ANNUAL REPORT FOR 1987

PROJECT NO. 87-Q6 - TREE AND CROP RESEARCH NITROGEN ON DRIP IRRIGATED ALMONDS

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Significance:

Drip irrigation is a method of providing water to trees which makes for a number of challenging management situations. Having a relative small volume of soil being used as the reservoir for water and nutrient uptake which is saturated a high percent of the time during the summer provides a setting for several unusual chemical reactions in the soil. As mentioned in previous reports the use of an acidifying nitrogen fertilizer such as urea may increase the solubility of toxic elements like manganese and aluminum. Denitrification may also be occurring at a rather rapid rate which could result in reduced nitrogen efficiency by the crop. Additionally the effect of plant nutrient uptake and the leaching effect of the low salt water on these neutral non-calcareous soils is a factor in lowering the pH of the soil. Because the answers to a number of these questions are still unknown this project was initiated and the continuing challenges will allow for the development of procedures that will allow growers to manage fertilizer application through drip irrigation systems to maintain profitable almond production.

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 assess the extent of soil acidification from nitrogen application under drip emitters. (3) To develop recommendations for nitrogen, irrigation and soil management for use in the establishment of almond orchards. (4) To evaluate changes in nutrient balance as a result of acidification, leaching and nutrient uptake.

Interpretive Summary:

The 1987 yield results of the fertilizer-irrigation trial were outstanding. The trees are in their seventh leaf, planted in 1981, and have been harvested for 4 years. There are 202 trees per acre. The weather for 1987, in contrast to 1986, was excellent during bloom. Rainfall beginning October 1, 1986, to October 1, 1987, was below average. Essentially no effective rainfall was received after March 24. The amount of effective stored rainfall from October 1 to end of rainfall in March for use after March would be about 0 inches. From October 1 to the end of March there was 11 inches of rainfall and water use from weeds and evaporation was equivalent to 17 inches during this period.

There are two water rates, the lower rate being .60 ET and the higher rate being 1.0 ET. The applied water rate at 90% efficiency for .6 ET was about 36 inches, while the rate for the 1.0 ET was 52 inches. ET reference water use from October 1, 1986, to September 30, 1987, was 59 inches and rainfall was 11.72 inches. Water use from March 15 to September 30 was about 44 inches. The higher rate of water gave a response at the higher fertilizer rates but not at the lower fertilizer rates. There are five fertilizer rates from low to moderate to very high. The highest rate was designed to be excessive. The rates in 1986 were 75, 150, 300, 450 and 600 pounds per acre of nitrogen. In 1987 these rates were increased to 100, 200, 400, 600 and 800 pounds of nitrogen per acre. The 1987 average yields in order of increasing nitrogen applications for all varieties in meat pounds per acre were 1746, 2434, 2937, 3068 and 3121 with an overall average of 2661 pounds. The highest plot yield being 3903 pounds. The average of the ten highest plots was 3671 pounds per acre. Yield records for the individual plots have been maintained and are being summarized for the four years. The highest yielding plot received the high nitrogen rates and high water rate and has produced a total four year yield of over 10,400 pounds per acre equivalent. The lowest yielding plot is a low nitrogen low water plot and has produced a total of 3218 pounds for the four years. The acidity trial is proceeding as scheduled; plots are receiving their scheduled acidifying or non-acidifying fertilizers. Nitrogen rates for 1987 were 600 pounds of nitrogen per acre. Leaf samples have been collected monthly. Amelioration of selected plots are scheduled to begin in 1988.

Plans and Procedures:

The orchard was planted on the Nickels Trust Ranch in the Spring of 1981 to three almond varieties--Butte, Carmel and Nonpareil. 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 include two water levels-0.6 and 1.0 of evapotranspiration (ET) each with five nitrogen rates, zero, low, medium, high and very high an exploratory rate. The first year no nitrogen was applied. In subsequent years the rates have increased each year to the seventh leaf. The 1982 applications were 0, 6, 12, 19 and 25 pounds per acre. The 25 pound rate is equal to 2 ounces per tree. These rates increase to 100, 200, 400, 600 and 800 pounds of nitrogen per acre in 1987. In 1987 the fertilizer was applied in six equal increments during the first week of the month beginning in April.

Plans for 1988 are to maintain the 1987 fertilizer rate, sample leaves and twigs, measure trunk diameter, maintain and monitor the irrigation system. Irrigation will be based on the CIMIS program as modified for the Nickels Trust. Soil samples will be taken to monitor the changes in soil acidity, monitoring the various nutrient gains or depletions. Soil sampling procedures were changed to reduce the number of samples per site to allow a greater number of sites to be taken.

The progress of the companion acidification trial is continuing and increased sampling will begin in 1988 to monitor changes which have occurred. Some treatments to correct soil acidity are planned for 1988.

Results:

The 1987 results are summarized in the following data sheets:

1. Nickels 1987 Fertilizer Irrigation Yield Data
2. ET_o and Rainfall for 1986-1987 Water Year
3. Irrigation Trial Nitrogen Application Rates
4. Nickels Fertilizer Irrigation Accumulated Yields
5. Annual and Total Accumulated Yields
6. Total Accumulated Yield or Total Accumulated Nitrogen Applied
7. 1987 Nitrogen Rates vs 1987 Yield lbs./Acre For Varieties
8. 1987 Nitrogen Rates vs Water Rates, Average Of All Varieties

Discussion:

While this trial has been very successful, judging by yield results, one should not conclude that these high nitrogen rates are necessary under other conditions. We believe that yield responses, to these high nitrogen rates, are not simply a result of the current year's application, but rather reflect the previous year's fertilizer applications as well. Consequently, the effect of the 800 lbs. nitrogen rate or any other current rate cannot be totally evaluated until 1988, and 1989. This is because the nitrogen cycle of a developing perennial crop is much more complicated than it is for annual crops.

One should particularly note that the trial area had never been previously irrigated. Neither had the area received any significant amount of fertilizer. The low nitrogen status of this area became more apparent as the zero nitrogen trees showed severe nitrogen deficiency and could not have survived without nitrogen application.

PUBLICATIONS 1987

1. For Drip Irrigated Almonds, Soil Adcidification Is Key Concern, Roland Meyer, Herbert Schulbach, John Edstrom, Almond Facts May-June 1987.

2. 1987, Nickels Trial Almond Yields, Herbert Schulbach, Colusa County Sun Herald November 10, 1987.

3. Managing The Soil Fertility And Tree Nutrition of Deciduous Fruit And Nut Crops, Roland Meyer, California Fertilizer Association February 18-19, 1987.

NICKELS 1987 FERTILIZER - IRRIGATION YIELD DATA
HERB SCHULBACH - JOHN EDSTROM - ROLAND MEYER
200 TREES/ACRE

IRRIGATION TREATMENT	0.6 ET						1.0 ET					
TREATMENT #	*1*	*2*	*3*	*4*	*5*		*6*	*7*	*8*	*9*	*10*	
FERTILIZER RATE '86 OZ/TREE	*6*	*12*	*24*	*36*	*48*		*6*	*12*	*24*	*36*	*48*	
FERTILIZER RATE '87 OZ/TREE	*8*	*16*	*32*	*48*	*64*		*8*	*16*	*32*	*48*	*64*	
YIELD LBS/ACRE												
CARMEL	2194	2767	2631	3012	2504		1838	2269	1271	2311	3458	
	1854	2236	2804	2796	2450		1576	2664	3518	3301	3716	
Average	2024	2451	2717	2904	2477	2515	1707	2461	2394	2806	3587	2581
BUTTE	1670	2423	3434	3835	2236		1131	2441	2918	2243	3642	
	1770	2204	2950	3026	3117		1353	2494	2614	3748	3480	
Average	1720	2313	3192	3430	2677	2666	1242	2467	2766	2996	3561	2606
NONPAREIL	2143	2867	3174	1919	3806		1362	2141	3455	3452	2816	
	2100	2432	3605	3278	2851		1971	2392	2875	3903	3384	
Average	2122	2649	3389	2598	3328	2817	1667	2267	3165	3678	3100	2776
AVERAGE ALL VARIETIES	1955	2471	3099	2977	2827	2676	1538	2398	2775	3160	3416	2657

