

Table 2

San Joaquin RVT Plot
Delta College
Manteca, California
Yield Summary - 1991

Variety	No. of nuts/tree	Ave. wt. (gm)	Kernel no./ oz.	% Kernel	Weight lb/ tree	lb/ acre
1978 Planting						
Early blooming varieties						
Jordanolo	8740	1.70	17	67	32.7	2487
Sonora	10398	1.40	20	72	32.1	2438
Ne Plus Ultra	9604	1.42	20	64	30.1	2291
Peerless	8417	1.19	24	40	22.0	1675
Mid blooming varieties						
Nonpareil	12318	1.37	21	67	36.8	2796
Price	14915	1.03	27	68	33.9	2580
Fritz	14525	1.00	28	55	32.0	2428
Carmel	10464	1.19	24	61	27.4	2086
Monterey	7523	1.44	20	52	24.0	1820
Sauret #2	7929	1.31	22	59	22.9	1740
Sauret #1	5817	1.35	21	68	17.3	1314
Late blooming varieties						
Tokyo	12193	1.21	23	56	32.5	2471
Butte	12183	1.08	26	56	29.0	2205
LeGrand	10459	1.23	23	67	28.4	2160
Mission	9956	1.16	24	51	25.5	1937
Livingston	7534	1.36	21	67	22.6	1714
Padre	7833	1.12	25	54	19.3	1466
Ruby	6641	1.31	22	59	19.2	1463
Mono	6343	1.34	21	48	18.7	1420
Thompson	3918	1.42	20	68	12.3	935
1984 Planting						
Dottie Won	8268	1.14	25	55	20.7	1576
Aldrich	8828	1.05	27	60	20.4	1548
Woods Colony	6766	1.33	21	62	19.9	1512
Rosetta	5600	1.51	19	51	18.7	1419
Jeffries	4324	1.53	19	74	14.6	1107
Valenta	5423	1.19	24	57	14.2	1079
Pearl	6034	0.97	29	55	12.9	978

19th ANNUAL ALMOND RESEARCH CONFERENCE, DECEMBER 3, 1991

Project No. 91-Q10 - Nitrogen on Drip Irrigated Almonds

Project Leader: Dr. Roland D. Meyer (916) 752-2531
Extension Soils Specialist
Department of Land, Air and Water Resources
129 Hoagland Hall
University of California, Davis, CA 95616

Cooperating Personnel: John P. Edstrom, Herbert Schulbach - Retired, Nickel's Soil Laboratory

Objectives: 1) To evaluate the effects of different nitrogen rates applied at two water levels on growth, nutrient concentrations in leaves and twigs, and nut yields of almonds. 2) To evaluate changes in nutrient movement in the drip zone as a result of nutrient uptake, leaching of nitrates and acidification. 3) To assess the extent of soil acidification from urea-nitrogen application under drip emitters. 4) To evaluate the effects of two rates of potassium on growth, nutrient concentrations in leaves and nut yields. 5) To develop recommendations for nitrogen, irrigation and soil management for use during the establishment and early maturity stages of almond orchards.

Interpretive Summary: Yield results for the 1991 season were slightly higher than in 1990 with five plots having yields greater than 3500 and 11 plots (out of 60) greater than 3000 meat lbs/A. The lowest plot yield was 1429 and the highest was 3954. There was an increase in yield from the lowest nitrogen rate (4 oz) to the third rate (16 oz) with a leveling off or a trend for a decrease at the highest rate (32 oz per tree) at the 1.0 ET irrigation level. Yields for the 0.6 ET irrigation level showed nearly the same or a trend towards lower yields as nitrogen rates increased. The yield differences between the 0.6 and 1.0 ET irrigation levels were nearly 600 meat lbs/A for the three highest nitrogen rates (Figure 14). The orchard was planted in the spring of 1981 to three almond varieties--Butte, Carmel and Nonpareil on a 12' X 18' spacing (202 per acre). In the spring of 1982, five-5 tree plots were selected from each of the four-28 tree rows of each variety to which the two replications of the ten treatments were assigned. The ten treatments included two water levels - 0.6 and 1.0 of evapotranspiration (ET) each with five nitrogen rates - 0, 0.5, 1.0, 1.5 and 2.0 oz/tree in 1982; 0, 0.8, 1.7, 3.5 and 7.0 oz/tree in 1983; 0, 2, 4, 8 and 16 oz/tree in 1984; 4, 8, 16, 24 and 32 oz/tree in 1985; 6, 12, 24, 36 and 48 oz/tree in 1986; 8, 16, 32, 48 and 64 oz/tree in 1987 and 1988; 6, 12, 24, 36 and 48 oz/tree in 1989 and 4, 8, 16, 24 and 32 oz/tree in 1990 and 1991. Rates scheduled for 1992 are 4, 8, 16, 24 and 32 oz/tree. Urea is the nitrogen fertilizer source and it is applied on a monthly basis in six equal increments (five in 1990 and 1991) beginning April 1st. The 1.0 ET irrigation level is based on CIMIS and visual observation to maintain active tree growth. The 0.6 ET treatments receive 60% of the water quantity of the 1.0 ET treatments. The remaining discussion is oriented specif-

