Assessing Nitrate Leaching From Groundwater Recharge in Almond Cropping Systems

Hannah Waterhouse[1], Sandra Bachand[2], Helen Dahlke[1], Philip A.M. Bachand[2], and William R. Horwath[1]

[1] University of California, Davis, [2] Bachand & Associates

BACKGROUND

Groundwater overdraft is an increasing problem, especially during drought when surface water allocations are reduced. Application of flood flow to agricultural lands could recharge underlying aquifers and reduce flood damage to downstream areas. Potential Benefits include a reliable future basin-wide water supply, reduced flood risks, reduced pumping costs, flushing of salts from the root zone, increasing water storage in the root zone and mitigating land subsidence. **However, uncertainties remain including the timing of groundwater recharge and the risk of nitrate (NO_3^-) leaching from cropping systems.**

RESEARCH QUESTIONS

1. **How will groundwater banking affect NO_3^- loading to the underlying aquifer in almond cropping systems? How does this compare to other cropping systems?**
2. **Will groundwater banking exacerbate or dilute NO_3^- concentration in aquifers?**
3. **Is NO_3^- attenuation in the deep vadose zone occurring?**
4. **If NO_3^- attenuation is occurring, is the mechanism via microbially mediated denitrification and/or chemical reduction of NO_3^-?**
5. **What soil structural and hydraulic factors are influencing the fate of NO_3^- during groundwater banking?**

FOCUS AREA

Three replicate cores were taken down to 9 meters in 4 grape, 4 tomato, and 4 almond fields using a Geoprobe (Geoprobe Systems, Salina, KS). Cores were analyzed in the lab for NO_3^-, texture, and moisture.

PRELIMINARY RESULTS

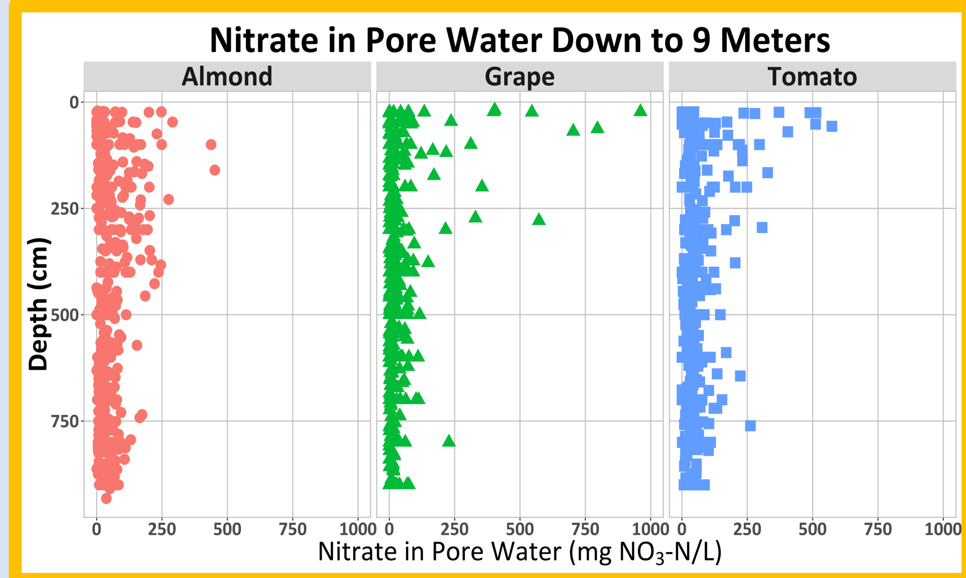

FIGURE 1: Nitrate-N distribution in pore water (mg NO_3^--N /L) for all 36 cores with depth (cm) by cropping system.

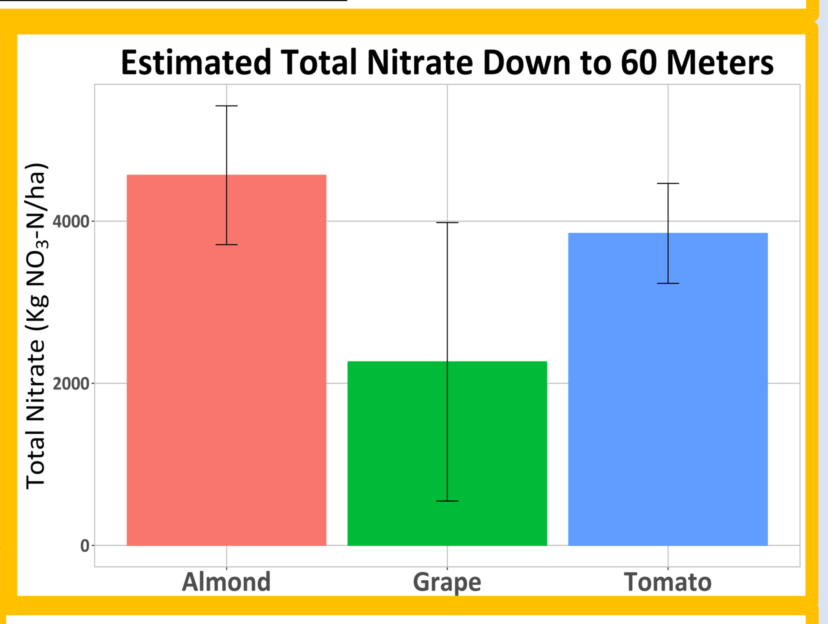

FIGURE 2: Total NO_3^--N estimated to a depth of 60 meters based on NO_3^--N levels at bottom of 9 meter core (kg NO_3^--N/ha). No significant differences between cropping systems, however grapes show a lower trend than Tomatoes and Almonds.

