Evaluation of Nitrogen Fertilization Practices for Surface-Irrigated Lemon Trees – 2009[1]

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Abstract

Lisbon lemons were treated with N levels ranging from 0.5 to 3.0 lbs. N per tree annually. Yield results from the trial show significant effects of the treatments upon overall yield and leaf N concentrations, but no effect upon fruit packout.

Introduction

The University of Arizona first published nitrogen and phosphorous fertilization recommendations for lemons on the sandy soils of the Yuma Mesa in 1961[2]. Using ammonium sulfate for that study, Hilgeman and Rodney reported that for lemon trees on the Superstition sand, 2½ lbs. of N per tree was sufficient for phosphate-fertilized trees up to 4 years of age. They also reported that for those young lemons, there was no improvement in yield as N fertilization increased to 4 lbs. per tree. These authors did not report results for older trees, nor did they correlate their results with lemon leaf nitrogen concentration; instead they noted that when leaf N levels dropped below 1.9% for grapefruit and 2.2% for orange, fertilization was required.

Thirty years later, Doerge *et al*. recommended that N fertilization rates for mature citrus should vary based on leaf concentration as shown in Table 1[3]. For mature citrus orchards, these authors recommend 2 to 3 lbs. N per tree on sandy soils; however they also suggest higher rates for lemons. It is unclear whether those higher rates refer to 3 lbs. per tree or more.

The most recent work that addressed the lemon fertilization question was done by Sanchez *et al.*, in 2002[4]. In that one-year study, on 8-year old lemon trees, just three rates (0, 1.5 and 3.0 lbs) of N per tree were applied via surface irrigation, along with foliar N

Table 1. Recommended N application rates based on leaf N concentration.

Total N in Leaves	Apply this amount of N per tree
%	Lbs.
<2.2	3 - 4
2.2 – 2.3	2 - 3
2.4 – 2.6	1 - 2
2.7 – 2.8	½ - 1
>2.8	0 - ½

Adapted from Doerge et al.

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[2] Hilgeman, R.H and D.R. Rodney. 1961. Commercial citrus production in Arizona. University of Arizona Agricultural Experiment Station and Cooperative Extension Service Special Report No. 7. University of Arizona, Tucson, AZ.

[3] Doerge, T.A., R.L. Roth and B.R. Gardner. 1991. Nitrogen fertilizer management in Arizona. University of Arizona College of Agriculture Publication No. 191025.

[4] Sanchez, C.A., G.C. Wright and M. Peralta. 2002. Continued evaluation of N fertilization practices for surface-irrigated lemons. In: G.C. Wright and R. Gibson (eds). 2003 Citrus and deciduous fruit and nut research report. University of Arizona Cooperative Extension Publication No. AZ 1331.

fertilization and P application. These authors noted that just 1.5 lb. N per tree was sufficient for maximum yield. It should be noted that this study was not conducted on Superstition sand, but rather on Superstition complex soil, a soil in which the sand is topped with a silt layer. Their results are similar to Hilgeman and Rodney's 1961 the recommendation of 1 to 2 lbs. N for lemons planted in Superstition complex. From this survey of the literature, it becomes apparent that there are still no concrete N fertilization recommendations for mature lemons grown in the Superstition sand. Therefore, our objective is to establish and conduct an N fertility trial to establish those recommendations.

Materials and Methods

This experiment was established in 2008 in a commercial lemon block near County 14th Street and Avenue 3E. There are six treatments, 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 lbs. (Treatments 1-6) nitrogen per tree. A treatment unit consists of four adjacent trees in a row, and experimental design was randomized complete block, with seven blocks. Therefore, there are a total of 42 treatment units, (168 trees, 1.54 acres) included in the experiment. Spacing is 20 ft by 20 ft. Each treatment consists of 7 treatment units, one for each block, with a total of 28 trees, or 0.26 acres. Guard rows separate one treatment from the next where possible. Irrigation is border flood, and normal cultural practices are used.

For 2009, nitrogen was applied as UN-32 (32-0-0) or 15-0-0-16S. Most treatments were applied at a rate of 7.5 or 8.0 gallons per acre. For treatments 5 and 6 (2.5 and 3.0 lbs N per acre), a double application was applied as needed. Application details are found in Table 1.

Table 1. Details of N application rates, materials, and timings.

Date	Material	Rate (gpa)	Treatments	Rate	Treatments
4-Mar-09	15-0-0-16S	8.0	1,2,3,4,5,6	15	None
2-Apr-09	32-0-0	7.5	3,4,5,6	15.0	None
23-Apr-09	32-0-0	7.5	4,5,6	15.0	None
11-May-09	32-0-0	7.5	1,2,3,4,5,6	15.0	None
21-May-09	32-0-0	7.5	5,6	15.0	None
26-Jun-09	32-0-0	7.5	2,3,4	15.0	5,6
10-Jul-09	15-0-0-16S	8.0	1,2,3,4,5,6		
24-Jul-09	32-0-0	7.5	2,3,4,5	15.0	6
7-Aug-09	32-0-0	7.5	4,5,6	15.0	None

Liquid fertilizer was applied to the soil surface using a boom sprayer, one to two days prior to a flood irrigation event. Leaf samples were collected for N analysis in August, 2009.