ically at addressing objective 5, "developing recommendations for nitrogen and irrigation during establishment and early maturity stages of almond orchards". During the fourth season of tree growth (1984), excellent meat yields were recorded. Figure 1 indicates average yields of approximately 700 up to 1300 meat lbs/A for the 0 and 16 oz/tree nitrogen rates respectively. An average of about 100 meat lbs/A greater yield was recorded for the 1.0 ET irrigation level. In 1985, the fifth year of growth, yields were from about 700 up to 1900 meat lbs/A for the 4 to 32 oz/tree nitrogen rates (Figure 2). At the three higher N rates the 1.0 ET irrigation level gave approximately 200 meat lbs/A greater yield. The 1986 meat yields were about 700 lbs/A for the 6 oz N/tree rate up to about 1800 lbs/A for the 48 oz N/tree rate (Figure 3). Little if any differences between irrigation levels were observed at the five nitrogen rates. Meat yields in 1987 averaged from about 1700 lbs/A up to 3000 lbs/A for the 8 and 64 oz/tree nitrogen rates respectively (Figure 4). In 1988, meat yields were about 1300 lbs/A for the 6 oz N/tree rate and increased up to about 2200 lbs/A for the 32, 48 and 64 oz/tree nitrogen rates (Figure 5). Very little if any difference between irrigation levels was observed. Figure 6 illustrates the 1989 meat yields which show no increase in meat yield at the 0.6 ET irrigation level as the nitrogen rate is increased from 6 to 48 oz N/tree. At the 1.0 ET irrigation level however, meat yields rose from about 2300 up to about 3200 lbs/A for the lowest (6 oz N/tree) to the higher three nitrogen rates (24, 36 and 48 oz N/tree). In 1990, yields increased from about 2000 up to 2400 and 2900 respectively for the 0.6 and 1.0 ET water levels for the three lowest nitrogen rates (4, 8 and 16 oz/tree) and then leveled off or showed a trend for decreasing yields (Figure 13). The 1991 yields showed a very similar pattern to those of 1989 (Figure 14).

The easiest, most accurate and economical way to assess the nitrogen status of almonds is by the use of leaf analysis with a July (1st week) leaf sampling for total nitrogen concentration. Figure 7 gives the leaf nitrogen concentration throughout the 1984 growing season for samples taken the first several days of each month. Note that only the 16 oz N/tree rate is above the recommended 2.2% nitrogen level on July 6th and that meat yields increased with more applied N and were the highest at the 16 oz/tree nitrogen rate. The leaf nitrogen levels for 1985 are given in Figure 8 and show that only the highest (32 oz/tree) nitrogen rate is above 2.2% on July 3rd. Note however that both the 16 and 24 oz N/tree rates are very close to the 2.2% level but have significantly lower meat yields. The 1986 leaf nitrogen levels on July 7th for the 24, 36 and 48 oz/tree nitrogen rates are all near or just slightly above 2.2% and the meat yields are likewise very similar (Figure 9). In 1987, the nitrogen levels for the three higher nitrogen rates were again nearly the same and all three significantly greater yields than the two lower nitrogen rates (8 and 16 oz N/tree) which had below 2.2% leaf N levels (Figure 10). Almost the same situation occurred in 1988 (Figure 11) as was observed in 1987. Figure 12 illustrates the changes in leaf nitrogen levels in 1989 where the four higher nitrogen rates had nearly the same yields. The three highest nitrogen rates had leaf levels above 2.3% whereas the 12 and 6 oz N/tree rates were just at or slightly below 2.2%. Figure 15 indicates that leaf N levels greater than 2.4% were required to

achieve high yields in 1990 whereas Figure 16 shows levels higher than 2.3% were necessary in 1991. These figures indicate that it is doubtful that yields will increase when leaf nitrogen levels are above 2.5% during the first week in July sampling.

Discussion: Evaluating the individual year or accumulative yields to arrive at nitrogen rates might at first glance suggest the use of the highest rate utilized in this experiment but more careful study indicates that in 1988 and to a lesser extent 1987 the three highest nitrogen rates gave nearly the same yields. In 1989, yields were nearly the same for the four highest nitrogen rates. The yield trends in 1990 were similar to those in 1989 with the 0.6 ET water level showing only a slight increase from 4 to 16 oz N/tree rates but decreasing thereafter while the 1.0 ET water level indicated that yields increased from 2000 to 3000 meat lbs/A for the first three rates of applied nitrogen, 4, 8 and 16 oz/tree (50, 100 and 200 lbs N/A) with little or no increase for the two highest rates, 24 and 32 oz/tree. Yields in 1991 were nearly identical to those in 1989 with the only increase in fields for the lowest three rates at the 1.0 ET water level. Note that rates used in 1990 and 1991 are one half those used during 1987 and 1988, a period (along with previous years) when substantial nitrogen was being utilized to grow the trees as well as produce the large meat yields. Yields in the 3000 to 3500 meat lbs/A range would remove approximately 150 to 180 lbs N/A meaning that the recovery of the two highest nitrogen fertilizer rates 24 and 32 oz/tree or 300 and 400 lbs N/A would be about 40 to 50% ($150/300 \times 100 = 50\%$, $160/400 \times 100 = 40\%$). For the 16 oz/tree or 200 lbs N/A fertilizer rate the recovery would be of the order of 75 to 80% ($150/200 \times 100 = 75\%$ or $160/200 \times 100 = 80\%$), thus the yield for this middle rate can be expected to decrease further during the coming years because of the difficulty of maintaining a 70 to 80% nitrogen recovery. Another very interesting tree growth parameter observed last winter was the lack of adequate new shoot growth. In past years the amount, both the number and length of new shoot growth has had a strong relationship to the rate of nitrogen applied, that is, more shoot growth associated with higher nitrogen application rates. The lack of much shoot growth would suggest that excessive rates are not being applied or that slight periods of water stress resulted in this phenomenon.

