Technician operates recording spectrometer in Department of Horticulture Plant Nutrition Laboratory. An analysis for twelve mineral elements is obtained within two minutes once the leaf sample is prepared. Data are punched on IBM cards for conversion into ppm or percent by a computer. (See cover story on Leaf Analysis, page 1).
News From S.A.F.

USDA ADDS 12 STATES TO CROP REPORTING PROGRAM

The U.S. Department of Agriculture has advised the Society of American Florists that 12 states and 2 new commodities will be included for the first time in the annual flower survey. Dr. E.C. Gasiorkiewicz, Chairman, SAF Research & Development Committee, states that increased funds for crop estimating and reporting, approved by Congress this year, have made this expansion possible. This increase has been strongly pursued by the Society for the past several years and both SAF and Florists' Transworld Delivery Assn. witnesses called for the expansion in their testimony before the House and Senate Agricultural Appropriations Subcommittees.

Potted chrysanthemums and foliage plants will be added to those flowers now included in the survey: carnations, chrysanthemums, roses, and gladioli. Commercial growers in the following states will be included for the first time: Connecticut, Michigan, Wisconsin, Minnesota, Iowa, Missouri, Delaware, Maryland, Tennessee, Texas, Washington, and Oregon. Growers in Massachusetts, New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, North Carolina, Florida, Colorado, and California will continue to be surveyed.

These 23 states account for over 90 percent of the U.S. value of the flower items in the survey, and close to half of the total value of flower output. In 1959, production of these flowers in the 23 states was valued at $137,231,000 compared with $149,726,000 for these same commodities in all states.

Producers in the 23 states will soon receive a questionnaire asking which flowers they grow and the dollar value of their sales. The results will be used to determine the commercial producers to be included in the January survey.

A commercial producer, for survey purposes, is one who grows and sells a minimum of $2,000 of all flower and nursery products in one year. In January, these producers will be asked for information about their sales and value of sales during 1966 as well as their production plans for 1967 for the 6 items.

NPP PREPARING FILMSTRIP ON FOLIAGE PLANTS

Based on the success of the educational filmstrip, "Flowers and You," the Society of American Florists is preparing a new sound-color filmstrip devoted entirely to foliage plants, announces Jack Kaufman, Chairman, Product Promotion Committee. The 13½ minute filmstrip will be ready for use in the spring, 1967, semester. It will be available to teachers of home economics and art classes at secondary and college levels, to adult groups, extension agents, 4-H and other youth groups. Florists will also be able to obtain copies for use in their communities.

Particular interest has been shown in foliage plants by those who have viewed "Flowers and You." The objectives of the new filmstrip are to stimulate even greater interest in and appreciation of house plants, introducing young people and adults to a fascinating hobby. Information covered in the filmstrip will include factors to be considered in selecting house plants, plant care, variety of uses and settings.

BEAUTIFY AMERICA POSTAGE STAMP

"Members of the floral industry should make every effort to purchase and use the new 5-cents Beautification of America stamp, designed to encourage participation in President Johnson's beautification program," said Jack Kaufman, Chairman, National Product Promotion Program, Society of American Florists. The new three-color stamp will be issued in Washington (D.C), October 5. It pictures the Jefferson Memorial framed by a bough laden with Cherry Blossoms and carries the legend "Plant for a more Beautiful America".

"The beautify America effort in which Mrs. Johnson has taken a leading role," continued Mr. Kaufman, "has gained much momentum and this stamp — designed by Gyo Fujikawa, a New York City freelance artist of Japanese parentage — is another step forward in the furtherance of this movement."

Mr. Kaufman indicated that addressed envelopes for first-day cancellations may be sent to the Postmaster, Washington, D.C. 20013, with remittance for the cost of the stamps. The outer envelope to the Postmaster should be marked "First Day Covers Beautification Stamp", and must be postmarked no later than October 5.

