Citrus Section

CHANGES IN FERTILIZER PROGRAM AND YIELDS IN CITRUS SINCE 1931

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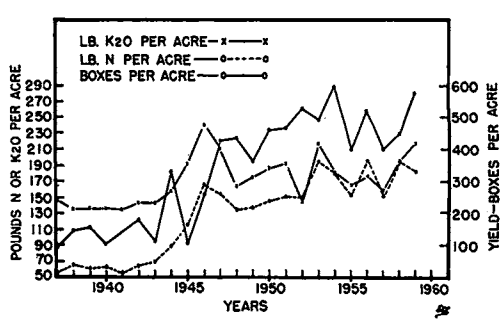
The fertilization of citrus trees in Florida is complicated by the number of nutrient elements added and the varying amounts in which they are applied. During the past thirty years many changes have been made in the fertilization program, including the addition of seven minor elements, changing the ratio of N-P-K and changing the poundage of each element applied. This paper presents a study of these changes during this time by showing the fertilization and yield records on what is believed to be fairly typical groves of the Ridge Area.

Two kinds of records were compiled: (1) the fertilization and yields on one Valencia Orange Grove covering twenty-three years; and (2) fertilizer costs on approximately thirty groves for twenty-nine years.

VALENCIA ORANGE GROVE

This grove is located near Haines City and is growing on a Lakeland sand. The trees are set thirty by thirty, giving forty-eight trees to the acre. At the time the records were started in 1937, the grove was approximately eighteen years old, and the trees were sufficiently large to produce good yields by present day standards. The fertilizer formulas and poundages used are believed to be fairly representative of those used on citrus during the period covered.

Fertilizer Ratios—The most widely accepted fertilizer program of the 1930's was the commonly called top-dresser in the spring followed with a summer and fall application of a complete fertilizer. Table 1 shows the analysis used for each fertilizer application from 1937 through 1959, a period of twenty-three years. The top-dresser contained a comparatively high ratio of nitrogen to potash, and did not carry any phosphorous. It was usually applied at very low rates. On the other hand, in the summer and fall high applications were made of mixed fertilizer that was low in nitrogen and high in potash. In the years 1956 through 1959 in the spring application the fifth figure refers to the percentage of boron oxide in the formula. The net result, as illustrated by the graph below was that the potash applied per acre far exceeded the nitrogen. It might be well to point out at this time that, contrary to popular belief, potash has not been decreased in the fertilization program over the years; but, rather, nitrogen has been brought up to an equal level. The graph below shows that potash, for all practical purposes, has been applied at about the same rate for the past twenty-three years. Nitrogen, starting at a low level of 57 pounds to the acre, has been gradually increased until it is now equal to potash at a rate between 150 and 200 pounds per acre.



From this, it can be said that in the thirties and early forties nitrogen was used at a low

FERTILIZER RATIOS USED ON A VALENCIA ORANGE GROVE

SINCE 1931

YEAR	FORMULAS USED SPRING	SUMMER	FALL
1937	15-0-12	3-8-8	2-8-10
1938	14-0-10	3-8-8-3-1	3-6-8
1939	14-0-10	3-6-8-3-½	3-6-10-2-1-½
1940	14-0-10	3-6-8-2-½-½	3-6-10-2-½-¼
1941	14-0-10	3-6-8-2-1-¼	4-8-10-2-½-¼
1942	10-0-8-6-1-1	4-8-10-2-½-½	3-8-8-2-½-½
1943	8-0-8-6-1-1	4-6-8-2-½-½	4-6-8-2-½-1
1944	8-0-8-6-1-1	4-6-8-2-1-1	4-6-8-2-1-1
1945	8-0-8-6-1-1	4-6-8-2-1-1	4-6-8-2-1-1
1946	10-0-10-7-1-1	5-6-8-2-1-1	5-6-8-3-1-1
1947	10-0-10-7-1-1	5-6-8-2-1-1	5-6-8-3-1-1
1948	10-0-10-7-1-1	6-6-8-4½-½-1	6-6-8-4½-½-½
1949	10-0-10-7-1-1.1	6-6-8-4-½	6-6-9-4-½-¼
1950	18-0-0-10-½-½	4-6-8-2-½	6-6-9-4-½-½
1951	10-0-10-7-½-0-1	4-5-8-3-½-½	8-6-8-5
1952	10-0-10-7-½-½	5-6-6-3	8-3-6-4
1953	10-0-10-5-3/4-.2	6-3-8-3-½-.2	8-3-8-5-½
1954	10-0-10-7-3/4	6-2-6-4-0-.2	8-3-8-5
1955	10-0-10-7-½	8-0-8-5	8-3-10-5-½
1956	10-0-8-7-.2	8-4-7-5	8-3-8-5-½
1957	8-0-8-4-.2	5-5-6-3	8-4-8-4-½
1958	12-0-12-7-.3	8-4-8-5-½	8-0-8-4
1959	10-0-10-5-.3	8-4-8-4-1	8-0-12-4

TABLE #1

rate and potash at about the same rate it is today. Table 2 gives the amounts of nitrogen applied per acre and the yields. It is readily seen that yields did not reach an acceptable level and stay there until nitrogen was applied regularly at a rate that averaged approximately 150 pounds per acre.

