History of the First 50 Years of the Florida Citrus Budwood Program  
1953-2003

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As we mark the 50-year anniversary of the clean stock or budwood protection program in Florida, I have compiled some of the program highlights to preserve this history for future generations. While not necessarily writing in chronological order, dates are recorded to archive this history and to highlight the transition through the years from an initial voluntary program to an industry-wide mandatory one. This is not meant to be a review of budwood program procedures as they are well documented in the original “Statement of Policy” and subsequent procedure manuals. Neither is this a history of Florida citrus diseases or their indexing methods, although their development parallels their use in the budwood program. The timeframe of the budwood program is important to the overall history of Florida’s citrus industry, as advances in new clonal variety selections and the growing of pathogen-free trees opened up new scion/rootstock options for growers to plant as citrus plantings expanded. This history of the budwood program is recorded where possible by topic, as I have attempted to keep pertinent information on one subject together. References are not given, but all facts were obtained from the Bureau of Citrus Budwood Registration annual reports and other papers that the bureau has bound into two volumes titled History of the Florida Budwood Program I and II.

Budwood Program Impact

The Florida budwood program has greatly impacted Florida citrus, as registered budwood selections or “budlines” are responsible for impressive increases in yield and fruit quality in the industry. The budwood program introduced many nucellar lines that are still the foundation of many of our main varieties. Growers today are familiar with program registered budlines and order trees by clonal numbers that have become as recognizable as car names are to automobile enthusiasts. The ability to test for graft-transmissible pathogens and exclude unclean propagating material has not only increased production and tree longevity but also the ability of our groves to withstand other environmental stresses. The use of clean stock has allowed the use of many new rootstocks that otherwise would have been unsuccessful because certain diseases are problematic on specific rootstocks. Budwood certification programs are essential for the control of graft-transmissible diseases as preventive measures are foundational to having healthy stock.

Mission Statement

The Bureau of Citrus Budwood Registration administers a program to assist growers and nurserymen in producing trees that are believed to be horticulturally true to varietal type, productive, and free from certain recognizable bud-transmissible diseases detrimental to fruit production and tree longevity.
Florida’s Diseased Past

Florida’s citrus industry found itself having many pathogen diseased trees throughout the state during the first half of the twentieth century. Although a complete pathogen survey of the state was not available, it was evident from cases documented in the Florida State Horticultural Society Proceedings that virus diseases played a significant role in reducing yields and decreasing tree life. The prevalence of virus diseases was confirmed shortly after the budwood program began indexing trees statewide. Once the bureau’s indexing results began to accumulate, it became apparent that finding trees completely free of viruses was more difficult than anyone had imagined. It was also hard to find trees of certain varieties that did not exhibit to some degree bud mutations.

The Need To Do Something

Due to grower alarm about virus issues, a Symposium of Certification of Disease-Free Nursery Stock was held in 1951 at the Camp McQuarrie Citrus Growers Institute sponsored by the Florida Agricultural Extension Service. The symposium addressed the importance of controlling bud-transmitted citrus diseases. Growers were especially concerned about citrus tree losses in Argentina and Brazil that occurred in the 1930’s and 1940’s due to citrus tristeza virus. By resolution the Citrus Growers Institute recommended that a budwood certification program was needed, as it would control graft-transmitted diseases, their rate of spread, and prevent the introduction of new diseases into Florida. The Florida Production Managers Association arranged for a discussion of the Texas Budwood Certification Program at the 1951 Florida State Horticultural Society meeting. That same year the Florida State Horticultural Society passed a resolution appointing a Budwood Certification Committee to work out a general policy to get the Florida program started.

Advisory Committee

A permanent Citrus Budwood Certification Committee was appointed by the Florida State Horticultural Society with members chosen to represent every major phase of the industry. The full Budwood Technical Committee that was used to set up the budwood program created a smaller permanent Advisory Committee in 1958. This committee would advise on program policy, indexing and on whether citrus budwood should ever be imported into the state and under what conditions, restrictions and procedures. The original budwood committees were appointed by the Florida State Horticultural Society and served until 1975 when the Florida Department of Agriculture and Consumer Services appointed a new committee. Currently the program works under a department-appointed Citrus Budwood
Technical Advisory Committee comprised of nurserymen, growers, researchers and regulators formed in 1996. This advisory committee is proactive in addressing new regulatory concerns as new pests may necessitate changing priorities. Having industry stakeholders as voting committee members empowers the growers to play an active role in deciding their own destiny.

