serious trouble from the gladiolus Fusarium and Stromatinia fungi. Certainly, the incentive to plant on non-infested land will be greatly increased. Growers may find it profitable to chemically treat or flood infested fields in good locations, thereby bringing back into production the better frost-protected land.

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# FERTILIZATION OF ORNAMENTAL PLANTS

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The purpose of this paper will be to review briefly the research work on the fertilization of ornamental plants and related crops, to present recommendations being used, and to emphasize the need for research work on the nutritional requirements of ornamental plants.

The complexity of the problem of the fertilization of ornamental plants can only be appreciated when one considers the variety of plants used for ornamental purposes. This field deals with both the commercial production and the home use of ornamental plants, flowers, trees, foliage plants, lawn grasses, bulb crops and some plants that require special cultural conditions, such as azaleas, camellias and roses. This situation is further complicated by the fact that the type of growth of a particular crop may vary with the type of production. That is, a nurseryman wishing to produce a flowering shrub may use a different fertilization program than a nurseryman growing the same plant as a vegetative specimen. This is particularly true of production of such crops as lilies and gladiolus where the fertilizer program used for the production of corms and bulbs is quite different from the one used to produce flowers. Another complication is the difference in the fertilizers used in commercial production as compared to those used for plants growing on the home grounds. In the commercial plantings, the most economical fertilizer is one that will produce a quality plant or crop as quickly as possible. Furthermore, the fertilizer program for ornamental plants should be flexible enough to be adapted for being applied as a dry fertilizer or as a liquid or soluble fertilizer. A fertilizer for the home grounds should be safe to apply and produce slow but uniform growth. In the latter case, the cost of the fertilizer is secondary to safety and adaptability to a wide range of plants.

A good fertilizer program for flowers or ornamental plants should satisfy as many of the following characteristics as possible: (1) It should produce the type of plant desired as economically as possible. (2) It should require a minimum of labor and care to apply. (3) It should be safe to use, and adapted to the experience and ability of the workmen or employees to handle. (4) It should be easy to apply uniformly either in dry or soluble form. (5) It should be easily changed or adapted for differences in growth of the plants and weather conditions.

It must be remembered that the results to be gained from a fertilizer are influenced by the soil type or soil mixture, watering procedure, type of production or type of plant, cultural methods, particularly as they affect the aeration and drainage of the soil, amount of shade, temperature and time of year, accuracy in applying. This last part is usually dependent on the training of the operator and the care which he uses in applying the fertilizer.

The following have been found to be useful guides for checking and advising nurserymen and growers in developing a good fertilizer program: (1) Check the cost of the fertilizer program. Fertilizers are expensive and, therefore, the cheapest fertilizer that will give the N-P-K ratio or level and that will produce the type of plant desired is the best fertilizer. (2) Do not apply any more fertilizer than is needed. Many nurserymen and grow-

ers injure plants with excessive applications of fertilizers. Others apply too much fertilizer and leach it by excessive irrigation. (3) Generally, light applications of fertilizer applied more frequently will produce better plant growth than heavy applications applied infrequently. This can usually be accomplished without too much cost by slight change in the type of fertilizer and method of application. (4) Use a soil analysis as a check on the fertility level of the soil, but do not depend on it entirely to determine fertilizer needs Use also the growth of the plants as an index. (5) Except in fertilizing a new soil or applying fertilizer when the area is being worked up, do not depend entirely on a complete fertilizer unless N-P-K are needed. Use nitrogen, phosphorus or potash or combination of these materials to adjust the fertility level of the soil. (6) When needed, work dolomite, lime and superphosphate into the soil before the plants are set. Nitrogen and potash can be applied as needed from the top, but the above materials should be incorporated into the soil. (7) Since many fertilizers will burn exposed or dry roots very quickly, follow the practice of watering, fertilizing and watering again. (8) Don't overdo the use of minor element mixtures. Avoid using minor elements that are not known to be deficient in a particular soil or with a particular plant. The excessive use of certain elements may induce deficiencies of other minor elements.

*Fertilization of Nursery Stock:*

A review of the literature reveals only a limited amount of research work on the nutrition of nursery stock. Chadwick (1) recommends 3 pounds per 100 square feet of 4-12-4 for broadleaf evergreens in Ohio. Edson (3) working with Chinese hibiscus in Florida, grown in Norfolk fine sandy loam found that this plant grew and flowered best when supplied with a nutrient level that would approximate 4 pounds of 4-8-10 per 100 square feet. Orr and Furuta (7) secured the best growth of camellias in Alabama from the use of 5 pounds of 6-10-8 per 100 square feet applied in four equal applications about three months apart. These same workers (6) found that azaleas grew best when supplied with 16 pounds of 6-10-4 per 100 square feet. Laurie and Kiplinger (5) recommend 4 pounds of 4-12-4 per 100 square feet for camellias and 6 pounds of 4-12-4 per 100 square feet for azaleas. The Florida Agricultural Extension Service recommends 3¼ pounds of 6-6-6 per 100 square feet for blueberries. One can note that the above results and recommendations vary considerably in the amount of nutrients supplied, the range being .12 to .83 pounds of N, .21 to 1.38 pounds $P_2O_5$ and .12 to .64 pounds $K_2O$ per 100 square feet.

