Sodium, Chloride and Boron Accumulation in Almonds – Westside Survey
Can Salt Levels in Woody Tissue Forecast Future Toxicity?

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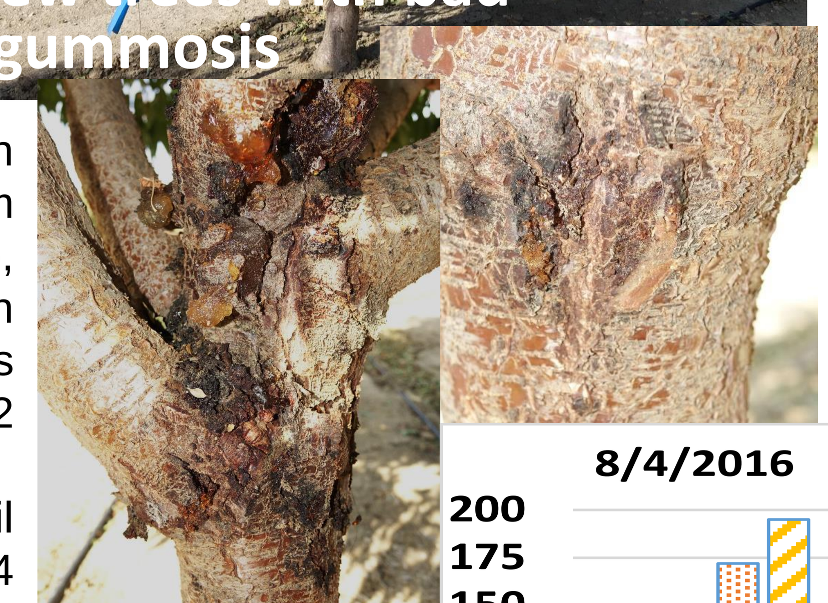
Problem and its Significance:

Almond growers have been pushing the limits on almond salt tolerance for the last 10 years as land price and availability have skyrocketed while available surface water supplies have decreased and groundwater salinity is increasing. Many of these plantings look good for several years and then hit the wall as one or more specific toxic ions (especially boron) finally reaches the critical level in the tree that can limit water/nutrient uptake, cause severe gumming, leaf burn, reduced growth and eventually death. There is no data documenting woody tissue deposition / concentration of these ions as a function of soil salinity to determine if this strategy of tissue analysis would give a grower an early warning sign of significant pending toxicity problems not yet seen in leaf tissues.

Objectives/procedures:

1. Starting 2015 using a 3rd to 4th leaf orchard (Hansen rootstock, Nonpareil and Monterey scions) select 4 areas that range from 0.5 to 5 dS/m EC and 0.6 to 3 ppm soluble boron. Collect soil and tissue data.
2. Document differences in yield and tree stature corresponding to these areas.
3. Correlate soil salinity and specific ion concentration with rootstock, scion and traditional leaf tissue samples to see if wood sampling provides an early indication of pending toxicity problems.



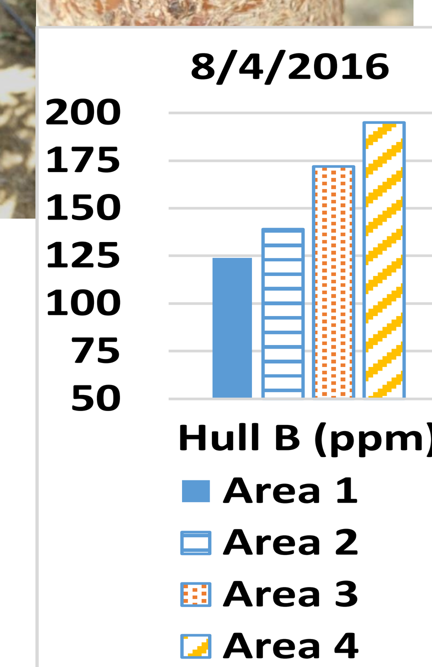


Fig. 10. Hull boron concentration @ harvest.

