Salinity Stress in Almond, Rootstock Screening and Tree Response to Non-Uniform Salinity

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Rootstock Screening for Salinity Tolerance

Objectives

- To study the salinity tolerance of different almond rootstocks by monitoring tree growth and salt accumulation in leaves

Materials and Methods

- Two year old grafted plants of Nonpareil on different rootstocks were planted in 7 gallon pot having Calcined clay (Turface)
- Plants were irrigated with nutrient solution having all essential nutrients with salinity of ~1 ds/m
- Treatments consisted of control and 4.5 ds/m salinity using ~ 30 NaCl mM and 15 mM Na as Na_2SO_4 to represent Na dominant salinity.
- Leaves were analyzed for Na and Cl concentration, trunk diameter was measured to determine growth

Results

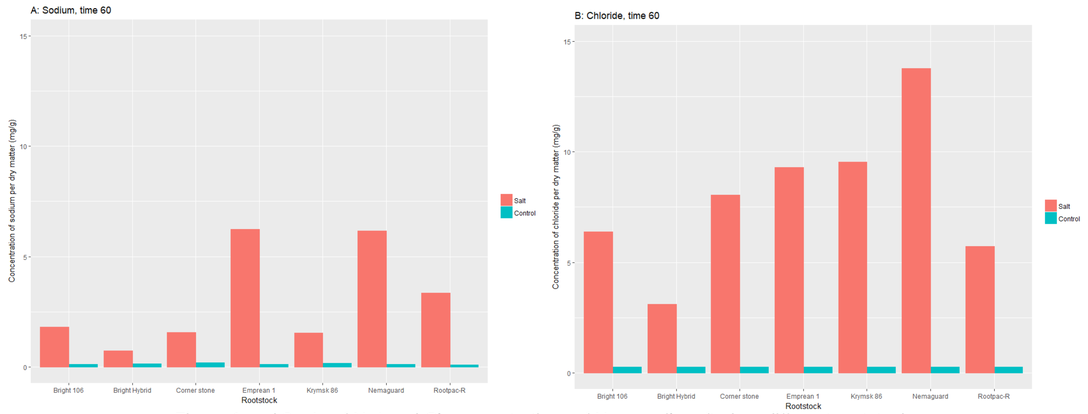

Figure 1 and 2 . Leaf Na^+ and Cl^- concentrations of Nonpareil grafted on different rootstocks

Rootstocks varied in Na^+ and Cl^- accumulation in leaves. Empyrean 1 and Nemaguard accumulated more Na in leaves whereas Bright 106, Bright Hybrid, Corner Stone and Krymsk 86 accumulated significantly less. Leaf chloride concentrations in Nemaguard was significantly higher than all other rootstocks. One hypothesis is that Nemaguard is physiologically unable to repress salt uptake, which causes in significant salt translocation to the leaves and subsequent damage. This finding is consistent with other research.

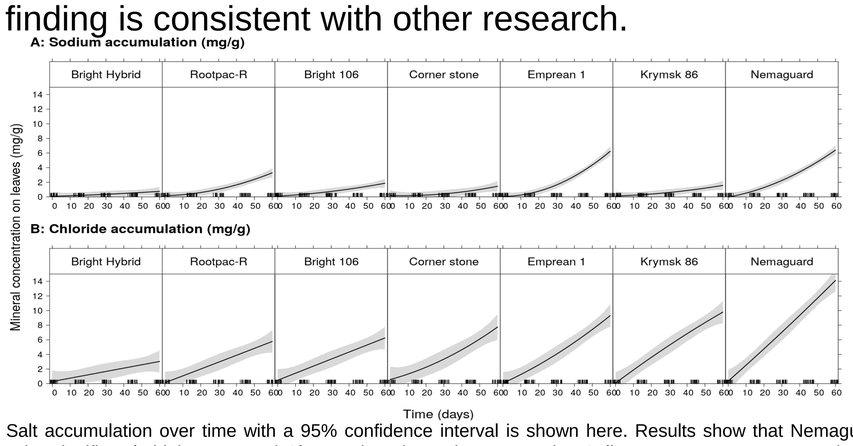

Figure 3. Salt accumulation over time with a 95% confidence interval is shown here. Results show that Nemaguard and Empyrean accumulated a significantly higher Na^+ and Cl^- over time than other rootstocks. Caliper measurements were taken to determine tree health and growth (data not shown). All rootstocks increased in diameter in the first month, however both Nemaguard and Empyrean 1 did not increase in diameter throughout the rest of the season.

