Proc. Fla. State Hort. Soc. 69:289-292. 1956.

SOME EFFECTS OF NITROGEN, PHOSPHOROUS AND POTASSIUM FERTILIZATION ON THE YIELD AND TREE GROWTH OF AVOCADOS

S. JOHN LYNCH AND SEYMOUR GOLDWEBEH
Division of Research and Industry
University of Miami, Coral Gables

The avocado industry in Florida has expanded only slightly in acreage during the past three years. This decrease in rate of planting commercial avocado groves, particularly in Dade County, has been due to the average to low returns received by the grower for his fruit, and to the tremendous increase in cost of good avocado land due to competition with home builders. The total production of fruit for Dade County should increase as the existing groves mature. Although some avocado acreage is being cut up into home sites, about two-thirds of the trees remain in sub-divisions as yard trees. This is supplemented each year by the planting of a great number of avocado trees in yards of new home sites on raw land. Hence, the population of avocado trees in Dade County will probably show an actual slow increase each year.

The nitrogen, phosphorus and potash levels in the fertilizers applied to these groves and yard trees (amounting to 8,000 to 10,000' acres) are still strongly influenced by recommendations made for citrus in central Florida and from observing the practices of successful avocado growers. In California, research workers are experiencing this same lack of documented information as applied to fertilizers in the field (1).

A preliminary report on a long term experiment to study the effects of N, P, and K levels on four varieties of avocados planted in 1949 at the University of Miami Experimental Farm, was given before this Society in 1954 (2). The methods and fertilizer treatments were described at that time and, the results of the first crop year for the Lula variety were reported. Since 1954 the magnesium in the fertilizer has been increased to *4%* in every treatment. This second paper is a report on three full crop years with accompanying data, excluding foliar analysis. Only the Lula variety will be discussed, except for cold damage and tree condition following the cold damage on all varieties. The varieties Booth #7, Booth #8, and Waldin have yielded yearly data but as these varieties have a tendency toward alternate bearing, it was felt that either four or six crop years should be reported upon to give a fair picture of the effects of the major nutrient elements.

Observations were made of cold damage resulting from freezing temperatures experienced January 15, 1956. At the Experimental Farm weather station (of standard United States Weather Bureau design and instruments) located about 300 feet from the avocado grove, a low of 27.7°F. was recorded for an hour or less about 7:00 A. M. on January 15th. The temperature approximated 32°F. or below for 2 to 3 hours. Cold damage per plot was measured in digits of 1 to 10, with 1 being 10% or less of leaves damaged, and 10 representing 100% leaf damage on a three tree plot.

EXPERIMENTAL RESULTS

The data in Table I represents the cumulative growth per tree, yield per tree, and average weight per fruit of Lula avocados. Tree condition and the relative tree size figures are given for the September 13, 1956, reading, as they are the most recent data.

TABLE I. EFFECTS OF FERTILIZER TREATMENTS ON TREE GROWTH, YIELD, AND TREE CONDITION OF LULA AVOCADOS.

TREATMENTS	1953 - 54 - 55 SEASONS			9/13/56	
	AVG. % TRUNK AREA GROWTH	AVG. WT. FRUITS LBS/TREE	AVG. WT. FRUIT LBS.	TREE COND. 1-10	TREE SIZE 1-5
2-0-6	131	5.75	.75	5	3
2-6-0	99	7.30	.75	4	2
2-3-9	155	14.95	.70	5	3
2-6-6	86	7.92	.82	6	3
2-9-3	202	5.08	.73	6	4
2-9-9	185	3.42	.79	4	3
4-0-4	189	76.93	.99	7	5
4-9-0	403	45.04	1.02	8	4
4-3-9	117	69.65	.98	9	4
4-9-3	329	57.83	1.07	8	4
4-9-9	299	48.95	.93	7	4
6-0-3	372	62.74	1.05	9	5
6-0-6	317	124.91	1.06	10	5
6-3-0	487	60.05	1.01	9	5
6-6-0	255	50.33	1.13	10	4
6-3-9	406	130.20	1.17	10	5
6-6-6	446	136.21	1.19	10	5
6-9-3	581	71.80	1.04	9	5

Increase of Trunk Area: The total increase for the past five years in transverse area of the trunk shows a direct relation between percentage increase and the Nitrogen level in the fertilizer treatment. At 2% N the increase averaged less than 150%; at 4% levels it averaged about 250%; and at the 6% level the increase averaged about 400%, when P and K levels were ignored. At any one nitrogen level, no consistent trends could be observed due to the gradual changing of P or K levels, except that at the highest P level at each nitrogen level, the percentage increase of trunk area was the highest. This was not as definitely so in the 1953 data, when the trees were younger. Also, at the 4% nitrogen level, when P was at its highest level, an increase of K resulted in a decrease in transverse trunk growth. This again was not in evidence in the previous report.