This suggests that high nitrogen rates can be utilized by almonds during the early growth and development of the tree which also has a varying need for nitrogen to produce large kernel yields. After the tree structure has been developed, the need for nitrogen is not as large with the major portion going into the kernels and a lesser portion going into the development of new fruiting wood. Another very important point to remember is that higher rates of nitrogen fertilizer will not be effectively utilized unless adequate amounts of irrigation water are applied. Note particularly the decrease in 0.6 ET irrigation level yields in 1989 (Figure 6) and 1991 (Figure 14) with higher nitrogen rates. Thus if for any reason water supplies might be limiting such as during a drought year, applying a rate slightly below the "full" rate would be advisable. On the other hand, excessive irrigation water applications should be avoided so that nitrogen in the form of nitrate will not be leached below the tree root zone and potentially reach the groundwater.

Figure 1. Almond meat yields in 1984 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch.

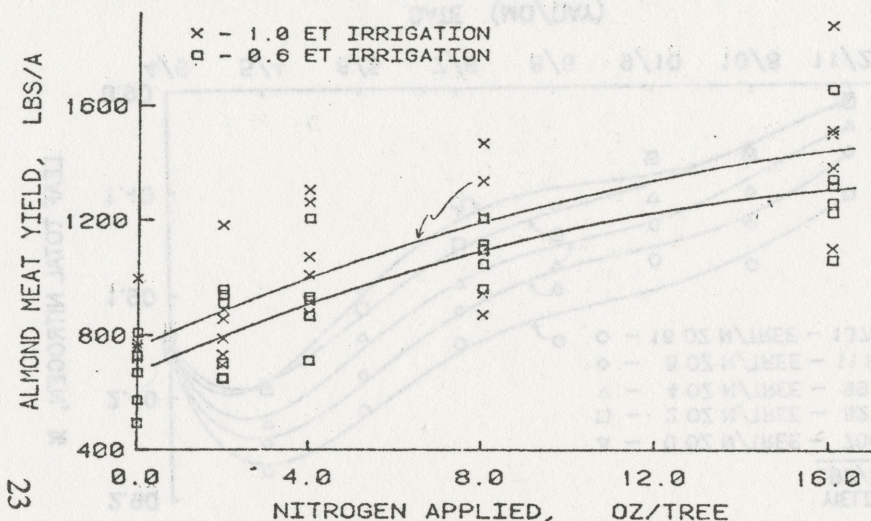


Figure 2. Almond meat yields in 1985 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch.

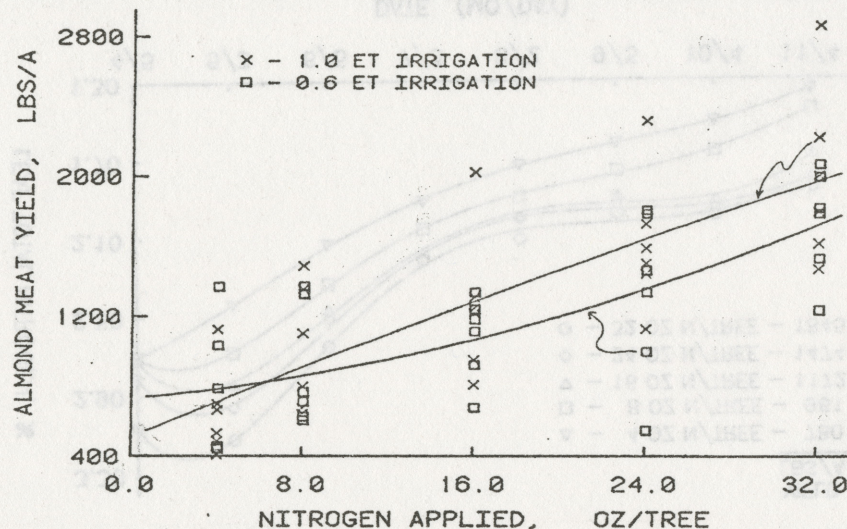


Figure 3. Almond meat yields in 1986 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch.

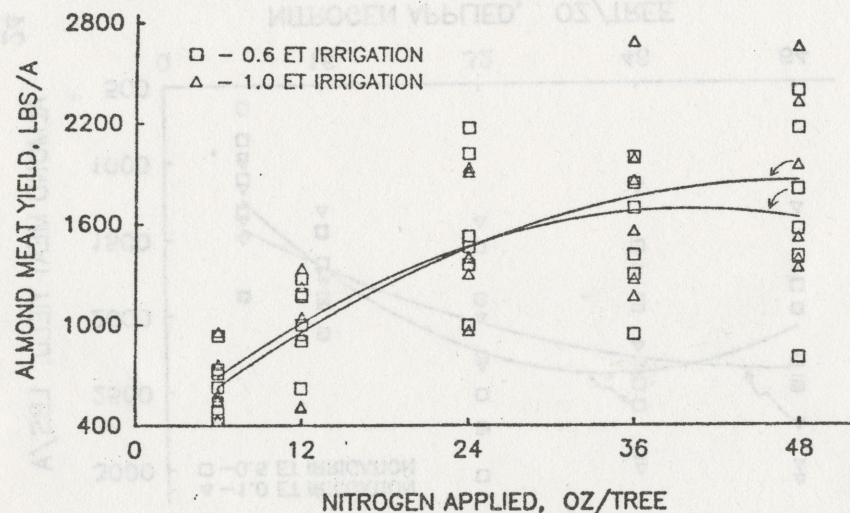


Figure 4. Almond meat yields in 1987 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch.

