University of California
Agriculture and Natural Resources

Performance of Six Almond Rootstocks with Long-Term Exposure to Sodium and Chloride

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Objectives:
To determine the long term effects of sodium and chloride on the yields of six rootstocks used for almond. Rootstocks include Halford peach, Lovell peach, Nemaguard peach, Red-Leafed Nemaguard peach (Nemared), Bright's #1 Hybrid, and Hanson Hybrid.

Summary:
Increasing salinity within irrigated perennial crops is a major problem facing the longevity of the almond industry. The varying tolerance of rootstocks to sodium has been observed within field plantings, but studies have never documented the long term effects of sodium exposure. In 1989, a rootstock trial testing two peach-almond hybrid rootstocks and four peach rootstocks was established to determine the effects of sodium on almond yields.The source of sodium was the irrigation water pumped from the regional aquifer. Throughout the 20 years of the trial, the grower noted that the peach rootstocks showed increasing signs of sodium toxicity within the leaves. 20 years after trial establishment, trees grafted to peach-almond hybrid rootstocks produced higher yields than trees planted on peach rootstocks.Tissue analysis indicated that peach-almondhybrid rootstocks had lower concentrations of sodium and chloride in comparison to the peach rootstocks. Results from this study suggest that peach-almond hybrid rootstocks are more tolerant to sodium than peach rootstocks and may provide a tool for managing salinity issues in affected areas.

Materials and Methods:
A rootstock trial was established in 1989 on loamy sand soil in northern Merced County. Rootstocks were spaced 24'x24' containing two varieties, Nonpareil and Carmel. The block was irrigated with solid-set sprinklers using well water with moderately high sodium (6.35 meq/L). All rootstocks and both varieties were farmed according to the grower's standard practice.

Mid-July leaf sampling was conducted following UC recommendations. Leaves from replicate trees of the same variety and block were pooled for analysis. All samples were submitted to UC Davis Analytical Laboratory for analysis. Prior to harvest, observations of the trees expressing symptom of salt burn were made. Harvest yields were taken to allow a comparison of rootstocks 20 years post planting.

Results and Discussion:
Earlier research within this trial has demonstrated that peach x almond hybrids out-grow and out yield peach rootstocks. Peach rootstocks were smaller in size, and often lost leaves in the late season due to salt toxicity within the leaves.

Leaf tissue analysis indicated that sodium and chloride levels were significantly higher in all peach rootstocks when compared to the two P/A hybrid rootstocks (Tables 1 and 2). Sodium within the leaves of the P/A hybrid rootstocks was below the UC established critical/toxic value of 0.25%, while all peach rootstocks exceeded the level. Late season observations supported this finding; the majority of trees planted on peach rootstocks showed significant leaf burn due to the accumulated levels of salt (Table 3).

Trees planted on P/A rootstocks yielded more kernel pounds per acre than all peach rootstocks within the Carmel variety (Table 4), and more than Halford, Lovell, and Nemared rootstocks within the Nonpareil variety (Table 5). Yields of Nonpareil on P/A hybrids were considered an acceptable and farmable yield by the grower. Carmel yields were lower than expected due to a frost event that occurred earlier in the spring.

The findings of this long term study indicate that there is a greater tolerance to sodium and chloride with P/A hybrids. Mechanisms of tolerance have not yet been determined, but results suggest root exclusion since sodium and chloride uptake was influenced by choice of rootstock. The use of P/A hybrids provides a management option for areas of high sodium and chloride, but the genetic tolerance should not take the place of proper irrigation and salinity management strategies.

Table 1: Sodium content as a percentage of almond leaf tissue of six different almond rootstocks.