Program Beginnings

In 1952, $12,000 in state emergency funds were obtained from the state cabinet to finance the beginning of the work until the 1953 legislature could fund the new budwood program. The program began as a part of the State Plant Board (SPB), now familiar as the Division of Plant Industry (DPI) and administered by the Bureau of Citrus Budwood Registration. In January of 1953, Gerald Norman opened a one-man, one-woman office in Nora Mayo Hall (the Florida Citrus Building) near downtown Winter Haven to direct the new budwood program. The bureau outgrew the one office after three years and moved into a wood frame house at 429 Second St. NW, Winter Haven. In October of 1963 the program was ready to expand again, and the office was moved into a newly constructed east wing of the Cowperthwaite building north of Winter Haven on US 17. In 1986 the office was moved to the Alex G. Shaw building on the Cowperthwaite compound. The bureau’s laboratory expanded back into the Cowperthwaite building in 1997 as greater emphasis was put on serological and molecular testing. Don Bridges assumed responsibilities for the budwood program in 1964, followed by Charles Youtsey as bureau chief in 1978, and Michael Kesinger in 1995.

By early 1953, five acres of land near Lake Fanny had been purchased to serve as a virus test plot. The plot was cleared and planted with seedlings that would express specific disease symptoms when inoculated with infected test material. The new budwood program had a two-fold purpose: 1) elimination of detrimental virus diseases; and 2) selection of outstanding parent trees to improve yield and quality. It is important for a budwood program to provide growers with selections that will provide increased production of higher quality fruit over longer time spans. Within seven months of opening the doors, 21 participants had entered 375 parent candidate trees free of visible virus symptoms for evaluation. Two years after the program started, it was already the largest of its kind in the world. By 1959 over 100 nurseries were participants in the program. In 1960 registered nursery propagations reached one million trees a year.
Graft-Transmissible Diseases

Testing for graft-transmissible citrus pathogens is an integral component in protecting Florida citrus from exotic and endemic diseases that would devastate fruit production and quality. The program was initially set up to deal with psorosis and cachexia known by name, along with other recognizable bud-transmissible diseases. Viral diseases of citrus have been long noticed in Florida, as psorosis was recognized in Florida in 1896, although not identified as a virus until 1934. Research on cachexia began in Florida in 1944. Without a certification program to provide virus and viroid free propagating material, the grower’s only option was to use tolerant rootstocks when encountering pathogen-infected stock. As there is no cure for viruses or viroids in the tree, the detection and elimination of graft-transmissible pathogens from propagating sources is of utmost importance in having a healthy citrus industry.

Citrus Tristeza Virus

Citrus tristeza virus was discovered in Florida simultaneously with the launching of the budwood program. Years later the brown citrus aphid would be found in Florida at the time the budwood program was changing to a mandatory budwood protection program. Originally, the extent of its spread or the degree of tristeza’s virulence was not known. Candidate trees had to be tristeza free before any other long-term indexing was begun. In 1960 the Florida Citrus Nurserymen’s Association requested that if a parent or scion tree indexed positive for tristeza virus, that it be ineligible for propagation on CTV susceptible rootstocks. The budwood program never guaranteed freedom from tristeza, but had heretofore not accepted CTV infected trees and eliminated trees found to acquire the virus. The recommended policy change in 1960 was to allow such trees to be used to produce registered nursery stock on tolerant rootstocks, but not to be used for registered scion trees. The Budwood Technical Advisory Committee then recommended in 1961 not to allow tristeza infected source trees or their propagation in the program. In 1962, Don Bridges of the Citrus Budwood Program stated, “It is dangerous for us to regard our tristeza experience as proof that we will continue to lose a relatively small number of trees on sour orange; rather let’s look on this as a period of grace during which we exert every effort to find a satisfactory rootstock replacement.” By 1964 the rate of tristeza spread and the number of infected trees increased to the point of changing the program policy to allow source trees to remain in the program even after becoming infected. The program, however, would still test program trees for tristeza on request for those wishing to still propagate on susceptible rootstocks. The committee met again in 1968 to review handling tristeza in the budwood foundation grove, as the policy of removing tristeza infected trees had to be abandoned.
with increasing rates of infection despite intense effort that was put into chemical control of aphids. Serological ELISA (Enzyme-Linked Immunosorbent Assay) testing for tristeza began in 1977-78 and replaced the biological key lime test as the bureau standard in 1980. Sour orange was used as a self-indicating rootstock to visually weed out Florida decline strains of tristeza in 1983. Monoclonal antibodies were used to identify Florida Sour Orange declining strains of tristeza starting in 1989. Tristeza testing of budwood sources became mandatory in 1997 and 2 private laboratories were certified by the program to handle the commercial nursery testing for tristeza. Certification involved the monitoring of test results and administering a panel of blind samples for the laboratory to identify.

In 1967-68 the bureau made an attempt to protect foundation trees from aphid-transmitted tristeza in an isolated location at the Ona Range Cattle Station in Hardee county. Nearby citrus trees were removed and the nearest commercial grove was ¾ mile away from the experiment. Four years after planting it was found that tristeza was rapidly spreading in the previously clean trees. In the early days of the program, most of the tristeza isolates in Florida were weak and caused minimal damage to the sour orange industry. By the 1980’s and 90’s the industry was seeing increases in strong tristeza strains, as quick decline of Sour Orange was present statewide. The introduction of the brown citrus aphid in 1995 saw a greater efficiency of transmission by the large numbers of brown citrus aphids that were vectoring the virus, and massive losses on Sour Orange soon occurred. Today the industry is concerned about even stronger stem pitting strains of tristeza either being selectively transmitted or being introduced. Florida’s severe tristeza today would still be considered mild on a worldwide perspective.

