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WATER SOLUBLE PHOSPHORUS AND POTASSIUM IN THE SOIL OF LIME AND AVOCADO GROVES IN DADE COUNTY

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The widely varying fertilizer practices in lime and avocado groves indicate quite clearly that there is no exact knowledge of the nutrient requirements of these trees. There are no long time experiments that might be used to assess the value of some of these practices, it was hoped that some clue to a more profitable fertilizer schedule might be gained from an extended program of periodic soil analysis.*

Soil testing has been used for some time as a measure of soil fertility. Water extraction of soils has been used in Florida (1, 4) and was chosen as the standard procedure in this investigation. Certainly, the water soluble phosphorus and potassium in the soil are available to the trees. Most of the tests in common use are based on an acid extraction and did not seem well suited to our highly alkaline soils.

No previous work has been done on the soils from lime and avocado groves in Florida, but the work done on soils from orange and grapefruit groves (4, 6) and on the organic soils of the Everglades (1) should be mentioned for comparison. In 204 samples from citrus groves, Peech and Young (4) found that water soluble phosphorus ranged from 0-42 pounds per acre or 0-21 ppm. The average was 6 ppm. These authors made particular mention that the water soluble phosphorus was low in the calcareous soils they examined. Work by Young and Forsee (6) on soils from an experiment with citrus in the Davie area showed a range of water soluble phosphorus from 2-18 ppm. Tissue analyses showed very little increase in the phosphorus content of the leaves as the water soluble phosphorus in the soils varied from 6-18 ppm. Where the water soluble phosphorus content of the soil was below 6 ppm, the phosphorus content of the leaves was distinctly lower. This same relationship between soil and plant was even more pronounced when the juice was analyzed.

In a recent bean experiment Forsee and Hoffman (1) found that marked response to phosphatic fertilizers was obtained when the soil contained less than five pounds of phosphorus per acre. Since they were working with organic soils, pounds per acre would be roughly equivalent to ppm. They recommended that phosphorus be included in the fertilizer when the water soluble phosphorus content of the soil dropped below seven pounds per acre.

Potassium in the soils from citrus groves was also studied by Peech and Young (4) They determined exchangeable potassium rather than water soluble but the values they found were of the same order as those reported in the present study. They found exchangeable potassium ranging from 17-350 pounds per acre or 9-175 ppm. The average potassium content of 204 samples was 58 ppm. These authors did not attempt to say what level would be desirable. Forsee and Hoffman (1) set 100 pounds per acre of acid soluble potassium as a level to be maintained for beans.

METHODS AND PROCEDURE

Thirty samples from 15 groves were taken every two weeks from August 22, 1948, to April 16, 1951. In a few cases the interval was longer or shorter. Two samples were taken in each grove, one from under the canopy of the trees and one from the row centers. Each sample was made up of about 12 sub-samples. The depth of sampling varied somewhat according to the depth of scarification of the soil. The portion of the sample which passed an eight mesh screen was analyzed.

