FLORIDA STATE PLANT BOARD PROGRAM FOR VIRUS-FREE BUDWOOD

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INTRODUCTION

This paper presents information about the origin and background of the Citrus Budwood Program operated by the Florida State Plant Board, and briefly outlines its purposes, procedures, and current status.

About 1940, the Florida citrus industry became aware of increasing costs of production. As the price of land, labor, materials, and equipment began to rise steadily, Florida growers sought means to offset rising costs, to achieve maximum efficiency in their operations, and, above all, to increase yields of fruit per acre. Agricultural agencies in Florida took every opportunity to inform growers of the constant and accumulative losses occurring in their plantings as a result of the destructive effects of virus diseases. By 1950, most growers had become aware of the extent of these losses and were beginning to have some realization of the need for disease controls. This led to a symposium on certified nursery stock in August, 1951, at the Florida Citrus Institute and, in October, to a discussion of the Texas budwood program at a meeting of the Florida Horticultural Society, where Florida growers learned that effective and practical methods of virus control were possible. The Horticultural Society immediately passed a resolution requesting the establishment of a program for budwood certification and appointed a committee to cooperate with other agricultural agencies within the state, as well as with interested nurserymen and growers, in the formulation of a program suitable to the needs of the industry.

The State Plant Board, working with this committee, completed the "Statement of Policy" under which the program would operate late in 1952. This policy in turn was edited by Plant Board officials for further clarification and definition of terms. By January 1, 1953, 5 acres of land had been purchased, cleared, and planted with seedling test trees. A special office was opened in Winter Haven, in the approximate center of the Florida citrus area, to handle the program and to process applications already received. After nearly one hundred years of commercial production, ten years of preparation and groundwork, and two years of concerted effort on the part of almost every segment of its citrus industry, the Florida Citrus Budwood Program was at last under way.

STATEMENT OF POLICY

As outlined in the Statement of Policy, "The purpose of this program is to assist nurserymen and growers to grow citrus nursery trees free from virus diseases." Specifically, it requires that registered parent trees be "vigorous, productive, true to type, free of any evidence of undesirable bud mutation, and also free of blight, declines, gummosis, leprosis, psorosis in any of its types, xyloporosis, tristeza, stubborn disease, or any other recognizable bud-transmissible disease." Participation in the program

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is voluntary both on the part of the nurserymen and also on the part of the Plant Commissioner, depending solely on the latter's sincere conviction as to the qualifications of the trees or the applicant.

The Statement of Policy further provided that registration would not imply any warranty on the part of the Florida State Plant Board; that all inspections incidental to registration would be performed by duly appointed employees or agents of the Board; and that these inspections and investigations would be undertaken as part of the duties of the Board's employees and would be discharged only so far as time, personnel, and available funds would permit.

PROCEDURE

Policy also provided for a system of rapid bud multiplication, once parent trees were selected. This was to be done through the use of progeny trees propagated from registered, or from candidate, parents under Plant Board supervision. These progeny trees in turn could be registered as certified scion trees under certain restrictions.

In addition to the extremely wide scope and comprehensiveness of its procedure as outlined, this program incorporated several basic factors of great value. First, by the delegation of complete authority to the Plant Commissioner, it achieved the ultimate in working efficiency because of its centralized control. Second, by its inclusion in the routine operating procedure of the Plant Board, it was given complete financial independence. Expenses totaling some $30,000 a year incurred in connection with the certification of budwood are paid from the State's General Fund as part of the regular budget of the Board. Application and registration fees from participants in the program are paid directly to the Certification Office and are then placed in the General Fund. Inspectors attached to the program are therefore free to devote all their time to the work of certification and are also free of the responsibility of collecting enough money in fees to keep the program operating. This willingness on the part of the State to accept almost the full burden of expense of operating the program is an indication of its importance from the viewpoint of the growers. Third, and perhaps the most important factor recognized by the committee from the beginning, was the need within the program for complete flexibility. It was recognized that by the very nature of any such long-range project, particularly one dealing with virus diseases, there would probably be a succession of changes over the years as new information came to light.