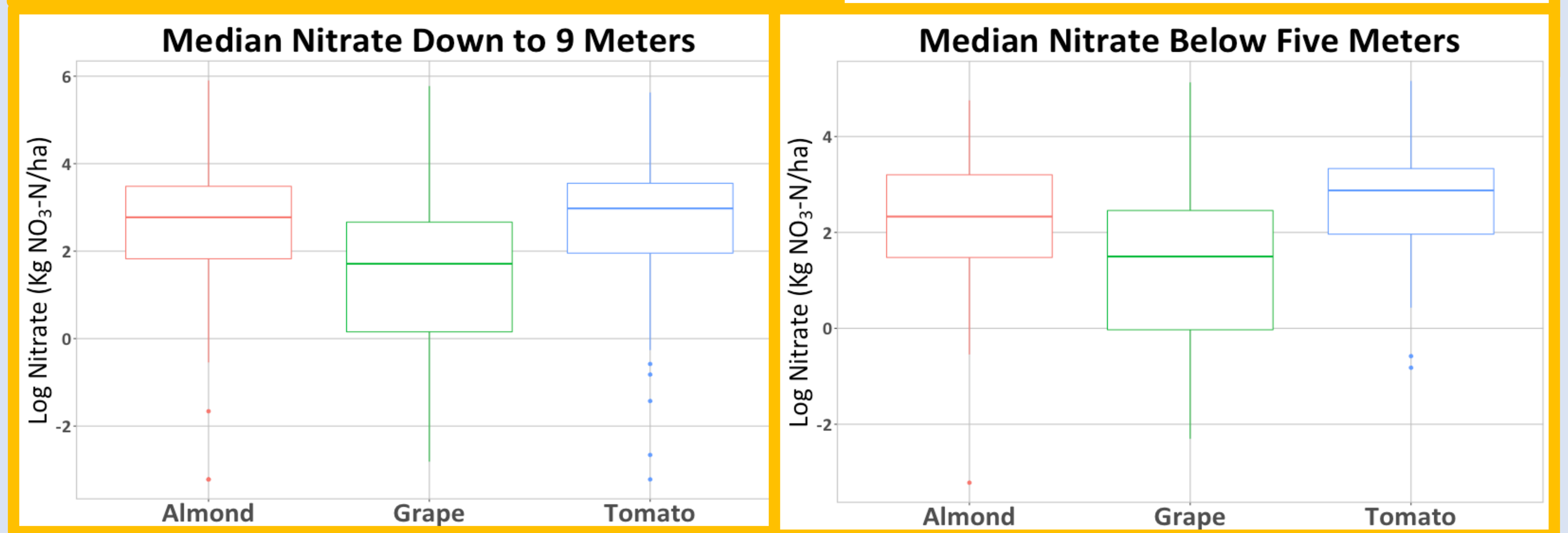

Figure 3: Median log scale NO_3^- levels (Kg NO_3^- -N/ha) throughout the entire profile (left) and below five meters (right). Nitrate variability decreases with depth. The non-parametric Kruskal-Wallace test indicates a significant difference between cropping systems throughout the entire profile and below five meters where values decreased in all cropping systems. Tomatoes had the highest median NO_3^- levels (19.07 Kg NO_3^- -N/ha) compared to almonds (14.83 Kg NO_3^- -N/ha) and grapes (5.310 Kg NO_3^- -N/ha).

DISCUSSION

- Tomatoes and almond systems have higher total and median NO_3^- levels and could pose a larger risk of leaching NO_3^- to groundwater under managed recharge compared to grapes
- NO_3^--N concentrations and variability decrease with depth. This could be due to dilution, attenuation by denitrification, or by preferential flow paths moving NO_3^- faster and further below the 9 meter profile.
- Nitrate-N decreases with depth, however 78% of NO_3^--N values are above the EPA drinking water standard of 10 mg/L.
- No correlation between NO_3^- and clay was found (results not shown), possibly indicating denitrification is not occurring.
- Total residual NO_3^- in kg/ha is very high. If we assume 2.5 tons of N have leached from these systems over the last 50 years, the vadose zone has higher levels than what could have been leached from agriculture alone based on estimates down to 60m.

CONCLUSIONS

- Almond and Tomato cropping systems have higher potential to contaminate groundwater due to higher residual NO_3^- levels in the root and deep vadose zone
- No correlation between clay and NO_3^- levels was found, possibly indication denitrification may not be attenuating NO_3^- in the deep vadose zone.

NEXT STEPS

- Calibrate 1-D HYDRUS model with texture and NO_3^- data collected from Geoprobe cores down to 9 m. Run scenarios for multiple cropping systems and management practices to see the potential for contamination
- Determine if NO_3^- can be attenuated in the deep vadose zone.
- Do the alluvial soils of the central valley have a natural capacity to supply N further contributing to NO_3^- contamination of groundwater?

REFERENCES AND ACKNOWLEDGEMENTS

- Bachand, Philip A. M., Sujoy B. Roy, Joe Choperena, Don Cameron, and William R. Horwath. "Implications of Using On-Farm Flood Flow Capture To Recharge Groundwater and Mitigate Flood Risks Along the Kings River, CA." *Enviromental Science & Technology Environ. Sci. Technol.* 48.23 (2014): 13601-3609.
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