nomenal agents for protection of horticultural crops — and of man — from insect infestations or attacks. Housewives and others have long been favored, or spoiled, by top quality food products free of insect infestations and injuries and uncontaminated by insect parts and of fecal matter. Growers of horticultural food crops desire to market uninjured, uninfested and non-contaminated food products. Although some indiscriminate uses of the new pesticides have been made and some unfortunate results accrued through no fault of the pesticides, *per se*, an unbalanced understanding pervaded the people of our land. A present duty of entomologists is to assist in guidance to restore equilibrium in the use of pesticides. The role of an economic entomologist today continues to be that of providing recommendations for control of insect pests which will enable the grower to produce high quality crops free of insect infestations and damage.

*Considerations for the Future.*—Sometimes a grower applies more pesticide than is needed. Sometimes a harmful insect or nematode is not infesting some field but is severely abundant in others. One with training and experience in the fields may often designate which fields or areas need treatment and which do not. Ability is needed to tell when the abundances of insect or nematode pests are reaching an economic level of injury or when the food product would be so heavily contaminated with insect particles asto require condemnation under the pure food laws. This is a delicate balance on occasions. Owing to so many factors involved in crop production and to the great variability of abundances of insects a farm-by-farm recommendation is almost mandatory to make the needed control recommendations.

Entomologists and nematologists have been employed in increasingly greater numbers by industry and the increase is likely to continue. Professional workers may be termed "practioners" or "prescription entomologists or nematologists" and function to solve many problems involved in individual groves or on farms. Such workers, whether industrial or professional, would require much training, guidance and leadership to observe and know field conditions and significant pests in order to make explicit recommendations. Scouts, assistants or others working with the professional service would also need training relative to insect pests.

What entomologists and nematologists can do owing to the unique position of Florida is to provide training for all types of personnel needed for such work. Library references, technical laboratories and equipment are available or are procurable at the Institute of Food and Agricultural Sciences, University of Florida. Training in entomology and nematology in Florida would contribute to the development of tropical horticulture.

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# FLORIDA'S ROLE IN THE DEVELOPMENT OF TROPICAL HORTICULTURE — IN PLANT PATHOLOGY

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Development of a successful and progressive horticulture is dependent on application of knowledge derived from several scientific disciplines. One of the more important of these is plant pathology. Unless adequate provisions are made to prevent or control diseases, no horticultural endeavor will flourish for more than a very short time. Florida's horticulture is a striking

example of this for few if any of the state's crops could be produced economically without effective disease control programs. What is true in Florida is also true in other horticulturally important areas. If tropical areas are to develop, horticulturally-speaking, and reach their potential, programs and procedures for control of diseases must be provided.

Because of favorable environmental conditions plant diseases flourish in Florida throughout the year. The hot, humid, rainy weather of summer months, is especially conducive to the development of a variety of fruit diseases common in the tropics, such as the scab diseases of avocados, mangos, citrus and a number of ornamental plants. These conditions also favor the development of anthracnose which is probably the most important single disease of fruits in tropical countries around the world. During the cool winter months in Florida when there is less rain but heavy dews, vegetable diseases predominate in as rich a variety as can be found in any one location. Pathogens flourish throughout the year in southern Florida as there is not sufficient cold weather to interrupt either their life cycle or kill their host plants.

With similar host plants and diseases and, in many localities, similar environments, it is obvious that plant pathologists in Florida share a wide range of common interests with those in tropical countries. Techniques used for plant disease control in one area are very likely to be applicable and helpful in other areas. With this thought in mind, I want to discuss some aspects of plant pathology in Florida which serve as examples of ways that Florida plant pathologists can contribute to the development of tropical horticulture.

Several agencies and organizations are active in Florida in the field of plant pathology. The University of Florida Institute of Food and Agricultural Sciences offers college education at both undergraduate and graduate levels. The Institute is also responsible for research on the nature and control of plant diseases and for extension programs which disseminate information to agriculturists throughout the state. The Division of Plant Industry of the Florida Department of Agriculture is responsible for inspection and regulatory activities within the state and, in addition, does research in areas relating to these functions. The United States Department of Agriculture also conducts research on plant diseases, on post-harvest problems, and administers the United States Plant Quarantine program. All of these groups have made many significant phytopathological contributions. Some of these contributions, which have implications for the development of tropical horticulture, are discussed below.