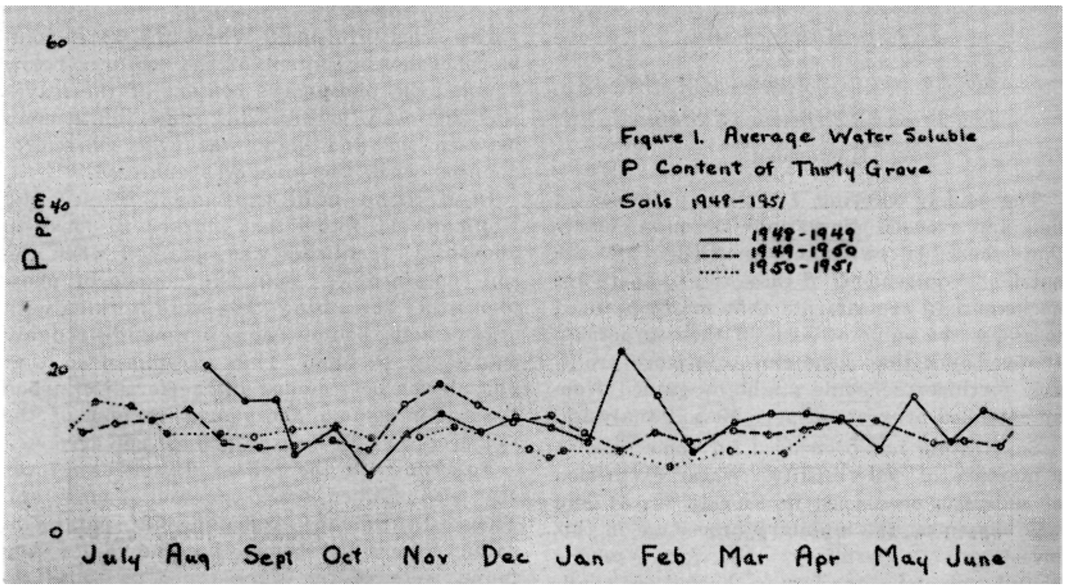


Figure 1. Average Water Soluble P Content of Thirty Grove Soils 1948-1951

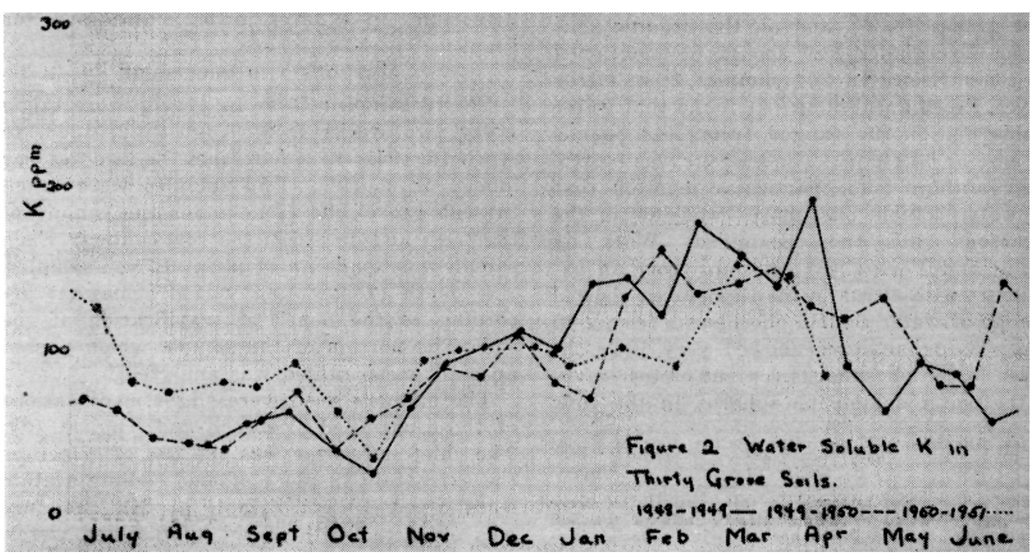
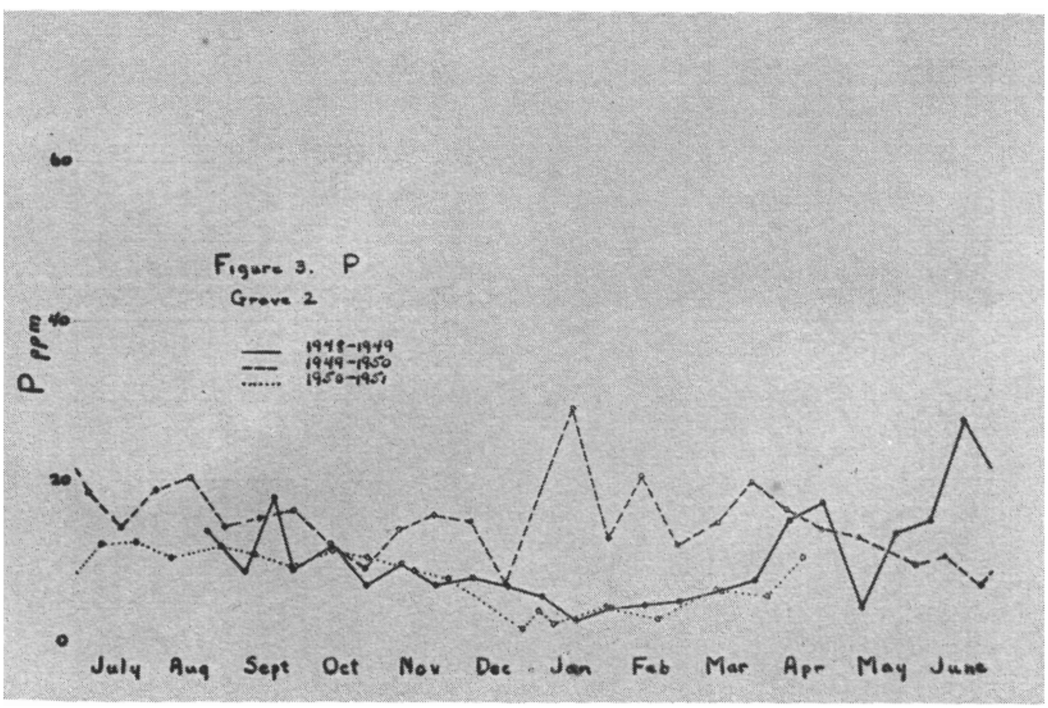