The rate of application, ratio and amount of nutrients supplied by the fertilizer program used by nurserymen covers an even wider range, varying from 3 pounds of 4-7-5 per 100 square feet for field-grown nursery stock in north Florida to 26½ pounds of 6-8-8 per 100 square feet used for azaleas in central Florida. These rates and formulaes supply .11 to 1.58 pounds N, .19 to 2.11 pounds $P_2O_5$, and .14 to 2.11 pounds $K_2O$. The fertilizer program of other nurseries visited would fall between these two extremes.

Our recommendations to nurserymen for woody ornamental trees, shrubs and vines are usually adaptations or adjustments of the fertilizer program already being used. For example, last year a fertilizer demonstration was conducted for a nurseryman to compare the cost and response from three fertilizers, namely, 4-6-8, tankage (10.5% N) and 13-26-13 applied in liquid form, and to find better combinations or adaptations of these fertilizers. The results showed that the addition of potash to the tankage, changing the formula to 9-0-6 applied dry, resulted in growth that compared favorably with the growth secured from frequent applications of 13-26-13 in liquid form, and cut his fertilization cost in half.

Our recommendations generally fall within the range of 4 to 6 pounds of 6-6-6 or 8-8-8 per 100 square feet divided into four equal applications, one each in early spring, late spring, summer and early winter. A complete fertilizer is often recommended only for the spring application followed with topdressings of 14-0-14, 10-0-20 and 20-0-10 during the growing season. These rates supply a range of about .25 to .44 pounds N, $P_2O_5$ and $K_2O$ per 100 square feet.

*Fertilization of Flower Crops:*

A review of the literature on the nutrition of garden flowers and cut flower crops grown in the open reveals that very little systematic work has been done on this problem. Cook

(2) studies the nutrition of five representative garden flowers. An average of the fertilizer ratios that produced the best growth and flowering of these species on a loamy sand and sand of low natural fertility, was a 4-1-2 ratio, supplying a nutrient level comparable to that that could be expected from applying one pound of 6-6-6 and one pound of 20-0-10 per 100 square feet. The recommendations of Laurie and Kiplinger (5) for asters, chrysanthemums and roses are 3, 8 and 10 pounds respectively of 4-12-4 per 100 square feet per year or per crop. Edson and Smith (4) recommend for peppers and tomatoes, vegetables that are similar in growth habits to certain flower crops, grown on marl and sandy soils, from 750 to 2250 pounds of 6-8-6 per acre. These rates are equivalent to an average of about two to five pounds per 100 square feet. These results and recommendations give a range of nutrient levels of .12 to 1.12 pounds N, .36 to 1.19 pounds $P_2O_5$ and .12 to .57 pounds $K_2O$ per 100 square feet.

The recommendations of the Florida Agricultural Extension Service for cut flower crop are as follows: (1) For new soil, 5 pounds of 0-20-0 and 4 to 6 pounds of 6-6-6 per 100 square feet, the 6-6-6 being applied in four equal applications during the growing season. (2) For old soil, 4 to 6 pounds of 6-6-6 applied in four equal applications. Nitrogenous fertilizers or nitrogen-potash combinations may be substituted for the 6-6-6 applied during the growing season. These fertilizer recommendations are designed to supply an average of about .30 to .70 pounds of N and about .30 pounds of $P_2O_5$ and $K_2O$ per 100 square feet per year or per crop.

The fertilizer situation with reference to several groups of ornamental crops, including foliage plants, ferns and trees, is similar to that outlined for nursery stock and flower crops, but space will not permit going into the fertilization recommendations for these crops.

To summarize, there is a very definite need for research on the fertilizer requirement of ornamental plants grown under Florida's unique climate. These plants and crops not only vary widely in their growth habits, but are grown under widely different soil, light and climatic conditions. Even though most of these plants are grown in mixtures of clays, sands, marl, muck, peat and other organic materials, the fertility levels and fixing properties of these parent materials vary widely from the loams and silt used as the major portion of soil mixture used for growing ornamental plants in most other sections of the United States. At present, fertilizer recommendations are adapted from research carried out in other regions of the United States, from research on crops having similar habits of growth, or merely by a "rule of thumb" based on the experience and observation of growers and technical workers. The 30 to 40 million dollar Florida ornamental industry needs help as cost of materials and cost of labor for applying fertilizer is one of the major factors in the cost of production of these crops. Not only must fertilization cost be considered, but also because of losses due to poor quality and plant injury in some cases amounting to as much as 35 percent.

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# BREEDING CATTLEYA TRIBE ORCHIDS

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The orchid family offers unusual and interesting opportunities in plant breeding because of the very wide range of plant characters available for recombination. Unlike most