And while there is much to be said along economic lines, much of geographical significance, and even more of political and historical prominence, we of the State Horticultural Society have taken it upon ourselves to campaign for those great natural resources of aesthetic and practical value which contribute so much to the beauty and attractiveness of Florida.

In many instances we see the beautiful parks, water fronts, boulevards and gardens of well planned cities which have sought, as an objective, the beautification of many acres and many miles that should rightfully be preserved as common property for the heritage of the coming generations. We see upwards of four hundred thousand acres of beautiful citrus groves, well kept and bearing delicious and healthful fruits. We admire the celery lands, the berry farms, the vegetable plantations, the fields of grain, the farms and the great chain of highways connecting and binding us together into a commonwealth of neighbors.

But much remains to be done even yet. Permanent thoroughfares need to be widened, waterfronts need to be preserved for the common good. Parks and boulevards need to be beautified and made more attractive. Many neglected groves and fields need attention, and above all, we need a continuation and a revival of interest in home beautification by every resident family in the State of Florida.

A trip through the famous Jungle Gardens, the Cypress Gardens, the Floral Gardens, and other parks, reveals hundreds of tropical and semi-tropical shrubs, plants and flowers which can be grown in Florida. The natural jungles, hammocks, everglades and uplands no doubt hold the secret of many more. I mention these things only to point out the possibilities of beautifying this land which the great Spaniard, Ponce de Leon, who was the first white man to see its beauties, named "The Land of Flowers."

Many valuable papers and discussions will be presented throughout this session, to reveal how we can improve the appearance and the value of our homes, our cities and our farms, thus making us a happier, better contented and even more hospitable people. I sincerely hope that all of you who are enjoying the hospitality of the remarkably beautiful city of DeLand, will also enter wholeheartedly into the enjoyment and the spirit of the program of the Society in this its 49th annual session.

We will now have an illustrated lecture, "Gardens of England," by Rev. John Everington, of Clearwater.

(There was no manuscript submitted to cover this address.)

MAJOR PLANT FOOD ELEMENTS FOR CITRUS

R. M. Barnette, Chemist
Florida Agricultural Experiment Station

There are several general statements about plant food elements which are pertinent to a conference on the "major plant food elements." Perhaps the most important point to keep in mind is the fact that the specific action of any plant food element is dependent upon an adequate available supply of all other elements essential for a healthy plant under specific growth conditions. This fact makes difficult a sharp delineation between elements to be considered "major" and those to be considered "minor." However, in order to draw a line, the elements carbon, hydrogen and oxygen which are obtained by the plant from air and water and build up the greater portion of the plant structure have been disregarded, and the elements nitrogen, phosphorus, potassium and calcium considered the "major" plant food elements. There is some justification for considering these elements as major in that they occur in relatively high percentages in plants, and their compounds form the bulk of fertilizing materials.

The beneficial action of these elements is de-
pended upon a readily available and adequate supply of the so-called “minor plant food elements” which may be more properly designated as “trace elements.”

Nitrogen is one of the most important of the major plant food elements, especially for Florida. The well drained sandy soils of this State have a low nitrogen content due to the fact that organic matter accumulates very sparingly in them. High temperatures, abundant rainfall and aeration of well-drained soils favor the rapid oxidation of organic matter and subsequent removal of nitrogen. Nitrogen goes into the all important proteins in the plant and, hence, is essential for the building up of the organic part of the tree. The importance of nitrogen for healthy plant growth is too commonly accepted to dwell further on its function in the tree.

Phosphorus is considered essential for the formation of lecithin, the nucleo proteins and nucleic acid. These compounds are present in practically every living plant cell. Phosphorus is also abundant in the embryonic cells. It is known to promote root formation, especially lateral and fibrous roots. However, there has been very little experimental evidence collected to show that the proportion of roots to tops is increased by the application of phosphorus. The maturity of some crops is hastened by the application of phosphorus compounds.