SUMMARY

IRRIGATION	0.6 ET						1.0 ET					
FERTILIZER TREATMENT	*1*	*2*	*3*	*4*	*5*	*AVE.*	*6*	*7*	*8*	*9*	*10*	*AVE.*
Average All Varieties	1955	2471	3099	2977	2827	2676	1538	2398	2775	3160	3416	2657

FERTILIZER TREATMENT	1 + 6	2 + 7	3 + 8	4 + 9	5 + 10	AVE.
CARMEL	1865	2456	2556	2855	3032	2553
BUTTE	1481	2390	2979	3213	3119	2636
NONPAREIL	1894	2458	3277	3138	3214	2796
AVERAGE ALL VARIETIES	1746	2434	2937	3068	3121	2661

ET_o AND RAINFALL FOR 1986-87 WATER YEAR

FOR DEPARTMENT OF WATER RESOURCES

STATION COLUSA, CALIFORNIA - #32

		ET_o"	ACCUMULATED ET_o"	IRRIGATION SEASON BEGINNING MARCH 15	PPT"	ACCUMULATED PPT"
October	1986	4.40	4.40		.16	.16
November	1986	3.18	7.58		.28	.44
December	1986	1.26	8.84		1.18	1.62
January	1987	1.90	10.74		2.68	4.30
February	1987	2.54	13.28		2.44	6.74
March	1987	3.67	16.95	1.67	4.22	10.96
April	1987	6.56	23.51	8.23	0.16	11.12
May	1987	7.20	30.71	15.43	0.00	11.12
June	1987	7.93	38.64	23.36	0.08	11.20
July	1987	7.74	46.38	31.10	0.08	11.28
August	1987	7.33	53.71	38.43	0.20	11.48
September	1987	5.15	58.86	43.58	0.24	11.77
October	1987	3.56	3.56		0.67	0.67

The irrigation season began approximately March 15th.

The percentage of infiltrated rainfall which is stored for crop use depends upon dryness of soil. If the soil is airdry and absorbs 11 inches of rainfall, then that portion above field capacity or about 50% or 5.5 inches would be available for plant use. If weed growth and evaporation used a portion of this supply it would further reduce the supply available for crop use. Of course rainfall does need to be evaluated to compensate for any run-off which takes place. On the average, only 50% of the rainfall should be considered stored. Five and one-half inches of water can be considered to be one good irrigation.

NICKELS FERTILIZER – IRRIGATION TRIAL NITROGEN APPLICATION RATES
NITROGEN FERTILIZER RATES AS OUNCES/TREE AND POUNDS/ACRE
HERB SCHULBACH – JOHN EDSTROM – ROLAND MEYER
(201.67 TREES/ACRE)

YEARS	PLOT NUMBERS + RATES									
	1 AND 6		*2 AND 7*		*3 AND 8*		*4 AND 9*		*5 AND 10*	
	OZ/T	*LBS/A*	*OZ/T*	*LBS/A*	*OZ/T*	*LBS/A*	*OZ/T*	*LBS/A*	*OZ/T*	*LBS/A*
1981	0	0	0	0	0	0	0	0	0	0
1982	0	0	.5	6.$^{+}$	1.0	12.$^{+}$	1.5	19^{-}	2	25
1983	0	0	1	12.$^{+}$	2	25	4	50	8	100
1984	0	0	2	25	4	50	8	100	16	200
1985	4	50	8	100	16	200	24	300	32	400
1986	6	75	12	150	24	300	36	450	48	600
1987	8	100	16	200	32	400	48	600	64	800
TOTAL	***18***	***227***	***40***	***498***	***79***	***995***	***122***	***1531***	***170***	***2142***
PROPOSED RATE:										
1988	8	100	16	200	32	400	48	600	64	800

NICKELS FERTILIZER - IRRIGATION ACCUMULATED YIELDS
1984 - 1987
AVERAGE MEAT POUNDS/ACRE/TREATMENT
HERB SCHULBACH - JOHN EDSTROM - ROLAND MEYER

IRRIGATION TREATMENT		0.6 ET						1.0 ET						AVERAGE 0.6 ET + 1.0 ET					
TREATMENT #		*1*	*2*	*3*	*4*	*5*	*AVE.*	*6*	*7*	*8*	*9*	*10*	*AVE.*	*1+6*	*2+7*	*3+8*	*4+9*	*5+10*	*AVE.*
CARMEL	1984	768	924	1067	1037	1289	1017	874	935	1281	1262	1685	1207	821	930	1174	1150	1487	1112
	85	1198	1344	1182	1793	2035	1510	920	1427	1646	1920	2556	1694	1059	1385	1413	1856	2295	1602
	86	456	760	1172	1178	1105	935	594	509	1130	1515	1650	1080	525	634	1152	1346	1378	1008
	87	2024	2451	2717	2904	2477	2515	1707	2461	2394	2806	3587	2581	1865	2456	2556	2855	3032	2553
	TOTAL	*4446*	*5479*	*6138*	*6912*	*6906*	*5977*	*4095*	*5332*	*6451*	*7503*	*9478*	*6571*	*4270*	*5405*	*6295*	*7207*	*8192*	*6274*
BUTTE	1984	610	675	892	1070	1142	878	740	790	959	1270	1238	999	675	732	926	1170	1190	938
	85	616	738	1147	1397	1524	1084	519	897	1272	1663	1820	1234	567	822	1209	1531	1672	1159
	86	832	1228	2046	1922	1994	1604	772	1278	1922	2340	2497	1761	802	1253	1984	2131	2245	1682
	87	1720	2313	3192	3430	2677	2666	1242	2467	2766	2996	3561	2606	1481	2390	2979	3213	3119	2636
	TOTAL	*3778*	*4954*	*7277*	*7819*	*7337*	*6232*	*3273*	*5432*	*6919*	*8269*	*9116*	*6600*	*3525*	*5207*	*7098*	*8045*	*8226*	*6416*
NONPAREIL	1984	620	804	788	1152	1497	972	623	835	972	904	1416	950	622	820	880	1028	1456	961
	85	449	615	798	771	1657	858	546	730	887	1294	1641	1020	497	672	842	1032	1649	939
	86	667	1082	1494	1498	1988	1345	560	988	1398	1414	1458	1164	613	1035	1446	1456	1723	1254
	87	2122	2649	3389	2598	3328	2717	1667	2267	3165	3678	3100	2776	1894	2458	3277	3138	3214	2796
	TOTAL	*3858*	*5150*	*6469*	*6019*	*8470*	*5992*	*3396*	*4820*	*6422*	*7290*	*7615*	*5908*	*3626*	*4985*	*6445*	*6654*	*8042*	*5950*
ALL AVERAGE TOTAL		4027	5194	6628	6917	7571	6067	3588	5195	6597	7687	8736	6359	3807	5196	6612	7302	8153	6214

NICKELS IRRIGATION & FERTILIZER STUDY
ANNUAL AND TOTAL ACCUMULATED YIELD MEAT POUNDS PER ACRE
OCTOBER, 1987 — HERB SCHULBACH, JOHN EDSTROM, ROLAND MEYER

