

1994.94-ZC5-Weinbaum.Optimization of Fertilizer N Usage in Almonds - Proceedings Report

Project No. 94-ZC5 - Optimization of Fertilizer N Usage in Almond Orchards

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- Objectives:**
1. Reassess the validity of the currently accepted N critical values for almonds.
 2. Evaluate the need for annual applications of fertilizer N in mature almond orchards growing in coarse-textured soils characteristic of Nitrate Sensitive Areas.
 3. Relate nitrate leaching in mature almond orchards growing in coarse-textured soils in "Nitrate Sensitive Areas" to leaf N concentration, tree yield and the rate of fertilizer N applied.
 4. Assess the relationship between differential fertilizer N application rates and the percentage recovery of fertilizer N by mature almond trees using isotopically labeled fertilizer.
 5. Develop management guidelines to maintain almond productivity while reducing the leaching of fertilizer N below the root zone in almond orchards growing in coarse-textured soils.

Results:

Fertilization Rate, Yield, and Leaf N Concentration

Two research plots were established in nitrate-sensitive areas of Stanislaus County in 1990. The orchards (located in Ceres and Salida) were planted in 1980, and the soils of both are classified

as Hanford sandy loams. Differential rates of N Fertilization (0, 125, 250, and 500 lbs. actual N per acre) have been applied as a 1/3 and 2/3 (of the annual application) split between April and October, respectively. The presence of high residual levels of nitrate in the soil and the utilization of high nitrate irrigation water (33 ppm nitrate in Salida and 44 ppm nitrate in Ceres) limited significant yield reduction in unfertilized trees to 1993 only (Table 1). In the Ceres orchard, tree yields did not differ significantly among the 125, 250, and 500 lbs N/A/Yr treatments in 1993, but the yields of the unfertilized trees were reduced. Similar results were obtained in the Salida orchard. The lack of significant yield reduction in unfertilized trees in 3 out of 4 years (Table 1) indicates that annual fertilization is not necessarily required to maintain productivity under these conditions. We must conclude, therefore, that sufficient N is available from other sources to meet tree demand. The most likely sources include the high nitrate irrigation water and residual nitrate in the soil. Annual yield fluctuations are not necessarily linked to N availability. Thus, yields in the Salida orchard decreased in 1992 irrespective of N treatment. Reduced flower formation and poor pollination are among the possible factors which could limit yield.

Pretreatment (1990) leaf N concentrations averaged above 2.6% in both orchards (Table 2). These values appear to be too high in light of the fact that there is no evidence of a yield response in almond at leaf N concentrations above 2.5%.

Two other points appear worthy of mention. First, a certain amount of annual fluctuation in leaf N concentration may occur which is not tightly coupled with the amount of N applied. Thus, in the Ceres orchard, the leaf N concentration of unfertilized trees varied from 2.69% to 2.49% to 2.29% up to 2.37% and finally up to 2.51% between 1990 and 1994. The second and perhaps more important point to mention is that there is virtually no difference in leaf N concentration between trees receiving a N application of 250 lbs/yr and those receiving an application of 500 lbs/yr (Table 2). This means that at higher levels of available soil N, tree capacity for N uptake is probably saturated. This conclusion is supported by the fact that yields were not significantly greater following a 500 lbs N/acre application as compared with the 250 lb. rate. That is, N applied in excess of the tree's capacity to use it accumulates in the soil and becomes vulnerable to loss - probably leaching - in coarse-textured soils. To summarize, on the basis of our data, the ideal range of leaf N concentration to both maintain yield and minimize leaching would appear to be between 2.3% and 2.5% N. The fertilizer rate needed to achieve these values will vary from orchard to orchard, depending upon a number of factors.