Preliminary Selection. In the Florida program, the participant is required to pay an application fee of $25.00 and is permitted to make selections from his own or other outstanding trees. Trees entered as candidates must be ten years old or older. Preliminary selection is based on trueness to type, general vigor, and the grower's own experience with the past production records of the trees in question. Growers are encouraged to enter trees with known records of high yield.

Preliminary Inspection. First inspection by the State includes appraisal of the entire planting from the viewpoint of general quality, visible disease symptoms, and degree of bud variation. Preference is given to uniform plantings of the same age, variety, and rootstock, rather than to mixed blocks or isolated trees because of the obvious advantage of a better basis of comparison. This inspection can be made at any time of the year by personnel attached to the Certification Office, together with the growers and Plant Board field inspectors in the district where the trees are located. Each tree in the entire block is examined and the results expressed in coded evaluation symbols on a map showing the location of each tree. During the subsequent spring inspection, time is not wasted on substandard trees but is confined to trees already screened and accepted as potentially satisfactory candidates.

First Flush Inspection. First flush inspection includes examination of the candidate parent tree together with the four trees immediately surrounding it. The four adjacent

trees must be free of any evidence of virus infection if growing within 35 feet of the candidate tree.

Registration. Candidate trees are registered as psorosis-free when reinspections of the parent tree, the adjacent trees, and all test trees in field indexing plots during flushes of growth over a period lasting through two succeeding spring growth flushes fail to disclose any evidence of psorosis. Psorosis-free trees in turn are registered as xyloporosis-free when Orlando tangelo test trees fail to disclose virus symptoms after four years of growth.

Psorosis-free and xyloporosis-free parent trees are registered as exocortis-free when test trees of trifoliate orange fail to disclose symptoms after six years or more of growth. These probationary inspections and test periods may be extended or modified at the discretion of the Plant Commissioner.

In the same manner, progeny of psorosis-free parent trees may be registered as psorosis-free scion trees two years after planting, provided that all other requirements for parent trees have been met, and, four years after planting, as both psorosis-free and xyloporosis-free, provided that all other requirements for parent trees have been met. Growers are limited to 40 parent trees of all varieties and to 350 scion trees of any one variety. Registration of eligible trees is voluntary. A fee of $10.00 is charged for registration of each parent tree, and a fee of $1.00 for each scion tree. Upon request of the grower, these trees will be reregistered every five years without any additional cost as long as they are used as sources of budwood.

METHODS OF DIAGNOSIS

Because of the grower's knowledge of the destructive effects of psorosis, this disease, more than any other, has been responsible for the initiation of budwood programs in general. Actually, all virus diseases are equally important in the Florida program.

Tristeza. Tristeza was discovered in Florida almost simultaneously with the launching of the budwood program. At the time, neither the extent of its spread nor the degree of its virulence was known. It was therefore decided that indexing of trees for tristeza should be undertaken, but should be done outside the citrus area in the laboratories of the Plant Board at Gainesville. Under present procedure, no budwood is taken to the field test plots from a candidate tree until the candidate tree is known to be tristeza-negative. By the use of this method, field plots are not exposed to possible contamination while the tests for tristeza are being made. Because of the rapidity of the test for tristeza, indexing for other viruses can be delayed until results of the tristeza test are known. This procedure results in considerable saving of seedling test trees of sweet orange, tangelo, and trifoliate orange and of time and effort involved in carrying out unnecessary tests for the presence of psorosis, xyloporosis, and exocortis viruses in trees that carry tristeza virus and would thereby be disqualified as candidate trees. The saving is especially significant when working with nucellar seedlings, because 25 to 75 per cent of such trees are, in our experience, positive for tristeza.

Of a total of 858 candidate trees of all varieties tested for tristeza to date, only 47 trees (5.5 per cent) were positive for tristeza. However, of these 47 positive trees, 30 (63 per cent) were nucellar seedlings. Of 48 eighteen-year-old nucellar seedlings of the Valencia variety tested, 18 (37.5 per cent) were positive for tristeza. Of 12 nineteen-year-old Parson Brown seedlings tested, 7 (58 per cent) were positive for tristeza.