When growers speak of using high analysis fertilizers, they are most often referring only to the nitrogen content. Table 1 indicates that on a total plant food basis we are not using any higher analysis than we were twenty-three years ago. The difference is in the ratios of one material to another. There is still room for improvement in the use of higher analysis mixtures. It is true that some growers are now using higher analysis, but they seem to be in the minority.

Minor elements were first added to the fertilizer in 1938, but yields were not substantially increased until 1944 and 1946. This increase cannot be associated with the correction of minor element deficiencies alone, for it was only when the nitrogen rate was also increased that much larger yields were obtained. When minor elements were first accepted into the fertilizer program the resultant correction of deficiency symptoms was very gratifying, so much so that amounts were quickly doubled. The fact that deficiencies had been corrected did not curtail the use of minor elements. If a little was good, then more was better, seemed to be the theory adopted by most growers. This approach soon lead to toxicity, and the problem is still with

FERTILIZER RATES AND YIELD OF A VALENCIA ORANGE GROVE

SINCE 1937

Year	Potash Per Acre Pounds	Nitrogen Per Acre Pounds	Yield Boxes Per Acre	Yield Boxes Per Tree
1937	147	57	93	1.94
1938	134	66	144	2.99
1939	135	61	152	3.16
1940	135	64	101	2.10
1941	134	55	139	2.90
1942	142	65	178	3.72
1943	142	69	111	2.31
1944	157	88	332	6.91
1945	192	115	101	2.11
1946	240	168	258	5.38
1947	211	153	425	8.86
1948	163	134	431	8.97
1949	175	137	360	7.50
1950	187	145	459	9.56
1951	192	151	466	9.71
1952	143	149	526	10.96
1953	217	195	490	10.21
1954	180	180	591	12.32
1955	165	152	395	8.23
1956	177	196	520	10.85
1957	157	150	398	8.30
1958	194	194	445	9.28
1959	218	183	575	11.97

TABLE #2

AVERAGE FERTILIZER COST AND YIELD OF APPROXIMATELY 30 CITRUS GROVES FOR 29 YEARS

YEAR	PER ACRE COST	PER BOX COST	BOX YIELD PER ACRE
31-32	37.07	22¢	166
32-33	22.87	17¢	132
33-34	17.73	19¢	92
34-35	18.94	16¢	121
35-36	19.22	17¢	114
36-37	21.80	16¢	138
37-38	26.95	17¢	158
38-39	26.70	14¢	205
39-40	19.90	11¢	179
40-41	20.73	11¢	199
41-42	21.48	12¢	187
42-43	32.42	13¢	257
43-44	41.22	13¢	305
44-45	48.73	21¢	227
45-46	52.58	19¢	277
46-47	76.35	20¢	395
47-48	57.72	12¢	481
48-49		13¢	
49-50	64.00	16¢	402
50-51	77.98	15¢	531
51-52	76.71	13¢	573
52-53	75.88	17¢	455
53-54	91.72	15¢	622
54-55	81.05	14¢	523
55-56	67.54	16¢	427
56-57	71.05	14¢	491
57-58	FREEZE - NO DATA		
58-59	67.60	13¢	501

TABLE #3

us in older groves. Today many new groves are doing very well on a limited amount of minor elements. They are essential, but the range is apparently narrower than at first supposed.

Fertilizer Rates and Yields — From 1937 through 1943, a period of seven years, an average of 62 pounds of nitrogen per acre was applied — the highest amount for any one of these years was 69 pounds. The average yield in this period was 131 boxes per acre. In 1944 the nitrogen rate per acre was increased to 88 pounds, and in 1945 to 115 pounds. The yield in 1944 was 332 boxes per acre, a new high, but in 1945 dropped to only 101 boxes. The big drop in production was most probably caused by the hurricane in late 1944, rather than an actual decrease in production. During the seven-year period from 1946 through 1953 nitrogen was applied at an average rate of 148 pounds per acre. The average yield for this period was 418 boxes per acre or 287 boxes more than the first seven-year period when nitrogen was used at an average rate of only 62 pounds per acre. The last seven-year period in this study, 1953 through 1959, an average rate of 180 pounds of nitrogen per acre was applied. The yield for the last seven years, including the freeze in 1957-58 when several boxes per tree were lost, averaged 487 boxes per acre, or 69 boxes more than when an average rate of 148 pounds was used.