Results and Discussion:

A quarter section almond block in NW Kern Count, 50/50 Nonpareil and Monterey, was planted on Hanson rootstock in 2013 with double-line drip on Twisselman sandy clay loam. A significant gradient in increasing native salt load in this soil is obvious as you move from East to West despite having leached this ground with two foot of water using sprinklers prior to planting. The total soil salt load (EC), sodium (Na), chloride (Cl) and boron (B) increases 2 to 3-fold from Area 1 to 4. But after two years of sampling there is no real difference in Na, Cl and B in leaf tissue samples or trunk corings in July or end of season sampling. The trunk circumference of Area 4 was 19% less than Area 1 the end of 2015, but was only 14% less the end of 2016. The 3rd leaf yield was very low even for the low salinity Area 1 @ 312 lb/ac and 137 lb/ac for Area 4, a 56% decrease. The 4th leaf yield was 2350 lb/ac for Area 1 and 514 lb/ac for Area 4, a 78% decrease.

At this time there is no measurable increase in rootstock or scion wood or leaf tissue Na, Cl or B correlated with higher soil concentrations from Areas 1 to 4. However, the hull B concentration at harvest was 124 ppm for Area 1 and significantly higher for Area 4 @ 195 ppm (Fig. 10). There does appear to be a higher amount of gummosis on the occasional tree in Areas 3 and 4 compared to Area1. The elevated salt load and associated osmotic resistance to water uptake has definitely decreased tree size in Area 4, but the usual marginal salt burn associated with this is basically absent. Surfactant amendments made no difference in tree water stress (CONDUCTANCE) or growth/vigor (NDVI) in the small plot companion test in the elevated salinity zone of Area 4.