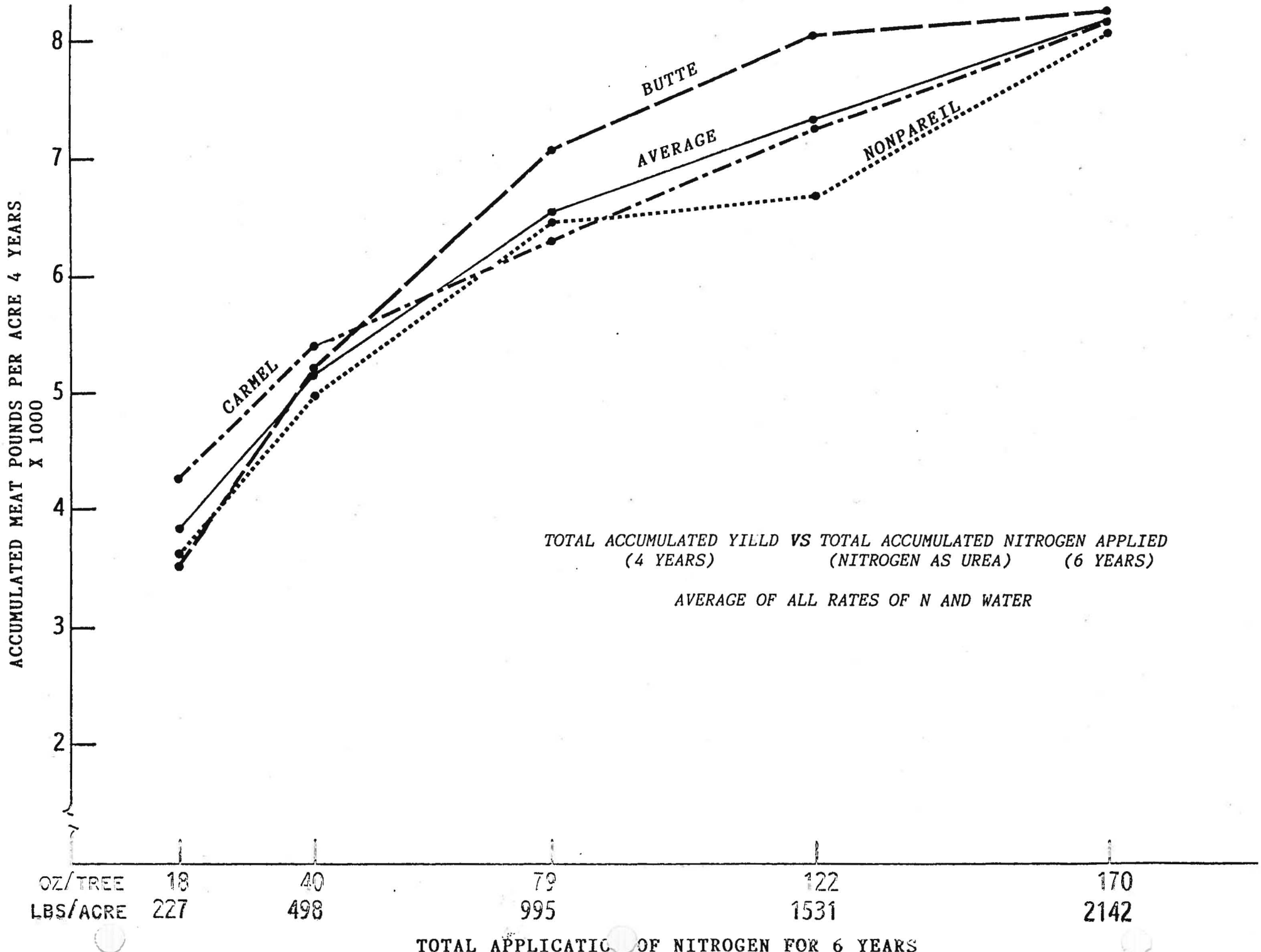
VARIETY	C	B	NP	C	B	NP	C	B	NP	C	B	NP
PLOT #	*5*	*6*	*15*	*16*	*25*	*26*	*35*	*36*	*45*	*46*	*55*	*56*
TREATMENT #	*8*	*6*	*4*	*9*	*9*	*10*	*3*	*6*	*8*	*6*	*9*	*1*
K 1bs/A '84	1260	766	1206	1062	1332	1510	931	714	1069	994	1207	572
'85	1256	542	546	1510	1597	1477	1238	1364	816	706	1735	458
'86	1299	954	1299	1168	1991	1395	1356	590	1393	758	2689	625
'87	1271	1131	1919	2311	2243	2816	2804	1353	2875	1576	3748	2100
Total	***5086***	***3293***	***4970***	***6051***	***7163***	***7198***	***6329***	***4021***	***6153***	***4034***	***9379***	***3755***
PLOT #	*4*	*7*	*14*	*17*	*24*	*27*	*34*	*37*	*44*	*47*	*54*	*57*
TREATMENT #	*3*	*5*	*6*	*5*	*8*	*7*	*1*	*10*	*4*	*4*	*7*	*9*
K 1bs/A '84	1203	1224	755	1261	1005	784	727	1098	1099	1114	853	941
'85	1334	1231	418	2070	1318	655	1031	1299	997	1804	1110	1451
'86	995	1812	549	800	1909	933	433	2332	1696	1416	1223	1559
'87	2631	2236	1362	2504	2918	2141	1854	3480	3278	2796	2494	3903
Total	***6063***	***6503***	***3084***	***6635***	***7150***	***4503***	***4145***	***8209***	***7070***	***7130***	***5480***	***7854***
PLOT #	*3*	*8*	*13*	*18*	*23*	*28*	*33*	*38*	*43*	*48*	*53*	*58*
TREATMENT #	*2*	*2*	*9*	*6*	*4*	*8*	*10*	*2*	*2*	*2*	*4*	*3*
K 1bs/A '84	940	646	867	754	1094	874	1853	704	957	908	1047	710
'85	1322	766	1138	1134	1459	959	2879	731	605	1366	1335	921
'86	902	1272	1270	431	2001	1404	1957	1182	996	618	1844	1461
'87	2767	2423	3452	1838	3835	3455	3716	2204	2432	2236	3026	3605
Total	***5931***	***5107***	***6727***	***4157***	***8389***	***6692***	***10405***	***4821***	***4990***	***5128***	***7252***	***6697***
PLOT #	*2*	*9*	*12*	*19*	*22*	*29*	*32*	*39*	*42*	*49*	*52*	*59*
TREATMENT #	*4*	*1*	*2*	*7*	*3*	*1*	*8*	*5*	*7*	*7*	*1*	*6*
K 1bs/A '84	960	492	650	693	920	668	1303	1061	886	1178	728	490
'85	1782	446	626	1360	1170	440	2035	1818	806	1494	786	674
'86	941	732	1168	514	2173	709	961	2176	1042	504	933	572
'87	3012	1548	2867	2269	3434	2143	3518	3117	2392	2664	1770	1972
Total	***6695***	***3218***	***5311***	***4836***	***7697***	***3960***	***7817***	***8172***	***5126***	***5840***	***4217***	***3708***
PLOT #	*1*	*10*	*11*	*20*	*21*	*30*	*31*	*40*	*41*	*50*	*51*	*60*
TREATMENT #	*5*	*7*	*3*	*1*	*10*	*5*	*9*	*3*	*5*	*5*	*8*	*10*
K 1bs/A '84	1496	728	865	808	1378	1654	1463	864	1340	1318	913	1322
'85	2234	685	675	1364	2017	1528	2330	1112	1785	2000	1227	1806
'86	1342	1334	1527	479	2662	2401	1861	2019	1574	1411	1935	1522
'87	3458	2441	3174	2194	3642	3806	3301	2950	2851	2450	2614	3384
Total	***8530***	***5188***	***6241***	***4845***	***9699***	***9389***	***8955***	***6945***	***7550***	***7179***	***6689***	***8034***

