# Physiology of Salinity Stress in Almond

Umit Baris Kutman, Steve Grattan, Patrick Brown

University of California Davis, Department of Plant Sciences, Davis, CA

bkutman@ucdavis.edu, srgrattan@ucdavis.edu, phbrown@ucdavis.edu

## INTRODUCTION

Salinity is a growing concern in all almond-producing regions of California and will become a greater problem as availability and quality of irrigation water is reduced.

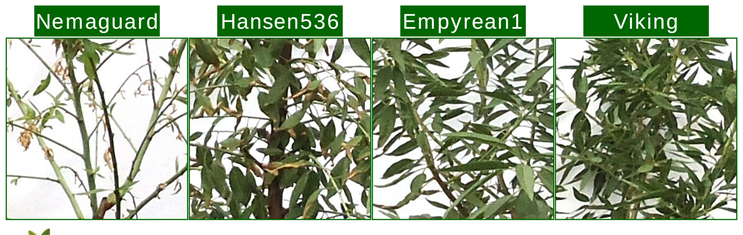
Almond is generally considered a salt-sensitive crop but observations indicate that there is wide variation in tolerance among the available rootstocks and cultivars.

The objectives of this project include:

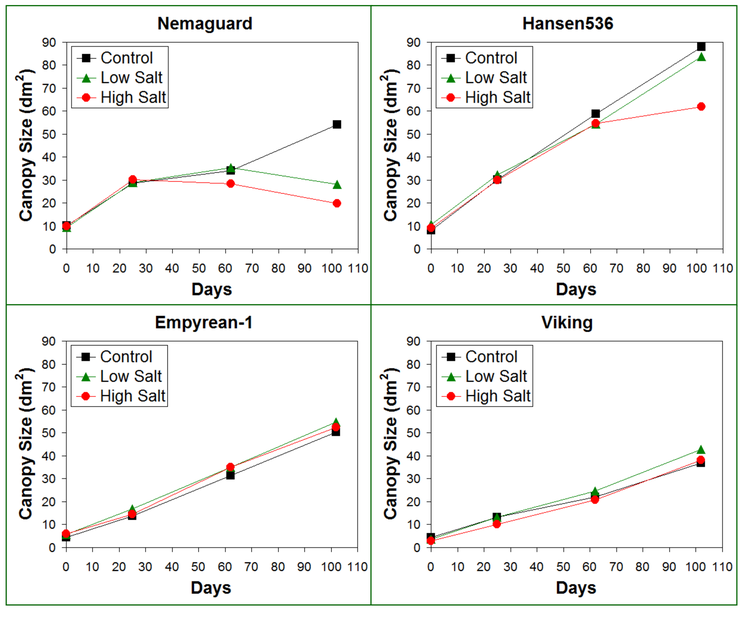
- Study the salinity tolerance of important rootstocks and cultivars by monitoring growth and toxicity symptoms,
- Elucidate the mechanisms conferring different levels of salt tolerance: root uptake, exclusion from leaves, tissue tolerance, etc.,
- Understand the relative importance of specific Na and Cl toxicities, and
- Provide the physiological basis needed to optimize almond breeding for salt tolerance.

## RESULTS

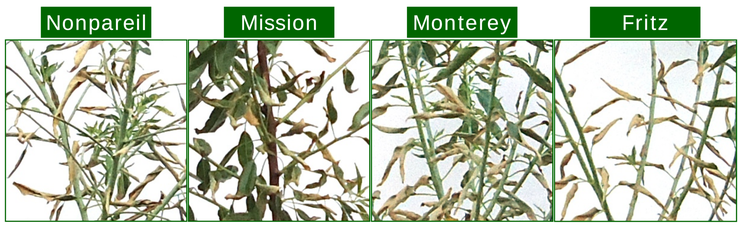
Rootstock effects on the severity of salt toxicity symptoms exhibited by Nonpareil:




Growth of Nonpareil on different rootstocks at control, low (+2 dS/m by 20 mM NaCl) and high (+4 dS/m by 40 mM NaCl) salt levels:



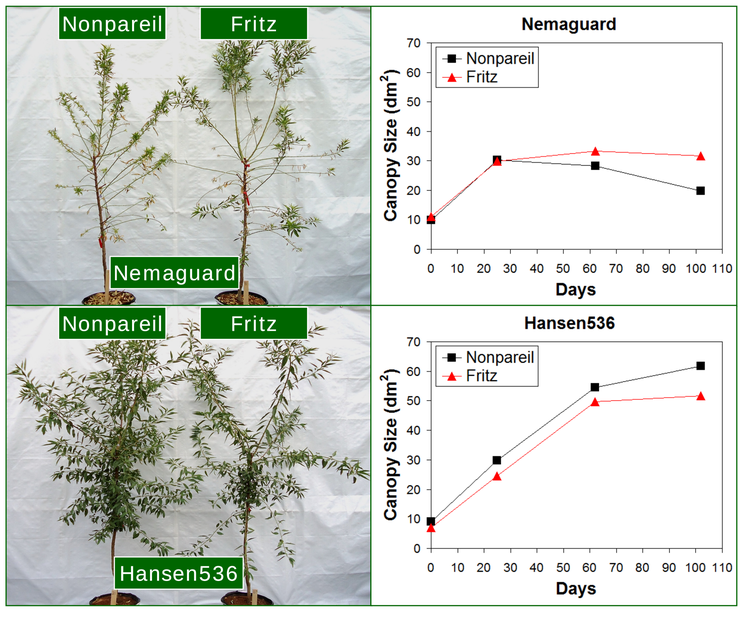

Salt toxicity symptoms exhibited by different cultivars grown on Nemaguard:



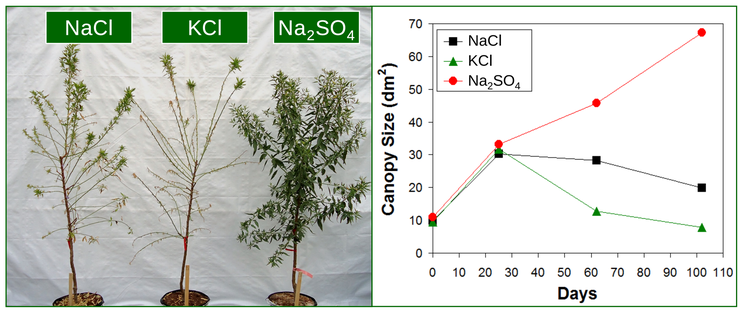

Typical symptoms of salt toxicity were:

- Leaf scorch starting along the margins of older leaves, and
- Defoliation of the inner canopy and eventually the whole tree.

Both Nonpareil and Fritz were remarkably more salt-tolerant when grafted on Hansen536 than on Nemaguard.



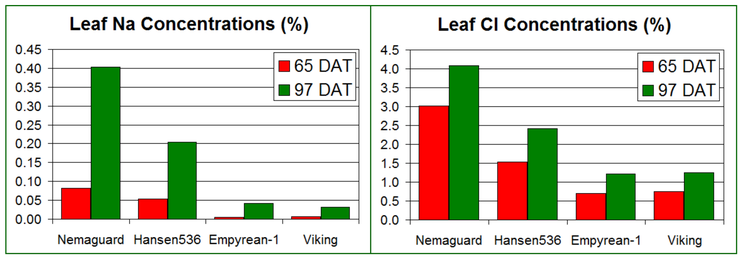

Effect of salt type* on salinity stress and growth of Nonpareil on Nemaguard:



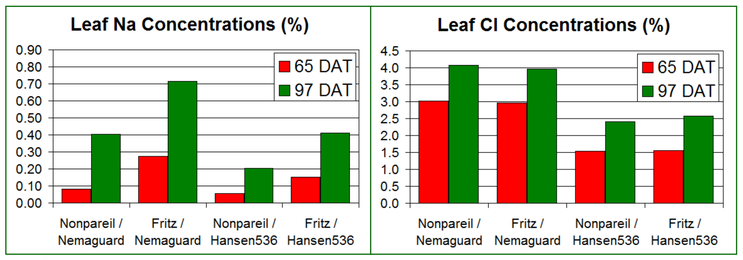

* NaCl, KCl or $Na_2SO_4$ to provide 40 mM $Na^+$ and/or $Cl^-$.

KCl appeared to be even more toxic than NaCl, whereas $Na_2SO_4$ did not cause any symptoms 3.5 months after treatment.

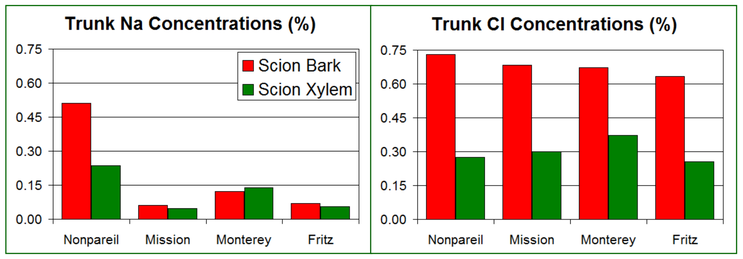
Rootstocks had a great impact on the leaf Na and Cl levels (cv. Nonpareil):



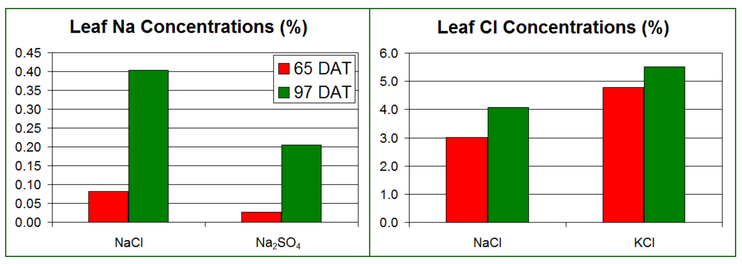

On both Nemaguard and Hansen536, Fritz accumulated much more Na in its leaves than Nonpareil.




Cultivars differ vastly from each other in the ability to store Na in woody tissues and thereby exclude it from leaves.




Effects of counter-ions on the leaf Na and Cl levels of Nonpareil on Nemaguard:




## CONCLUSION

- At practically relevant salt levels, specific ion toxicities are primarily responsible for salt damage to almonds.
- In leaves, Cl can accumulate to toxic levels faster than Na.
- Trunk storage of Na makes Na a “perennial” problem.
- Rootstock tolerance to Na and Cl:
  Nemaguard < Hansen536 < Empyrean1 = Viking
- Expected cultivar tolerance to Na:
  Fritz = Mission < Monterey < Nonpareil