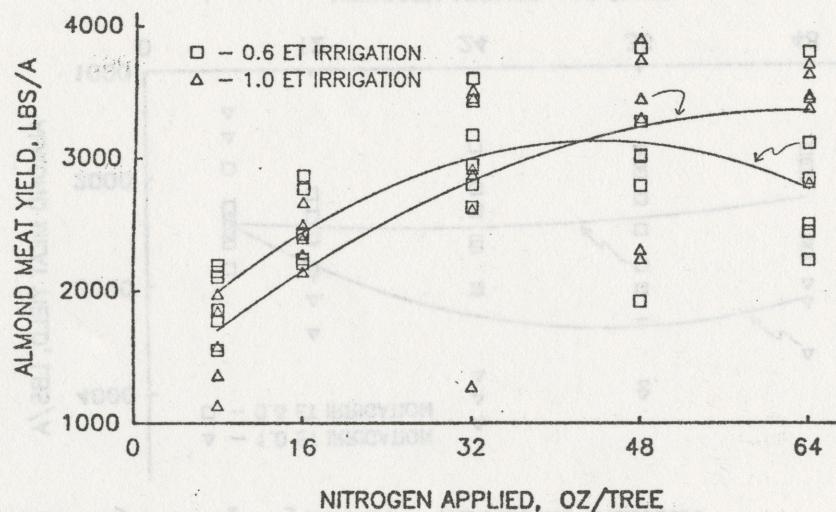


Figure 5. Almond meat yields in 1988 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch.

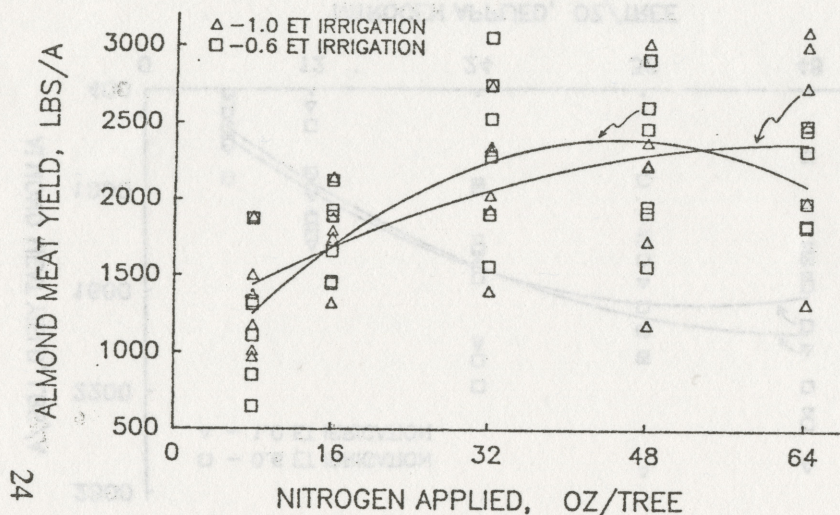


Figure 6. Almond meat yields in 1989 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch.

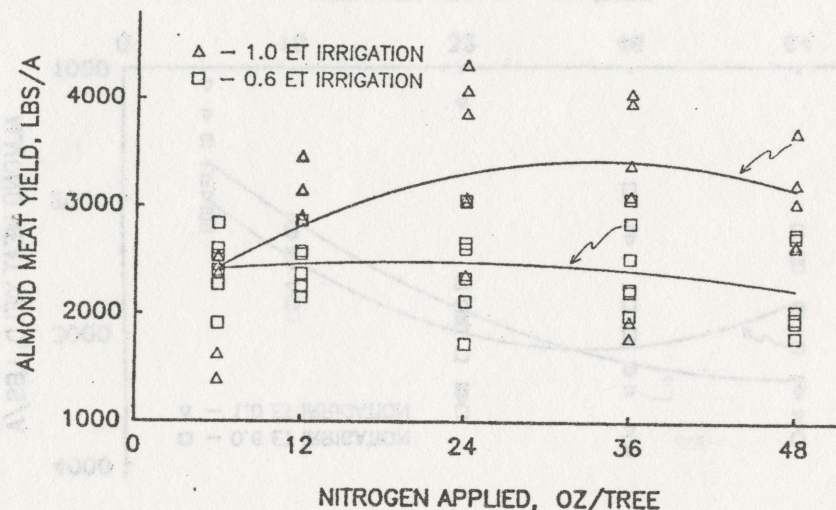


Figure 7. Almond leaf total nitrogen throughout 1984 for five rates of drip irrigation applied nitrogen. Nickels Ranch.

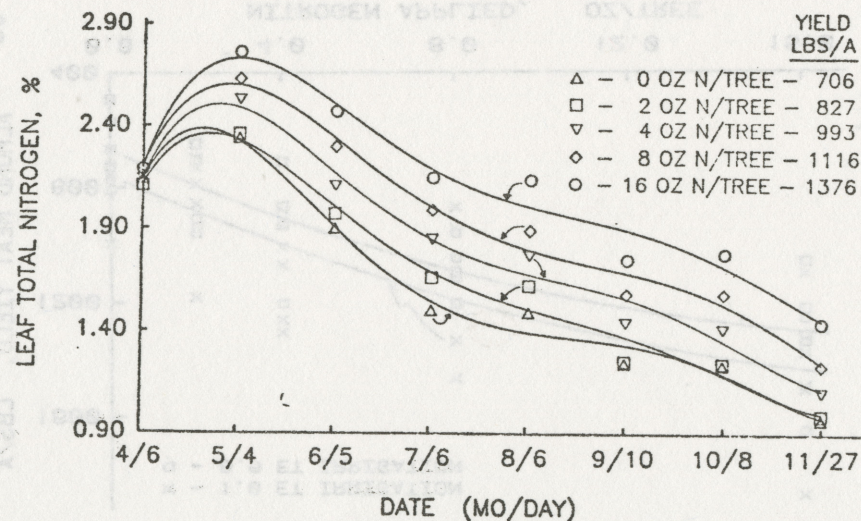


Figure 8. Almond leaf total nitrogen throughout 1985 for five rates of drip irrigation applied nitrogen. Nickels Ranch.