Perhaps the most logical explanation for the much higher incidence of tristeza in Florida seedlings, as opposed to old-line strains, is that the lush vegetative growth of the nucellar seedling trees presents an inviting habitat for aphids. McClean (5) found that tristeza virus was not transmitted through seed. Seedling trees in Florida

are planted as far apart as budded trees. Therefore, it seems unlikely that a higher rate of transmission is being effected through root grafts in seedling trees than in old lines. The foregoing explanation might be supported by the fact that incidence of tristeza in Florida is generally higher in Temple oranges, which have a habit of almost continuous small flushes of growth with a consequent higher-than-average level of aphid infestation, than in other varieties of Florida citrus.

Whatever the cause of the high incidence of tristeza virus in nucellar clones, it seems advisable for any certification program to be especially watchful of such clones. Where certification is to extend over any considerable period of time, a single test for tristeza should not be the basis for certification. In the one area in north central Florida where tristeza is known to be spreading, re-indexing of certified parent trees for this virus will begin this coming spring, although the original tests were run on these trees only two to four years ago. It is anticipated that additional tests will be made every two to four years.

Of the 858 candidate trees thus far tested for tristeza, 205 are sweet orange varieties on sour orange rootstock. Seven of these (3.4 per cent) are positive for tristeza on the basis that Key lime test plants have shown stem pitting and vein clearing. All seven of these trees were symptomless in the field; in fact, they were outstanding trees of exceptional quality. Why the seven trees of this susceptible stock-scion combination have not reacted to the presence of this virus is not known. The trees could have been infected only shortly before they were indexed and thus had not yet developed tristeza symptoms. Other possible explanations of their symptomless condition are 1) the sour orange rootstocks by chance were tristeza-tolerant, 2) the presence of a strain of tristeza virus so mild that it caused no significant injury to the bud-union tissues, or 3) the masking or suppression of tristeza symptoms by another virus. The point is that apparently healthy sweet orange trees on sour orange rootstock under Florida conditions may give a positive tristeza reaction on lime test trees. Although inconsistency in only 7 of 205 tristeza tests might be considered of no particular consequence, this example is cited here to illustrate how highly specific information accumulates in a certification program like Florida's. Furthermore, just such inconsistencies may lead the way to recognition of viruses now unknown.

It is a practice at present to put buds from the candidate tree into six seedling lime plants, five of which are used as test trees, and one of which is used to perpetuate the particular strain of budwood. The latter is kept under screen from the time the tests are started and, whenever tests are negative, will become the source of budwood for foundation plantings.

This screening precludes insect transmission of the virus to the potential budwood source; it is especially important for the fourteen citrus-producing counties in Florida, where little if any insect transmission of tristeza is known to occur.

Psorosis. Of 317 trees indexed for psorosis during the program's first year of operation, 11.5 per cent were positive. To date, tests have been completed on 565 trees; the incidence of psorosis in these trees is 6.7 per cent. Not included are 106 candidate trees dropped because of bud variation, and 79 trees dropped because of virus infection in adjacent trees.

The average age of all trees tested was about twenty-five years. All appear to be outstandingly healthy; none show any known bark symptoms of psorosis or any apparent stunting or other adverse effects. None displayed leaf symptoms during the first flush examination. The apparent reduction in incidence of psorosis in candidate trees from 11.5 per cent for the first year of testing to 6.7 per cent for the average of the first three years may be due to increasing experience in selecting candidate trees, but is probably due to the development of a more thorough method of preliminary selection.

To date, there are 417 certified psorosis-free and tristeza-free parent trees. There are also 5,826 certified psorosis-free and tristeza-free scion trees. From these two sources, parent and scion, there are 155,005 progeny trees. Many of these will become scion trees in the next few years. Including noncertified trees under test, trees in the program now total 161,689. These will be examined at least once during the spring growth flush. The 858 parent trees are scattered over an area 400 miles long and about 100 miles wide. The problem of inspection of these trees is not so difficult as it might seem; Plant Board inspectors, already thoroughly familiar with their respective districts, are, in many cases, able to accomplish the certification inspections in the course of their routine nursery inspections in that same area. Usually, inspectors join together to work as a team.