VARIETY C = Carmel, B = Butte, NP = NonPareil

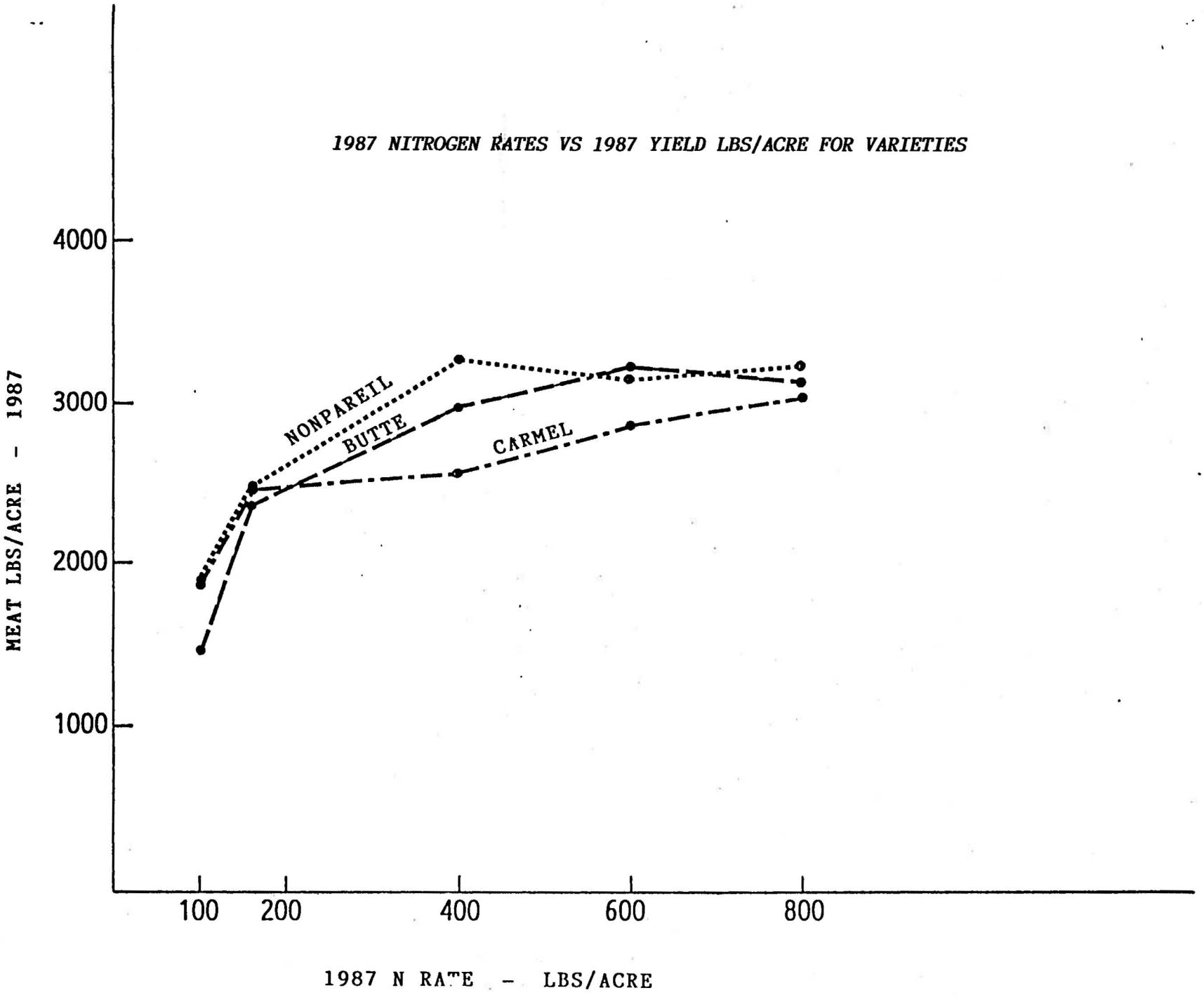
IRRIGATION TREATMENTS 1 - 5 = .6 ET; 6 - 10 = 1.0 ET

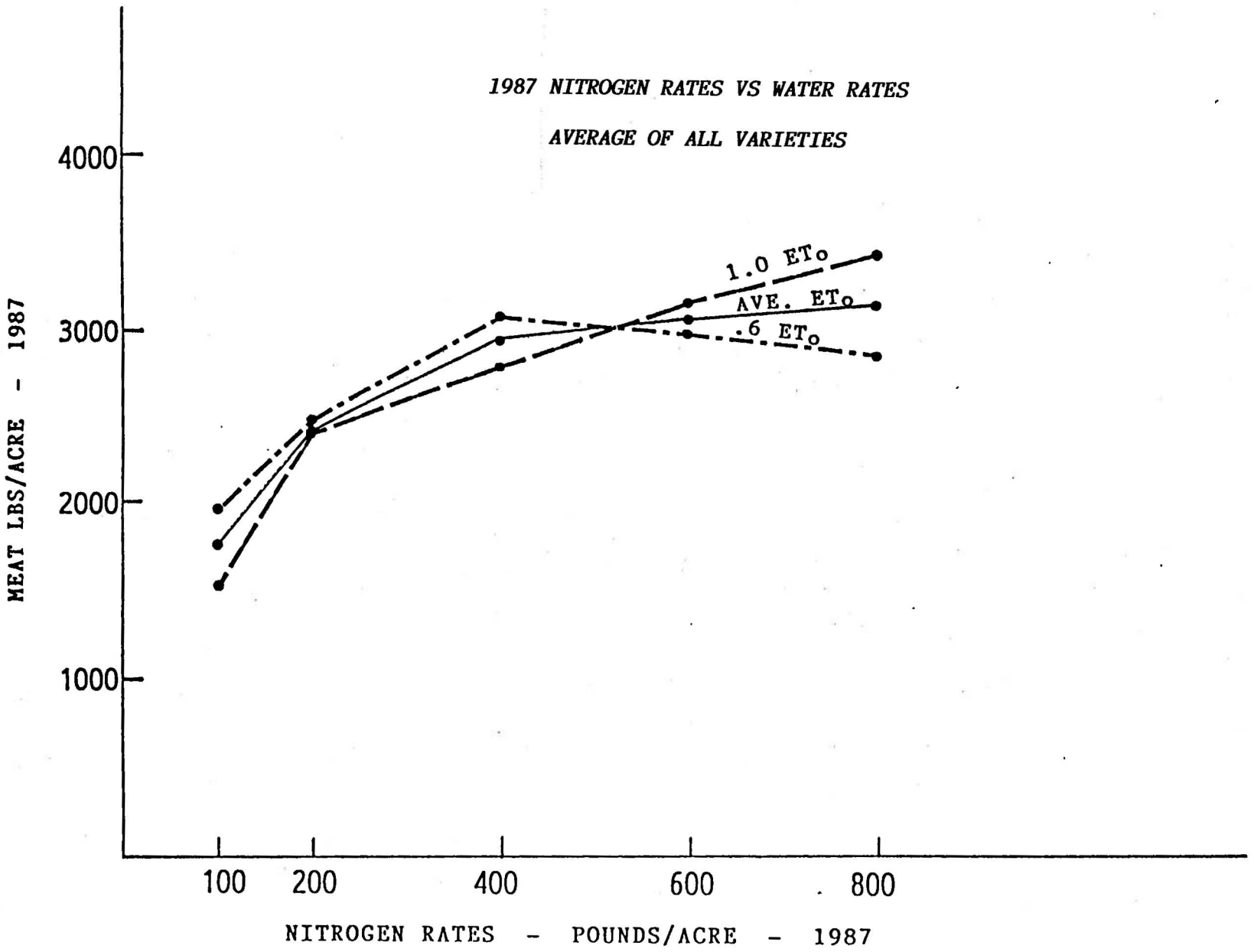
FERTILIZER RATE -- ANNUAL -- OZ/TREE N

	1-6	*2-7*	*3-8*	*4-9*	*5-10*		*1-6*	*2-7*	*3-8*	*4-9*	*5-10*
1981	0	0	0	0	0	1985	4	8	16	24	32
1982	0	.5	1.0	1.5	2.0	1986	6	12	24	36	48
1983	0	1	2	4	8	1987	8	16	32	48	64
1984	0	2	4	8	16						