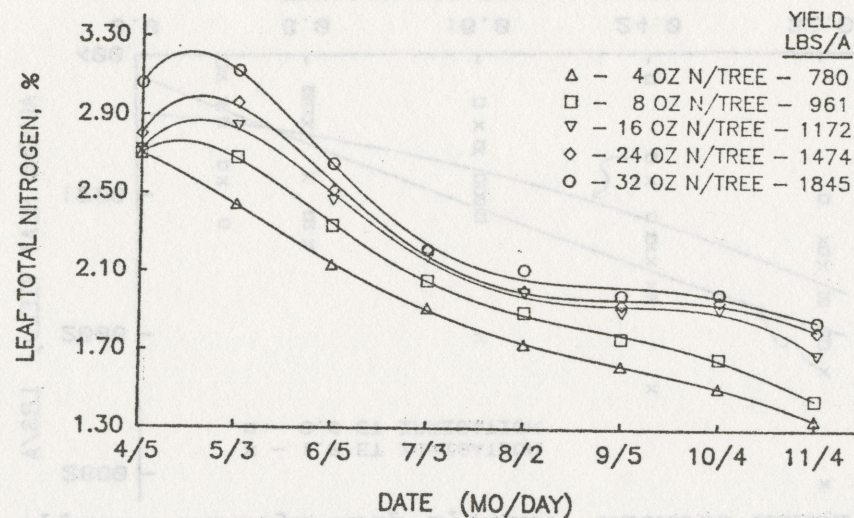


Figure 9. Almond leaf total nitrogen throughout 1986 for five rates of drip irrigation applied nitrogen. Nickels Ranch.

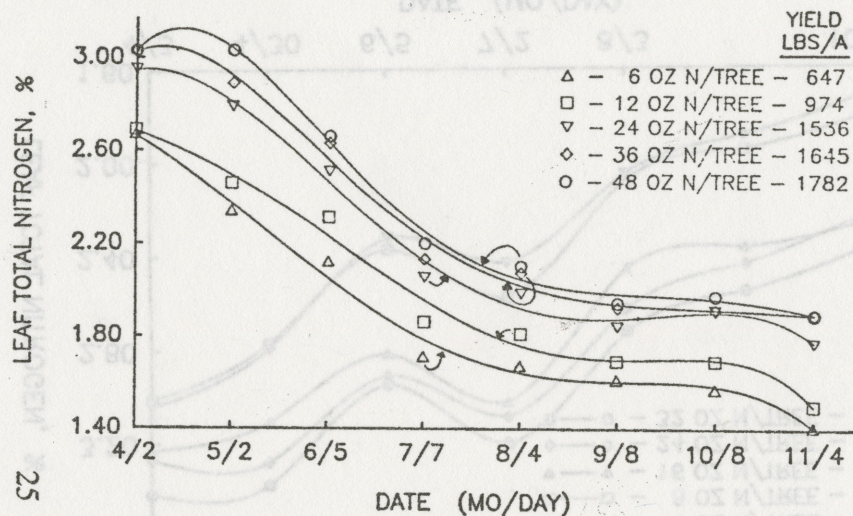


Figure 10. Almond leaf total nitrogen throughout 1987 for five rates of drip irrigation applied nitrogen. Nickels Ranch.

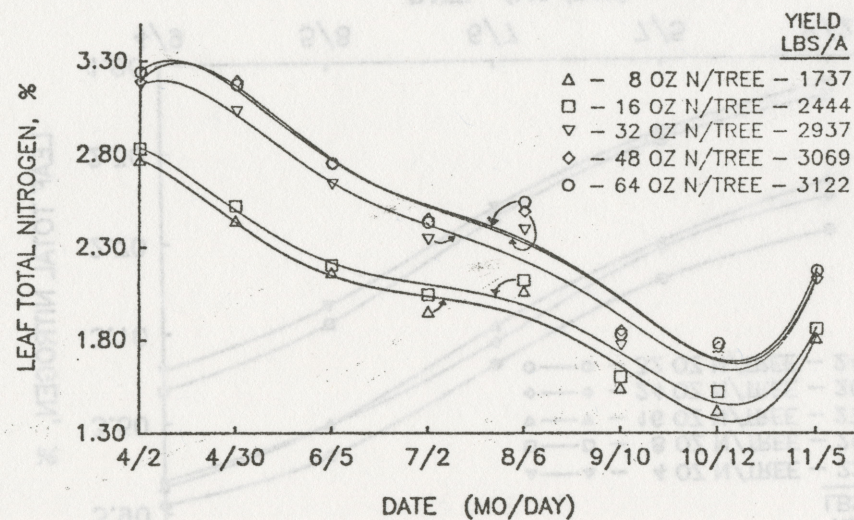


Figure 11. Almond leaf total nitrogen throughout 1988 for five rates of drip irrigation applied nitrogen. Nickels Ranch.