From the beginning of this program, producers of citrus nursery stock were warned that when adequate supplies of psorosis-free budwood became available, State inspectors would begin to quarantine all citrus nursery stock showing the leaf patterns of psorosis. The time is approaching when this important final step in the control of psorosis can be accomplished. It is anticipated that by January 1, 1960, after additional warnings to growers to look to their sources of budwood, the movement of psorosis-infected nursery trees into Florida citrus plantings will end.

The certification program is voluntary, but the quarantining of insect pests and diseases is a matter of statutory law. Psorosis has been present for many years in Florida citrus and little could be done about it. Now that better budwood is available to the industry, the movement of trees carrying this disease into Florida plantings can be eliminated by the simple act of classifying psorosis as a dangerous disease. This will be done. If the Florida program had never accomplished anything else, this one thing would more than justify its existence.

To date, psorosis has not been found in any nucellar trees planted and maintained as such. However, of 54 Rough lemon and sour orange trees growing as escaped seedlings along river bottoms and in other remote areas, and now under test as potential seed sources, two are positive for psorosis. Whether or not these trees were ever budded is not known. Further study of seed transmission of psorosis is indicated.

Xyloporosis. From the beginning of the program, Orlando tangelo seedlings have been used as indicator stocks for xyloporosis. This use was based on the assumption (*2, 3*) that the disease of Orlando tangelo and certain other tangelos and mandarin hybrids, first described by Childs (*1*) under the name cachexia, was identical to the xyloporosis disease described in Palestine by Reichert and Perlberger (*6*).

About 72 per cent of all the trees in the program thus far tested show reaction on Orlando tangelo stocks. Under Florida conditions, symptoms on Orlando tangelo test plants have appeared as early as 13 months after budding. Optimum symptoms for diagnosis occur between the third and fourth year after inoculation. From the trees previously cited as both tristeza-free and psorosis-free, there are 46,604 xyloporosis-free progeny trees from 140 xyloporosis-free parent trees.

Exocortis. Information already presented to this conference has discussed in detail problems arising from, and incident to, the indexing of exocortis virus in relation to certification. The color test (*4*) for early diagnosis of exocortis appears to have solved many of these problems. Observations made during the two years' work of development of the color test indicate that 40 per cent or more of the trees on susceptible rootstocks in Florida and Louisiana are positive for exocortis. The accuracy of this figure is confirmed by the color test. Exocortis-susceptible rootstocks are not now important in Florida, partly because of past experience with this virus.

Bud sources free of exocortis and other viruses may make possible the planting of thousands of acres of Florida land previously considered unsuitable for citrus, now that an effective and relatively rapid method of finding such sources which can then

be grown on rootstocks not previously used because of their susceptibility to exocortis. The Florida program has carried out tests for more viruses than any other citrus budwood program has, and for that reason knowledge of virus incidence is more complete for this program than for others. When other citrus areas carry out similar programs, their results are likely to be comparable or may even reveal a higher incidence of viruses and an equal need for the production of virus-free planting stock.

SUMMARY

If the candidate trees in the Florida program are a representative cross section of the State's citrus trees, and if the indexing of the Florida program is a reasonably reliable measurement of the four viruses, tristeza (5.5 per cent), psorosis (6.7 per cent), xyloporosis (72.3 per cent), and exocortis (40 per cent), these total 124.5 per cent and reflect the fact that many of the best trees obtainable in the largest citrus-producing area in the world are infected by two or more viruses.

Florida's answer to this is its citrus budwood program. Working against a general high level of virus incidence, in five years it has given the State 150,005 sources of psorosis-free budwood and 46,744 sources of psorosis-free and xyloporosis-free budwood of commercially important varieties. The program will continue to select, test, and compare the best old-line clones; to select, test, and compare the best of more than 2,700 nucellar seedlings now under observation; to select, test, and compare some 400 seedling seed-source trees now under observation; and eventually to define, stabilize, and standardize the best of all these, so far as this is possible. In carrying out these objectives, the Florida program will continue to give every possible aid to science, no matter how small, and to use every applicable contribution of science, just as it will make full and immediate use of the information presented by the brilliant and dedicated men and women whose work appears in the Proceedings of this Conference on Citrus Virus Diseases.

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