SUPPORT DILLON RESEARCH FUND

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PLANT ANALYSIS FOR FLOWER CROPS

DR. JOHN W. WHITE
Penn State University
Presented at the 1966 Penn State Florists Conference

Introduction

Man has long been interested in controlling the yield and quality of products grown on his land. At first, crop growing was dependent on the natural fertility of the soil. Then it was discovered that decomposed or decomposing forms of plant and animal matter could be used to increase crop growth. Next it was found that inorganic chemicals could be used as fertilizers to change the nutritional status of the soil and thus improve crop productivity. The amounts of fertilizer used and the frequencies of fertilizer application have increased steadily through the years to the present day highs.

Visual Analysis

There are several approaches possible for deciding the amounts and kinds of fertilizers to use. One of the oldest and possibly one of the first used methods was diagnosis by visual plant symptoms. The grower looks at his crop and compares what he sees with his knowledge of what he expects a normal healthy plant to look like. However, experience and experiments have shown that such symptoms may be unreliable in pinpointing the element which is deficient. In some cases two different elements in deficient supply may give symptoms quite similar in appearance. In fact, often toxicity symptoms appear the same as symptoms created by deficiencies of the same element. Furthermore, growth, yield and quality may be seriously reduced without the development of recognizable deficiency symptoms. This situation has been called “Hidden Hunger” in many publications.

Standard Fertilization Program

The standard fertilization program provides a method of scheduling in advance the kind and amount of fertilizers to be applied at certain intervals throughout the year, such as weekly or at each irrigation. Such a pre-planned consistent fertilization program is usually based on planned distribution of the crops yearly fertilizer requirements as determined by experiments and grower experience. Standardization of soil mixtures, watering schedules, temperature and other crop management operations are necessary to make the best use of this approach to fertility control.

Soil Analysis

Soil analysis has been used for many years to assess the fertility status of a particular soil. The analyses are usually made on the available nutrient minerals in the soil and not the total minerals. The assumption is made that there is a direct relationship between chemically extractable nutrients in the soil and their uptake by the plant.

However, soil scientists are beginning to realize that this is an over-simplification and that at best a soil test can only serve as a guide to fertility recommendations when soil samples are collected in sufficient numbers and at regular intervals.

Soil testing can be used to follow the trends of fertility for nitrogen, potassium, phosphorus, calcium, magnesium, pH and soluble salts and to predict necessary corrective measures in a fertility program. The need for an understanding of the plant requirements for many additional chemical elements has come with the advent of liquid fertilization programs, the changes from low analysis to high analysis fertilizers, from using peat moss instead of manure as an organic amendment, from continuous use of soil with steam sterilization, and from using fertilizers containing essentially no trace elements to those containing many of the trace elements. However, since less than one-half of the fifteen essential elements required for normal crop growth can be determined with any accuracy by chemical soil analysis, man has continued to search for methods of determining the total nutrient requirements of each crop. Even though soil tests do not give all the necessary information, they will not be discarded.

Essential Elements

There are fifteen elements (C H O P K N S Ca Fe Mg Mo B Cu, Mn Zn) which are considered necessary for normal plant growth. In most cases carbon, hydrogen and oxygen are adequately supplied through air and water. However, it is now recognized that there can be a deficiency of carbon for plant growth in terms of lack of carbon dioxide.

Nitrogen and potassium are required by the plant in relatively large amounts, calcium, phosphorus, sulfur and magnesium in smaller amounts while iron, manganese, copper, boron, molybdenum and zinc in very minute or trace amounts. For example, if 100 pounds of fresh carnation leaves were dried in an oven, they would lose 90 pounds of water, leaving 10 pounds of dried matter; if the 10 pounds of dried plant matter were burned in a high temperature oven, they would lose 9 pounds of organic compounds, leaving 1 pound of mineral elements. The 1 pound of ash,
remaining after the two drying processes, is made up of approximately 0.4 pound nitrogen, 0.3 pound potassium, 0.15 pound calcium, 0.1 pound sulfur, 0.04 pound phosphorus, 0.04 pound magnesium, 0.002 pound manganese, 0.0005 pound each of iron, boron, sodium, zinc, aluminum and strontium and 0.00008 pound of copper.