Initial pick of the experiment was 10-28-09 followed by an additional pick on 1-15-10. The first pick was selective, using rings, and workers picked all remaining marketable fruit on the second pick. For each harvest, fruit from each tree was harvested by hand into sacks using professional pickers from a local packinghouse. Yields were calculated by counting the number of sacks harvested from each tree. Fruit from the sacks was poured into plastic bins, each holding approximately 800 lbs. For the first pick, about 40 lbs of fruit were removed from the sacks into plastic sample tubs for determination of packout. Fruit from the tubs was optically sorted using a completely automated photographic sorter (Autoline, Inc., Reedley, CA). This sorter is trailer-mounted so that it can be towed to the citrus orchard study site. Each fruit that passes through the sorter was photographed and weighed. Weight, color, exterior quality (% blemish), fruit shape and fruit diameter data was collected for each fruit. Fruit were not physically sorted, but the data collected was stored in a laptop computer that is an integral part of the sorter. Data collected from the sorter were later analyzed and the percentage of fruit from the eight fruit sizes and fruit grades (fancy, choice and juice) as well as fruit peel color and shape were determined. Our results typically show that fruit is larger than is the case if the packout was determined at the packinghouse. This due to the fact that we measure each fruit shortly after it is removed from the trees. In typical packinghouse reports, the percentage of large fruit is less, because fruit shrinks as it moves through the house, and the reports are taken after the fruit is degreened, washed, waxed and

dried. Throughout this experiment, we found no effect of the treatments on fruit grade, shape or peel color, In general, exterior fruit quality ranged from 96 to 98% fancy, about 1 to 2%% choice, and less than 1% juice.

All data was analyzed using SPSS 11.0 for Windows (SPSS Inc., Chicago, Illinois).

Results and Discussion

Yields for the 2009-10 season appear in Figure 1. For the 10/28 harvest, yields ranged from 279 lbs. per tree for the trees treated with 3.0 lbs. per tree to 214 lbs. per tree for the trees treated with 0.5 lbs. per tree. Despite the range of yields, we found no significant effect of the treatments upon first harvest yield. For the second harvest on 1/15/10, yields ranged from 203 lbs per tree for the trees treated with 2.5 lbs. per tree, to 164 lbs. per tree recorded for the trees treated with 0.5 lbs. of N annually. Again, there was no significant effect of the treatments upon the yields for the second harvest. However, there was a significant effect of the treatments upon cumulative yield. Trees given 2.5 lbs. N annually had 476 lbs. of fruit per tree, while those treated with 0.5 lbs. N per tree had 378 lbs. of fruit. This difference was significant, and represents a 20% decrease in yield for the trees provided with only 0.5 lbs. Trees given 2.0 lbs. N annually (469 lbs. fruit) and 3.0 lbs. N annually (464 lbs.) also had significantly more yield than the trees given 0.5 lbs. N. Trees given 1.0 lbs N (418 lbs. yield) and 1.5 lbs N (441 lbs) had yields that were not significantly different than any of the other treatments. Our yield results are reflected in the leaf N concentration levels of the treated trees (Table 2). Leaves of trees treated with 0.5 lbs. N averaged 1.93% N, significantly less than leaves of trees treated with 2.5 lbs. N (2.15% N). Leaves of trees treated with the other N levels were had intermediate N concentrations, falling between these two extremes.

We found no effect of the treatments upon fruit packout (Figure 2).

In 2008, our second harvest results suggested that the treatments were beginning to have some effect. This was confirmed in our 2009-10 results, and likely will be emphasized in our results from the upcoming 2010-11 season.