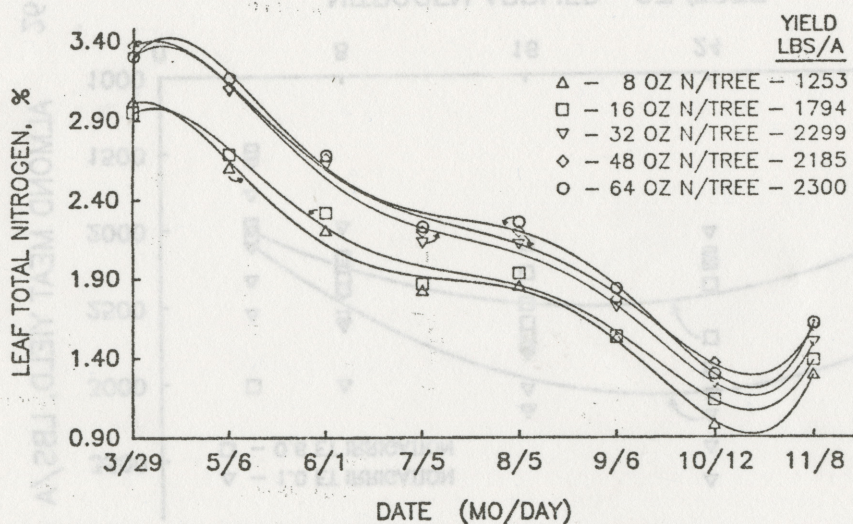


Figure 12. Almond leaf total nitrogen throughout 1989 for five rates of drip irrigation applied nitrogen. Nickels Ranch.

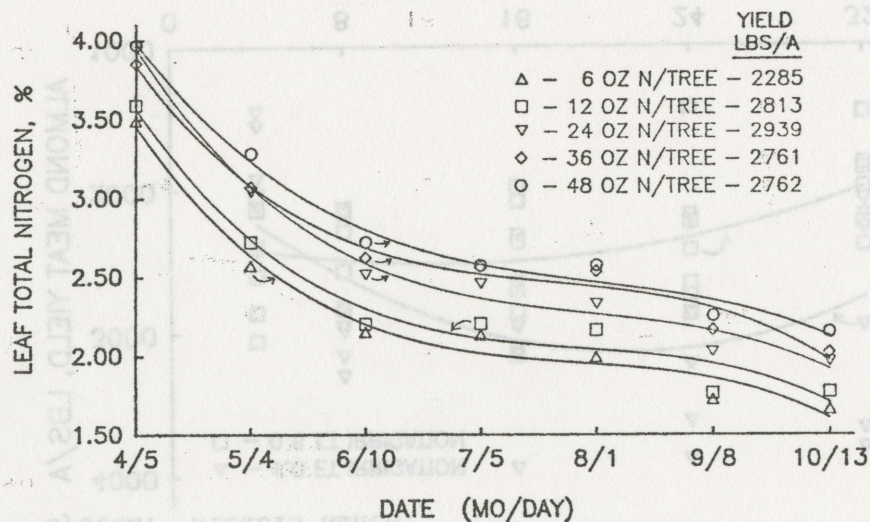


Figure 13. Almond meat yields in 1990 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch.

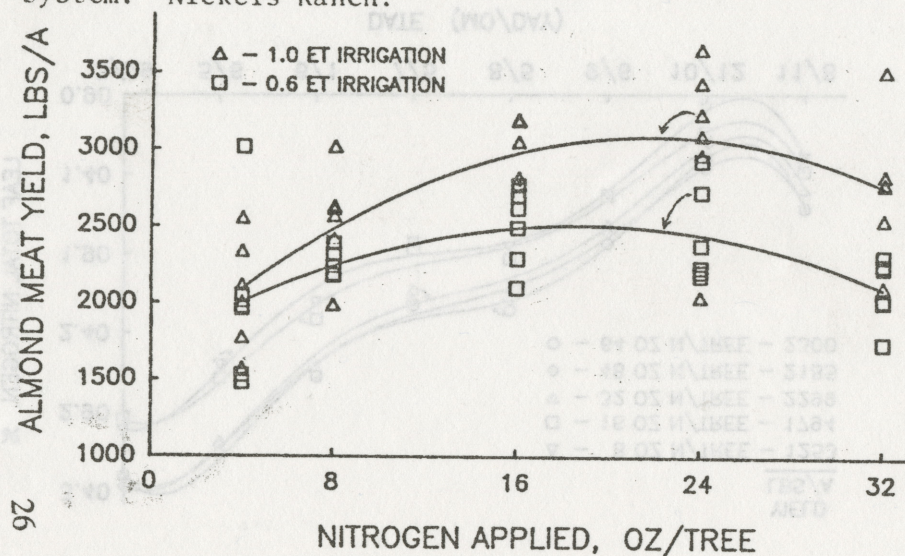


Figure 15. Almond leaf total nitrogen throughout 1990 for five rates of drip irrigation applied nitrogen. Nickels Ranch.