Since soil testing is used basically to test nitrogen, phosphorus, potassium, pH and total soluble salts and not for the remaining 9 elements, another method of determining the fertility status of a crop has been developed which can be used to determine all 12 of the essential mineral elements and also determine if the plant has absorbed these elements from the soil.

**Plant Analysis**

The objectives of plant analysis are: 1) to determine whether certain changes in leaf or plant appearance are caused by a deficiency or an excess of a given nutrient element. 2) to determine how effective fertilizer applications and soil nutrient supply are meeting plant nutrient needs. 3) to evaluate those nutrients where soil tests are not available. 4) to assess plant nutrient content before unfavorable conditions are evident from reduced or excessive growth or visible symptoms.

The plant analysis method involves the following steps: 1) sampling 2) cleaning 3) drying 4) grinding 5) weighing 6) ashing 7) analysis 8) interpretation. Fortunately the first seven steps have been worked out by research personnel at various universities with the staff at Pennsylvania State being among the leaders in this field. Although the light emission spectrograph (the major instrument used in the analysis) has eliminated many of the time-consuming procedures previously necessary for chemical analysis; a minimum of one week is required to process a sample, assuming that the sample is processed without any delays. However, we can now obtain the composition of a leaf for 12 elements within minutes once the sample is ready for the spectrograph. Since there are only a few pieces of equipment of this kind in the United States being used for horticultural crops; time for use of the equipment is at a premium. The demands for equipment time for various crops often overlap, consequently, someone must wait his turn.

**Interpretation**

Many factors are known to influence the nutrient content of plants and all of these factors must be considered in the interpretation of the analysis. Among the factors to be considered are: 1) plant species and variety 2) time of the year sampled 3) age of plant tissue 4) position or plant part sampled 5) nature and frequency of applications of fertilizer, water, insect and disease sprays 6) environmental and management practices, such as temperature and light control and pinching dates.
Leaves differ in mineral composition depending upon their location on the stem. Standardization of sampling location is a must in plant analysis programs. Comparison of leaf composition values of the same variety between two different growers is not possible unless leaves from comparable positions have been taken for analysis.

Unfortunately, there is probably no single part of the plant that is best for estimating all plant nutrients. Research studies on roses by W. H. Carlson while at The Pennsylvania State University and on carnations by P. V. Nelson while at Cornell University have helped to define the most favorable sampling positions and stages of plant maturity for plant analysis studies of these two crops.

Fertility studies and surveys being conducted at several institutions have begun to provide general ranges of plant nutritional status for selected soils, varieties and management systems through the use of the plant analysis technique. However research personnel do not agree on the best method of interpreting plant analysis results.

Interpretation of plant analysis results has usually involved at least two major approaches: 1) problem solving, i.e., looking for elements which are either too high or too low and thus may be preventing normal plant growth 2) maintenance of balanced and sufficient nutrient levels for the highest possible yield and quality in keeping with the genetic potential of the crops being grown. Flower crops generally contain high concentrations of the major nutrients, particularly during early stages of growth. As plants approach maturity, concentrations of nutrients may drop to extremely low levels. Often this low nutrient concentration nearing maturity is not associated with decreases in yield. For this reason, it is desirable to adopt a sliding scale of critical nutrient levels for asserting the plant nutrient status of flower crops.

Survey Results
In order to try to gain an understanding of the amount of variation to expect from commercial plant samples, a survey was made of 5 rose growers and 5 carnation growers in Pennsylvania. Three hundred sixty samples were collected and analyzed for each crop over an eight month period in 1965. The results of this survey are reported in Tables 2 and 3.