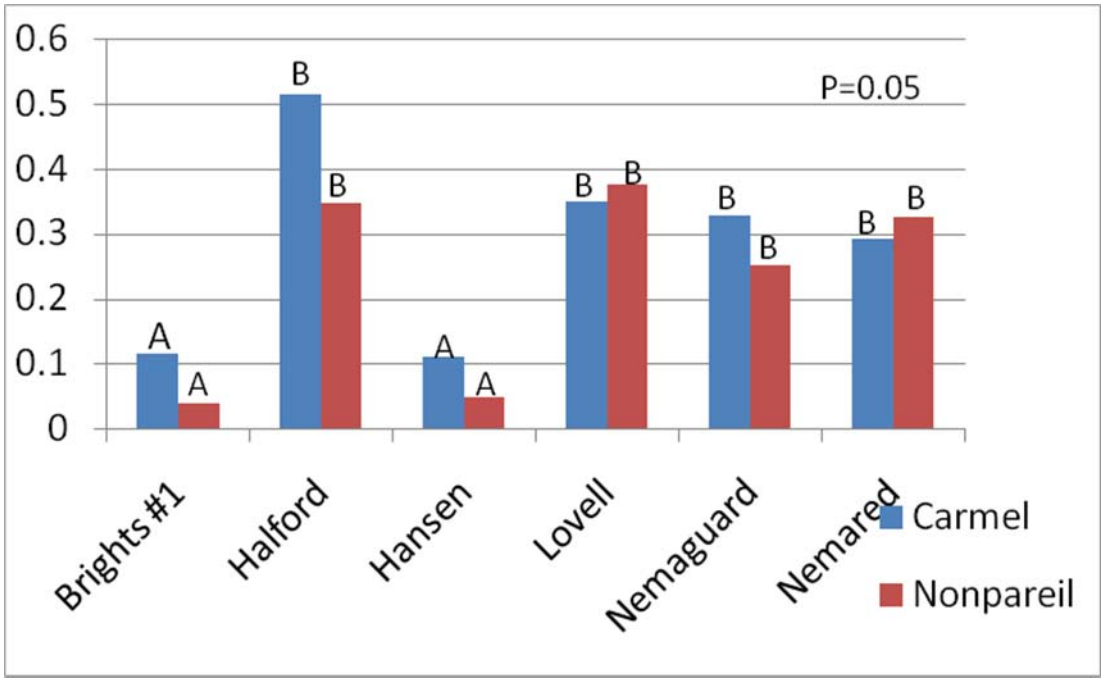

Table 2: Chloride content as a percentage of almond leaf tissue of six different almond rootstocks.

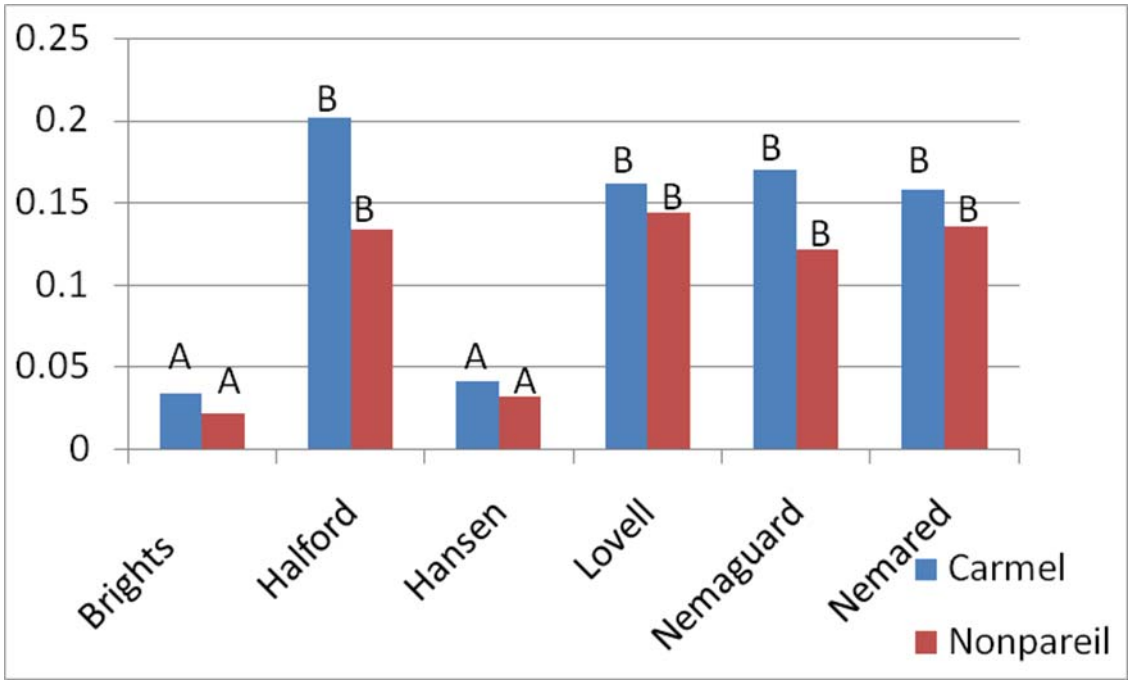

Table 3: Percentage of trees from six different almond rootstocks showing symptoms of salt burn in late August.