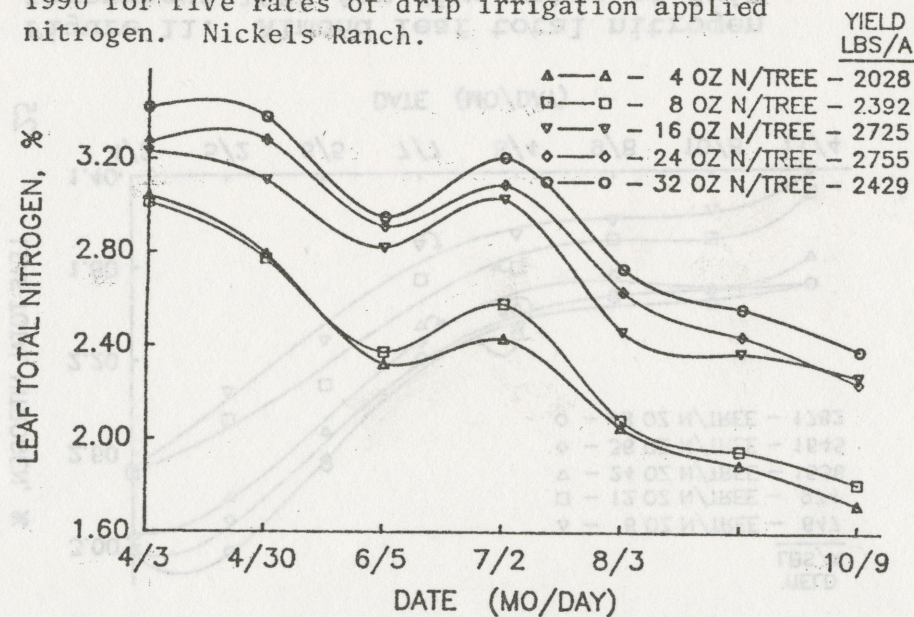


Figure 14. Almond meat yields in 1991 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch.

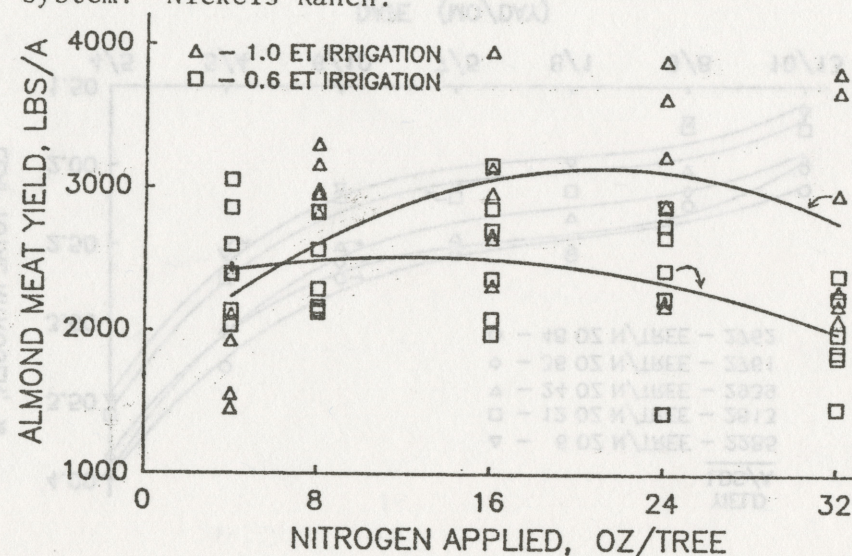
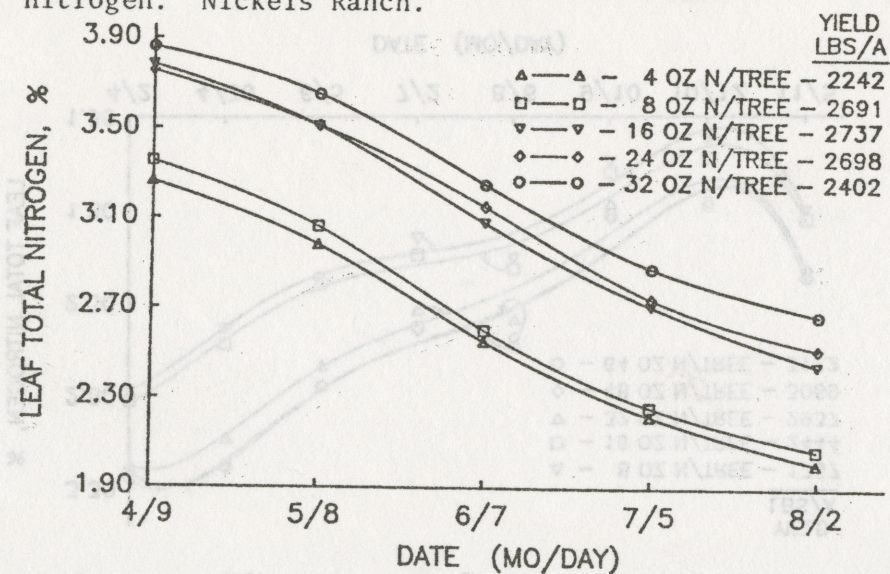


Figure 16. Almond leaf total nitrogen throughout 1991 for five rates of drip irrigation applied nitrogen. Nickels Ranch.



19th ANNUAL ALMOND RESEARCH CONFERENCE, DECEMBER 3, 1991

Project No. 91-R5 - Root Zone Acidity and Chemistry

Project Leader:

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

Cooperating Personnel:

R. Meyer, J. Edstrom, H. Schulbach, and Nickel's Trust

Objectives:

- 1) To determine the effects of nitrogen (N) fertilization on soil.
- 2) To compare the bulk and rhizosphere soil properties. This project quantifies the Al, Mn, Ca and H levels in bulk and rhizosphere soil in relation to fertilization rate.
- 3) Studies of root distribution in relation to soil properties started in 1989.