Comparisons of the survey results with results of leaf analyses made on plants from controlled experi-
TABLE 1. Categories for Interpreting Plant Analysis

<table>
<thead>
<tr>
<th>Categories</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHORTAGE</td>
<td>Plants should be showing clearly visible symptoms of a nutrition deficiency.</td>
</tr>
<tr>
<td>BELOW NORMAL</td>
<td>Plants may be normal in appearance but probably will be responsive to fertilization with addition of low-testing element.</td>
</tr>
<tr>
<td>NORMAL</td>
<td>Plants are normal in appearance and have adequate concentrations of this element for maximum yield.</td>
</tr>
<tr>
<td>ABOVE NORMAL</td>
<td>Plants are normal in appearance and optimum yield levels can be expected. However the concentration of this element is higher than normally anticipated.</td>
</tr>
<tr>
<td>EXCESS</td>
<td>Plants either show clearly visible symptoms of a nutritional disorder or have normal appearance. Yield may be significantly reduced by excess of this element.</td>
</tr>
</tbody>
</table>

Many commercially grown carnations were found to be high in manganese. This is a problem which was spotted several years ago through plant analysis. Through extensive research this problem has been pinpointed to be due to over sterilization and low pH conditions. Additional research work is planned on this problem through cooperative experiments conducted by the department of Plant Pathology (Paul Nelson), Agricultural Engineering (Bob Aldrich) and Floriculture (John White). Part of the cost of this project will be sponsored by the Middle Atlantic Carnation Growers through the Dillon Research Fund of the Pennsylvania Flower Growers plus additional money from the Flower Growers. The main approach to solving this problem will be through the use of aerated or low temperature steam. Dr. Aldrich will be working on the mechanics, Dr. White on production and nutrition and Dr. Nelson on the pathological aspects of the problem.

Individual grower problems have been found through the use of leaf analysis which were related to: 1) boron toxicity caused by an accidental use of too much 20 Mule Team Borax, 2) excess sodium in carnation leaves due to poorly draining, compacted soils.

**Plant Analysis Service**

We hope to have a plant analysis service for commercial growers in the near future. Announcement of this service and the information procedures to follow in using the service will come through the extension service county agents, area floriculture agents and The Pennsylvania Flower Growers bulletin. This new diagnostic tool of plant analysis will be used as only one of many techniques to help diagnose problems and control plant productivity through proper fertilization. In addition to the plant analysis we will continue to use soil testing, visual plant appearance and will continue to recommend nutritional adjustments based on proven fertility practices.

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**TABLE 2. Results of Leaf Analysis Survey of Commercial Rose Growers in Pennsylvania, 1965.**

| Nutrient element | N  | P   | K   | Ca  | Mg  | Mn   | Fe | Cu  | B   | Al  | Zn  |
|------------------|----|-----|-----|-----|-----|------|----|-----|-----|-----|-----|-----|
| Units of Measure |    |     |     |     |     |      |    |     |     |     |     |     |
| Mean Concentration | 3.56 | .277 | 2.22 | 1.04 | .321 | 163  | 70 | 8   | 36  | 18  | 51  |
| Range - High      | 3.75 | .347 | 2.81 | 1.27 | .410 | 444  | 93 | 12  | 47  | 29  | 68  |
| Range - Low       | 3.27 | .229 | 1.75 | 0.90 | .279 | 61   | 60 | 7   | 21  | 9   | 34  |

*Each mean value represents an average of 360 samples from 5 growers.*

**TABLE 3. Results of Leaf Analysis of Commercial Carnation Growers in Pennsylvania, 1965.**

<table>
<thead>
<tr>
<th>Nutrient element</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>B</th>
<th>Al</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units of Measure</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Concentration</td>
<td>3.71</td>
<td>.362</td>
<td>3.09</td>
<td>1.38</td>
<td>.421</td>
<td>93</td>
<td>73</td>
<td>7</td>
<td>37</td>
<td>16</td>
<td>37</td>
</tr>
<tr>
<td>Range - High</td>
<td>3.93</td>
<td>.405</td>
<td>3.32</td>
<td>1.50</td>
<td>.613</td>
<td>186</td>
<td>87</td>
<td>11</td>
<td>53</td>
<td>19</td>
<td>48</td>
</tr>
<tr>
<td>Range - Low</td>
<td>3.41</td>
<td>.338</td>
<td>2.84</td>
<td>1.32</td>
<td>.189</td>
<td>52</td>
<td>54</td>
<td>5</td>
<td>28</td>
<td>14</td>
<td>22</td>
</tr>
</tbody>
</table>

*Each mean value represents an average of 360 samples from 5 growers.*