cial varieties can take this punishment and give a good performance, but the premium price being paid for air-shipped glads indicates that they perform better when treated kindly. Many beautiful varieties which were not suited to commercial production because they did not ship well may prove to be good performers when shipped quickly by air. The homemaker will want the dainty, small decorative varieties as well as the large commercial varieties with which we are familiar. A well-grown spike of most commercial varieties is much too large for any vase the average home can supply. Also the smaller glads fit the average room of the home better than the large spikes. It is time that we begin to cater to this market.

Further investigation on the gladiolus farm to see where the grower can cut down on costs of production will show us many operations that might be eliminated or reduced in cost by the use of labor-saving machinery, by using new weed-killing devices and chemicals, and, possibly, by handling the corms differently. The use of fertilizer is a matter about which much is said but little is known definitely from experimental evidence. The growers tend to blame the fertilizer when their plants look sick. There is a definite feeling with some growers that their fertilizer program is faulty.

These and other problems need investigation. Research can point out the best practices which will lower the costs of production, and equally important, improve the quality of our cut-flowers.

DEFICIENCIES IN ORNAMENTALS

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Ornamental plantings are made for a specific purpose to produce definitely desired effects. If the plants used in the landscape are well adapted to the environment in which they are placed and make a vigorous thrifty growth, they serve the purpose for which they were planted. If, for any reason, they fail to make a thrifty growth, their desirability for ornamental purposes may be materially reduced and thus they may ultimately prove a disappointment.

The mineral soils of Florida are generally deficient in the major plant foods—nitrogen, phosphorus and potassium—and usually require the addition of these materials for normal healthy growth. Organic soils are high in nitrogen but may be deficient in phosphorus and potassium.

Micro-Element Deficiencies

During the past 15 years much work has been done on the micro-element deficiencies of fruit, nut and vegetable plants in Florida and, to a similar but lesser degree, with certain ornamental plants. Under some conditions and in certain locations, even though nitrogen, phosphorus and potassium have been supplied in adequate amounts and other conditions are favorable for growth, some plants may still remain in an unhealthy condition.

Some of these malnutrition troubles are caused by a deficiency of certain of the micro-elements. Thus far, micro-element deficiencies due to manganese, zinc and iron are the only ones reported on ornamental plants in Florida.

Manganese Deficiency

A manganese deficiency of several ornamental plants has been identified in Florida (1 2, 3). Though disorders due to this cause are common on the acid sands of the

