Determination of Root Distribution and Physiological Parameters of Nitrogen Uptake in Almonds to Optimize Fertigation Practices

UC DAVIS PLANT SCIENCES

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california almonds Almond Board of California

• BACKGROUND

Optimal fertilization practice can only be developed if knowledge of the 4 R's (right source, right rate, right place, and right time) are explicitly developed for the almond production context. To optimize nutrient use efficiency in fertigated almond it is essential that fertilizers injected into irrigation system are provided at the optimal concentration and time to ensure that deposition patterns coincide with maximal root nutrient uptake.

• OBJECTIVES

- Determination of almond root phenology and characterization of root distribution.
- Determine nitrogen uptake and demand dynamics for almond.
- Determine the best fertigation practice for almonds orchards.
- Reduce the contamination of groundwater with pollutants (NO_3) without reducing crop performance.

• METHODOLOGY

In order to achieve the objectives proposed in this project, two experimental trials have been used contrasting different rates of nitrogen (N), fertigation methods and irrigation methods.

1. Nitrogen rate experiment

The orchard is a high producing 13 year old Nonpareil/Monterey planting located south of Lost Hills in Kern County. The project has already established very clear differences in crop yield and nitrogen demand and represents an ideal field site for this work. Twenty minirizotron access tubes were installed to follow root phenology (root flushes, root lifespan, growth, etc.) under four fertilization regimes. Root images have been taken during the 2012 season in 2 week basis and images will be analyzed at the end of each season.

In addition, a total of 80 root bags filled with media were installed in the different treatments and N uptake was measured in excised roots.

2. Fertigation method experiment

The effect of fertigation technique (pulsed, continuous, drip, microjet) will be examined in a subset of trees in the same orchard as above (Fig. 1).

In this experiment an additional 20 minirizotron access tubes were installed in order to determine root phenology. In addition, 72 soil solution access tubes (SSAT, AKA "suction lysimeters") have been installed in each treatment at 3 depths (30, 60, 90 cm) in order to measure nitrate (NO_3) concentration and transport through the soil profile at each fertigation event.

Individual trees have been analyzed for leaf nutrient analysis, yield, nut size and crackout percentage and contrasted among treatments (see results section).

Treatment Key:

C300-200KN	200 lb K as KNO3 and 193 lbs N as UAN (total N 300) as continuous application.
C300-200SOP	200 lb K as SOP dissolved in gypsum mixer and 300 lbs N as UAN (total N 300), continuous application
C300-75KN	200 lb K. 125 lb K as SOP in band February, plus 75 lb K as KNO3 and 273 lb UAN continuous application
F300-75KN	200 lb K. 125 lb K as SOP band February, 75 lb as KNO3 and 273 lb N as UAN in 4 in season fertigations 20% Feb, 30% April, 30% June, 20% post harvest.

Fig 1. Treatments used in the fertigation management

• RESULTS

1. Nitrate Uptake by roots

Fine roots from each treatment in experiment 1, were isolated, excised and then incubated in solutions of different NO_3 concentration for 30 minutes. Preliminary results from this experiment are shown in figure 2. When roots where incubated in solutions from a low range concentration (0.42 to 3.50 ppm of NO_3), all of the treatments showed an increase in uptake followed by a saturation at the end of this range; however, low N treatments exhibited a higher uptake capacity than the high N treatments. This results suggests that N starved trees may upregulate N uptake and can access N from lower NO_3 concentrations than trees with sufficient N content. Trees with high N application showed a low capacity to absorb NO_3 and at the lowest NO_3 concentration (0.42 ppm) they lost NO_3 from the roots system to the solution. At high NO_3 concentration ranges (7.01 to 14.01 ppm of NO_3) however, low N trees exhibited lower uptake capacity than high N status trees.

2. Fertigation method

Preliminary results from soil solution extraction at different soil depths and times are shown in figure 3. Results from that analysis of soil solution extraction, showed that the NO_3 concentration in the soil is much lower in continuous fertigation than the standard practice. At the deepest depth (90 cm), N-NO_3 concentration from continuous fertigation treatments, were much lower that the maximum allowed (10 ppm of N-NO_3) by CDPH.

In terms of productive parameters (yield, nut size, and crackout percentage), results from both seasons (2011 and 2012) did not show significant effect of the treatments. Similarly, leaf nutrient status in mid-summer did not showed any treatment effect.

• CONCLUSIONS

- Almond roots are able to adapt their physiology to different soil N-NO_3 concentrations.
- Continuous fertigation practices have shown reduction in soil N-NO_3 and therefore groundwater contamination without affecting crop performance.
- Methodology used in this project can provide useful information for the application of fertilizers at the right time and place.

