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Root Zone Acidity

by

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Objectives: Objectives of this project are to determine the acidification effects of urea fertilization on soil and to compare bulk and rhizosphere soil properties including pH, Al, Mn, Ca and Mg in relation to acidification. Fertilization effects on foliar Mn and other nutrients affected by acidity and root distribution are also objectives included in this project.

Problem and its Significance: Application of high urea levels to a limited volume of soil associated with drip irrigation can cause a reduced pH and the potential for Al toxicity, Ca deficiency, and other nutritional imbalances. In drip irrigated almonds, our previous studies have demonstrated a lowered pH and increased extractable Al levels and lowered Ca levels. The main manifestation of lowered pH has been an increased level of Mn in almond foliage. Many almond growers and other farmers are using drip irrigation and the long term implications of soil acidification have not been addressed. Soil acidification from conventional fertilization practices on the coarse textured soils of the eastern side of the San Joaquin is also a concern along with the question of N efficiency and the potential for N leaching losses.

Interpretive Summary: Previous results from this project have documented a reduction in soil pH directly under emitters where urea had been applied. This reduced pH was low enough to cause concern about root growth and nutrition, however information on root distribution was not available. During the past year, root distribution was included in the sampling scheme in addition to the usual description of soil properties. Both root and soil chemical properties were examined by an extensive sampling in and out of the tree rows in relation to emitter locations and depth. Sampling was coordinated with Project 89-Q8 (Nitrogen on drip irrigated almonds). In high and low nitrogen plots samples were taken at 6 inch increments to a depth of 5 feet at locations in and near the drip basins were fertilizers were applied as well as in the row middles which were not treated. Subsamples were taken from each 6 x 6 x 6 inch cube to assess root distribution in the upper two feet of soil. Immediately on sampling the soil was screened, mixed and a subsample was extracted to determine ammonium and nitrate levels. Root samples were frozen and roots were latter washed from the soil and weighed. Soil samples were dried and analyzed for pH,

electrical conductivity, saturated paste extractable Ca, K and Mg and exchangeable Ca and Mg. Roots were extracted on site for rhizosphere samples. In all 501 samples were taken for chemical analyses, 224 samples for rhizosphere analyses and about 160 samples for root weights. Many of these samples are currently being analyzed, however results have been completed for nitrate and ammonium distribution, pH, soluble cations, and exchangeable Ca and Mg. Figure 1 is a schematic of the sampling plan. Sampling sites 1 and 14 were located at the emitters and other locations were varying distances from the tree and emitters.

High rates of urea application have continued to reduce pH in the bulk soil. Average pH in the high N treatments for all locations and depths was 4.95 compared to 5.7 for the low N treatments. The lowest pH values were localized in and near the drip zone at depths below 6 to 12 inches. At depths down to 3 or 4 feet, values as low as 3.3 were recorded. Accompanying these low pH's were reductions in exchangeable Ca and Mg which were 4 to 6 fold lower in some cases.

Soils were sampled in late spring. At that time extractable nitrate and ammonium levels were generally low throughout the soil and even below the emitter basins in the low N treatments. In low N plots extractable ammonium averaged 1.7 ppm while extractable nitrate averaged less than 1 ppm. In the high N treatments, extracted ammonium and nitrate averaged 33 and 27 ppm respectively. Values in these plots were variable being very high under the basins and diminishing away from the point of fertilizer applications. Concentrations of nitrate were extremely high (> 100 ppm) at the outer edge of the wetted zone, to the sides and below the emitter. Nitrate, as expected, was deeper in the profile than ammonium and some lateral movement was observed. Soluble Ca and Mg were strongly related to soluble nitrate as nitrate increased soluble Ca and Mg increased .

Only preliminary information is currently available on root distribution. Table 1 contains data on root distribution in relation to depth at three locations in the high and low N treatments. Table 2 presents the information we currently have on root distribution in relation to locations as shown in Figure 1. Fine roots are concentrated in the surface foot (Table 1) and more roots are found in locations (1,8, 14) near the emitters (Table 2). These data are not corrected to an ash free basis and the data on coarse roots is not currently available. The soil at Nickels Trust is a relatively fine textured soil and the distribution of roots in this drip irrigated system should not be assumed to apply in other orchards on coarse textured soils. Low soil pH is not associated with reduced root weights in these samples.

Table 1. Root distribution (grams dry weight in a 4 inch cube) in relation to depth in Plots 20 (low N) and 21 (high N).

Location	Depth (in)	Low N	High N
1	2	14	25
	8	13	14
	14	7	6
	20	3	4
3	2	10	9
	8	4	6
	14	1	3
	20	1	2
8	2	13	20
	8	14	17
	14	5	7
	20	2	2

Table 2. Fine root weights (grams of dry weight) in a 4 inch cubes for the first 4 depth increments (0-22 inches).

Location	Low N	High N
1	35 ± 2.8	42 ± 9.9
3	13 ± 4.2	17 ± 3.5
5	9 ± 0.7	10 ± 2.8
8	30 ± 12	39 ± 4.2
9	15 ± 5.7	27 ± 4.2
14	29 ± 0.7	22 ± 4.2

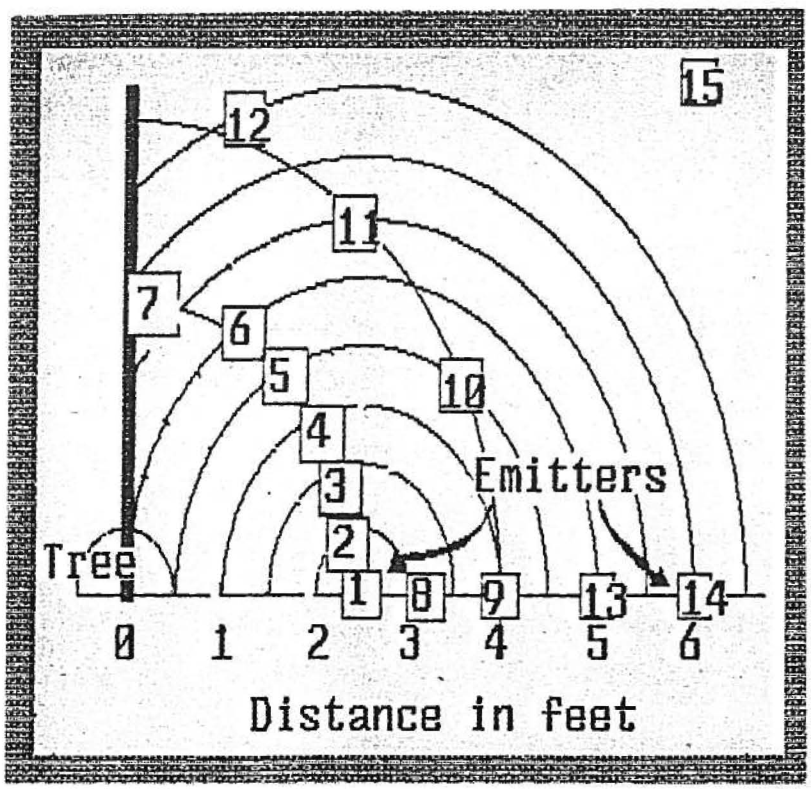

Figure 1. Sampling locations around a single tree. Emitters were located at positions 1 and 14.