ACCUMULATED MEAT POUNDS PER ACRE 4 YEARS
X 1000
8
7
6
5
4
3
2
BUTTE
AVERAGE
NONPAREIL
CARMEL
TOTAL ACCUMULATED YILLD VS TOTAL ACCUMULATED NITROGEN APPLIED
(4 YEARS) (NITROGEN AS UREA) (6 YEARS)
AVERAGE OF ALL RATES OF N AND WATER
OZ/TREE 18 40 79 122 170
LBS/ACRE 227 498 995 1531 2142
TOTAL APPLICATIO OF NITROGEN FOR 6 YEARS

1987 NITROGEN RATES VS 1987 YIELD LBS/ACRE FOR VARIETIES




1987 NITROGEN RATES VS WATER RATES
AVERAGE OF ALL VARIETIES
4000
3000
2000
1000
MEAT LBS/ACRE - 1987
1.0 ETo
AVE. ETo
.6 ETo
100
200
400
600
800
NITROGEN RATES - POUNDS/ACRE - 1987

PROCEEDINGS

THIRTY-FIFTH ANNUAL

FERTILIZER CONFERENCE AND TRADE SHOW

Sponsored By

California Fertilizer Association

February 18-19, 1987
Visalia Convention Center
Visalia, California

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PROCEEDINGS MAILED COURTESY OF CHEVRON CHEMICAL COMPANY

MANAGING THE SOIL FERTILITY AND TREE NUTRITION OF DECIDUOUS FRUIT AND NUT CROPS.

By Roland D. Meyer, Extension Soils Specialist
LAWR, University of California, Davis

In some respects the management of soil fertility and tree nutrition of perennial fruit and nut crops is quite different from that of annual crops. This may be a result of the deeper, well drained and perhaps generally better quality soils on which deciduous tree crops are planted. Although tree crops can and are grown on shallow, less well drained or higher salt containing soils, a much higher level of management intensity and skill is required to maintain adequate profitability. In other cases, some of the same nutritional concerns for tree crops are quite similar to those of a number of annual crops.

Nitrogen is the most frequently applied nutrient to all crops and deciduous fruit and nut crops are no exception. Perhaps because of the relatively economically priced nitrogen fertilizers on the market the past 20 to 30 years, higher than optimum rates have been applied to achieve the greatest yield levels. Most of this "extra" nitrogen has been applied and justified by growers, dealers, advisors and even researchers on the basis that "it won't hurt to have a little extra and we don't want to be short." As we continue to learn more about how best to achieve higher yields, the rate, method and time of application become more important in determining higher profitability and decreasing the adverse impacts on the environment. In the case of nitrogen usage the adverse impact is often the potential for groundwater contamination by nitrates.

If one were to group the tree crops on the basis of nitrogen removal it could be done generally as fruit with 20 to 60 lbs N/A and nut with 40 to 200+ lbs N/A. Although nitrogen removal is not the only parameter to consider when deciding on application rates, it can be considered as one of the more important guidelines to use along with soil characteristics and irrigation practices. Past research has indicated that rates of 40 to 100 lbs N/A for fruit trees and 80 to 200 lbs N/A for nut trees are in the most profitable range. Labeled nitrogen studies have shown that the most efficient uptake occurs during the period of the year when the leaves are on the trees and they are actively growing.

Because of our interest in learning more about the nitrogen rates that would be applicable for a newly established drip irrigated almond orchard a trial was initiated in the spring of 1981. This was accomplished with the help of Thomas Aldrich, Herbert Schulbach, the Nickels Estate and in recent years John Edstrom as well as myself. In the spring of 1982, five-5 tree plots were selected from each of the four-28 tree rows of the three almond varieties — Butte, Carmel and Nonpareil to which the two replications of the ten treatments

As many almond growers know spring weather conditions in 1986 had a dramatic impact on yield which in a lot of cases was negative. This was also true at the experimental site as yields were somewhat lower for the Carmel variety which ranged from 400 up to 1900 kernel pounds per acre (Figure 1). Nonpareil had nearly the same range with the exception of one plot on which a 2400 yield was recorded (Figure 2). Climatic conditions were slightly more favorable for a better set for the Butte variety thus yields ranged from 500 up to over 2600 kernel pounds per acre (Figure 3). Yields tended to increase with greater amounts of applied nitrogen however responses with more than 24 oz N/tree were rather small. The Butte and Carmel varieties showed the greater responses when more than 24 oz N/tree was applied particularly at the higher water level. A much larger yield response may have occurred had there been more favorable climatic conditions for a better set. The Nonpareil variety continued to show as it has in past years, little different between the 0.6 and 1.0 ET irrigation levels whereas the Butte and Carmel had higher yields at the 1.0 ET irrigation, particularly at the 36 and 48 oz/tree nitrogen rates.

The nitrogen use efficiency is defined as that portion or percent of the applied nitrogen which is recovered in the hulls, shells and kernels when almonds are harvested. It is calculated by subtracting the amount of nitrogen contained in the yield of the control or no nitrogen treatment (lowest nitrogen rate of 4 oz/tree in 1985) from all other treatments and expressing this difference as a percent of the amount of nitrogen applied. Figures 4 and 5 illustrate the nitrogen use efficiency for almonds across the nitrogen rate and water level treatments during 1984 and 1985 respectively. It is quite normal to see higher efficiencies with a larger range as well at the lower rates of nitrogen application as is indicated in 1984 (Figure 4). The averages of about 30% at the 2 oz N/tree rate going to 20% at the 16 oz N/tree are within the normal values reported by researchers. The near constant efficiencies of about 15% for all rates of nitrogen application in 1985 are somewhat low but still within the range of normal values. It is unusual for the efficiency not to drop however as higher rates of nitrogen are applied.

To more thoroughly characterize soil pH and other parameters under the drip emitters, one quarter of the sphere below the point of water entry into the soil was sampled as 3" X 3" X 3" cubes in October 1985. These samples were taken in the 3" increments up to 21" from the injection point and to a depth of 18" under trees from the control and 30" under trees from the highest nitrogen rate treatments. Table 1a and 1b present the results of soil pH determinations for one 3" plane of soil samples from a high nitrogen-high water treatment (Table 1a) and from a low nitrogen-low water treatment (Table 1b). Where no or very little nitrogen was applied there are relatively few samples having a pH below 6 and they occur directly below the emitter from 9 to 18" depth. Table 1a shows a large number of soil pH values below 4 and they extend to a depth of 30" as well

Table 1a. Soil pH under drip emitter from High nitrogen, High water treatment.

Soil Depth (inches)	Distance from emitter, inches 0	3	6	9	12	15	18	21
0- 3"	7.1	6.7	6.7	6.7	5.1	6.2	6.2	
3- 6	4.7	5.3	6.6	6.2	5.4	6.6	6.4	
6- 9	5.8	5.1	5.0	5.7	5.6	4.8	5.5	
9-12	4.2	4.2	4.2	4.8	4.8	4.4	4.5	
12-15	3.8	3.7	3.9	4.0	4.2	4.1	4.3	
15-18	3.6	4.2	3.6	3.4	4.1	3.7	4.8	
18-21	4.1	3.9	4.0	4.2	4.5	4.5	5.4	
21-24	4.0	3.9	3.8	3.9	4.1	4.4	4.9	
24-27	4.0	3.9	3.8	3.8	3.9	4.2	4.4	
27-30	4.1	3.9	4.0	4.0	4.0	4.4	4.7	

Table 1b. Soil pH under drip emitter from Low nitrogen, Low water treatment.