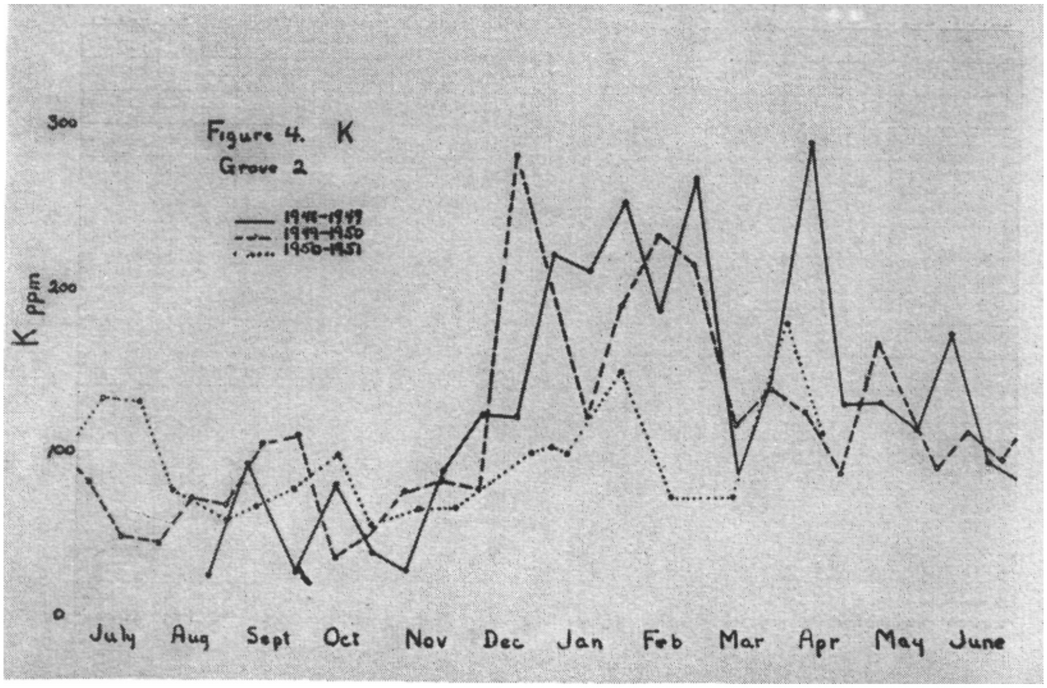
Figure 2. Water Soluble K in Thirty Grove Soils.

