Understanding Genetic and Physiological Bases of Salt Tolerance in Almond Rootstocks

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PROJECT SUMMARY

Objectives for current year:

1. Evaluation of almond rootstocks to determine their tolerance response to a range of salt concentrations.
2. Characterizing different almond genotypes based on different components of salt tolerance mechanism.
3. Study global changes in the gene expression profiles under normal versus salt stress conditions in almond rootstocks.

Background and Discussion:

Salinity is one of the most important abiotic stresses that adversely affect plant growth and productivity globally. In order to tackle this complex problem, it is important to link the biochemical and physiological responses with their underlying genetic mechanisms. To determine the importance of specific ion toxicities on salinity tolerance in almond rootstocks we evaluated 16 rootstocks under: i) controlled condition (EC =1.4 dS m^{-1}) (Treatment 1); and 4 mixed ion composition solutions (EC = 3.0 dS m^{-1}) consisting of: ii) sulfate (Treatment 2); or iii) chloride (Treatment 3) as predominant anions; iv) sodium (Treatment 4); or v) calcium and magnesium (Treatment 5) as predominant cations. These mixtures represent a range of natural water compositions. Water concentrations of the nutrients NPK were constant in all treatments. Non-grafted plants of 16 rootstocks (Atlas, BB106, Bright's 5, Cornerstone, Empyrean 1, Flordaguard x Alnem (F x A), Guardian, Hansen, Krymsk 86, Lovell, Nemaguard, Nickels, Rootpac 20, Rootpac 40, Rootpac R, and Viking) were evaluated in a randomized block design experiment with 16 genotypes, 3 replications, 3 plants per replication and 5 irrigation water treatments (total 720 trees).

At the beginning of treatments, trunk diameter was recorded 10 cm above the soil level using a Vernier caliper. Change in diameter will be recorded at the end of the experiment and the association between percent change in trunk diameter with tissue ion concentration will be used to determine effect of different ions during salt stress.

Evaluation of physiological parameters indicated that almond leaf photosynthetic performance was quite sensitive to the increase in the salinity of irrigating waters. An increased salinity from 1.4 dS m^{-1} (control) to 3 dS m^{-1} (treatments) caused significant reductions in chlorophyll SPAD (SPAD), photosynthetic rate (Pn), stomatal conductance (gs), transpiration (Tr) and water use efficiency (WUE) for most rootstocks. Treatment 3, where chloride was the predominant anion, presented maximum reduction for all five parameters (SPAD, Pn, gs, Tr and WUE); on the other hand, Treatment 5, with Ca^{2+} and Mg^{2+} as predominant cations displayed minimum reduction.

Expression analysis was carried out for a set of 10 genes selected for their involvement in salt stress. The *Prunus* genes were selected based on their functional conservation with Arabidopsis pla genes. These include genes known to be associated with Na^+ efflux from root to soil (SOS1, SOS2 and SOS3), genes involved in sequestration of Na^+ in vacuoles (NHX1, NHX2 and AVP1), genes important for retrieving Na^+ from xylem (*HKT1* and *AKT1*), and genes involved in signal transduction during salt stress (SAL1 and SERF1). The expression analyses for 10 genes revealed that Treatment 3 and Treatment 4 both led to induction of majority of salt associated genes during salt stress, suggesting importance of both the chloride and sodium toxicities during salt stress in almonds.

In the current year, we will generate information on transcription patterns of specific genes that are already known to play role in salt stress in the model plants and also some novel genes that may be specific to the genus *Prunus* using RNA-Seq. This knowledge will be particularly important for geneticists in isolating genes or quantitative trait loci (QTL) important in salt tolerance and to help breeders identify salt-tolerant rootstocks.

Project Cooperators and Personnel:
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For More Details, Visit

- Poster location 85, Exhibit Hall A + B during the Almond Conference; or on the web (after January 2018) at Almonds.com/ResearchDatabase
- 2016 - 2017 Annual Reports (16-HORT26-Sandhu) on the web at Almonds.com/ResearchDatabase
- Related projects: 17-HORT20-Brown; 17-HORT23-Drakakaki