Distance from emitter, inches 0	3	6	9	12	15	18	21
6.7	6.7	6.5	6.6	6.8	6.9	6.8	
6.5	6.9	6.7	7.0	7.0	6.7	6.9	
6.3	6.6	6.6	6.3	6.5	6.6	6.2	
5.8	5.9	6.3	6.3	6.3	6.4	6.5	
5.8	6.0	6.1	6.1	6.1	6.2	6.2	
5.9	6.3	6.3	6.4	6.4	6.2	6.1	

Figure 5. Nitrogen use efficiency of almonds in 1985 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch

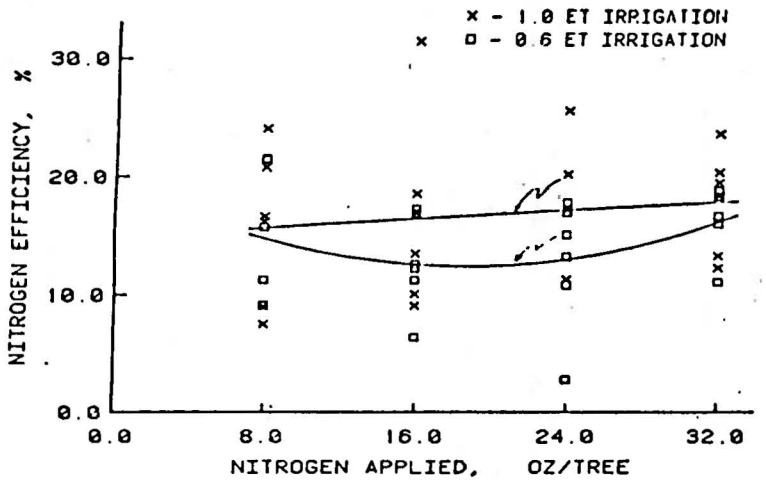


Figure 6. Total manganese concentration in almond leaves on October 8, 1984 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch

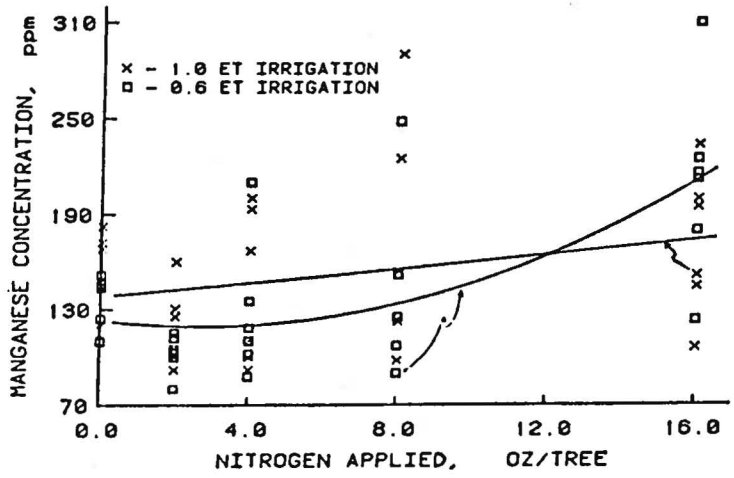


Figure 7. Total manganese concentration in almond leaves on October 4, 1985 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch

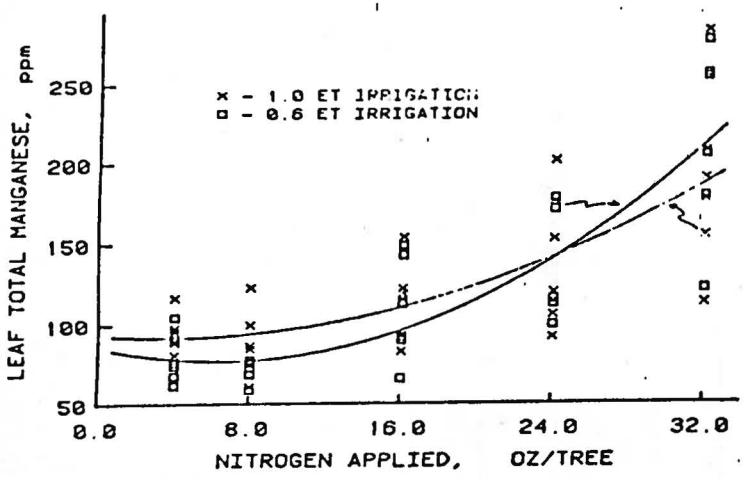
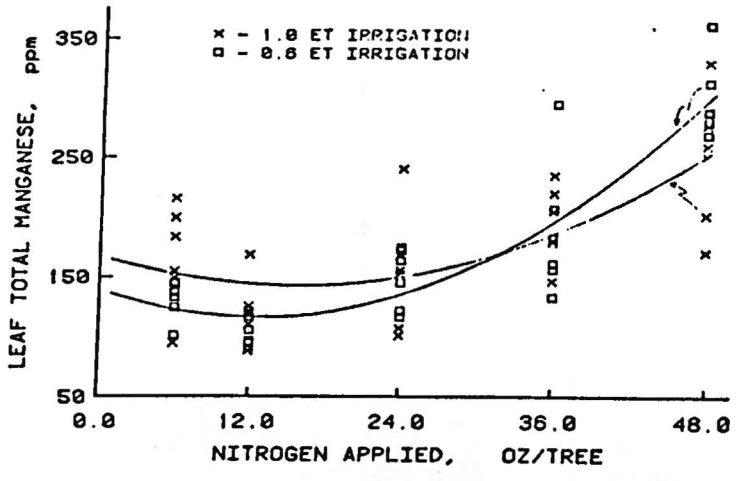


Figure 8. Total manganese concentration in almond leaves on October 8, 1986 as influenced by nitrogen rate and water applied through drip system. Nickels Ranch

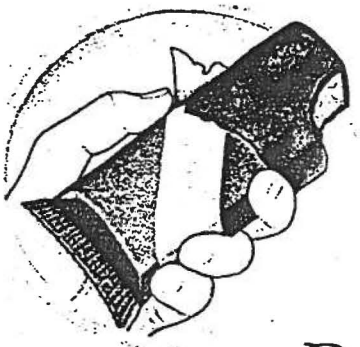


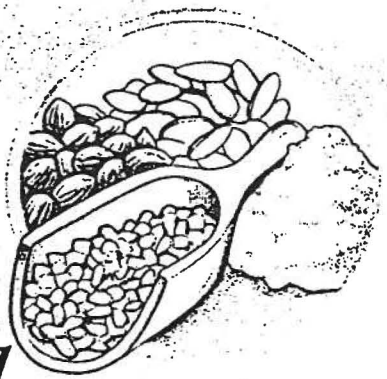
May/June 1987

BLUE DIAMOND

ALMOND FACTS

For the members and friends of the California Almond Growers Exchange





Blue Diamond captures competitive edge

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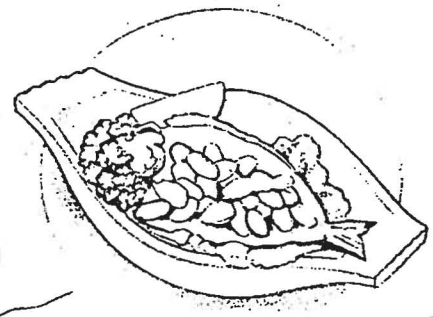