Split-root experiment under non-uniform saline conditions

Objectives

- Elucidate the physiological mechanisms of root under heterogeneous saline conditions with the final goal of improving field management practices of orchard using micro-irrigation strategies.

Materials and Methods

- To test the effects of heterogeneous salt and nutrient distribution on plant performance non-grafted seedlings of Nemaguard were grown for 60 days then roots were divided in half and placed in a split root system that allowed for differential application of nutrients and salts to root halves.

Figure 4. Split-root experiment setup under solution culture.

Results

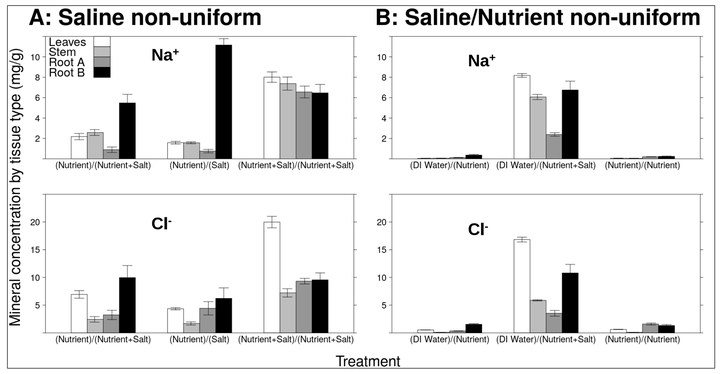

Figure 7 Sodium and chloride concentration for different tissue and different root treatments.

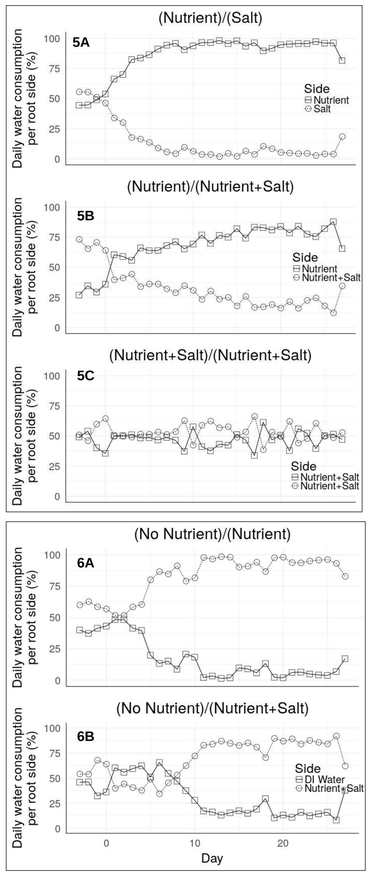

Figure 5 and 6 Percentage of water consumption per root treated sub-zone for non-uniform saline treatments and non-uniform nutritional/saline conditions.

Almonds are remarkably plastic at early stages exhibiting a nearly complete shut-down of water consumption from the saline treated root half if a non-saline root zone was present (Figure 5A). However, if the saline root-zone contains nutrients then uptake from saline root-zone will occur (Figure 5B) demonstrating that roots will exploit saline soils if nutrients are present. (Figure 6B). In the long term (after 28 days) morphological plasticity was observed (data not presented).

Non-uniform saline conditions decreased significantly the accumulation of salt in tissue (Figure 7). When nutrients are only present in the saline sub-zone, plants then strong salt uptake occurred (Figure 7).

A significant decrease on salt tissue concentration under non-uniform saline conditions was observed (Figure 7); this less amount of salt accumulated on shoots improved growth performance significantly (data not presented).

Conclusions

- Bright 106, Bright Hybrid and Corner Stone, and Krymsk 86 accumulated significantly less Na, while Empyrean 1 and Nemaguard accumulated more Na. Rootpac-R were intermediate in Na accumulation in leaves.
- Bright Hybrid accumulated the lowest amount of Cl, while Corner stone, Empyrean 1 , and Krymsk 86 accumulated an intermediate amount and Nemaguard accumulated the highest amount.
- Diameter measurements indicate that there was rapid growth early in the season and then no growth throughout the season for the highest salt accumulator, Nemaguard.
- Substantial root plasticity and ability to restrict uptake from saline soils if nutrients are available in non-saline root zone.
- Our findings suggest that this preferential uptake of water and NO_3^- when root are exposed to heterogeneous saline/nutritional conditions may be a useful tool to improve field management practices to limiting nitrate leaching while enhancing salt leaching in arid agricultural areas using micro-irrigation strategies.

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