Psorosis Virus

Studies on the incidence of psorosis and blind pocket/concave gum virus at the time of the formation of Florida’s certification program showed that yield was reduced by 10 to 35 percent. Some groves had over 90 percent psorosis infected trees, but many more groves were infected at a 5 to 10 percent level. Psorosis infection not only reduced yields but weakened trees to be more susceptible to cold damage. From the inception of the program nurserymen were warned that when adequate supplies of psorosis and blind pocket/concave gum free budwood became available, state inspectors would begin quarantining nursery stock with psorosis and blind pocket/concave gum leaf symptoms. A tentative date of January 1, 1960 was set when known psorosis and blind pocket/concave gum infected trees would be refused certification. Because of a subsequent freeze many young registered trees were lost or set back and an extension was made until January 1, 1961. The Division of Plant Industry started the psorosis
quarantine by prohibiting the sale of psorosis infected nursery stock of nine major citrus varieties. Throughout the years this list of varieties was amended as psorosis free material became available. In 1967 seven additional varieties were added to the psorosis quarantine list.

**Seed Transmission**

By rule of thumb, viruses are not transmitted through seed. However, in mid-1960’s the bureau reported that a percentage of Valencia scion trees on Carrizo rootstock were showing leaf symptoms of concave gum disease. Further investigation showed a high percentage of Carrizo seed actually could transmit this psorosis like agent. This resulted in a massive search to identify and index all Carrizo rootstock seed sources.

**Spring Flush**

Every spring when temperatures were most favorable for psorosis and blind pocket/concave gum virus leaf symptoms, DPI inspectors would walk out citrus nurseries looking for leaf symptoms. This process was effective in eliminating many psorosis and blind pocket/concave infected sources. When positive leaf samples would show up in Carrizo rooted scions, the attention would turn to the seed sources. Bureau inspectors would also visit parent and scion grove trees during the spring for flush inspections. The visual inspection of field trees was a practical way of quickly identifying and eliminating infected trees before investing greater time and money in long term indexing. The visual inspection of field trees and nursery blocks permitted many leaves to be looked at from a single source, while optimal temperatures and control plants gave greater accuracy in a controlled indexing environment. The bureau virus field test plot would also be closely scrutinized during this time frame. Office staff were busy preparing lists of trees needing inspection and then recording inspection results and other updates that were also performed this time of year.

**Cachexia Viroid**

In 1955 it was determined by bureau indexing that cachexia viroid infection was higher in Florida citrus groves than previously thought. One of the first changes to the budwood policies was to register budwood trees for freedom from psorosis virus alone. This change was made because a lot of productive psorosis free parents were infected with viroids and very little propagating material was available that was both psorosis and cachexia free. This allowed growers to have psorosis free trees and still obtain good production using a cachexia tolerant rootstock. The early philosophy of the program was to develop budwood sources free of psorosis first and later certify
freedom from other graft-transmissible diseases as such trees were developed.

Registered trees carried a metal seal and different colored tags that would distinguish between psorosis–free trees and psorosis & cachexia–free trees. I have used the current name cachexia, although xyloporsis was the name used early in the program and an “X” represented a tree being xyloporsis–free. An “E” would later be added to indicate freedom from exocortis. Today an “XE” represents a tree tested for cachexia, and exocortis and no viroid was found to be present. The program also tests for viroids II and III detectable by polymerase chain reaction (PCR) testing.

By 1958 data showed 72 percent of the candidate trees in the budwood program had cachexia as determined by symptoms on Orlando tangelo test plants. Our number one variety, Valencia, had only one or two trees that were free of cachexia viroid. It was estimated in 1958 that 40 to 50 percent of the candidate trees were carrying exocortis viroid. All Marsh grapefruit, Ruby grapefruit and Temple oranges were infected with exocortis viroid in 1958. Five years into the budwood program it was found that approximately 5.5 percent of the trees were infected with citrus tristeza virus, most likely a mild strain. Psorosis virus was found in only 6.7 percent of the candidates, primarily due to the fact that they were visually screened and selected for the absence of visual trunk and leaf symptoms. The first inspection a candidate tree received was called a preliminary inspection as trees were often rejected for visual disease symptoms before being accepted for parent tree indexing. A parent candidate tree had to be at least ten years old, so many trees were rejected on sight for bark scaling. Within five years of the start of the budwood program, there were already selected 858 parent trees averaging 25 years of age, 417 of which were psorosis and tristeza free.