*Breeding and Selection of Disease Resistant Cultivars*:—Use of disease resistant varieties is the cheapest and one of the most effective methods of plant disease control. Its big advantage is that the grower obtains control of a given disease for the life of the crop merely by planting seeds of the appropriate vegetable variety or by selecting budwood from resistant clones when propagating fruit trees. This method is particularly valuable in areas where horticulture is not highly advanced and some of the more sophisticated methods of disease control cannot be used. Florida's contribution in this area has already had a significant impact on tropical horticulture and much progress can be expected in the future.

For many years Florida has operated a rather large vegetable breeding program to incorporate disease resistance into new varieties of vegetables. Perhaps the most comprehensive effort has been with tomatoes resulting in the release of many new varieties each resistant to several diseases. These varieties have been widely tested and found to be well adapted to tropical countries. During the past two years, I have seen Florida varieties being offered for sale in local markets in Trinidad and Colombia. Reports from cooperators indicate these varieties do well in other areas also.

In fruit crops disease resistance has come about mostly by selection of resistant types from among seedling populations rather than by a deliberate breeding effort. Many new and improved varieties of tropical fruits including avocado, mango, guava and sapodilla, have been selected and propagated in Florida. These varieties vary greatly in disease resistance as well as in horticultural characteristics. For example, mango varieties vary widely in susceptibility to anthracnose as do avocado varieties to scab. The more susceptible types require a rigorous fungicidal program in order to produce a crop whereas the more resistant types will bear in the absence of a disease control program.

The germplasm bank operated by the USDA Plant Introduction Station is a fine example of

how resources in Florida can be used to benefit tropical horticulture over a wide area. At this Station clones of cacao, coffee and rubber (Hevea) of desirable germplasm are collected from the tropics throughout the world. Those found to be free of diseases are forwarded to interested breeders on request. This arrangement permits an exchange of germplasm without the hazard of introducing foreign diseases such as would exist if the exchanges were made directly. Since none of these crops are produced in Florida, this program offers no threat to local agriculture.

*Control of Plant Diseases with Fungicides*:—Many plant diseases can be controlled only by the use of fungicides and few, if any, horticultural crops can be produced in Florida without them. The greatest use of fungicides is to protect plants against foliage and fruit diseases, but there is increasing use of chemicals to control soil-borne diseases and diseases that affect produce in transit and storage. Much research has been done in Florida to develop fungicidal programs. Most of these programs would be effective in tropical areas, especially where the same diseases occur. Where diseases differ, the principles and techniques of fungicidal use still apply and should be quite helpful in adapting or developing programs to meet unusual needs.

Results of research to control post-harvest diseases with chemicals and modified atmospheres indicate that these methods have much promise for horticulture in Florida and in the tropics. These techniques, when perfected, might make it possible for people in temperate zones to enjoy fruits now available only in tropical countries. Such a development would open exciting possibilities for expansion of tropical horticulture.

*Regulatory Activities*:—Research on the nature and control of diseases is not all that is needed to keep a horticultural industry reasonably free of diseases. Also needed are quarantines to exclude foreign diseases. Surveillance is required for detection of new diseases and measures are needed to eradicate them promptly, as was done years ago when citrus canker was found in Florida.

The Citrus Budwood Certification Program, operated by the Division of Plant Industry, is a fine example of another type of regulatory activity that serves to reduce disease incidence in a horticultural crop. The objective of this Program, as stated in a recent brochure, is to: ". . . assist nurserymen and growers to produce citrus nursery trees that are believed to be horticulturally sound, and free from virus and other recognizable bud-transmissable diseases". This type of program is especially suited for fruit crops which may be infected by diseases transmitted during propagation.