In common with many other elements, the physiological role of potassium in the plant is not definitely known. It is known to be beneficial if not essential in the formation of carbohydrates such as sugar by the plant. Potassium is usually present in relatively high amounts in the growing tips of plants. Thus, the leaves and spring growth of the citrus tree have been shown to contain much higher percentages of potassium than the other tree parts. It also plays a role in the formation of proteins and oils in plants. In many of these processes potassium apparently acts as a catalyst. A catalyst is an element or substance whose presence will cause a chemical reaction to take place or hasten the reaction without being combined in the reacting substances.

Calcium is one of the most interesting and important of the mineral plant food elements. Many functions are attributed to it in the growing plant. It is considered necessary for the translocation of carbohydrates such as sugar. It is an important component in the structure of some plant parts such as cell walls and so forth. It is also known to influence the absorption of other elements by the plant and to a degree control the activity of other elements. It is known to reduce the toxic action of other elements. These are just a few of the functions attributed to calcium in the plant, but they emphasize the importance of this element in plant nutrition. Turning from these generalizations, the distribution of these major plant food elements in the citrus grove will next be considered.

Table I gives the pounds per acre of nitrogen, phosphoric acid, potash and lime which may be found in the virgin soil, the average yearly leaching, the trees, fruit and cover crop of a 19 year old Marsh seedless grapefruit tree. As this type of data may be somewhat new to you it will be necessary to explain how they were obtained and calculated.

The calculations for the quantities of plant nutrients contained in the soil were made from analyses of Norfolk sand reported by Collison and Walker in Florida Agricultural Experiment Station Bulletin No. 132. They were made on the basis of 2,000,000 pounds of soil per acre six inches.

The data for the leaching of the plant nutrients was taken from two sources. The average leaching data from the soil tanks at Gainesville as reported in the Annual Reports of the Florida Agricultural Experiment Station for the years 1923, 1924 and 1925 were used. The soil in the tanks was planted to orange trees by Collison and Walker for their studies reported in Bulletin 132. There were eight tanks, four of the tanks were fertilized with superphosphate as a source of phosphoric acid and four with steamed bone meal. The sources of nitrogen were ammonium sulfate, nitrate of soda, dried blood and manure. One tank of the superphosphate series and one of the steamed bone meal series received each of these four sources of nitrogen. The source of potash was sulfate of potash. The leaching data from the eight tanks for the three years has been av-
TABLE I
TOTAL QUANTITIES OF MAJOR PLANT FOOD ELEMENTS IN SOIL, LEACHING, TREES, FRUIT AND COVER CROP OF AN ACRE OF 19 YEAR OLD MARSH SEEDLESS GRAPEFRUIT

<table>
<thead>
<tr>
<th>Plant Food Elements</th>
<th>Annual Leaching (2)</th>
<th>Cover Crop (4)</th>
<th>Cover Crop (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soil 3 ft. 9 in.</td>
<td>Tree Area</td>
<td>Cover Crop Area</td>
</tr>
<tr>
<td>Nitrogen (N)</td>
<td>3,380</td>
<td>45.20</td>
<td>4.38</td>
</tr>
<tr>
<td>Phosphoric Acid (P₂O₅)</td>
<td>12,250</td>
<td>0.52</td>
<td>0.64</td>
</tr>
<tr>
<td>Potash (K₂O)</td>
<td>5,970</td>
<td>113.44</td>
<td>4.24</td>
</tr>
<tr>
<td>Lime (CaO)</td>
<td>40,700</td>
<td>153.60</td>
<td>59.84</td>
</tr>
</tbody>
</table>

(1) On basis of 2,000,000 pounds per acre 6 inches.  
(2) On basis of 70 trees with 20 feet spread each.  
(3) On basis of 6 crates per tree.  
(4) On basis of 2,000 pounds dry material.