Exocortis Viroid

In 1958 the Childs Color Test for exocortis viroid was incorporated into the routine indexing procedures to supplement the eight-year trifoliate field test. This development would reduce the time frame for testing to 3 or 4 years. Technology drives change as newer methods develop and benefits detection capabilities, efficiency and costs. Etrog citron indicator plants were investigated to increase sensitivity and to shorten exocortis indexing time in 1964-65. Etrog citron became the standard biological indexing test plant in 1968. Dr. Peggy Sieburth incorporated PCR testing in the bureau to complement biological viroid testing in 1998. As with most plant pathogens, the time honored biological indexing on sensitive indicator plants is the standard and any new testing technologies will be judged on comparison with the standard.
Viroid Management

Mechanical transmission of Exocortis viroid was reported by Dr. Steve Garnsey in 1966 and sanitation recommendations were given to nurserymen for sterilizing knives, clippers and other tools. The discovery that exocortis could be spread on contaminated budding tools made it evident that all previous testing for exocortis was suspect. The massive job of re-indexing all budwood sources required intensive testing under aseptic propagation procedures. The threat of mechanical contamination also necessitated a periodic retesting of all scion trees in the state.

In the 1970’s the Florida budwood program had viroid-tested stock available as the industry was changing rootstocks to those that were very susceptible to viroid stunting. Having viroid free budwood made it possible for the industry to transition to Carrizo and other trifoliate hybrid rootstocks when citrus blight dictated abandonment of Rough Lemon as the number one rootstock. The industry received great benefit in having nucellar and viroid free trees for the growers to use. Other countries that had to change to trifoliate hybrid rootstocks were not as fortunate, as many examples of viroid-infected groves being planted are noted in the literature. The viroid-free propagating material provided by the Florida budwood program was a major factor in opening up the use of new rootstocks in Florida.

Bacterial Leaf Spot

The budwood program and nursery industry faced new challenges in 1984 as a new bacterial leaf spot disease resembling citrus canker was found in citrus nurseries. The following of nursery propagation records (budwood trails) condemned many nurseries to destruction as a result of association with other nurseries having this pathogen. The bureau closed the Florida Citrus Arboretum to the public for a good part of 1984-85 as a citrus canker protective measure. The bacterial leaf spot outbreaks of the mid-80’s made nurserymen more aware of their budwood and the importance of having protected sources. However, due to a shortage of registered budwood, some nurseries resorted to using non-registered sources which resulted in an upsurge on viroid-infected plantings, that ultimately lead to the move for a mandatory budwood program in the 1990’s. The bureau also recognized the importance of diversifying foundation budwood supplies to several locations.

Budwood Distribution

Prior to 1958 budwood was distributed by nurserymen owning parent or scion budwood sources and not by the State Plant Board. The high level of virus incidence in Florida citrus meant that some citrus
varieties were represented by very few completely virus-free source trees. Scarcity of clean budwood sparked discussions for the State Plant Board to establish a budwood bank and distribute propagating material directly to the industry. In 1956 the State Plant Board was given authorization to accept and test non-participant’s trees. A number of desirable trees were entered into the program in the name of the State Plant Board (SPB). The advent of clean nucellar seedlings selected by the State Plant Board and research agencies further intensified the need of a means to distribute tested budwood. A major issue at this time was if the State Plant Board could maintain a small collection of clean budwood sources to distribute budwood from. This collection was to consist of the best old line, nucellar clones, new hybrids, and seed source trees that were obtainable.

Hughes Nucellar Valencia

One notable bureau involvement was the evaluation and release of Hughes nucellar Valencia budwood in 1960 from an older seedling block near Plymouth in Orange County. Dr. Ausker Hughes originally planted seeds of Parson Brown and Valencia in 1937-38 as he was interested in the polyembryonic nature of citrus and the benefits derived from nucellar sources. The bureau began a five-year process of evaluating and indexing individual trees in 1955. These nucellar budlines quickly became industry favorites and a Hughes Memorial Foundation was formed in 1961 that provided scholarships to students studying citrus at Florida Southern College and the University of Florida. The history of the budwood program is tied to many new varieties that were released throughout the years as a result of field inspectors spending much time and labor in walking groves and selecting outstanding parent trees that represented some of Florida’s best varieties.

True to Type Rootstocks

While the budwood program initially concentrated on having clean scion material available for nursery use, it did not take long for the bureau to see the importance of having true-to-type rootstock sources. By 1958, approved seed source blocks were planted. Prior to the selection of horticulturally selected true-to-type rootstock trees, many seed collectors simply visited seed sources that arose from frozen out scions. Others found seed trees in swamps and hammocks as there was no standard rough lemon selection available. Today, bureau inspectors witness the planting of registered clonal seed varieties in budwood scion groves. The bureau provided another important service in hot water treating seeds for nurserymen. The treatment of 125°F for 10 minutes was to control fungal pathogens such as phytophthora.
Parent Trees

Florida’s budwood program was unique because it allowed nurserymen to own parent trees and establish their own plantings of scion source trees. This feature made it convenient for the nurseries to have bud source trees located at their sites. Once trees had become established it was an excellent means to evaluate horticultural traits, as fruiting trees would give the inspector an overall picture of health, production and vigor. Inspectors would often find off-types, mutated limbs, branches with variegated foliage and fruit with chimeras. Most of the graft-transmissible diseases are non-symptomatic on tolerant rootstocks and indexing is required on sensitive indicator plants to determine the presence of a graft-transmissible disease. The program had difficulty keeping up pathogen testing all the nursery scion grove trees as their numbers exceeded 50,000 in the 1980’s.