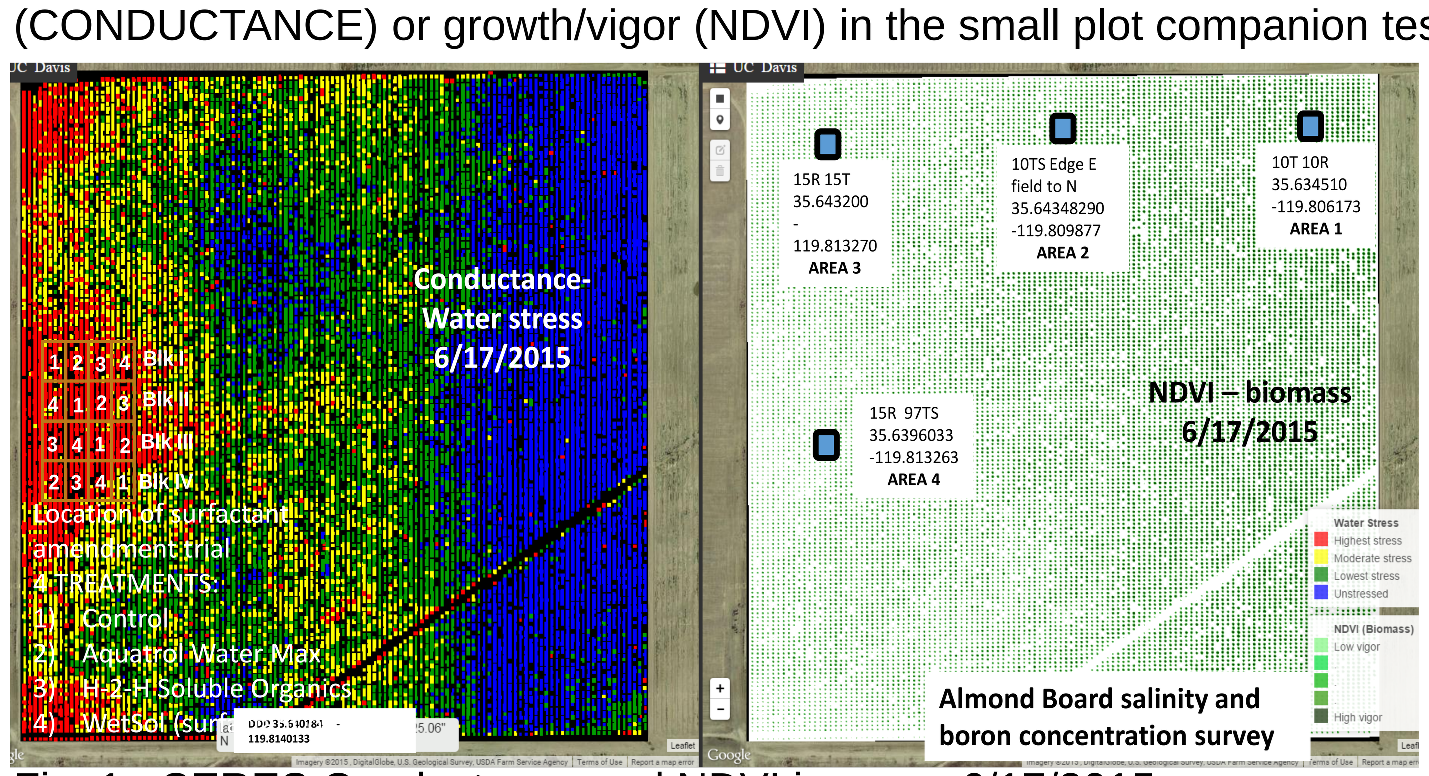


Fig. 1. CERES Conductance and NDVI imagery 6/17/2015

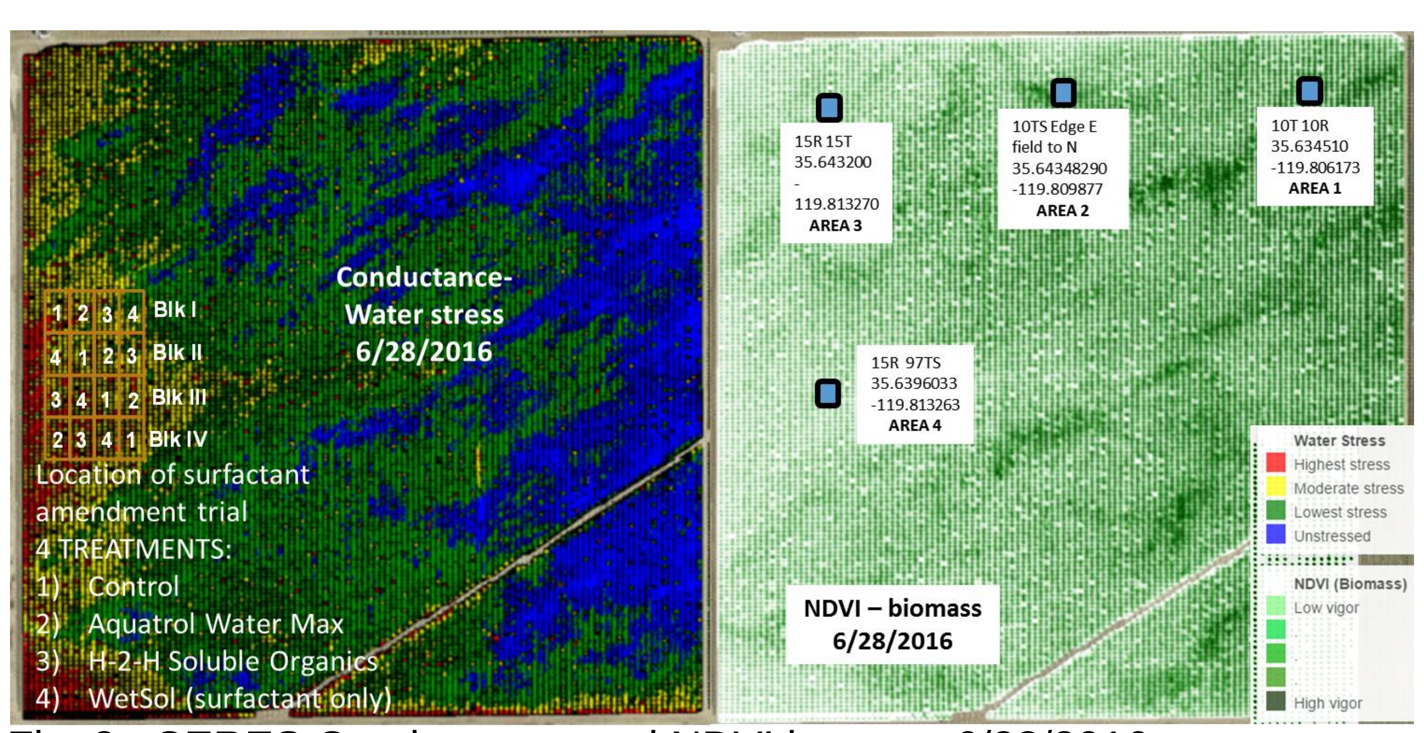