TABLE II
THE MAJOR PLANT FOOD ELEMENTS REQUIRED ANNUALLY FOR LEACHING, TREE GROWTH AND FRUIT FOR 19 YEAR OLD MARSH SEEDLESS GRAPEFRUIT

<table>
<thead>
<tr>
<th>Plant Food Elements</th>
<th>Leaching</th>
<th>Leaf Renewal and New Leaves</th>
<th>Twig Growth Up to ½ Inch</th>
<th>Fruit</th>
<th>Total</th>
<th>Calculated From Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>Nitrogen (N)</td>
<td>49.58</td>
<td>28.00</td>
<td>18.20</td>
<td>50.40</td>
<td>146.18</td>
<td>154.00</td>
</tr>
<tr>
<td>Phosphoric Acid (P₂O₅)</td>
<td>1.16</td>
<td>3.50</td>
<td>5.60</td>
<td>16.80</td>
<td>27.06</td>
<td>224.00</td>
</tr>
<tr>
<td>Potash (K₂O)</td>
<td>117.68</td>
<td>34.30</td>
<td>23.80</td>
<td>100.80</td>
<td>276.58</td>
<td>224.00</td>
</tr>
<tr>
<td>Lime (CaO)</td>
<td>213.44</td>
<td>46.20</td>
<td>59.50</td>
<td>29.40</td>
<td>348.54</td>
<td>--------</td>
</tr>
</tbody>
</table>

The applications of complete fertilizer were made three times a year to the 1/2000 acre tanks at a rate corresponding to the applications made to a tree with a ten foot spread. The figures have been further increased to correspond to applications made to a tree with a twenty foot spread.
planted 70 to an acre. The area occupied by the trees has been deduced and the leaching from the cover crop area calculated from unpublished data obtained in a study of the relationship of summer cover crops to leaching of plant nutrients. The average data for two years for five tanks growing Crotalaria striata, cowpeas, velvet beans, beggarweed and Florida pursley, respectively, have been used for these calculations.

The mineral analysis of a 19 year old Marsh seedless grapefruit tree reported by Barnette, DeBusk, Hester and Jones, in the Citrus Industry of March, 1931 (vol. 12, p. 5) has been used for calculating the amounts of the elements in the tree per acre of seventy trees.

The fruit analyses were taken from an average of numerous determinations made on the complete fruit of Marsh seedless trees grown in sandy soils. These analyses together with the cover crop analyses have been made in the laboratories of the Department of Chemistry and Soils of the Florida Agricultural Experiment Station.

Despite the fact that the soil contains relatively large total quantities of the plant food elements, it must be borne in mind that only a very small percentage of these elements are available to the tree at any one time. Also, in comparison with most soils these sandy soils contain only small percentages of these necessary plant nutrients. For practical purposes of fertilization, the content of the soil in these elements may be more or less disregarded.

As is to be expected, the greater quantities of the major plant food elements, with the exception of phosphoric acid, are leached from the fertilized area. This area comprises approximately half of the acre. Lime is leached to the greatest extent, potash second, nitrogen third and phosphoric acid least. The low leaching of phosphoric acid may be attributed to its fixation in the soil in combinations which are very insoluble in water. The average annual leaching of nitrogen is equivalent to 302 pounds of nitrate of soda. The leaching of phosphoric acid is equivalent to 7 pounds of 16 per cent. superphosphate; that of potash to 242 pounds of sulphate of potash and that of lime to 426 pounds of ground limestone.

Of the four major plant food elements, the trees contained largest quantities of lime, the second largest of potash, the third of nitrogen and the lowest of phosphoric acid. It is interesting to note and perhaps significant, that these four major plant food elements are found in the trees in the same order with regard to amounts that they are leached from the soil. However, it is readily seen that the proportionate quantities of nitrogen and phosphoric acid found in the trees are larger than are leached from the soil.

In the fruit, potash is found in the largest quantities. About one-half as much nitrogen as potash is contained in the fruit. Lime is the third highest of the major plant food elements, with phosphoric acid lowest.

