1987 ANNUAL REPORT - ALMOND BOARD of CALIFORNIA

Project No. 87-R1 - Tree and Crop Research
Root Zone Acidity and Chemistry

Project leader: Dr. Robert J. Zasoski (916) 752-2210 or 752 -1406
Land, Air and Water Resources Department
University of California
Davis, CA 95616

Cooperators: R.D. Meyer, H.Schulbach, John Edstrom

<u>Objectives</u>: Determine the effects of nitrogen (N) fertilization on soil and rhizosphere (root zone) pH and the tree response consequences of this acidity. Acid soils are normally high in aluminum (Al), manganese (Mn), and hydrogen (H) and low in calcium (Ca) other bases and phosphorus (P). This project will quantify the Al, Mn, and H levels associated with root zone acidity generated by nitrogen (ammonium based) fertilization and contrast bulk soil conditions with that surrounding fine roots.

<u>Interpretive Summary</u> :

Application of urea up to 4 pounds per tree at the Nickels Trust has resulted in very good nut yields and no apparent problems with tree vigor and growth. At the same time soil pH in the drip zone has been substantially reduced. This project began in July and has been concerned with evaluation and validation of techniques for:(1) measurement of pH in soil very close to the roots, (2) methods to evaluate Al in the rhizosphere and (3) evaluation of foliar Mn and Al levels. Initial soil and rhizosphere sampling examined a technique of placing a thin layer of agar containing pH indicator on excavated roots and soil and visually determining pH by a change in color. This technique was not useful because the soil surface was too rough to allow adequate contact between the agar and the soil. An alternative technique will be tested. This method uses finely woven stainless steel screens placed in the soil. Roots which grow along the screens will have a smoother surface and allow for better contact and visualization of the pH near the root.

Separating roots and their adhering soil from the bulk soil by sieving was a second technique used for measurement of rhizosphere and bulk soil pH. Moisture level of the sample was very important in this method. Roots and separated soil were allowed to dry and the adhering rhizosphere soil was removed by shaking. This technique works well and was used to collect samples from high and low N treatments by by driving a metal pipe into the drip zone. Samples were collected in three inch intervals to a depth of 21 inches. For each depth increment soil, from three separate cores were combined into one sample. Two

samples from each tree and two trees from the high and low N treatment were collected. Soil pH data are presented in Table 1.

Table 1. Soil pH in bulk and rhizosphere samples from high and low N fertilization treatments.

Depth	pH			
	Low N		High N	
inches	Bulk	Rhizosphere	Bulk	Rhizosphere
0-3	7.51	7.08	5.35	5.36
3-6	6.93	6.69	5.63	5.63
6-9	6.64	6.50	5.05	5.28
9-12	6.40	6.34	5.03	5.46
12-15	6.32	6.32	5.13	5.15
15-18	6.27	6.25	5.17	---
18-21	6.41	6.31	5.01	---

In both N treatments bulk pH decreases with depth rapidly near the surface and changes little after the first 9 inches. Individual samples varied in pH from 4.2 to 7.7. Rhizosphere pH is consistently less than bulk pH in the low nitrogen treatments and the same or higher in the high N treatments. The reason for this difference is not readily apparent. Uptake of ammonium by the roots could account for a lower pH in the rhizosphere; however, most nitrogen should be in the nitrate form in these soils. Extraction of K from the soil could be responsible for a lower pH in the rhizosphere. Potassium uptake will be investigated during the next year. There are dramatic pH differences between the high and low N fertilization treatments. Table 2 contains the computed difference between low and high N treatments in bulk and rhizosphere samples. In all cases the high N treatments are more acidic than the lower application rates. Low N treatments were consistently 1.1 to 1.6 pH units higher than the high N applications with the exception of the 0-3 inch samples. Acidity differences (pH) between N rates were smaller in rhizosphere samples, but high N applications were about 1 pH unit lower at all but one depth.

Table 2. Comparison between rhizosphere and bulk pH in high and low N fertilizer treatments.

Depth	Bulk Soil	Rhizosphere Soil
inches	Low N - High N	Low N - High N
0-3	2.20	1.72
3-6	1.30	1.16
6-9	1.59	1.22
9-12	1.37	0.88
12-15	1.14	1.17
15-18	1.10	----
18-21	1.40	----

Rhizosphere samples at lower depth were difficult to obtain as there were fewer fine roots as soil depth increased.

In samples that are strongly acidic (pH around 5 or less), levels of Al could be high, however the toxicity of Al is modified by the form in which it exists. Complexation by organic matter has been shown to lower Al toxicity. A technique for determining Al form and complexation has been developed by James et al.(1983). We tested this procedure and found that it worked well with standards and was sensitive enough to detect about 0.5 ppm Al in solutions. We are currently modifying the procedure to work with smaller samples because of the limited amount of soil collected from the rhizosphere. A measure of Al in the soil is necessary as toxicity is commonly expressed in the roots and foliar analyses may not be a sensitive technique for assessment of Al status. We did, however, measure foliar Mn and Al levels in the high and low N treatments, to determine whether foliar Al and Mn could be used to assess acidification. Manganses in the almond leaves was related to N treatment, but Al was not. It is evident that, because of dust contamination, leaves must be washed before Al analyses. Table 3 presents results of tissue analysis from high and low N treatments and the effects of washing on tissue concentrations.

Table 3. Foliar levels of Al and Mn in washed and unwashed samples from high and low N treatments.

Treatment	washed		unwashed	
	Al	Mn	Al	Mn
Low N	101 $\pm$ 18	88 $\pm$ 3.5	650 $\pm$ 172	96 $\pm$ 8.5
High N	109 $\pm$ 76	322 $\pm$ 40	579 $\pm$ 244	349 $\pm$ 85

Washing decreases Al nearly six fold which indicates that dust contamination is a problem that must be avoided if foliar levels of Al are to be analyzed.

In summary results to date have shown that rhizosphere samples are different in pH from the bulk soil and that ammonium based fertilizers are lowering both soil and rhizosphere pH. Techniques to study rhizosphere pH and Al have been developed and will be applied in 1988. Questions to be pursued in 1988 are related to the seasonality of pH in bulk and rhizosphere samples and the relationship between nitrogen form and pH, acidity and Al in the rhizosphere.