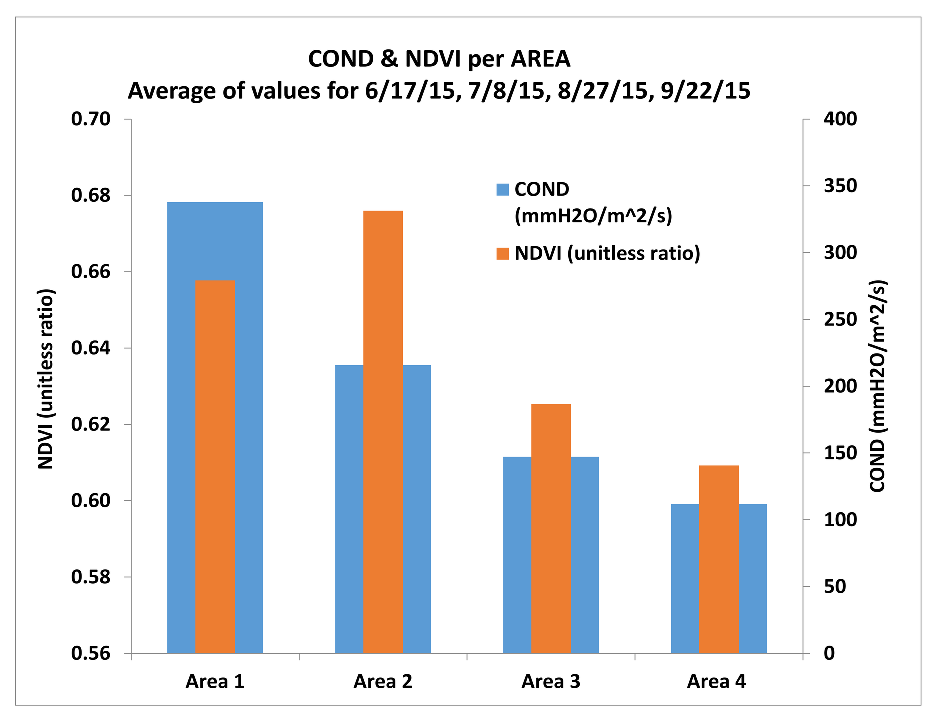
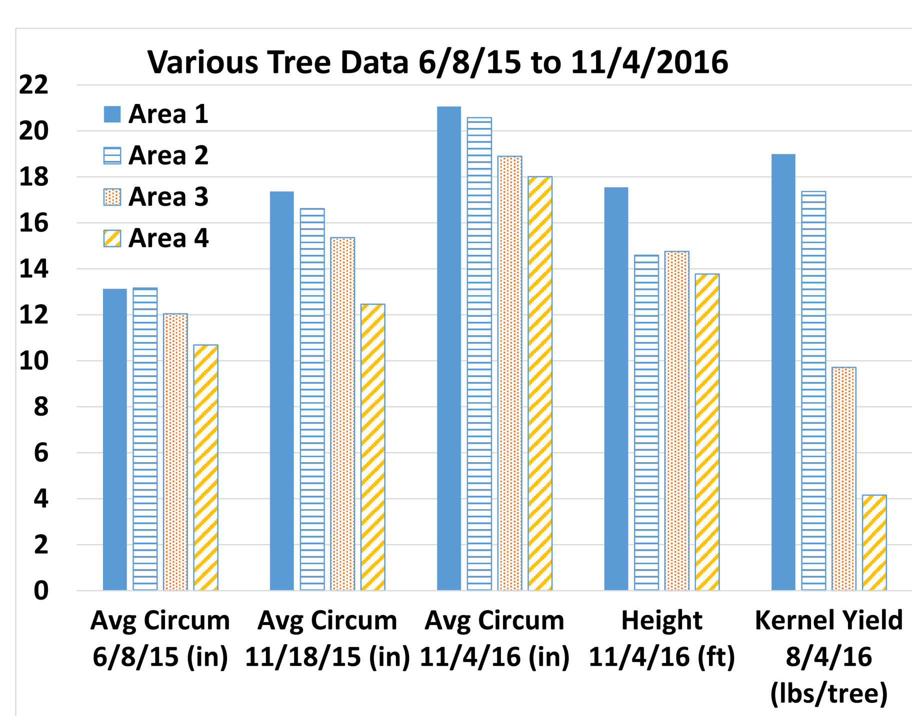
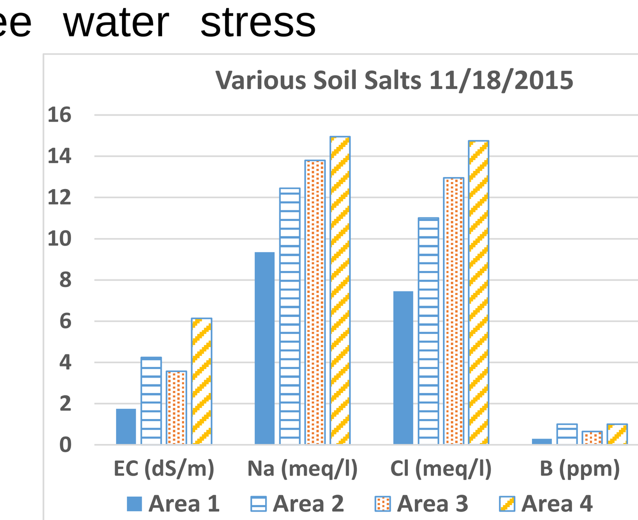
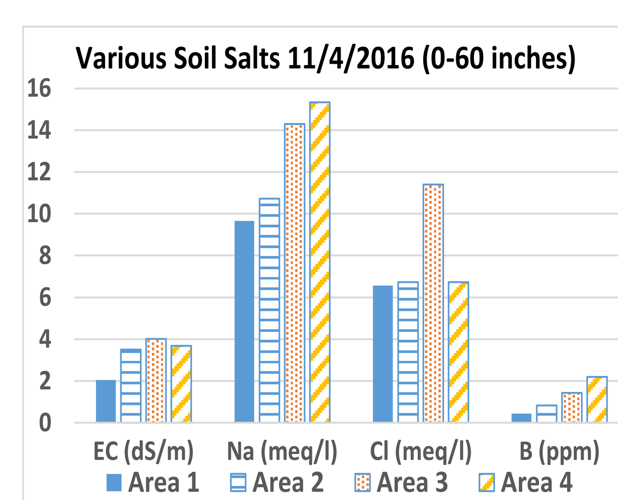


