**Annual Report to the Almond Board of California**

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Project No. 92-R6 - Root Zone Acidity and Chemistry

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Objectives: 1) To determine the effects of strongly acidified soil on the growth of seedlings and to examine root distribution in acidified soil. For the first time since inception of this project, sufficient quantities of soil acidified in place can be removed with out compromising on-going experiments. 2) To grow seedlings in strongly acidified soil which has been produced in the field. Previous studies have utilized soils acidified by acid additions which introduce high levels of salt and may not reflect the situation in the field. 3) This phase of the project will utilize field-acidified soil and soil which has been limed to evaluate seedling response to acidity and to quantify rhizosphere properties. 4) A second phase of the project is evaluating root distribution around drip basins.

Results:

Acidified soil from the drip basins which had been fertilized with ammonium sulfate for 3 years were collected in the spring of 1992. This soil had a pH of 4.8 in water. The soil was mixed and limed to establish a control ($L_0$) a low lime rate ($L_1$) and a high lime rate ($L_2$). Lovell peach seedlings were planted in these treatments which had pH values of 3.9, 5.8 and 6.5 ( in $CaCl_2$) after lime addition. Either ammonium or nitrate with a nitrification inhibitor was added to all treatments in a split application of 200 mg/kg. Seedlings heights were measured as a nondestructive indication of growth in November, 1992. These results are presented in Table 1. It is apparent from examination of Table 1 that the ammonium treated seedlings are growing poorly relative to the nitrate treatment and the unfertilized control especially without added lime. It is also evident that lime is a benefit to seedling growth. The seedlings were harvested on December 18, 1993 after three and one half months of growth. Data for the dry weights of the seedlings are shown in Table 2. As with the height data, it is obvious that lime benefits seedling growth or that soil acidification by high rates of ammonium sulfate adversely affects seedling growth. It is also evident that the soil from the drip basin was well supplied with available N. In fact, additional N was not necessary as N applications reduced seedling growth.

The second phase of the project is concerned with root distribution and nitrogen uptake by trees pretreated with ammonium sulfate or calcium nitrate. These pretreatments were imposed to establish differences in soil pH in the drip basins. During 1991 plots were fertilized with $^{15}N$-depleted ammonium sulfate to establish uptake efficiencies in the plots with different pH levels and fertilization histories.

Table 1. Seedling height in relation to lime and nitrogen source.

| | | LIME TREATMENT | | |
|---|---|---|---|---|
| N TREATMENT | $L_o$ | $L_1$ | $L_2$ | N Ave |
| $N_o$ | 15.4 ± 2.7 | 17.4 ± 1.5 | 19.4 ± 1.0 | 17.4 |
| $NH_4$ | 4.9 ± 2.6 | 10.0 ± 3.2 | 12.5 ± 3.1 | 9.1 |
| $NO_3$ | 10.8 ± 3.5 | 13.3 ± 3.0 | 17.9 ± 1.1 | 14.0 |
| LIME AVE | 10.4 | 13.6 | 16.6 | |

In January 1992, three eleven-year old trees from calcium nitrate treatments and three trees from ammonium sulfate pretreatments were extracted from the soil. The trees were excavated by backhoe and the soil to a depth of 60 cm was screen to remove roots greater than 6 mm (1/4 inch). Roots 6 mm in diameter and larger were removed dried and analyzed to determine N content and N uptake.

Fine roots (roots < 1/4 inch) were sampled by systematically removing 3 inch cores of soils from areas in and around the drip basin and tree. Analysis of the soil and quantification of the root biomass are currently in progress. Dr. S. Weinbaum cooperated on this aspect of the project which was jointly funded by TVA and CDFA and the California Almond Board. The amount of extracted root per tree (> 1/4 inch) is presented in Table 3 along with biomass of the above ground tree components.

Table 2. Seedling dry weights (g) at harvest on December 18, 1992 in relation to lime and nitrogen source.

| N TREATMENT | LIME TREATMENT $L_O$ | $L_1$ | $L_2$ | N Ave |
|---|---|---|---|---|
| $N_O$ | 3.2 | 3.5 | 6.2 | 4.3 |
| $NH_4$ | 0.5 | 2.6 | 3.2 | 2.1 |
| $NO_3$ | 1.5 | 2.3 | 4.1 | 2.63 |
| LIME AVE | 1.73 | 2.80 | 4.50 | |

Examination of Table 3 shows that the majority of the biomass is associated with the tree stem and branches, which averaged 263 lbs per tree for the six trees. The roots greater than 1/4 inch in diameter accounted for 16% of the total measured weight but contained 36% of the nitrogen in these components (Table 4). This reflects the fact that the woody tissue such as stem and branch wood is generally low in nitrogen. Average above ground weight for the coarse and medium roots was 336 lbs per tree. This extrapolates to 33.9 tons of dry material per acre. About 360 lbs of N are need to construct the above ground tree structures plus the coarse and medium roots in this orchard. Additional N is cycled into the foliage and fine roots. This additional N is retained in the orchard, while some N is removed in the crop. We are in the process of determining the amounts of N in these additional components.

Table 3. Dry weights of tops, coarse roots, medium roots and stumps of trees extracted in late January 1992. (Pounds of dry weight per tree)

| Treatment | Tops | Coarse Roots | Medium Roots | Stump | Total |
|---|---|---|---|---|---|
| Ammonium sulfate | | | | | |
| AVERAGE | 254 | 30 | 24 | 22 | 323 |
| SDEV | 25 | 8.5 | 4.2 | 4.0 | 23 |
| Calcium Nitrate | | | | | |
| AVERAGE | 273 | 24 | 31 | 20 | 348 |
| SDEV | 39 | 2.6 | 1.5 | 2.6 | 40 |

The goal of this project is to develop a budget for nitrogen contained in the soil and trees as a guide to nitrogen needs of the orchard and to estimate the efficiency of N utilization in this drip irrigated orchard. The data contained in this report along with information on crop removal of N and soil N levels will allow for a more detailed look at the utilization and storage of N in this orchard.

Table 4. Total nitrogen contained in the tree components (lbs per acre).

| Treatment | | Top | Coarse Roots | Medium Roots | Stump | Total |
|---|---|---|---|---|---|---|
| Ammonium sulfate | | | | | | |
| | AVERAGE | 211 | 62 | 64 | 11 | 348 |
| | SDEV | 4 | 23 | 17 | 1 | 39 |
| Calcium nitrate | | | | | | |
| | AVERAGE | 221 | 51 | 86 | 10 | 369 |
| | SDEV | 16 | 7 | 13 | 3.5 | 17 |