Bureau Investigations

The normal workload of running a certification program led to many investigations of new varieties and requests to identify tree problems. Trees entered into the budwood program were a good representative cross section of the commercial trees in the state. Throughout the years many off-type propagations were traced back to a mutant source tree by using the bud cutting reports and nursery plats that were required for registration. The job of identifying and eliminating undesirable budwood sources was just as important as selecting the superior ones. Bureau personnel discovered severe stem pitting in and trunk distortion on Milam trees in 1972. Bureau personnel also investigated grapefruit bark scaling in the early 1980’s that resembled psorosis virus. In the 1990’s a decline of Roble orange on trifoliate hybrid rootstocks was investigated and in all likelihood attributed to virus. Throughout the course of years the bureau has investigated many pathogen-caused declines, budunion incompatibilities, along with many other site-specific and environmental problems.

Lime Blotch Disease

One of the first Florida successes in dealing with a genetic disorder was the selection of lime trees free of wood pocket, then called “lime blotch disease”. The budwood office spent many days selecting symptomless trees to use as budwood sources. It is estimated that 100,000 possible candidate trees were looked at before 10 were selected and finally 2 clones were made available for propagation. The resulting lime plantings made from these selected trees were said to have “brought the industry back from disaster”. This same process of rigorous selection of many different variety parent trees has given the Florida grower outstanding horticultural selections to choose from when planting a grove.
Research

One early concern was that the budwood program was regulatory and should not be involved in research. There is a fine line between the two as the horticultural evaluation needed to screen budlines involved data collection. Yield and maturity test data were gathered in the early days of the budwood program to be able to make proper assessments. Applying various indexing diagnostics often required refining experimental techniques to efficiently run the mass of samples that a certification program requires. In 1961 the budwood bureau was cooperating on 14 projects with research scientists doing related studies on everything from rootstocks to citrus diseases. During the 1980’s the bureau was using a portion of the foundation grove in a cooperative tristeza virus cross protection test.

Today the bureau is still cooperating on pathogen research and works closely with the University of Florida Lake Alfred Citrus Research and Education Center, the Immokalee Southwest Florida Research and Education Center, the USDA Ft. Pierce Agriculture Research Service Center, and USDA researchers in Beltsville, Maryland. Florida Citrus Production Research Advisory Council grant funds have made it possible to refine PCR viroid testing protocols, determine composite sampling sizes, and optimal time of year for sample collecting. Grant funds in 2000 made it possible to construct a pathogen collection greenhouse to segregate pathogen infected control plants from healthy material. Having a readily available supply of various pathogens is critical for having proper indexing controls and to test and refine new diagnostic techniques. The bureau continues to research tristeza diagnostics and indexing methodologies for new diseases such as citrus leaf blotch virus.

Florida Citrus Nurserymen’s Association

The Florida Citrus Nurserymen’s Association (FCNA) was active in supporting the budwood program from the beginning. The association required their membership to be participants in the program when the program was voluntary. The FCNA often provided funds to help bureau personnel travel to international citrus conferences and helped provide money to complete a greenhouse when state funds came up short. The nurserymen’s association also donated a computer to the bureau at a point when the bureau was struggling with outdated equipment. Florida nurserymen have been extremely generous in sharing information and new growing techniques. Plant material was also freely distributed among growers and nurserymen with no concern for compensation beyond the normal price for budwood. Patenting new varieties by Florida citrus nurserymen was basically unheard of during the past 50 years, as they were quick to freely share their new discoveries.
First Foundation Grove

Land for the original foundation grove was acquired in 1959, and was located at the intersection of US Highway-27 and Interstate-4, north of Haines City. This property was a portion of land owned by the Citrus Experiment Station that was divided in two when Interstate 4 was constructed. As this portion of the land was not practical to access with the experiment station property across the interstate highway, the Board of Control of Florida entered into a Memorandum of Agreement with the State Plant Board for the budwood program to use the property. The property was triangular in shape with a large portion unusable because it contained a cold pocket. By 1960 the land had been cleared and rootstocks planted across 20 acres of the approximately 50 available acres. By 1961 the grove contained 152 old-line clones and 268 nucellar seedlings of commercial varieties along with many standard and potential rootstocks. The foundation trees were budded on 5 standard rootstocks to serve as virus indicators as well as being evaluated for fruit quality and yield. With what proved to be valuable foresight, nucellar seedlings of the major commercial varieties were planted in order to obtain trees free of graft-transmissible diseases. Of these trees the selections from Valencia seedlings became particularly valuable and now comprise a significant percentage of the commercial Valencia propagations in use today. One particular selection of Ruby Red grapefruit has replaced all others as the most popular grapefruit selection in current use. Likewise with many other varieties, the nucellar foundation trees became mainstays of the industry.