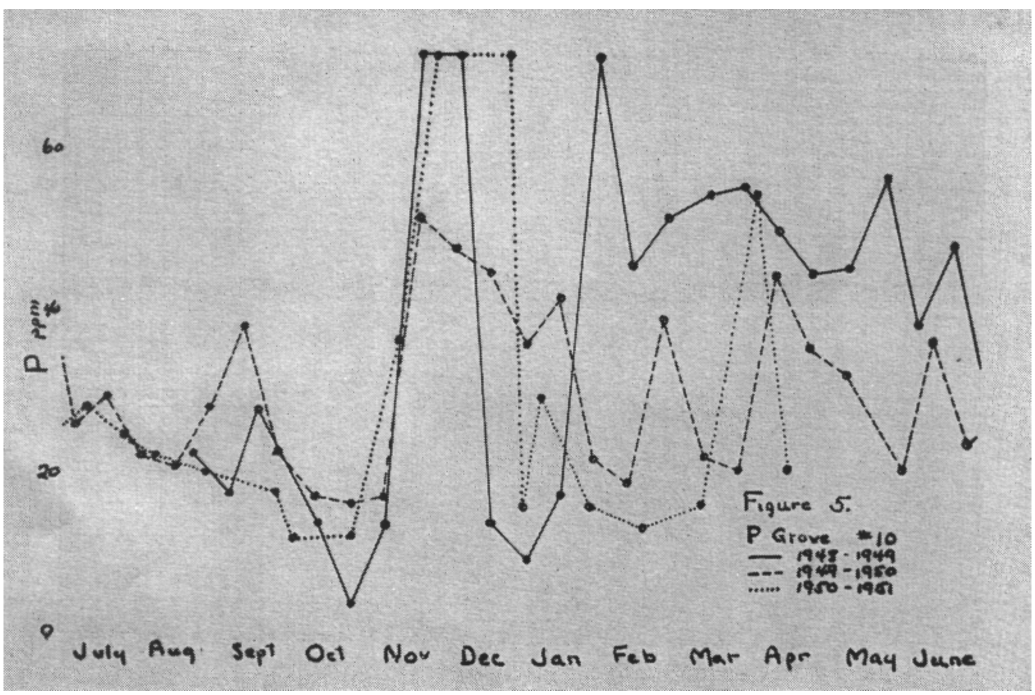
The methods used were slight modifications of those proposed by Peech and English (3). The chief difference was the use of water as the extractant in place of acid sodium acetate solution. A 10 gm. sample at field moisture was extracted with 50 ml. of distilled water. The moisture content of each sample was determined and the results of the analyses calculated on dry weight basis. Each sample was stirred mechanically for three minutes, and then poured onto a Whatman No. 2 filter paper. The portion of the filtrate that ran through in the next three minutes was caught in the stirring beaker and returned to the paper. In most cases this gave a clear extract. Some of the extracts were yellow but this did not interfere seriously when a red filter was used in the determination of phosphorus and potassium.

FERTILIZER PRACTICES

Relatively high rates of application of fertilizer were found in most groves. The rate recommended by Wolf *et al* (5) for mature avocados was from 3,400-4,500 pounds of 4-7-5 per acre. Lynch (2) recommended approximately the same rate of application for lime trees eight years old. Lower acre rates of application were recommended for young trees. Fertilizer is usually applied to the ground immediately around young trees. As a result the concentrations of fertilizer under the leaf canopy in young groves were as high or higher than those found in mature groves







RESULTS

The results of the present investigation are presented in Figures 1-10. Curves showing the average water soluble phosphorus and potassium content of all the soil samples are shown in Figures 1 and 2. Separate graphs showing the phosphorus and potassium content of two lime and two avocado groves also are presented.

Some points of similarity and of difference occur between the curves obtained for the two elements in Fig. 1 and 2. The amounts of both of these elements which could be extracted often varied considerably from one sampling to the next. The amount of this variation was very different in different groves, reflecting method of application of fertilizer as well as frequency of application. Roughly eight times as much water soluble potassium as phosphorus was found in these soils.

Over the three-year period the phosphorus levels remained about the same. Sharp increases reflecting the application of fertilizer were noted but no seasonal trend. The average phosphorus content of all the samples run was 12 ppm.

When the water soluble potassium content of these samples was examined, results were quite different. There was a distinct seasonal trend in this data. During periods of high rainfall, the potassium level dropped very low in spite of heavy applications of fertilizer in some groves. During the dry months, the potassium from one fertilizer application often would not be absorbed or leached away before more was applied. This led to a build up of potassium in the soils until a heavy rain. The maximum amount of potassium found in any sample was 411 ppm. And the minimum 0 ppm. The average was 98 ppm.