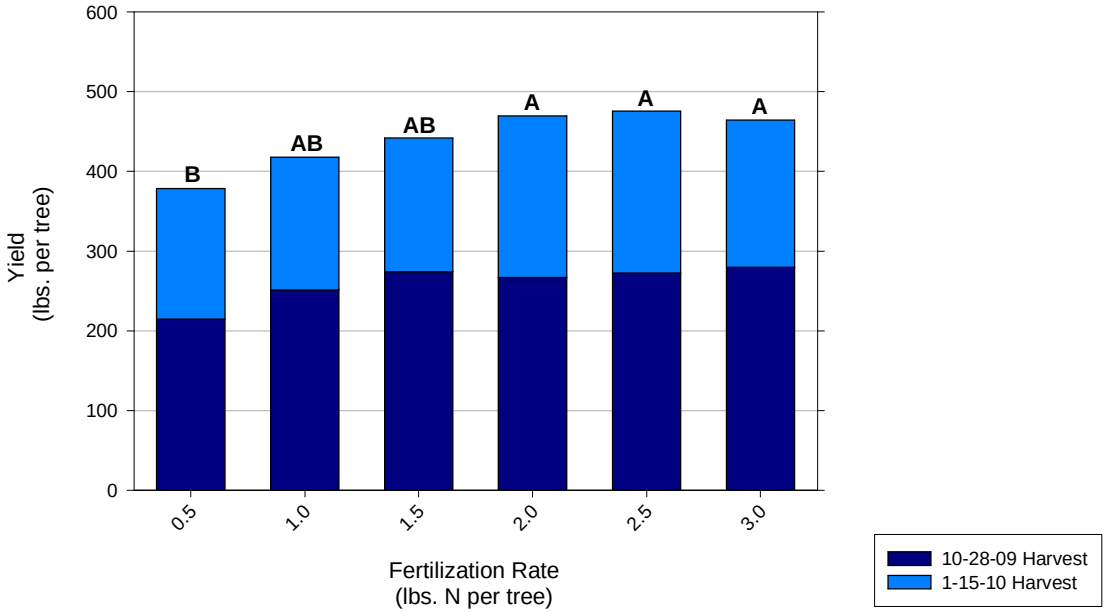

Figure 1. 2009-10 season yields for lemons treated with various N levels.

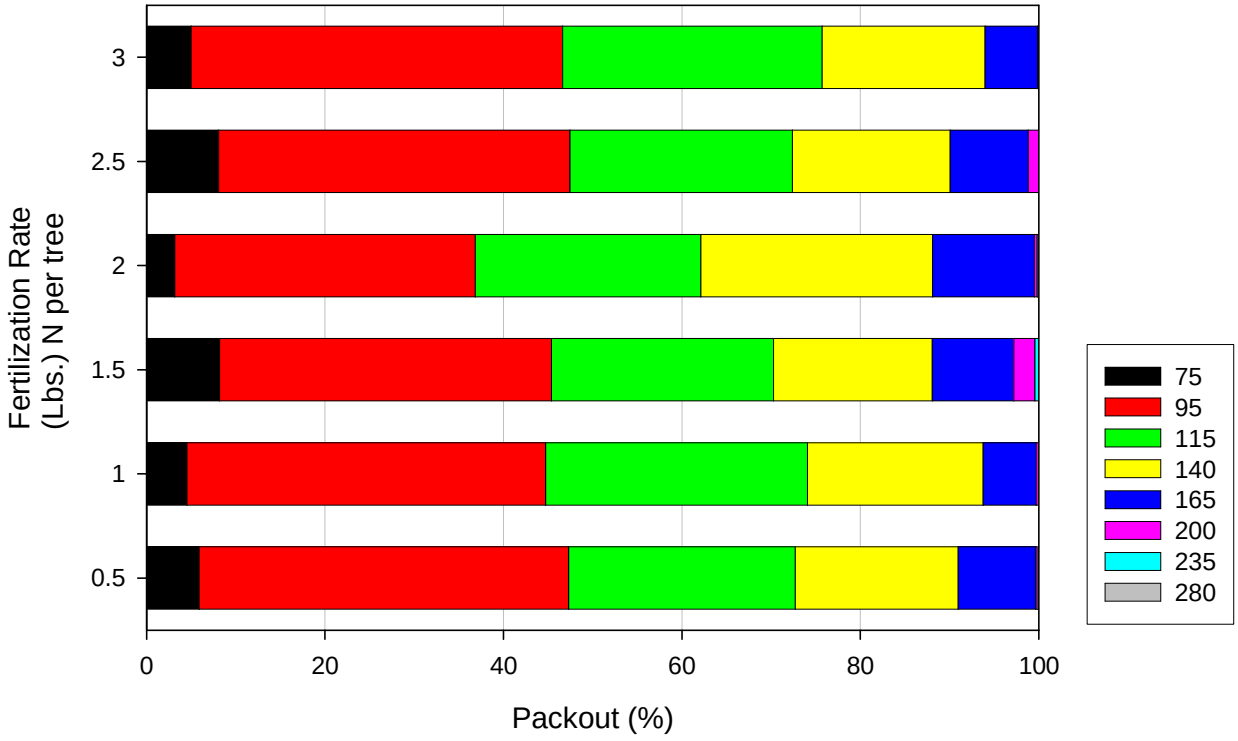

Figure 2. 10-28-09 packout of lemons treated with N levels ranging from 0.5 to 3.0 lbs. of N per tree.

Table 2. August 2009 leaf N concentrations of lemons treated with N levels ranging from 0.5 to 3.0 lbs. of N per tree.

N applied (lbs)	Leaf N Concentration (%)
0.5	1.93 b
1.0	2.02 ab
1.5	2.11 ab
2.0	2.07 ab
2.5	2.15 a
3.0	2.08 ab

[z] Means separation in columns by Duncan's Multiple Range Test, 5% level.