Fruit Yields and Size: The level of nitrogen in the fertilizer mix has a direct effect upon the yield per tree. At 2% N level, regardless of the P and K levels, the yield per tree is so low as to be out of the realm of practicality. The average size of the individual fruit is three quarters that of the fruit from the 4% nitrogen treatments.

The yield at the 4% nitrogen level is about 8 times that at the 2% N level, ignoring the influence of P and K. The influence of gradually increasing levels of P and K at the 4% N level is not appreciable as yet in this experiment, but it is becoming evident that the lowest and highest levels of potash are not favorable to the greatest yields and that

when potash is kept at a high level, increasing the phosphorus level tends to depress yields.

With nitrogen at the 6% level, the yield is about 50% higher than at the 4% N level. In creasing the P levels and keeping K constantly low at the 6% N level seems to have very little effect upon the yield. However, when P is kept low and K is increased, there seems to be a large increase of yields in 6% K, over 0% or 3% K. But very little increase in yield results from increasing the K level from 6% to 9%.

It is safe to assume from the tables that increasing nitrogen from 2% to 6% in the fertilizer treatments results in an increased fruit weight or size. It is doubtful whether the gain in fruit size between the 4% N level and the 6% N level is economic, but with the Federal Avocado Marketing Agreement in effect it could mean earlier harvesting of fruit when the higher nitrogen level is employed. The fruit produced at the 2% N level was of an undesirable size and quality.

Tree Condition and Size: In full agreement with the 1953 results, the added readings of tree condition and size show a direct relation to nitrogen levels. P and K levels at any of the N levels showed little or no influence on the Lula. Increase of nitrogen resulted in increased depth of green leaf color, heavier foliage, and larger tree size. After three more years of treatment, the other three varieties of avocados failed to show any influence from increased K levels as was observed in 1953.

Frost Damage: Table II shows the comparative cold damage to the four varieties of avocados in the fertilizer test grove The trees were planted in 1949 and the fertilizer tests began 19 months later. It is rather obvious that the trees under the higher levels of nitrogen suffered less cold damage than those at the 4% N level and considerably less than the trees at the 2% N level, for all varieties except

TABLE II. EFFECTS OF FERTILIZER TREATMENTS ON RESISTANCE TO COLD DAMAGE AND TREE CONDITION AND SIZE OF LULA, BOOTH #7, BOOTH #8, AND WALDIN AVOCADOS.

	FROST DAMAGE 1-10 (1/15/56)					AVG. TREE CONDITION ALL VARS.	
TREAT-MENTS	LULA	BOOTH # 7	BOOTH # 8	WAL-DIN	AVG.	1/3/ 1956	9/13 1956
2-0-6	4	5	5	7	5.3	5.5	4.8
2-6-0	2	5	5	8	5.0	5.5	4.5
2-3-9	2	7	7	6	5.5	5.5	4.5
2-6-6	5	5	8	7	6.3	5.3	5.2
2-9-3	3	3	6	8	5.0	6.8	6.5
2-9-9	2	3	7	5	4.3	6.3	6.5
4-0-9	2	4	5	3	3.5	7.3	7.3
4-9-0	2	5	6	5	4.5	7.0	8.3
4-3-9	3	4	7	4	4.4	6.5	8.0
4-9-3	3	7	8	4	5.5	6.0	7.8
4-9-9	2	4	8	4	4.4	6.8	7.5
6-0-3	1	4	8	3	4.0	7.8	9.0
6-0-6	1	2	4	4	3.8	8.3	9.3
6-3-0	1	1	7	4	3.3	8.5	9.3
6-6-0	1	1	7	4	3.3	8.0	8.5
6-3-9	2	3	8	2	3.8	7.5	8.3
6-6-6	1	3	5	2	2.8	8.5	8.5
6-9-3	1	3	8	3	3.8	7.5	9.3

Booth #8. Booth #8 suffered heavy damage to foliage at all levels of N, but this can be explained in part by the low type of growth of this variety. Cold damage was heaviest up to 6 feet from the ground. Lula and Waldin trees had half or more of their leaf area above 6 feet. Booth #7 had about one-quarter to one-third of their leaf area above this level. Whereas, Booth #8 had from 0% to 10% of their leaf area above six feet.