Two lime groves and two avocado groves were selected for special consideration. All four of these were productive groves in very good condition. In spite of this, their fertility levels contrasted sharply.

The phosphate levels found in the two lime groves are shown in Figures 3 and 5. Grove 2 was maintained at a comparatively low, but uniform, phosphate level during the course of this study." In contrast Grove 10 samples showed extreme fluctuation in phosphorus content. The maximum in Grove 2 was 29 ppm. in January 1950. The maximum in Grove 10 was three times as high, 99 ppm., in November 1948. When moisture was available, these high concentrations disappeared quickly. In Grove 2, the phosphorus was generally higher in summer than in winter. This may have resulted from increased availability of the element during the rainy season. In Grove 10, the frequent application of fertilizer obscured any evidence of natural availability.

Much less difference occurred between the potassium curves drawn from these lime groves. The levels in Grove 10 were a little higher than in Grove 2. More potassium was found in Grove 10 than in Grove 2 in the early fall and late spring. The occurrence of rains seemed to be the primary factor affecting the persistence of potassium in these soils. The curves for both these groves showed the same seasonal trend as the average curve for all the soils.

A similar contrast was found in soils from avocado groves. Figures 7 and 8 show the water soluble phosphorus and potassium content of samples from Grove 16. Figures 9 and 10 show the same things for Grove 30.

Both of these were mature avocado groves. One of these was maintained at a low and uniform level of water soluble phosphorus and the other was repeatedly fertilized, even though reasonable concentrations of the element were still available.

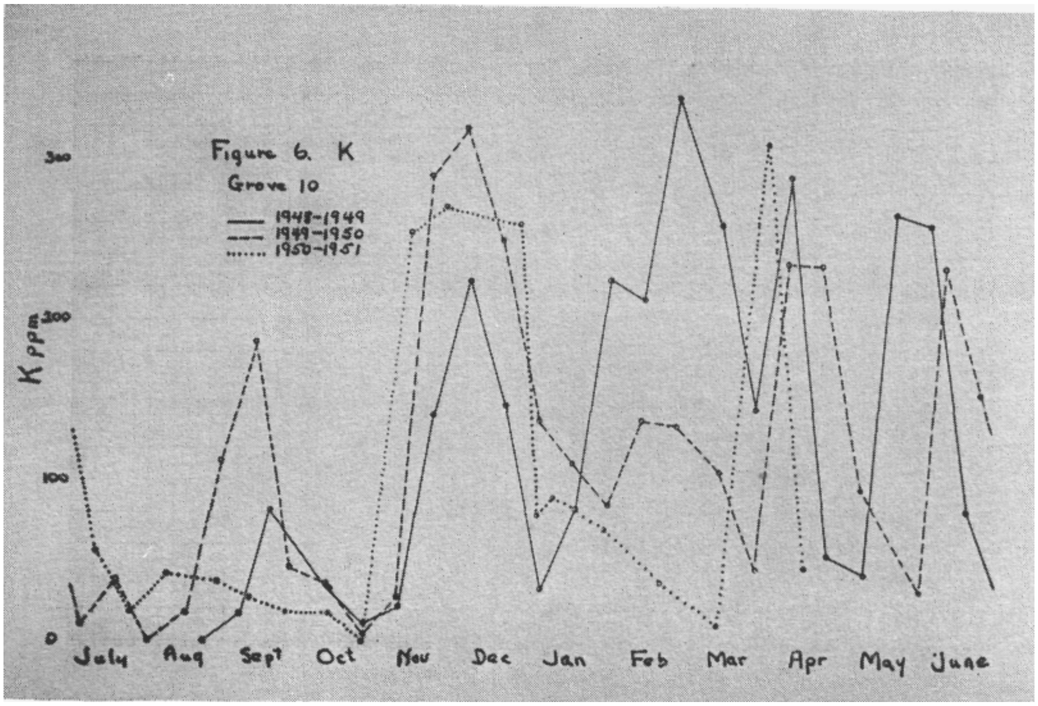


Figure 6. K
Grove 10
1948-1949
1949-1950
1950-1951
K ppm
300
200
100
0
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June