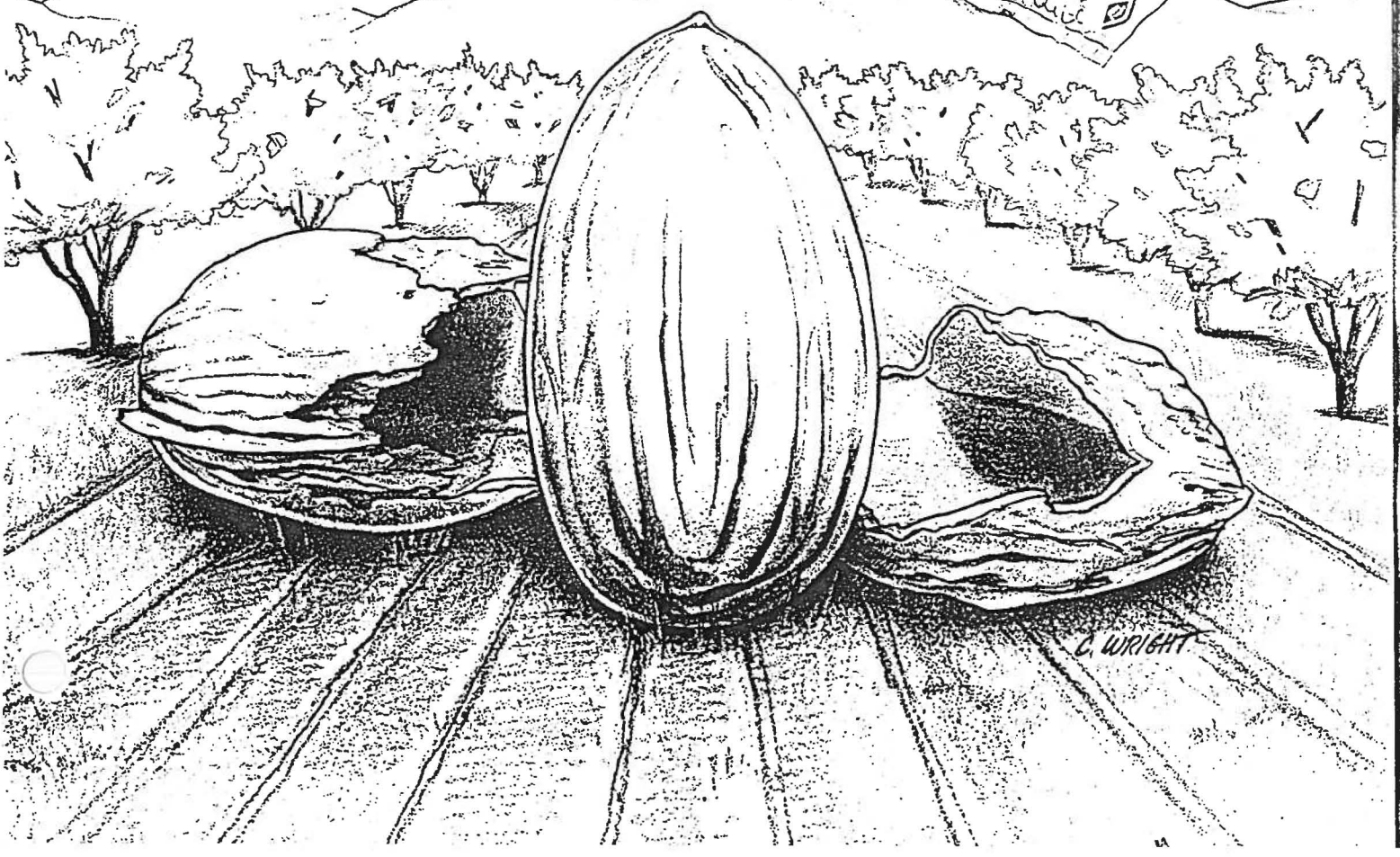

FOR DRIP IRRIGATED ALMONDS, SOIL ACIDIFICATION IS KEY CONCERN

by
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Drip irrigation is a way of providing water to trees which creates many management challenges. A relatively small volume of soil used for the water and nutrient uptake reservoir, which is largely saturated during summer, provides a setting for several unusual chemical reactions in the soil.

As expected, the use of an acidifying nitrogen fertilizer such as urea may increase solubility of toxic elements like manganese and aluminum. Nitrogen removal may also occur at a rapid rate which could cause reduced nitrogen efficiency.

Because the answers to a number of these questions are still unknown, an experiment was initiated at the Nickles Trust in spring 1981 with three almond varieties — Butte, Carmel, and Nonpareil on a 12' x 18' spaced plot with 200 trees per acre. Nitrogen applications cited in Table 1 began April 1 and ended August 1, except in 1986 when the last application was made September 1. Water was applied at two rates, either 100 percent of the trees' evapotranspiration (ET) needs or 60 percent of ET.

Growers may recall that 1986 spring weather conditions negatively impacted yields in many orchards. Consequently, experimental site yields were somewhat lower for the Carmel variety, ranging from 400 to 1,900 kernel pounds per acre (2,300 in 1985 on fifth leaf trees). Nonpareil yields were similar except for one plot that produced 2,400 kernel pounds. Slightly better climatic conditions helped produce a better set on the Butte variety with yields ranging from 500 to over 2,600 kernel pounds per acre. Yields increased with greater amounts of applied nitrogen, but responses with more than 24 ounces N/tree were small.

Butte and Carmel showed greater responses when more than 24-ounces N/tree was applied, particularly at the higher water level. Much larger yields may have occurred with more favorable climatic conditions. As previously experienced, Nonpareil yielded almost the same between 0.6 and 1.0 ET irrigation levels, whereas Butte and Carmel yields were higher at 1.0 ET irrigation, particularly at 36 and 48 ounce rates.

Nitrogen use efficiency is that portion or percent of applied nitrogen recovered in hulls, shells, and kernels when almonds are harvested. It is calculated by subtracting the amount of nitrogen contained in the yield of the control or no nitrogen treatment (lowest nitrogen rate of 4-ounces/tree in 1985) from all other treatments. The difference appears as a percent of nitrogen applied. Similar to 1984, it is normal to see higher efficiencies at a larger range and at lower rates of nitrogen application. Averages of about 30 percent at the 2 ounces N/tree rate to 20 percent at the 16 ounces N/tree rate are within normal values reported by researchers. The near constant efficiencies of about 15 percent for all rates of nitrogen application in 1985 are somewhat low, but still within range of normal values. However, it is unusual for the efficiency not to drop as higher rates of nitrogen are applied.

To analyze soil changes under the drip irrigation system, several samples were taken in fall 1984. These preliminary samples indicated lower than expected pH levels. In fall 1985, soil pH and other parameters under drip emitters were more thoroughly characterized by taking one quarter of the sphere below the point of water entry into the soil and sampling 3" x 3" x 3" cubes.

These samples were taken in 3 inch increments up to 21 inches from the injection point and to a depth of 18 inches under trees from the control and 30 inches under trees from the highest nitrogen rate treatments.

The soil pH results for each of the individual 3" x 3" x 3" cubes are illustrated in Figures 1 and 2 for the two sides of the larger 21" x 21" blocks, which are 21" or 30" deep. Figure 1 illustrates that little pH change occurred where only 4 ounces of nitrogen had been applied during 1985 and none prior to that time.

A different situation is present where a total of 57 ounces N/tree of urea was applied from 1982 through 1985. Figure 2 indicates a large number of soil pH values below four. They extend to a depth of 30 inches and 15 inches to the side of the emitter. Having pH values in this range might suggest that rather adverse effects would be observed in trees, but this is not the case. Although manganese

concentrations in the leaves increased slightly from October 1984 to 1986 at higher nitrogen rates, almost no effect was observed in tree growth.

Apparently, a small portion of the root system is exposed to the low pH environment causing no ill effects on the trees. A newly initiated trial to evaluate different nitrogen fertilizers and their effect on soil pH, as well as corrective treatments to neutralize the acidity, will hopefully suggest management alternatives to this potential problem.

Considering the progress of the experimental orchard through six seasons of growth with three years of favorable kernel yields, nitrogen and water rates to date illustrate a wide spectrum of almond growth and development. Trees receiving higher rates of nitrogen produce good to excellent growth and respond with outstanding meat yields during the fourth, fifth, and sixth seasons.

The earlier concern that trees receiving no nitrogen the first four years and showing tip dieback plus other signs of unthrifty growth look much better after receiving 4 ounces N/tree in 1985 and 6 ounces N/tree in 1986. The long shoot growth with nitrogen applications after extreme shortage may not be the most desirable tree growth for long-term productivity. Nitrogen rates suggested from the study for early years of growth would range from 1 to 3 ounces N/tree during the first season, 2 to 6 ounces N/tree the second, 4 to 8 ounces N/tree the third, 6 to 16 ounces N/tree the fourth, 16 to 32 ounces N/tree the fifth, and 24 to 48 ounces N/tree in the sixth season.