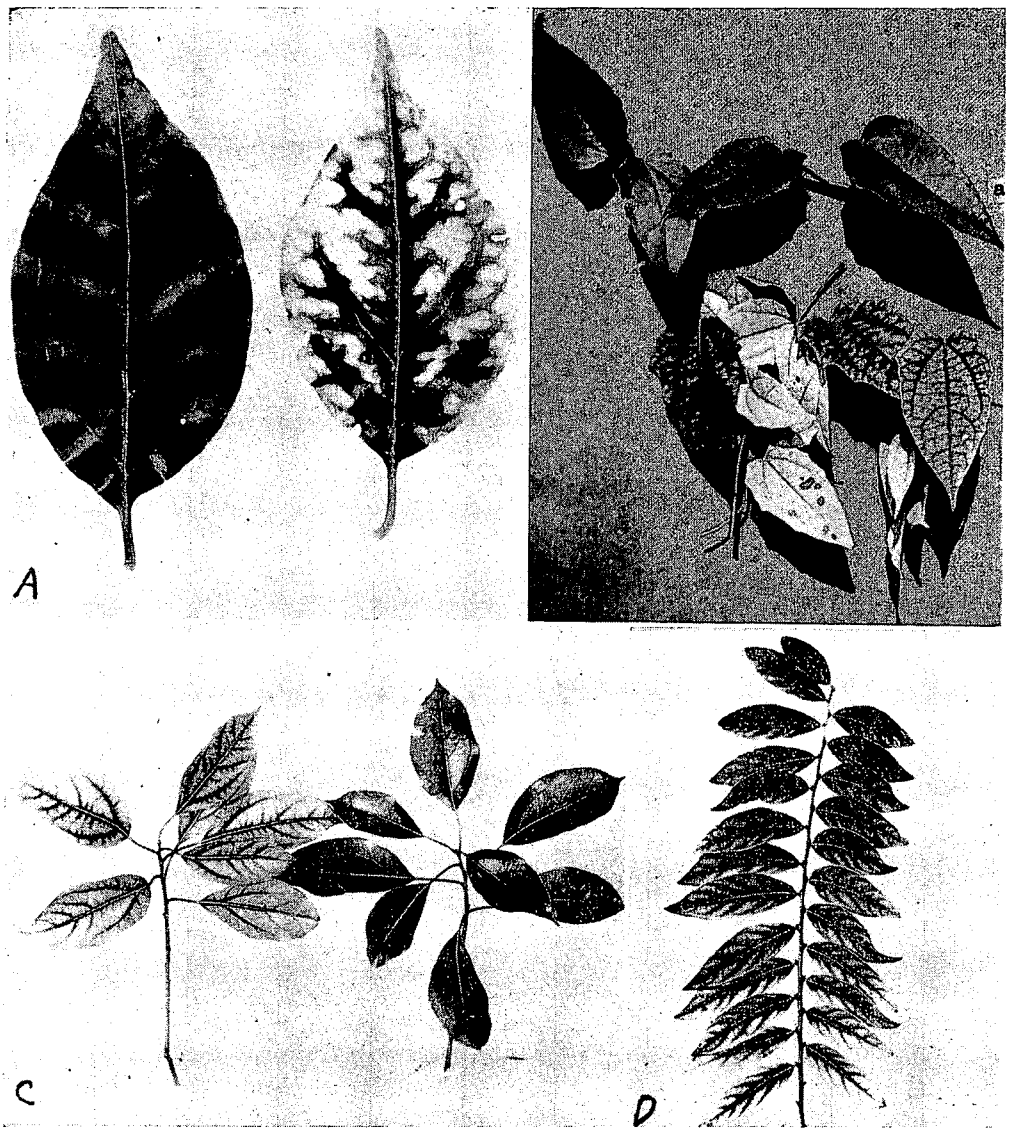

Figure 1—Symptoms of manganese deficiency and effect of manganese sulfate spray.

A. Treated and chlorotic leaves of Sander bougainvillea. Left, an affected leaf 5 weeks after treatment with manganese sulfate spray. Right, an untreated chlorotic leaf on same plant.

B. Typical treated (a) and untreated (b) **Thunbergia grandiflora** foliage from same plant.

C. Typical treated (right) and untreated (left) foliage of camphor tree.

D. Typical chlorotic branch of **Agyneja impubes.**

central and southern peninsular areas, they are most prevalent and acute on the calcareous soils of the coastal areas.

Leaves on affected plants show chlorotic areas between the midrib and primary veins (Fig. 1). Usually, affected leaves are normal or nearly so but in chronic and acute cases they may show some reduction in size. In severe cases the foliage is sparse and some dead wood may show in the plant.

Woody ornamental plants that evidence a chlorosis due to a manganese deficiency are: Crape myrtle, bougainvillea, allamanda, cattley guava, flame vine, *Agyneja impubes* L., Bengal Clockvine, camphor tree, cape plumbago, crape jasmine, wax privet, glossy privet, furry or downy jasmine, rusty fig of Australia, pale butterflybush, *Psidium* sp. and sweet viburnum.

Spray and soil treatments are the 2 general methods of controlling chlorosis of plants produced by a manganese deficiency (Fig. 1). Spray applications are most effective when made during or just before a period of active growth, hence from spring to early summer is usually the best time to spray. As a general rule, response of chloroic foliage will be observed from 2 to 8 weeks after treatment. Usually, 1 or 2 applications during the year will effect satisfactory control. However, under some conditions it may be necessary to make several spray treatments annually to maintain healthy growth. Care should be taken to cover all of the foliage with the spray as only those portions of the plant responded which had been sprayed.

A suitable spray mixture for ornamentals may be prepared by dissolving 2 ounces of manganese sulfate in 2 1/2 gallons of water, and then adding 1 ounce of hydrated lime. Dissolve the manganese sulfate by sprinkling it into the water while stirring with a paddle. Make the lime into a smooth paste by the addition of a small quantity of water and thoroughly mixing, then add slowly while the manganese solution is stirred rapidly. Add some good spreading agent to the spray at the rate suggested by the manufacturer. Apply the spray immediately with any type of spraying equipment which will produce a good mist. The spray should not be allowed to come in contact with buildings, particularly stucco or brick, as it will stain them.

Soil treatment, when effective, is the most satisfactory method of control because of the residual effect and ease of application. Satisfactory response to soil applications of manganese sulfate have been obtained on several shrubs and vines growing in both acid and alkaline sands. Limited soil treatments with some shrubs and experience with other plants on the marl soils of the Miami-Homestead area indicate that soil applications of manganese sulfate will probably not be satisfactory on this type of soil. The amount of manganese sulfate to apply will range from 1/4 to 1 pound per plant, depending upon size and severity of symptoms. The initial soil application should be made during spring or early summer. The need for subsequent treatments will be determined by the condition of the plants. As a general rule, soil applications take longer than sprays to produce greening-up of the foliage. From 1 to 6 months or even more may be required for complete response. On alkaline soils it is desirable to mix an equal amount of sulfur with the managanese sulfate. A well rounded control program would be first to green up affected plants with a manganese spray. Then supplement spray with soil applications which will give a supply of manganese to the plant that will keep it in a healthy condition.

It is not possible to make definite recommendations at this time in regard to soil applications to ornamental trees. However, this method of control may be effective on acid sands if sufficient manganese is supplied. Limited trials with the camphor tree indicate that satisfactory control will be much more difficult to obtain on alkaline sands. In all probability, soil applications to trees will not control this disorder on marl soils.