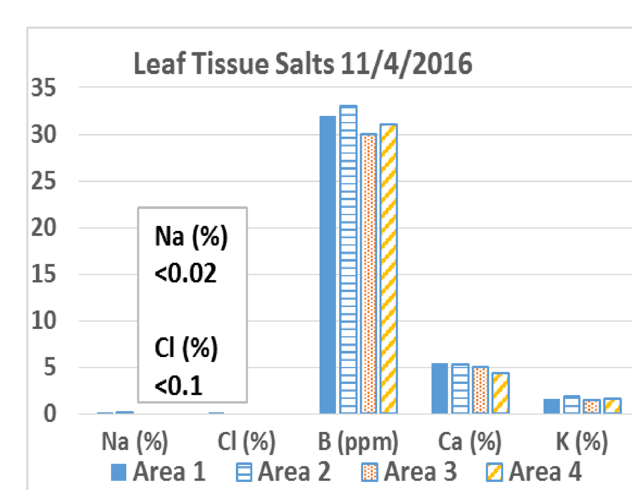
Fig. 2. CERES Conductance and NDVI imagery 6/28/2016

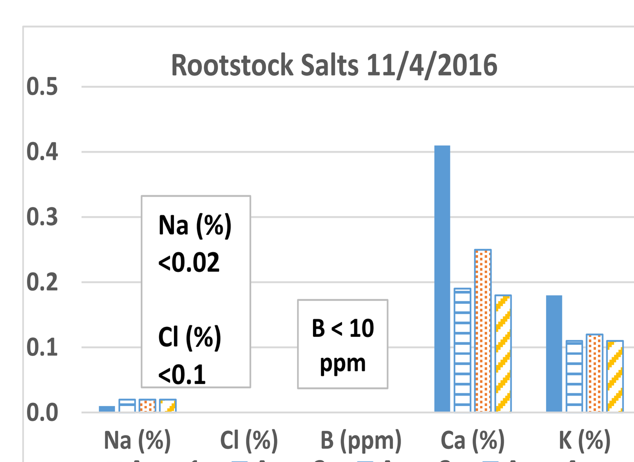


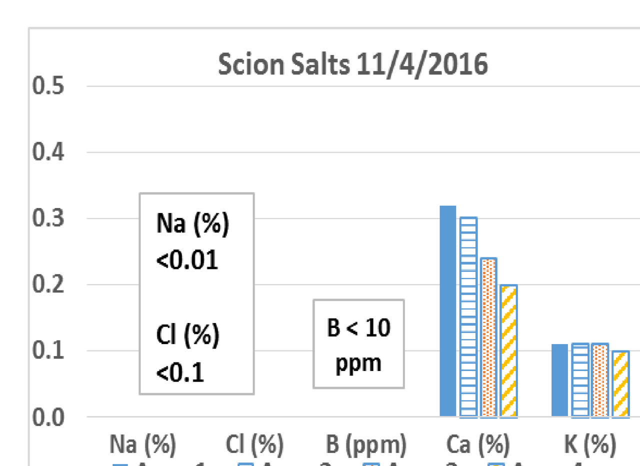












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Companion Project: Mitigation of Salinity and Water Penetration Problems in Westside Almonds Using Soil Amendments