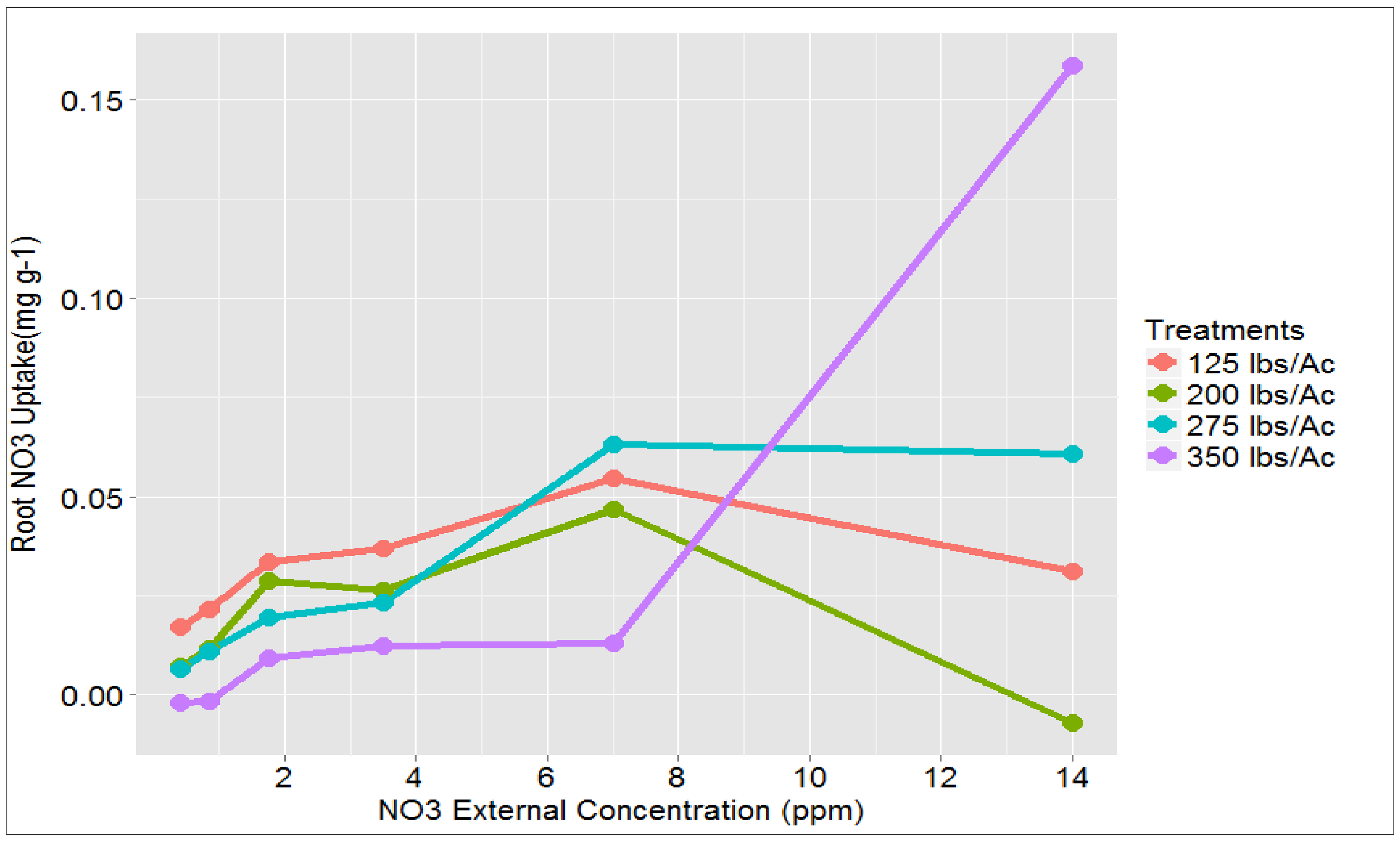

Fig 2. Effect of soil nitrogen treatments on root NO_3 uptake

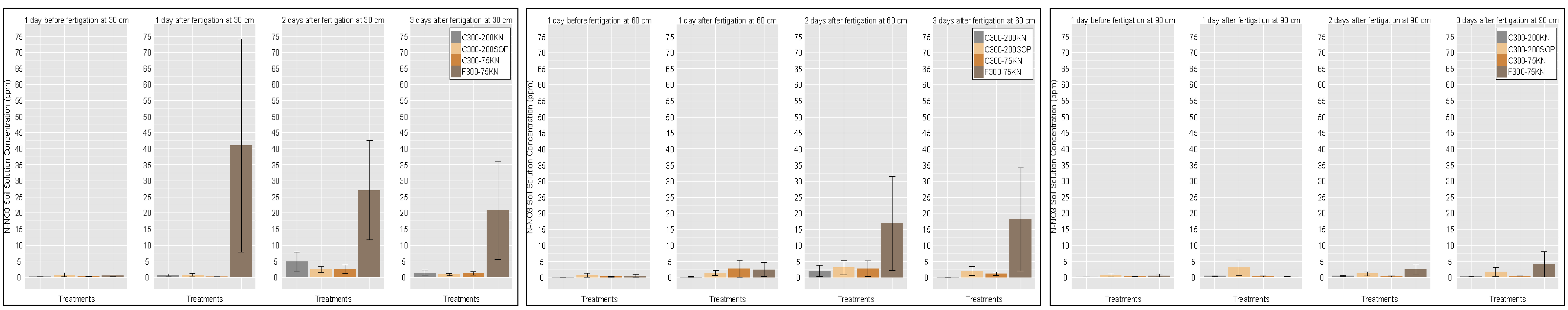

Fig 3. Soil solution NO_3 concentration (ppm) at 30, 60 and 90 cm from soil surface at different times relative to the fertigation event