1962 Freeze

The December freeze of 1962 caused a demand for budwood, as many of the nursery source trees were damaged. The budwood foundation grove was brought through the freeze with 1400 grove heaters and 4 wind machines. The budwood office distributed over 93,000 budeyes following the freeze, to avert large-scale use of virus infected propagating material as nurserymen scrambled to bud replacements.

Dundee Foundation Grove

The foundation grove was relocated south to the Dundee area in 1973 when Circus World purchased the original property. The Cabinet sitting as the Board of Trustees for the Internal Improvement Fund approved a land swap with Circus World for property of equal value. The exchange of properties benefited the program as the original 50 acres were traded for 80 acres plus additional infrastructure. The new groves were valued at $300,880 and Circus World provided an extra $164,200 for moving expenses, improvements and construction of facilities. This new location provided a warmer location and more
land for evaluation and indexing work. The new facilities were dedicated with an open house in October 1974 with Agriculture Commissioner Doyle Conner giving remarks to about 150 people in attendance. Over 790 trees, one-to-ten-years old, were moved from the original foundation grove to the new site. Initially 126 clones were propagated at the new Dundee foundation nursery site and 27 different rootstocks were being evaluated at the Dundee grove. New greenhouses and a screenhouse were soon constructed. An additional screenhouse was added to the Dundee foundation grove in 1996 as citrus tristeza virus was infecting most field trees.

Yields

Fruit yields were compiled on young foundation grove trees beginning in 1963. A tractor mounted hydraulic lift and scale that weighed 10 box bins was added in 1978. Growers were quick to utilize the horticultural information provided by the bureau, as the higher yielding clones became the industry standard for planting.

Freezes

The 1980s were known as the decade of freezes, and bureau personnel spent many nights firing grove heaters in the foundation grove, test plots and Florida Citrus Arboretum. During the winter of 1981 nearly 20,000 gallons of diesel fuel were used to protect test nurseries and budwood foundation trees. The major citrus freeze of 1989 caused the loss of over 31 acres of foundation trees. Looking a little further back in history, a freeze in January 1977 saw bureau personnel witnessing nursery trees being dug for scion tree planting during a rare central Florida snowstorm. The Dundee foundation grove was changed from overhead to low volume irrigation by 1998 and the arboretum was converted to micro irrigation in 2001. The use of these under the tree low volume irrigation systems are the mainstay of foundation cold protection in 2003. Prior to permanent fixed irrigation systems, much time and labor went into moving portable aluminum pipe in the original foundation grove. The 1964 bureau annual report records a drought that required almost continuous irrigation in the grove and test plots as it took 7 days to complete one irrigation cycle.

Florida Citrus Arboretum

Construction began on the Florida Citrus Arboretum in 1975. The arboretum was planted in 1978 with unique citrus varieties collected from all over the state. Other varieties selected represented budlines originating from the “outback” of Australia to mainland China. Even the landscaping of the arboretum incorporated distinctive citrus wherever possible. Leon Hebb of the bureau was instrumental in the
design and establishment of this valuable industry germplasm garden. Today many visiting citrus enthusiasts, including agricultural classes and citrus breeders tour the Arboretum and use its resources for citrus research.

**Imokalee Foundation Grove**

A 20-acre foundation grove was planted at the Immokalee Research Center in 1989 in cooperation with the University of Florida, Southwest Florida Research and Education Center. Florida Department of Agriculture Commissioner Doyle Conner and dignitaries from University of Florida IFAS participated in the official opening of this foundation grove in June 1990. The planting consisted of 28 different registered selections replicated on 22 different rootstocks. The foundation trees were inoculated with 3 different isolates of tristeza virus in 1992 hoping to provide the industry with cross-protective strains of tristeza. Budwood was distributed from this grove from 1992 until 1998. When citrus tristeza virus infection increased from 5.5 to 37.5 percent as a direct result of being vectored by the brown citrus aphid, first detected there in 1996, field budwood cutting stopped. In the 7.5 years of budwood cutting, 1,113,462 budeyes were distributed from Immokalee foundation field trees. Screenhouse construction began in 1989 and additions were built in 2000 and 2002. Today all budwood distributed from Immokalee comes from these protected screenhouses. A board of directors of the non-profit Southwest Florida Research and Education Foundation manages the Immokalee foundation grove and supports research activities through budwood and fruit sales.

**Whitmore Foundation Expansion**

The budwood program expanded its locations in 2002 by utilizing existing greenhouses at the USDA Whitmore Foundation Farm south of Leesburg. The first of two greenhouses was occupied in November of 2002 and immediately helped alleviate overcrowding in bureau greenhouses at Dundee and Winter Haven. The bureau will use this location to receive and distribute new varieties coming out of the germplasm introduction program quarantine facility located in Gainesville.