During the past year, two lines of investigation have been followed at Nickel's Trust. The first is examining root growth into acidified root cores placed at different locations in relation to the emitters. Thirty-two cores were constructed, as described last year, and placed in the field in April. Cores were located at 15 and 25 cm below the surface both in the row and 1 meter from the row center. These cores were extracted in early November. Root weights in the control and acid-treated cores will be determined along with pH, nutrient and salt content. A second line of investigation determined solution pH and nitrogen levels following ammonium sulfate applications to the drip basin. Porous ceramic solution samplers were placed at 5, 20, 30, 40 and 60 cm below the surface of the drip basins. Ammonium sulfate was applied monthly during the growing season. Figure 1 shows the changes in dissolved ammonium levels following fertilizer addition in late July. At all depths ammonium was low before fertilization. Three days after fertilization dissolved ammonium had increased dramatically except at the 60 cm depth. During the next three weeks, solution ammonium decreased toward the pre-fertilization value. Dissolved nitrate (Figure 2) showed a similar but smaller response to fertilization. Within three days solution nitrate increased at the 5 cm depth, which indicates rapid nitrification. At the 60 cm depth both ammonium and nitrate were very low and changed very little over the fertilization cycle. Solution pH (Figure 3) exhibited some interesting trends during the fertilization/irrigation cycle. Before fertilization solution pH was 5.6 at the 5 cm depth and varied from 7.85 at 60 cm to 4.35 at 40 cm. After three days, solution acidity increased as pH dropped to values ranging from 4.1 to 4.65 except at the 60 cm depth which remained nearly neutral. During the next three weeks, pH increased at the 5, 20 and 30 cm depths but the increases were small at the 40 and 60 cm depths. In water below the emitters at Nickel's Trust, acidity is changing dramatically during a fertilization cycle. Part of the reason for the large difference in the upper soil

depths is the alkaline irrigation water. Before ammonium sulfate addition, water in the drip basin had a pH of 8.3. Immediately following ammonium sulfate addition solution pH dropped to 6.8. The alkaline water and the changes in solution pH over a four week period suggests that the roots are not continuously exposed to the extremely acid conditions which have been measured in earlier studies. This may help to explain the lack of deleterious effects associated with the strongly acid soils in this orchard.

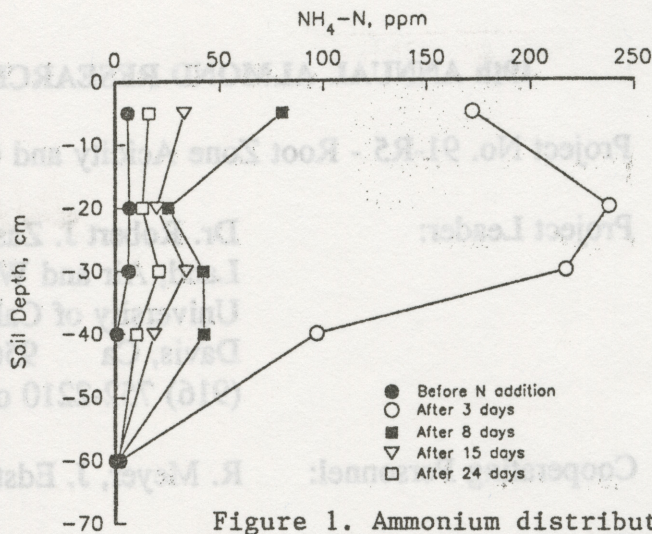


Figure 1. Ammonium distribution

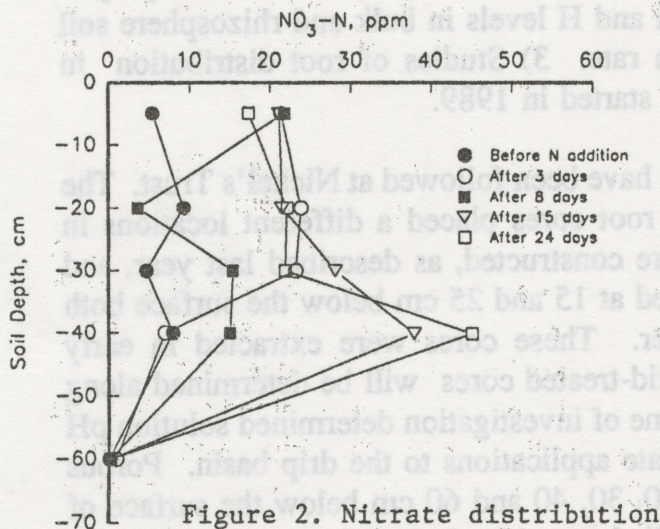


Figure 2. Nitrate distribution

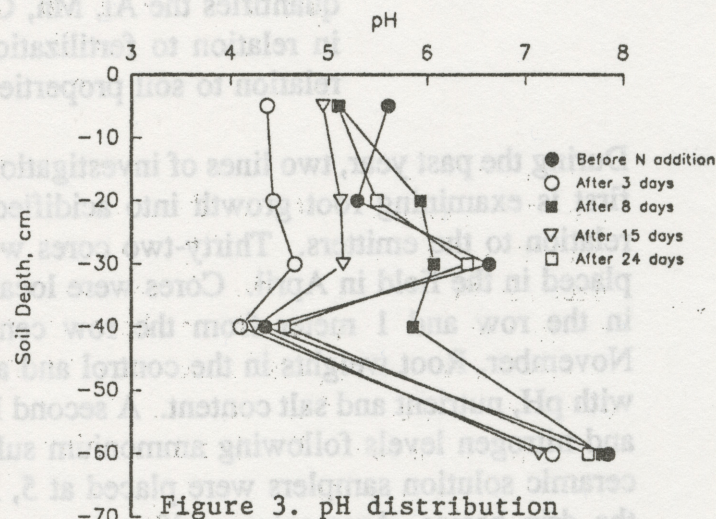


Figure 3. pH distribution