The quantities of the major plant food elements contained in the cover crop are quite variable. However, the quantities found in a ton of the commonly used cover crops emphasize the importance of an adequate summer cover crop and organic matter in the turnover of the major plant food elements in the soil. A goodly portion of the plant food elements in the cover crop becomes available to the growing tree.

In addition to the quantities of the major plant food elements found in an acre of citrus, it is of interest to attempt to determine the quantities necessary for producing a crop of fruit, maintaining tree growth and making up losses which occur through leaching. The results of such an attempt at the calculation of the quantities of the major plant food elements required yearly per acre for a 19 year old Marsh seedless grapefruit grove are given in Table II.

The quantities of nitrogen, phosphoric acid, potash and lime in the leachings from the soil, in leaf renewal and new leaves, in twig growth up to ½ inch in diameter, and in mature fruit have been calculated together with applications of these plant foods as recommended in Citrus Fertilizer Programs for Florida, issued by the Extension Division in 1934. In these calculations, it has been assumed that one-half of the major plant food elements contained in the leaves would be required each year for leaf renewal and new leaf growth. Twig growth up to ½ inch in diameter is considered as corresponding to the several flushes of
growth during the year. The quantities of the plant foods in the leachings and fruit were taken from Table I. The small quantities of the plant foods contained in yearly trunk and limb enlargement have been disregarded.

The total quantities of nitrogen, phosphoric acid, potash and lime required to maintain the tree, produce fruit and make up for losses by leaching are of interest. Thus, approximately 146 pounds of nitrogen per acre per year are required to maintain a producing 19 year old Marsh seedless grapefruit grove. This is equivalent to 890 pounds of nitrate of soda and closely approximates the recommendations of the Extension Division. However, only 27.06 pounds of phosphoric acid which is equivalent to 169 pounds of 16 per cent. superphosphate is required to maintain the grove. But these calculations for phosphoric acid are misleading if the insoluble nature of phosphorus compounds in the soil are not taken into consideration. It must be borne in mind that even relatively soluble phosphorus compounds are rendered practically insoluble, when they react with the soil. Thus the apparent requirements cannot be expected to be equivalent to the recommended additions.

For potash, the calculated requirements are similar to average applications calculated from the fertilizer recommendations. It is interesting to note that the calculated requirements for lime are approximately equivalent to an application of 1400 pounds of superphosphate per acre containing 28.44 per cent. CaO. This yearly application of superphosphate contains the minimum phosphoric acid recommended by the Extension Division in their Citrus Fertilizer Programs for Florida.

Prof. Lord: Dr. Barnette, I would like to ask you if you think the lime taken from the Marsh Grapefruit is typical of the amounts taken from other citrus fruits. The seedless grapefruit, I think, is not quite typical, and it is not quite fair, it seems to me, to give the lime required as based on grapefruit.

Answer: The analysis from the orange does show a high content of lime and potash. However, the results with grapefruit are typical of a great section of the state. In other words, the analysis of other fruits may show very nearly the same results. Insofar as I had the analysis on the Marsh Seedless tree, I feel justified in using it.

Question: Is it true that the lime requirement of oranges is much higher than that of grapefruit?

Answer: In the analysis which we have, the Marsh Seedless is somewhat high in lime content. I am sorry I can't answer that question.

Question: I would like to ask you another question. You say that the phosphorus is fixed in the soil in soluble quantity. Isn't that a little in conflict with Dr. 's theory? Isn't it true that the proportion of phosphorus depends on the bases involved—that is, you would expect an acid soil, if it was an acid soil, to render the phosphorus acid to some extent? Isn't it true that plants with a high calcium requirement have a high nitrogen requirement?

Answer: I would be reluctant to make a definite statement of that nature.

Question: Isn't it true also that plants with a high calcium requirement do better with nitrates than ammonia?

Answer: Plants with a high calcium requirement do better use of nitrogen.

Question: Did I understand your last statement correctly—you said that the lime requirements of the citrus are very largely met by the lime that is in the calcium sulphate that is recommended?