From these figures, it is hard to say if we have reached the optimum level for nitrogen; however, with the yields being as good as they are, we must certainly be approaching it. It would seem that perhaps 200 pounds of nitrogen per acre might be a good level for this grove.

Estimating Fertilizer Rates — This study also indicates that there may be good reasons to apply fertilizer on the basis of total pounds of nitrogen per acre rather than on *pounds* of nitrogen per box of fruit. Such a procedure would result in a more even application of nitrogen to the grove. It is easily seen that nitrogen applied on the basis of anticipated yield is going to vary quite a bit unless the anticipated yield is kept at a constant figure for a number of years. Any adjustment in the anticipated yield per tree, even a very slight one, causes a large adjustment in pounds of nitrogen per acre, because it is multiplied by the number of boxes per acre. This particular grove has been fertilized, using anticipated yield as a basis. The graph shows that the yields and pounds of nitrogen per acre have fluctuated widely. A more even rate of application might conceivably result in more uniform production. We will never stop fluctuation in yields all together, as there are too many other factors involved.

Twenty-Nine Year Record of Mixed Groves

In another study, the average costs and yields were compiled for at least thirty mature citrus groves. The number varied from year to year depending on changes in ownership and other factors. The groves consisted of mixed varieties growing on the Ridge in Polk County. The records were started in 1931 and the fertilizer costs and yields are given in Table 3.

Production costs are of major concern to the citrus grower, and it is gratifying to see that the fertilizer cost per box of fruit is less

today than twenty-nine years ago. This has been brought about by several factors, but one of the most important has been the tremendous increase in yields obtained by using higher rates of nitrogen per acre. The fertilizer materials in use today, from which the citrus fertilizer is made, are generally of a higher analysis, and this has tended to keep the per unit cost of plant food stable. Better and faster methods of mixing, handling, and distributing fertilizer has kept the costs of actually putting the fertilizer on the ground from getting too high.

Table 3 would indicate that the primary reason has been the increase in yields obtained with the higher rates of nitrogen application. The first ten years shown in Table 3 averaged $23.19 per acre for fertilizer, with a per-box cost of 16 cents. The last ten years of record averaged $73.12 per acre, but with a per-box cost of only 14½ cents. The per-box costs of fertilizer have remained rather stable because of increased yields. As fertilizer costs increased slightly more than three times as much per acre, yields also increased by more than three times. If the deflation of the dollar since 1931 is taken into account, it is quickly apparent that by accepting improved fertilizer practices the grower has made it possible to realize a greater return from his investment in fertilizer.

SUMMARY

Fertilizer and yield records were compiled for twenty-three years on a Valencia Orange Grove and for twenty-nine years on a group of mixed varieties of citrus. These records are believed to show typical fertilizer programs that were used during the period covered. The fertilizer ratios were found to change from low nitrogen, high potash to about equal amounts of each. The total poundage of nitrogen applied per acre increased from approximately 62 pounds to 180 pounds per acre. During this time potash rates remained fairly constant. Minor elements were first added to the fertilizer in 1938. Yields increased from 131 boxes per acre to 487 boxes per acre. The large increase in yields was associated with increasing nitrogen rates.

The cost of fertilizer decreased from an average of 16 cents per box to an average of 14½ cents per box during the twenty-nine year period. In this same period per-acre costs of fertilizer increased from $23.19 to $73.12. The decreased box cost was due mainly to increased yields.

REPORT ON GENERAL ASPECT OF TRISTEZA AND STEM PITTING IN CITRUS VARIETIES IN SAO PAULO, BRAZIL

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Sao Paulo produces more citrus than any other state in Brazil. A 1960 (15) estimate indicated that there were 160,000 acres in citrus, two-thirds orange trees and the others tangerine, lime, lemon, and grapefruit trees in Sao Paulo. There are about 14 million trees, of which one-third are not yet producing fruit. In 1959 approximately 13 million boxes (90 lbs. each) were produced. The production per tree varied from 1 to 10 field boxes and the producing trees were 5 to 12 years old.

The groves are young because in 1939-49 tristeza killed about 9 of 11 million trees. Exports of citrus dropped from about 2.8 million boxes (75 lbs. each) in 1939 to 100,000 in 1952. From 1955 to 1959, as a result of the use of tristeza-tolerant rootstocks, exports rose from 500,000 to over 3 million boxes (9).

These figures show that oranges are being produced in Brazil in spite of tristeza. The use of tristeza-tolerant rootstocks for oranges solved this problem, at least temporarily, for orange production. Grapefruit and West Indian lime trees, however, are directly injured by the tristeza virus regardless of the tolerance of the rootstock employed. Symptoms of tristeza on West Indian lime and grapefruit are stem pitting on the trunk and branches,

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