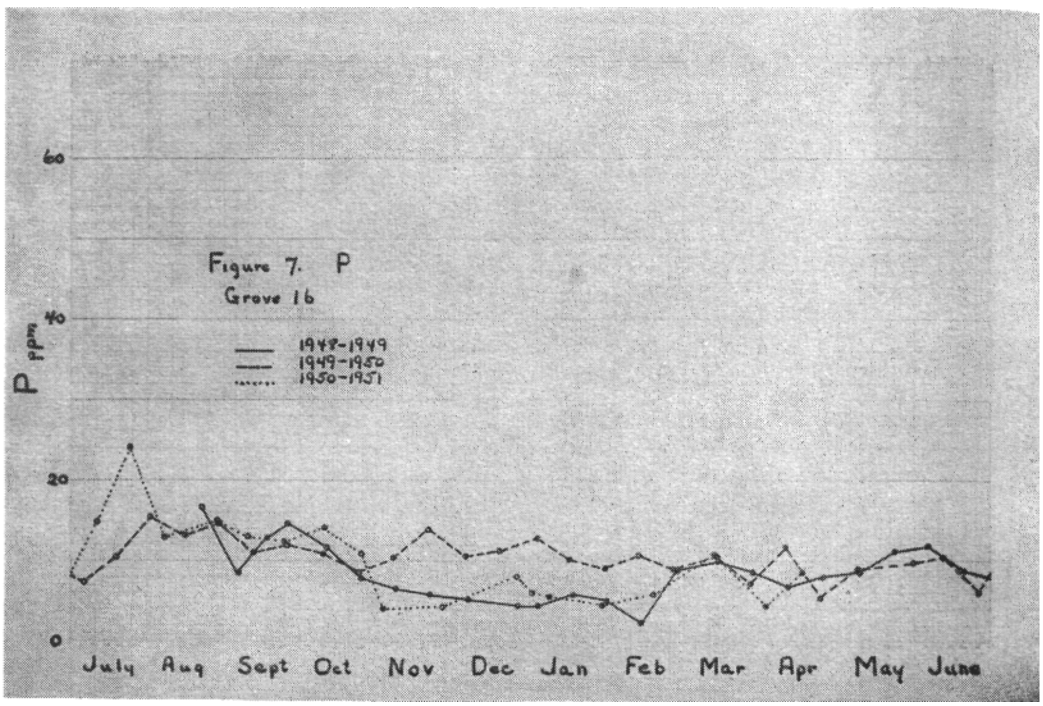
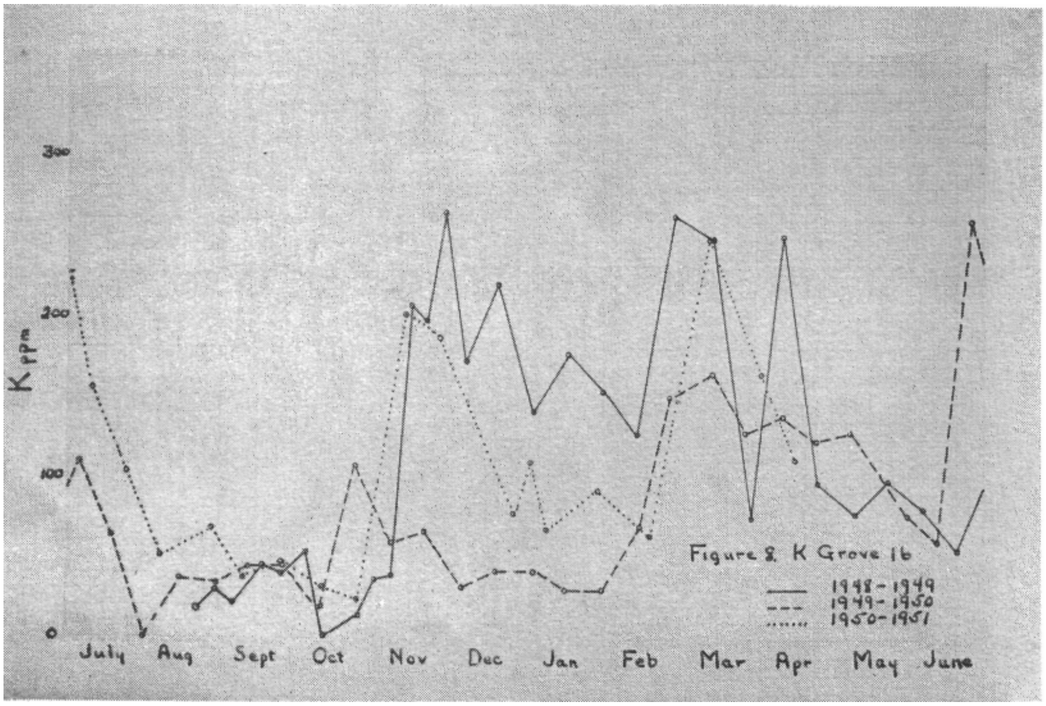
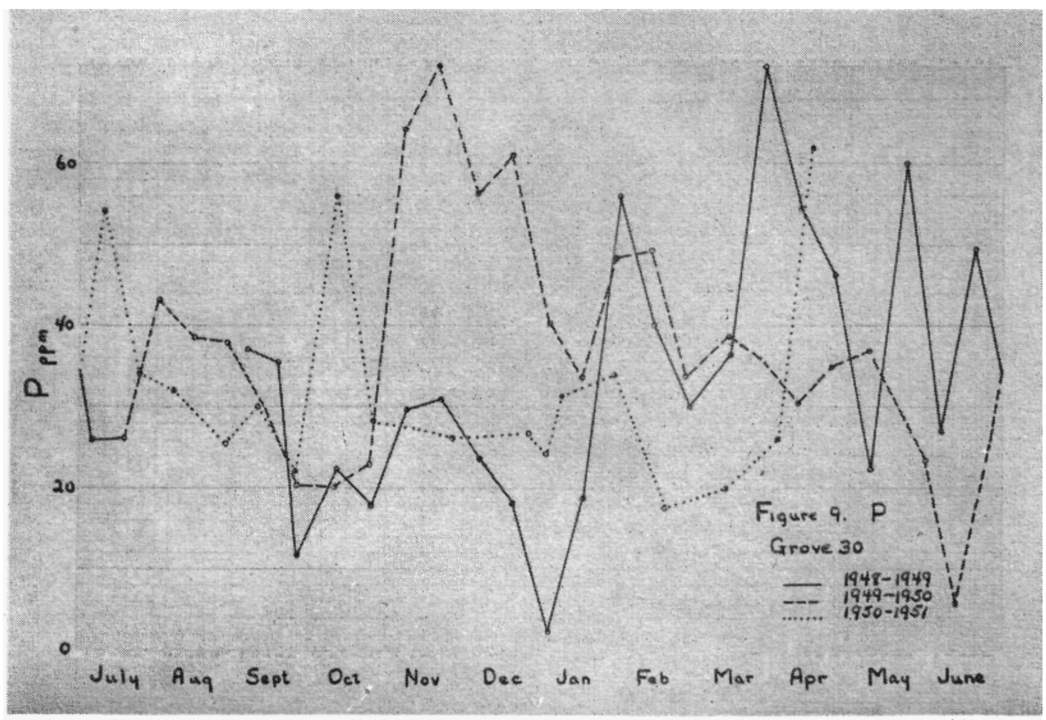