**Nomenclature**

The term “registered” and “certified” has from the 1950’s caused a certain degree of confusion in the industry as nursery trees were “nematode certified” and then “state certified” for general insects and diseases. The terminology used in 1958 was that budwood in transit was known as certified budwood and trees budded from inspector certified budwood were known as registered trees. The original
program was called the Citrus Budwood Certification Program; the name was changed to the Citrus Budwood Registration Program in 1958, and then the Citrus Budwood Protection Program in 1997. Originally the budwood program was voluntary but the certification for insect pests and diseases was statutory law. In 1993 a mandatory Quality Tree Program was proposed by an industry committee of nurserymen and growers. After 4 years of rule revision and 6 statewide grower workshops, the mandatory budwood protection program took effect in 1997. As of January 1, 1997 all commercial citrus nurseries had to be registered with the Division of Plant Industry and use registered or validated propagating material. The following year the program was expanded to include homeowner or dooryard citrus nurseries. Commercial citrus nurseries are nematode certified along with being visually certified for common pests and diseases by the Bureau of Plant Inspection.

Premium Quality Citrus Nursery Stock

A Premium Quality Citrus Nursery Stock Program was attempted in the late 1960’s. The “Premium Quality” (PQ) designation went beyond the normal registration and nurserymen had to adhere to stricter guidelines, specifically in dealing with nematodes and fungal pathogens in producing trees. Extra sanitation at the nursery site was required along with rigorous spray schedules. The PQ designation required trees be grown in a fumigated site, use approved irrigation water, use treated approved true-to-type seeds and finished trees were required to have a fungicidal root dip. The PQ designation was dropped from the budwood program by the mid 1970’s as the extra costs involved in producing these nursery trees were not accepted in the market place, as the majority of growers were unwilling to pay any sort of premium over the standard tree price.

Budwood Introduction

Early on, no mechanism was in place to import budwood into Florida. A safe system of introduction, quarantine, and testing had to be developed. Funding of $45,540 was requested in 1970 to construct suitable quarantine greenhouse facilities to assure safe introduction of citrus into Florida. Gainesville was selected as the location for safe germplasm introduction facilities as its northern location was outside the citrus growing area. Prior to the completion of the $58,000 DPI quarantine greenhouse in 1975, new varieties could be brought into quarantine at a USDA greenhouse. Since 1971, a major role of the budwood technical committee has been to approve new varieties to bring into Florida. Star Ruby grapefruit was one of the first varieties brought into the state in 1971. Star Ruby was held in quarantine and indexed by the USDA since the DPI quarantine greenhouse was not
yet constructed in Gainesville. Now the Division of Plant Industry is the only agency through which new citrus can be introduced into the state. The Division of Plant Industry greenhouse was dedicated February 1976 in Gainesville. The Citrus Germplasm Introduction Program moved into larger greenhouses and laboratory facilities in 1999. The new facility has approximately 3,000 square feet of space, which allows for introducing 5 new selections a year. Since 1979, twenty-two new selections have been released to Florida growers through germplasm introduction, quarantine, and indexing.

Illegal Star Ruby Grapefruit

Unauthorized Star Ruby grapefruit had been brought into Florida in May 1971 from Texas as what newspaper articles labeled as “bootleg trees”. One hundred-four balled and burlaped Star Ruby trees were flown into Florida from Texas in a rented DC-3 airplane. Illegal Star Ruby budwood was also introduced on at least 3 subsequent occasions. The Star Ruby plantings amounted to about 210 acres in 1975 and some of the trees were exhibiting a necrotic ringspot virus. This ringspot virus was similar to a ringspot virus found in Texas and has since been identified as psorosis virus. Most of the Star Ruby trees were planted in the Indian River area of the state but trees were found in seven counties in what was called “the largest citrus smuggling operation in the state’s history”. It was estimated that 66,000 unauthorized Star Ruby trees were either budded or topworked in Florida. As many as 26,000 trees had been voluntarily destroyed by conscientious growers worried about spreading the ringspot virus.

The official release of the approved Star Ruby was delayed two years until 1977 in an effort to identify all illegal introductions and keep the unauthorized ones from being co-mingled with the officially released material. The Florida Department of Agriculture lost, on appeal, a court case to have the unauthorized Star Ruby trees destroyed. However, the state legislature strengthened the department’s authority in keeping citrus trees and propagating material out of Florida as a direct result of the Star Ruby litigation.

Shoot-Tip Grafting

The Bureau of Citrus Budwood Registration utilizes heat therapy and shoot-tip grafting to clean up pathogen-infected trees and has been able to provide clean budlines of all commercial varieties. Prior to shoot-tip grafting, going through seed to develop nucellar budlines was the only means of obtaining virus free plants. The bureau selected many nucellar budlines of the major commercial citrus varieties and in many cases these nucellar lines were the only virus-free budwood of a particular variety that was available in the state. Unfortunately, not all citrus produced nucellar seedlings and
pathogens were unavoidable in a few varieties. As recently as 1976, prior to full utilization of shoot-tip grafting, 13 different old-line varieties did not have any exocortis-free trees. The bureau started shoot-tip grafting in 1976. Within 24 months of starting shoot-tip grafting, 416 living grafts had been transferred to the greenhouse from the lab. Today it is possible to have virus free plant material of every variety available due to shoot-tip grafting technology.