Problem and its Significance: Excess sodium and the extremely fine particle size of many of these soils results in poor aggregation, soil structure and, therefore, water movement. Efficient water penetration and leaching is critical to enable profitable production in these orchards. Gypsum and acid are the standard amendments for this condition. Other products such as surfactants and polymers may aid water penetration and soil structure. A replicated trial using such additional amendments was established in the most saline-sodic area of this quarter section almond block used for the differential salinity/boron survey (see Figs. 1 and 2 for trial location). In addition to grower **standard injection of acid and solution gypsum, the following treatments were applied starting May 2015:**

1) **Control** – no additional amendment
2) **Aquatrols Water Max** (non-ionic surfactant + long-chain alkyl/polyol aggregation aid): 1st application 5/21 @ 1 g/ac, 2nd @ 0.5 g/ac, 3rd @ 0.5 g/ac, 4th @ 0.5 g/ac
3) **H-2-H Soluble Organics** (surfactant, digested food waste yielding complex amino acids, micronutrients, etc.): 1st application 5/27 @ 20 g/ac, 2nd @ 10 g/ac, 3rd @ 10 g/ac, 4th @ 10 g/ac
4) **WetSol** (non-ionic surfactant): 1st application 5/21 @ 1 g/ac, 2nd @ 0.5 g/ac, 3rd @ 0.5 g/ac, 4th @ 0.5 g/ac

Subsequent applications followed at 2-3 week intervals.

Results and Discussion:

In general, tree stature, rootstock, scion and leaf tissue nutrients/salt concentrations and yield are consistent with the data for Area 4, which is actually the same location as the 3rd replication for the Control treatment in this amendment trial. There is absolutely no difference between treatments with respect to tree growth and kernel yield (Fig. 11). Nor is there any difference with respect to soil salinity or water content as indicated by electromagnetic resonance using a hand-held EM38 probe (Geonics, Inc. Data not shown.)

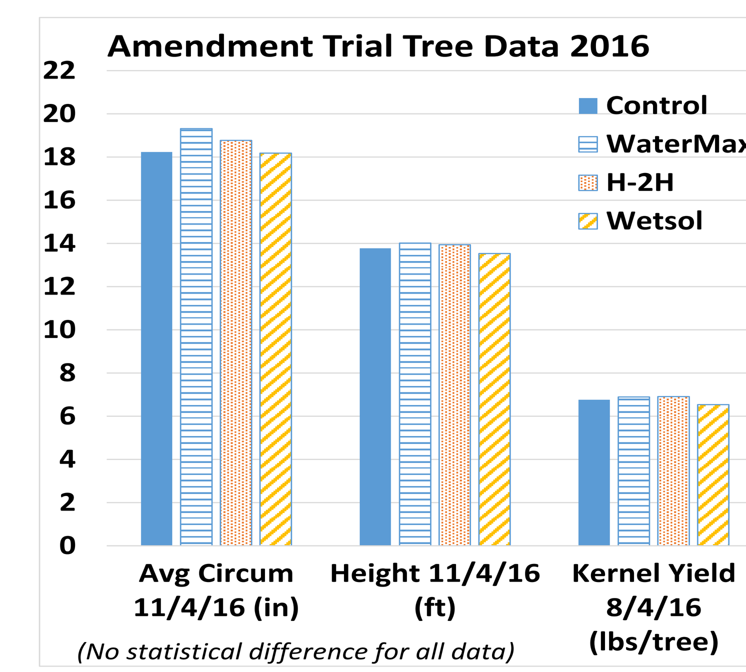

Fig. 11. Amendment trial tree circumference, height and yield.

OVERALL CONCLUSION

Higher total rootzone salinity will reduce tree growth as it limits water uptake. But extra leaching in this area as a result of this stress can help the tree "catch up". Aerial imagery can identify these areas. The Hanson rootstock was able to exclude excessive Na, Cl and B concentrations measured in the wood and leaf tissues (so these are no help in predicting future problems), but still allowed excess B accumulation in the hull and random gummosis. Additional surfactant, polymer and nutrient amendments did not reduce soil salinity or improve tree growth or yield.