If a larger set and potential nut yield develops, higher rates should be used with adequate amounts of water to at least the 1.0 ET level. These rates are for drip irrigated almonds when the emitters are placed approximately 30 inches on either side of the tree and nitrogen applications are split into three to six equal increments and applied throughout the season.

TABLE 1. Nitrogen and water treatments applied to field experiment

Treatment Number	Irrigation Level				Nitrogen Rate, ounce/tree					
	0.6 ET		1.0 ET		1981	1982[a]	1983[a]	1984[b]	1985[c]	1986[d]
1	X				0	0	0	0	4	6
2	X				0	.5	.8	2	8	12
3	X				0	1.0	1.7	4	16	24
4	X				0	1.5	3.5	8	24	36
5	X				0	2.0	7	16	32	48
6				X	0	0	0	0	4	6
7				X	0	.5	.8	2	8	12
8				X	0	1.0	1.7	4	16	24
9				X	0	1.5	3.5	8	24	36
10				X	0	2.0	7	16	32	48

[a] The two lower rates of nitrogen were split into three applications at 60-day intervals and the two higher rates into four applications at 40-day intervals.
[b] Nitrogen split into four applications at 40-day intervals.
[c] Nitrogen split into five applications at 30-day intervals.
[d] Nitrogen split into six applications at 30-day intervals.

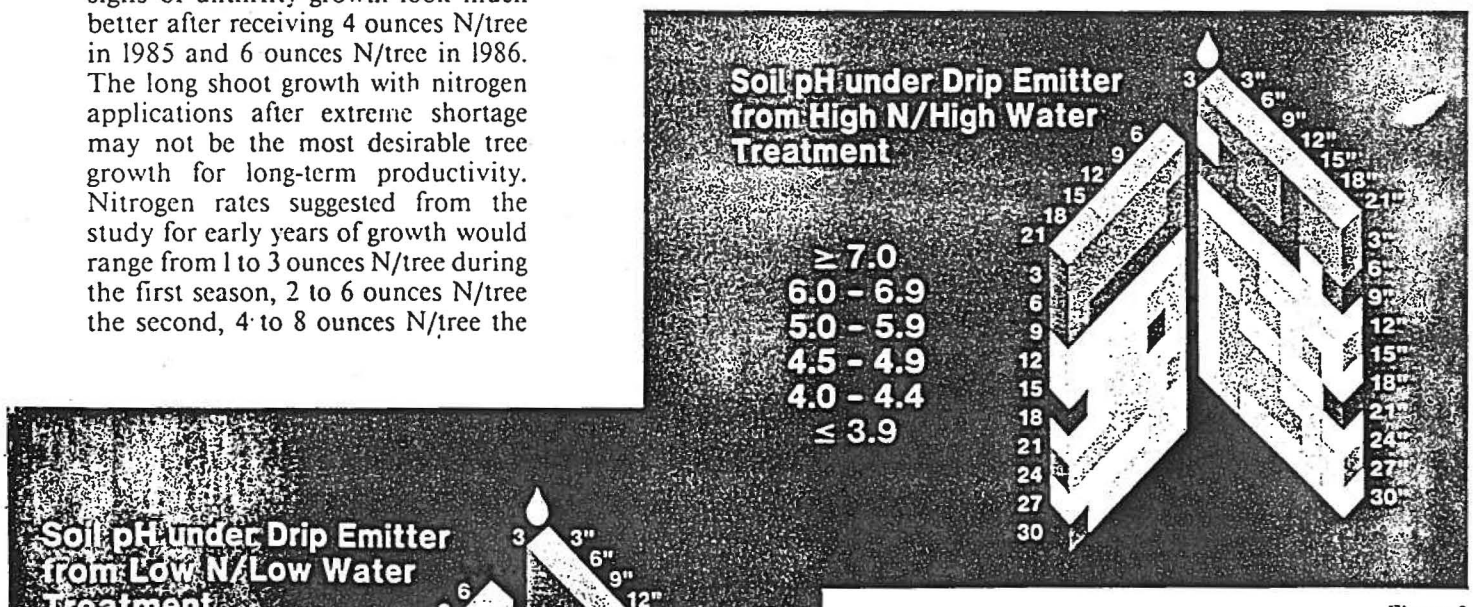

Figure 1

Figure 2

agriculture

U.C. By Extension

1987 Nickels trial almond yields

By HERB SCHULBACH
U.C.Soils & Water Specialist

The 1987 yield results of the fertilizer-irrigation trial were outstanding. This trial is a cooperative effort of the Universityh of California Cooperative Extension and the Nickels Trust and supported by the California Almond Board. The trial is a joint effort of John Edstrom, Roland Myer from Davis and Herb Schulbach. The trees are in their seventh leaf, planted in 1981, and have been harvested for four years. There are 202 trees per acre.

The weather for 1987, in contrast to 1986, was excellent during bloom. Rainfall beginning October 1, 1986 to October 1, 1987 was below average. Essentially no effective rainfall was received after March 24. The amount of effective stored rainfall from October 1 to end of rainfall in March for use after March would be about 0 inches. From October 1 to the end of March there were 11 inches of rainfall and water use from weeds and evaporation was equivalent to 17 inches during this period.

There are two water rates, the lower rate being .60 ET and the higher rate being 1.0 ET. The applied water rate at 90 percent efficiency for .6 ET was about 36 inches, while the rate for the 1.0 ET was 52 inches. ETo reference water use from October 1, 1986 to September 30, 1987 was 59 inches and rainfall was 11.72 inches. Water use from March 15 to September 30 was about 44 inches. The higher rate of water gave a response at the higher fertilizer rates but not at the lower fertilizer rates.

There are five fertilizer rates from low to moderate to very high. The highest rate was designed to be excessive. The rates in 1986 were 75, 150, 300, 450 and 600 pounds per acre of nitrogen. In 1987 these rates were increased to 100, 200, 400, 600 and 800 pounds of nitrogen per acre.

The 1987 yields in order of increasing nitrogen applications for the Nonpareils in meat pounds per acre were 1,894, 2,458, 3,277, 3,138 and 3,214 with an overall average of 2,796 pounds. For the Butte variety the corresponding yields in meat pounds per acre were 1,481, 2,390, 2,979, 3,213 and 3,119 with an overall average of 2,636 pounds. For the Carmels the corresponding yields are 1,865, 2,456, 2,556, 2,855 and 3,032 with an overall average of 2,553 pounds, the highest plot yield being 3,903 pounds. The average of the ten highest plots was 3,671 pounds per acre. The average for all treatments and all varieties was 2,661 pounds per acre.

What is contributing to these high yields? It is not just one factor, but a combination of all factors being at their best and adding to the yield, and at least not reducing the maximum yield potential. These factors which contribute to high yields include good weather, adequate fertilizer, proper water management, adequate bees, proper variety selection and tree arrangement and pruning. No one thing can do it alone.

Now we can look forward to the 1988 harvest to see what effect the high yields of 1987 had on the trees and the following yields.

Yield records for the individual plots have been maintained and are being summarized for the four years. The highest yielding plot received the high nitrogen rates and high water rate and has produced a total four year yield of over 10,400 pounds per acre equivalent. The lowest yielding plot is a low nitrogen low water plot and has produced a total of 3,218 pounds for the four years.

Other trials and plots at the Nickels Estate have also produced outstanding yields. High yields for 1987 are also being reported by growers in the Sacramento Valley. Some say it's the best they have ever obtained.

The summary yield data sheets are available for the 1987 harvest year and for the four years accuumulated harvest from the Colusa office at 100 Sunrise Blvd., Suite E.