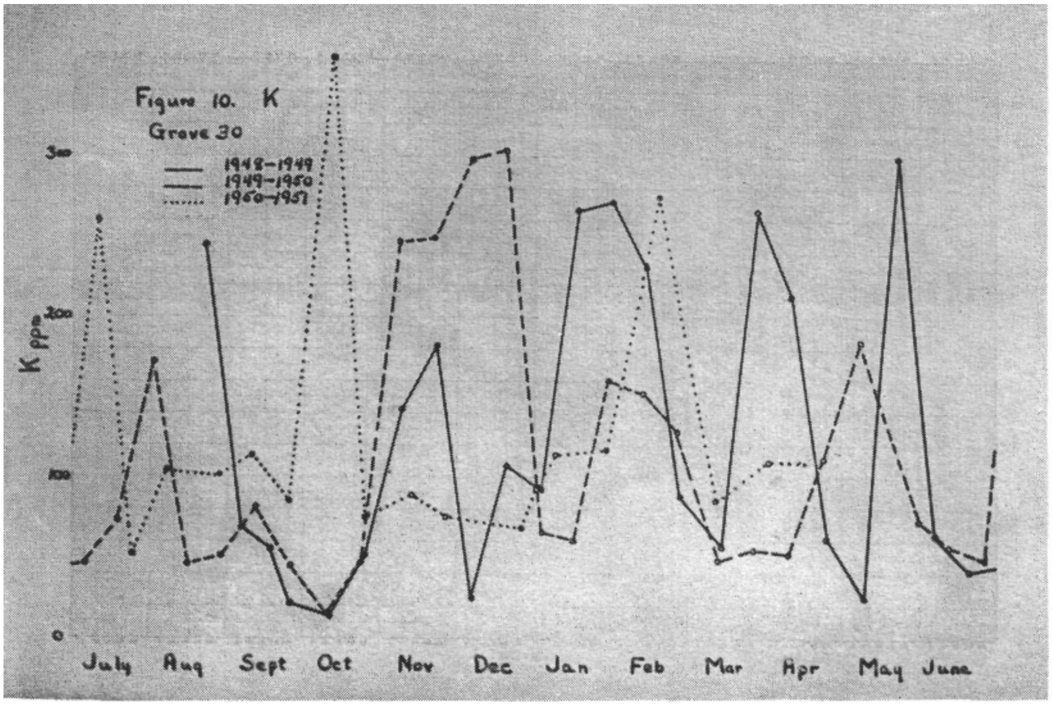
Figure 7. P
Grove 16
1948-1949
1949-1950
1950-1951
P ppm
60
40
20
0
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June