Our data suggest that tree yields are reduced when leaf N concentrations dip below 2.2%. Preliminary analyses also suggest that tree yields may even be reduced at leaf N concentrations between 2.2% and 2.3%. Additional analyses of the data may clarify those relationships. Flower number per acre determines the yield potential in almond, and flowers begin development 6 months prior to bloom and a year before fruit maturity and harvest. We believe, therefore, that leaf N concentrations determined in July may be linked more directly to yield in the subsequent year than in the current year. Data presented in Table 2 can be used to illustrate these points. Leaf N concentrations in July 1992 averaged less than 2.2% (Salida orchard) in both the unfertilized trees and those receiving 125 lbs N/acre/year. July 1992 is about the time of flower formation for the 1993 crop. A significant yield reduction occurred in 1993 among the unfertilized trees relative to trees receiving 125, 250, or 500 lbs N/acre. Tree yields were also lower among trees receiving 125 lb N/acre/year, relative to tree yields following application of 250 or 400 lbs N/acre in 1993 but were not statistically lower. In the Ceres orchard, a significant yield reduction among unfertilized trees (relative to the 500 lb N rate) also occurred in 1993 (Table 1). Although leaf N concentration (Table 2), averaged 2.29%.

Fertilization Rate, Yield, Nitrate Leaching and Tree Recovery of Isotopically Labeled Fertilizer Nitrogen.

Between 1990 and 1993, differential rates of fertilizer N were applied (Table 1) to establish a range of tree yields and leaf N concentrations (Tables 1 & 2). Labeled N was applied in the Salida orchard post-harvest in 1993 to 18 trees which varied in leaf N concentration between 2.1% and 2.9% N. Fruit samples and total yields were obtained in 1994, and these samples are currently being processed and analyzed to determine how tree N status influences tree capacity for fertilizer N recovery. These data and conclusions will be included in our final report.

Similarly, soil solution samples have been collected periodically throughout the last year at depths from 2 to 7 feet beneath trees receiving zero, 250 or 500 lbs N/acre/year. We are currently analyzing the nitrate concentrations of these samples. Those values will be used to calculate the flux of nitrate below the root zone (i.e., leaching) as a function of the fertilizer application rate. Those analyses and their implications will also be discussed in our final report.

Table 1. Differential N Fertilization and Almond Yields in 2 Stanislaus County Orchards

Orchard	Treatment ^z (lbs N/A/Yr)	Meat Pounds Per Acre ^z				
		1990 ^y	1991	1992	1993	1994
Salida	0	3508	3587 a	1470 a	1938 c	*
	125	3508	3554 a	1538 a	2735 ab	*
	250	3508	3421 a	1606 a	3120 ab	*
	500	3508	3610 a	1789 a	3710 a	*
Ceres	0	4444	1633 a	2512 a	2421 b	3967 a
	125	4444	2309 a	2542 a	2956 ab	3837 a
	250	4444	1807 a	2712 a	2913 ab	3786 a
	500	4444	1919 a	2879 a	3315 a	4008 a

^z Treatments initiated post-harvest in 1990

^y Pretreatment yields

* Plot treated with labeled N to assess effect of tree N status on fertilizer N recovery

Table 2. Changes in Leaf N Concentration With Rates of Applied Fertilizer N in 2 Stanislaus County Orchards

Orchard	Treatment ^z (lbs N/A/Yr)	Leaf N Concentration (% dry wt.) ^x				
		1990 ^y	1991	1992	1993	1994
Salida	0	2.61	2.27c	2.13c	2.28c	*
	125	2.61	2.34bc	2.18c	2.40bc	*
	250	2.61	2.36bc	2.24b	2.52b	*
	500	2.61	2.42ab	2.37a	2.68a	*
Ceres	0	2.69	2.49a	2.29b	2.37c	2.51a
	125	2.69	2.48a	2.30b	2.51b	2.64ab
	250	2.69	2.49a	2.44a	2.68a	2.75bc
	500	2.69	2.53a	2.49a	2.74a	2.82c

^zTreatments initiated post-harvest in 1990.

^yPretreatment values.

^xValues sharing the same letter within a column did not differ statistically at P<0.05.

*Plot fertilized with labeled N to assess effect of tree N status on fertilizer N recovery.