A serious growth-retarding trouble of the queen palm (*Arecastrum romanzoffianum Becc.*) variously called "curly top," "curly leaf" and "frizzle leaf' is quite prevalent in Florida. A chlorosis of the leaves is the first symptom to appear on affected palms. In advanced stages the leaves are chlorotic, necrotic areas appear in the leaflets, the leaves are much reduced in size and the entire leaf presents the "frizzle leaf" appearance so characteristic of this disorder.

It has been found (2) that this trouble is a manganese deficiency and that it can be controlled by soil or spray applications of manganese sulfate. Both methods of application were equally effective. The time required to effect control was, in most instances, from 3 to 6 months. Soil applications of manganese sulfate were made broadcast under the spread of the top, by "plugging" and in a small cleared circle at the base of the tree. All 3 methods were equally effective. Soil treatments made in March, April, May and August were equally effective and 1 treatment per year was as good as 2 provided enough manganese sulfate was applied. The amount to be applied should range from 1/2 to 5 pounds per tree, depending upon tree size. Those palms which fail to respond properly, in from 3 to 6 months after treatment, should be retreated. Soil applications were effective on acid and alkaline sands but it is yet to be determined whether soil applications will be effective on marl soils.

Similar results were obtained from spray applications and time required for response was approximately the same as with soil treatments. In spraying the palms the bud must be wet thoroughly. It is quite possible that it is not necessary to spray the entire palm but only to pour the spray into the bud making certain that it is thoroughly drenched. The manganese sulfate spray previously discussed is satisfactory for this purpose.

A chlorosis of the Canary Island date palm (*Phoenix canariensis* Chaub.), caused by a manganese deficiency, has been observed at several locations on the east and west coasts. Applications of from 1 to 4 pounds of manganese sulfate per tree on small to medium palms, depending upon tree size, produced a marked response in 3 months. Spray treatments were not tried but they should be equally effective.

Zinc Deficiency

Zinc deficiency of ornamental plants is not nearly so prevalent as manganese deficiency but has been identified on several plants on the marl soils of the extreme southern area (5, 6).

Leaves on affected plants are chlorotic and in acute cases much reduced in size, producing a "little-leaf" condition characteristic of zinc deficiency. When symptoms are severe, twigs may be partially or entirely defoliated and many of these later dieback.

Plants evidencing symptoms of this disorder, which responded to a zinc sulfate spray, were: orange-jessamine (*Murraya exotica* L.), wax privet, loquat, silk oak (*Grevillea robusta* Cunn.), Hatai catalpha (*Catalpha longissima* Sims) and American elm. This trouble is apparently more prevalent on orange-jessamine, a citrus relative, than the other plants mentioned. Zinc deficiency has been observed at several locations on the west coast as well as on the marl soils of the Miami-Homestead area.

Zinc deficiency can be controlled by using a zinc sulfate spray. This spray is made in the same manner as described for the manganese sulfate spray by using 2 1/2 gallons of water, 2 ounces of zinc sulfate, 1 ounce of hydrated lime plus a good spreader. Soil applications of zinc sulfate have not been tried experimentally, but the results obtained with citrus indicate that soil treatments would probably not be effective in the central and southern portions of the state.

Iron Deficiency

Iron deficiency has been reported on only 3 woody ornamental plants in Florida,

namely: Azalea, gardenia and *Bignonia magnifica* Bull. (4, 7). This disorder is much more prevalent and acute under alkaline soil conditions but may sometimes appear on acid soils.

Symptoms of iron deficiency are a pronounced chlorosis of the foliage in which the leaves are yellow with the veins appearing as fine green lines. Young forming leaves are dwarfed, growth of the plant is reduced or many cease altogether, some of the affected leaves fall and dead wood appears in the plant.

Azaleas and gardenias have long been known as acid-loving plants because, under alkaline soil conditions, they frequently develop a so-called "lime induced chlorosis."

This trouble is an iron deficiency brought about by the calcareous soil rendering the iron unavailable to the plant. However, iron deficiency may sometimes develop on these plants under acid soil conditions.

This trouble can usually be remedied on azaleas by spraying with a 1 or 2 percent iron sulfate spray. This spray is made in the same manner as previously described for manganese sulfate spray, using 2 gallons of water, 2 1/2 to 5 ounces of iron sulfate, an equal amount of hydrated lime and a suitable spreader. In addition to the spray, measures should be taken to acidify the soil. For quick results aluminum sulfate should be used, but agricultural sulfur will correct the trouble in a reasonable time. Either is applied at the rate of 2 to 3 pounds per 100 square feet. These, in conjunction with soil applications of iron sulfate, will control the trouble. Mulching the plants with acid peat, compost, leafmold or other decaying organic matter will be helpful. If the soil is not naturally well supplied with organic matter, then considerable quantities should be mixed with the soil before planting.

Iron deficiency of gardenias cannot be controlled by spray applications of iron. However, soil treatments as described for azaleas, will correct the trouble on gardenias.

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