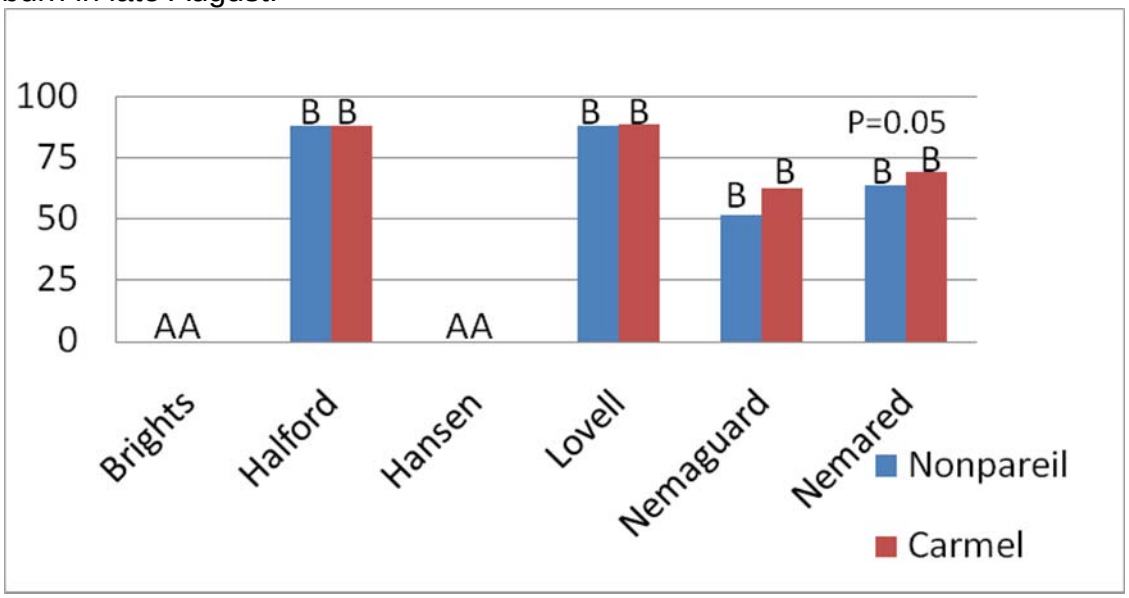

Table 4: 2009 Carmel almond yields for six different almond rootstocks from a 20 year old orchard irrigated with water containing a high amount of sodium.

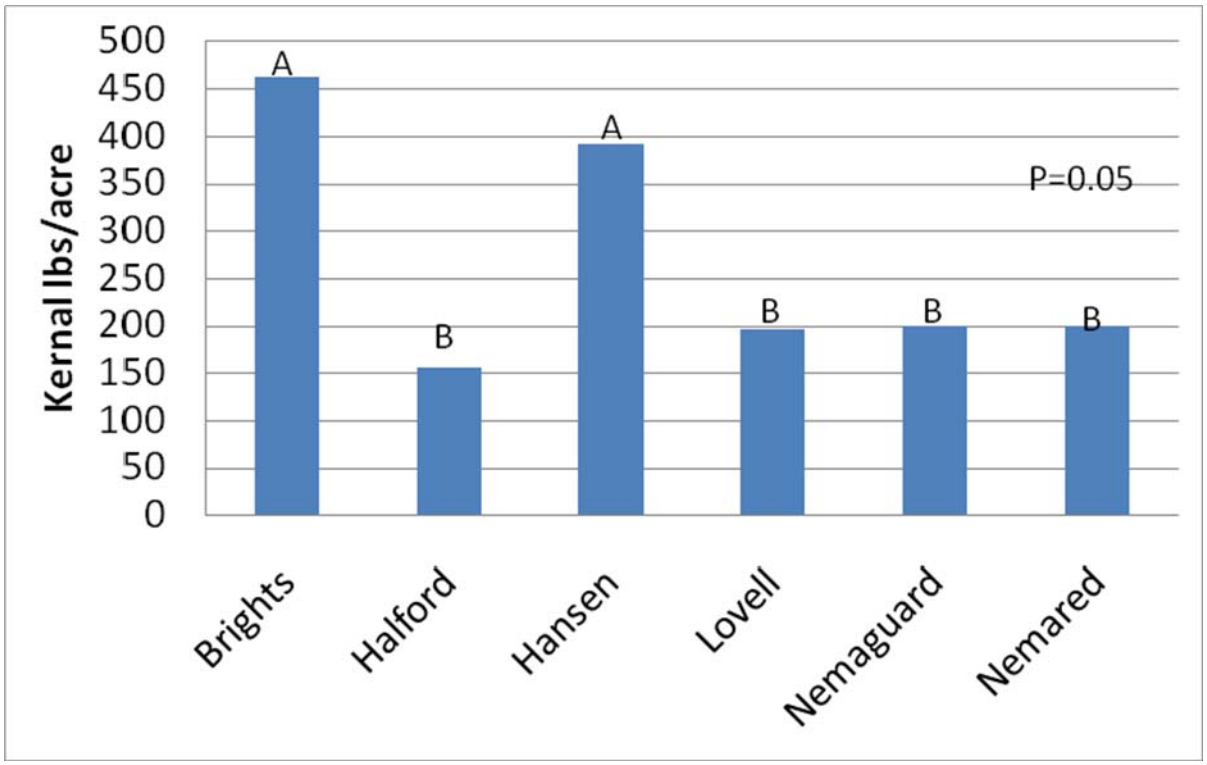

Table 5: 2009 Nonpareil almond yields for six different almond rootstocks from a 20 year old orchard irrigated with water containing a high amount of sodium.