No consistent relation between P and K levels and resistance to cold could be observed on any of the varieties. However, this may become more accentuated as definite deficiencies in these two elements become more critical.

The cold resistance of the varieties can be listed in a descending scale as Lula, Booth #7, Booth #8, and Waldin. Waldin, a pure West Indian avocado, has in general been considered as more tender than the Guatemalan X West Indian hybrids, but these data would indicate that a vigorous Waldin tree with nitrogen at either 4% or 6% level is as hardy as, or maybe a little more hardy than, Booth #8. The table shows a distinct difference between these two varieties but one must take into consideration the differences in growth habit or tree shape.

Tree condition values were taken at the time when the frost damage was observed and again 8 months later. As has been observed before, there is an improvement in tree condition as the nitrogen level increases in the fertilizer. Influences of levels of P and K in the fertilizer had no consistent effect on tree condition. There was a general improvement in tree condition in September over the condition in January, except at the 2% N level, where there was an actual small decrease in many plots. The recovery from cold damage could be considered excellent except in Booth #8, and to a lesser extent in the Waldins. The cold damage had little or no effect on the subsequent bloom. The crop

is not completely harvested yet, so actual yields will not be measured before spring.

DISCUSSION

The general trends of yield, tree condition, and growth which were observed after the first crop year in 1953 on the effect of N, P, and K levels have become more strongly evident after two more crop years. Nitrogen is proving to be the plant nutrient with the greatest influence on trunk area increase, yields, fruit size, tree condition, and general tree size. In fact, any one of these criteria could be used as a general reflection of the nitrogen influence on any of the other measurements.

The authors expected by this time, the fifth year of this experiment, that trees receiving phosphorus and potash at the 0% and 3% levels not only would be showing obvious deficiency symptoms, but that the tree growth and yields would be materially affected. A few minor influences have been noted. Perhaps there is residual P and K from the juvenile stage of the plant when P and K were applied in sufficient quantities to establish the new trees in the field, or there may be small quantities of each element made available to the tree under sod culture and natural mulch in sufficient amounts to keep the influence of the lack of these two elements from becoming evident for several more years.

Probably the extreme depressant effect of the 2% N on size and crop has had a masking effect on any influence which might come from the variations in P and K. As the experiment continues, these influences, especially the deficiencies, may become more apparent. Even though the influences of only five years of treatments are available for observation, the grower can draw some inferences from these data. Nitrogen in the mix should be at a high level, phosphorus at a moderately low level, and potash probably at a medium level. The ratios could be considered about 1-½-1. This discussion has dealt almost entirely with the data on the Lula variety; however, the three other varieties under study, in the main, are in agreement with these figures. Booth #7 showing some indication that nitrogen level probably can be 1 to 1½ units less than the three other varieties. Continued croppings may result in more uniformity with Lula and the others.

SUMMARY

In this experiment the level of nitrogen in complete fertilizer mixes has a direct beneficial influence on tree growth, yield of fruit, size of fruit, and tree condition of Lula avocados on oolitic soils of Dade County.

The 2% nitrogen level is uneconomic in tree growth and crop yield with poor quality fruit at all levels of potash and phosphorus.

Total yield of fruit at the 4% nitrogen level is not appreciably affected by variations of potash and phosphorus, but the trend is evident that the lowest and highest levels of potash are not favorable to the greatest yields, and that when K is kept at a high level, increasing the P level tends to depress yields.

At the 6% nitrogen level, when P is kept low and K is increased, there seems to be a

large increase of yield at 6% K over 0% or 3% K, but very little increase results by increasing the K level to 9%.

The cold resistance of the avocado varieties in descending order is Lula, Booth # 7, Booth #8, and Waldin. Trees of Lula, Booth #7 and Waldin, under 6% nitrogen levels, suffered less cold damage than those at 4% N level and considerably less than those at 2% N level. Booth #8 avocado trees suffered considerable cold damage at all levels of nitrogen, but this may be due in part to the low headed type of tree produced in Booth #8, as compared to the three other varieties.

LITERATURE CITED

1. Embleton, Tom E., W. W. Jones and J. D. Kirkpatrick.—Avocado fertilizer experiments. Calif. Avocado Soc. Y. B. 39:62-66. 1955.
2. Lynch, S. John, Seymour Goldweber and Clarence E. Rich.—Some effects of nitrogen, phosphorus and potassium on the yield, tree growth and leaf analysis of avocados. Proc. Fla. State Hort. Soc., 67: 200-224. 1954.