*Education and Extension in Plant Pathology*:—If a horticultural industry is to be protected against diseases, manpower trained in the science and "art" of plant pathology is required. Such training is provided by the Department of Plant Pathology of the University of Florida Institute of Food and Agricultural Sciences. The Department offers a full range of courses leading to the Bachelor, Master and Doctor of Philosophy degrees for students majoring in plant pathology. In addition, courses are offered to give students majoring in other subjects the basic understanding of plant diseases needed to deal with diseases in field or grove. Diseases of tropical crops are used in all courses to illustrate underlying phytopathological principles. The Department is responsible also for extension in plant pathology which has the general aim of gathering and disseminating information about new ideas and techniques and assisting horticulturists in adapting them to local use. Florida plant pathologists have made significant contributions to tropical horticulture by training students at the University, by personal visits to tropical areas for consultation about disease problems, and by counselling with visitors from abroad who come seeking help with their disease problems.

The need in tropical countries for plant pathologists is great at all levels whether it be in research, teaching, extension, or practicing the art at the local level. Florida plant pathologists could contribute much by training such people. Florida could do this most effectively because students coming to the state for training could study many of their native diseases on crops growing in the state.

*Benefits to Florida*:—Although it is true that Florida has many phytopathological resources which could be used in developing tropical horticulture, it is also true that Florida would gain much by programs designed to accomplish this. The acumen and professional competence of the people involved would be greatly enhanced which would in turn increase their value to the state

of Florida. Students with different points of view and from different cultural backgrounds would contribute to a kind of intellectual ferment which is found in all great universities. The research performed by these students would increase the fund of available knowledge which might be applied to the benefit of the state.

Working relationships established with plant pathologists in tropical countries would be valuable in several important ways. It would facilitate sending research teams to study diseases not present in Florida but which, if introduced, might cause serious losses before means to control them were developed. This was done a few years ago with the tristeza disease of citrus. Since the ancestral home of a cultivated species is often a rich source of disease resistances, and since many of Florida's crops originated in the tropics, cooperative efforts with plant pathologists in these areas would facilitate the finding of resistances to diseases still troubling Florida's crops. Finally, a student exchange program might be developed which would have a salutary effect on students that could be obtained no other way.

In summary, plant pathology in Florida has a great deal to offer in the development of tropical horticulture, and Florida in turn would be greatly benefited thereby. In a larger sense, and perhaps of greater significance, such programs of mutual benefit would make a real contribution toward understanding and good will between Florida and her neighbors in the tropics.

### Acknowledgment

Regretfully, it is not practical or possible in a paper of this type to acknowledge the specific contributions of each person. However, the author does wish to acknowledge the contributions of many individuals, ranging from relatively untrained pioneers to highly skilled researchers, which have made Florida the outstanding horticultural state that it is today.

# FLORIDA'S ROLE IN THE DEVELOPMENT OF TROPICAL HORTICULTURE — IN MINERAL NUTRITION OF FRUIT TREES

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### Introduction

The State of Florida is recognized among horticulturists around the world as the area where the planting of citrus trees and the processing of citrus products on a commercial scale has reached astronomical figures. Less well known is the fact that many types of tropical fruit trees are successfully grown in the nearly frost-free areas of the State, but particularly in the lower east coast, and Miami-Homestead area. The prevailing soils in these warm areas are undoubtedly the most infertile of all the regions of the world in which intensive agriculture is practiced. All crops without exception need periodic applications of complete fertilizer mixtures, and most fruit crops need in addition nutritional foliage sprays. Plants grown in the Miami-Homestead area have been found to need applications of practically all the essential elements, and the list of recognized deficiencies include N, P, K, Mg, Fe, Mu, Cu, Zn, B and sometimes Mo.

With this background it should be obvious why the need for research in mineral nutrition of tropical fruit trees, especially those grown on a commercial scale, has received so much emphasis in South Florida. It is the purpose of this paper to review what has been done in Florida in this field, present the current situation, and point out the application of this knowledge to other tropical areas especially those with soils with similar low natural fertility.

### The Soils of South Florida

A brief description of South Florida soils will help the reader understand the nature of th nutritional problems with which the grower is faced. Most of peninsular Florida was at one time covered by ocean waters, and when they