K_{ppm}
300
200
100
0
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
Figure 8. K Grove 16
1948-1949
1949-1950
1950-1951



P_{ppm}
60
40
20
0
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
Figure 9. P
Grove 30
1948-1949
1949-1950
1950-1951



Paralleling the results from the lime groves, there was much less difference between the potassium levels than the phosphorus levels in the two avocado groves. Both groves received heavy applications of potash during the winter months. An apparent attempt to maintain the high potash level in Grove 30 during the summer months was not successful.

SUMMARY AND CONCLUSIONS

The average water soluble phosphorus content of soils from lime and avocado groves was twice that found in orange and grapefruit grove soils by Peech and Young (4), 12 ppm. Compared to 6 ppm. It was also higher than that found necessary for a bean crop on the organic soils of the Everglades.

The water soluble potassium content of soils from lime and avocado groves in Dade County was higher than the exchangeable potassium content of the grove soils studied by Peech and Young (4), 93 ppm compared to 58 ppm.

A relatively low and uniform supply of water soluble phosphorus was maintained in some of the lime and avocado groves. Where this was done the trees were in excellent condition. While the trees showed no evidence of injury in areas of high water soluble phosphorus concentrations, they showed no benefit. On the average, the water soluble phosphorus content of these soils was the same in all seasons. Probably phosphate fertilizers could be applied to many lime and avocado groves less frequently and at lower rates than at present without any harm to the trees.

Water soluble potassium was not maintained at a uniform level in any grove. When there were heavy rains, high concentrations disappeared as quickly as moderate ones.

During periods of dry weather the potassium remained in the soils. The potassium level of these soils was highest in the late winter and lowest at the end of the summer. Potash should be applied frequently, but only if there has been enough rain to make the potassium in the soil available to the trees or an excess rain to leach it away.

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*—The soil samples analyzed in this investigation were taken and prepared by Mr. M. H. Gallatin of the Soil Conservation Service in connection with a more comprehensive study of the nitrogen economy of these soils which he is undertaking.