Answer: I said it is interesting to note that the minimum phosphorus in the fertilizer recommendations is an application of 1,400 pounds of superphosphate per acre, which would contain the quantities of lime which we had calculated in the requirements of the tree.

Question: I appreciate the fact that the calcium phosphate is highly available to citrus fruit, but I do not believe the calcium in the form of calcium sulphate is available to citrus trees. It might be available to the cover crop, such as crotalaria.

Answer: I recognize your opinion.

Question (Mr. Sexton): What does the com-
mittee recommend, after applying 1,400 pounds of sulphur phosphate, lime in addition?

Answer: It would not necessarily recommend that; it was the minimum recommendation for the fertilizer program; they have several different programs. That was their minimum for the complete program.

Question: Then you might recommend additional lime?

Answer: Certainly.

SOME FIELD TESTS WITH MAGNESIUM SOURCES

W. L. Tait, Winter Haven

The yellowing of foliage of citrus trees in the late summer and fall has been observed for several years. This loss of green color is generally first noted and develops to a greater degree in the seedy varieties of grapefruit. Later in the season it becomes apparent in Pineapples and Valencias. While Marsh Seedless grapefruit do not escape the yellowing, they are not often as seriously affected as the other varieties. Tangerines also sometimes show the chlorotic condition more or less.

The type of chlorosis, or loss of green color, which has been referred to, is very easily distinguished when once its characteristics have been fixed by the mind's eye. First of all it appears in the older leaves—it has never been observed in leaves of the most recent growth flush. The pattern is distinct—a row of light green or yellow spots on each side of the midrib, which gradually merge to form a yellow stripe and finally the entire leaf becomes pale green or yellow. Several names, such as "bronzing," "yellow leaf," "copper leaf" and so forth, have been applied to this symptom, but here the term "yellow leaf" will be used since it most accurately describes the color of the affected leaves. Indications are that "yellow leaf" in citrus is due to a deficiency of magnesium.

Bryan and DeBusk (3) recently reported the prevention of "bronzing" of citrus by the use of dolomitic limestone. The use of the term "bronzing" for the above described symptoms of citrus associates it to some extent with the abnormal condition of tung trees called "bronzing" which is corrected by the application of zinc sulfate. The use of zinc sulfate on citrus trees affected with "yellow leaf" has not corrected the condition—at least that was the observation in a limited number of cases in the summers of 1934 and 1935. The yellowed leaves soon dropped after the application of the zinc sprays, leaving the trees much thinner in foliage.

Bahrt (1) reported improvement in the condition of bronzed citrus trees from the use of dolomitic limestone and magnesium sulfate as well as certain other materials.

Very often "yellow leaf" is severe on those trees

<table>
<thead>
<tr>
<th>Material</th>
<th>Summer Application Lb. per Tree</th>
<th>Fall Application Lb. per Tree</th>
<th>Approx. Application per Acre (Lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardwood Ashes</td>
<td>30</td>
<td>15</td>
<td>2250</td>
</tr>
<tr>
<td>Finely Ground Oyster Shells</td>
<td>20</td>
<td>10</td>
<td>1550</td>
</tr>
<tr>
<td>Hydrated Lime plus</td>
<td>20</td>
<td>10</td>
<td>1550</td>
</tr>
<tr>
<td>Manganese Sulphate</td>
<td></td>
<td></td>
<td>1550</td>
</tr>
<tr>
<td>Dolomitic Limestone</td>
<td>20</td>
<td>10</td>
<td>1550</td>
</tr>
<tr>
<td>Finely Ground Oyster Shells</td>
<td>20</td>
<td>10</td>
<td>1550</td>
</tr>
<tr>
<td>Plus Epsom Salt</td>
<td>2</td>
<td>1</td>
<td>150</td>
</tr>
<tr>
<td>Epsom Salt</td>
<td>2 1/4</td>
<td>1 1/4</td>
<td>168</td>
</tr>
</tbody>
</table>