 15-HORT4-Duncan; 15-HORT10-Gradziel; 15-HORT16-Aradhya/Kluepfel;