Validated

In 1964-65 the budwood program began distributing new releases as “validated” rather than registered because they had not been fully field evaluated and tested. The USDA variety release of Lee, Robinson, Osceola, Nova and Page, and the University of Florida’s Lake Alfred Citrus Experiment Station’s release of the rootstocks Milam, Estes Rough Lemon, Carrizo, Ridge Pineapple and Sanguine Grosse Ronde prompted the set up of a validation system to distribute new varieties before they became more fully evaluated. Validation allowed for adequate authentication while quickly getting new material in the hand of growers. The term “validated” is still a part of the budwood program, although its main use is now intended to be for own-use growers who want to use their own unregistered budwood sources. Validated still indicates that a budwood source has not been fully evaluated, although it has been tested for vector transmitted pathogens.

Increase Blocks

A major change in the program occurred in 1991, as nursery increase blocks became a part of the budwood scheme. Increase blocks are a quick means to multiply budwood. Being in a nursery setting for a relatively short period of time, they are not likely to become pathogen infected. The traditional field scion tree, that could be quickly evaluated visually for fruit and horticultural characteristics, is being replaced by increase blocks and also by screened scion sources that are protected from insect vectoring. The importance of increase blocks to today’s nurseries is evidenced by the fact that 46 percent of budwood used by nurseries came from increase blocks in 2002.

Witnessing Budwood Cutting

An important long-standing job for division inspectors was the witnessing of budwood cutting. Every time propagating material was removed from a tree, a state inspector had to be present to give an accurate accounting. The correct trees had to be located and approved for cutting and the inspector made sure the virus testing status was up to date for each tree cut from. The inspector would also walk around the tree looking for overall tree vigor, rootsprouts and mutations that
might make the tree unworthy for propagation. In the summer it was common to find an inspector sitting under the shade of a tree canopy counting budeyes, as nursery budders usually cut the wood from the trees. On windy cold winter days a small fire might be started in the grove to warm the crew collecting budwood. The job of witnessing budwood and writing budwood cutting reports was privatized in 1997, as trustworthy, dependable nursery employees were trained and authorized by the budwood office to witness budwood cutting for their own nursery.

Restructuring

As a result of restructuring the Division of Plant Industry in 1979, the bureau assumed responsibilities of witnessing bud cutting, scion tree planting and other routine activities connected with tree registration, in both Polk and Highlands counties, where most of the citrus nursery trees were grown. Prior to this time, budwood witnessing, scion tree planting and spring flush activities were carried out by district plant specialists of the Bureau of Plant Inspection. The budwood bureau gained two additional positions to compensate for the additional workload associated with the division restructuring. In August 1985, the bureau acquired four additional personnel as the division’s plant pathology section in Winter Haven was merged with the Bureau of Citrus Budwood Registration. This consolidated all the greenhouse and laboratory indexing in Winter Haven within the bureau. The Winter Haven pathology laboratory/greenhouses had previously augmented the bureau’s own Dundee greenhouse indexing by cooperatively growing citron and key lime indicator plants.

Training

Training has always been an important part of educating nurserymen and employees on program specifics and the reasons for such a program. Classes were held for new plant inspectors in which the program was covered in depth from virus indexing to general procedures. Initially, the training for budwood certification lasted two weeks and enabled inspectors to be proficient in all phases of program work. Today, the budwood phase of the training for Division of Plant Industry inspectors is done in one day. Further specialized training is available for inspectors working in areas with citrus nurseries. Specialized training is also conducted on pathogen indexing techniques and shoot-tip grafting. Throughout the years, bureau personnel have lectured grower groups and university students on budwood activities. Future Farmers of America (FFA) classes tour the Florida Citrus Arboretum to learn citrus variety identification and the bureau annually supplies fruit samples for the FFA fruit identification contest.
Worldwide Impact

Florida registered budlines have been distributed around the world. The Spanish introduced citrus to Florida between 1513 and 1565. During the latter half of the twentieth century, the Florida budwood program redistributed improved citrus varieties back to many growing areas of the world where citrus originated. Florida’s budwood program has been a model used by many other countries setting up their own certification programs. Foreign scientists are occasionally trained on program administration, pathogen testing, shoot-tip grafting and other program particulars. Florida registered budwood has been sent under phytosanitary certification to over 80 different countries in the past 50 years.

Growth

The bureau has grown from that one-man, one-woman office to 21 employees stationed at four different locations (Winter Haven, Dundee, Immokalee and Leesburg). Bureau personnel perform the jobs of growing virus indicator plants in greenhouses and maintaining field trees for evaluation and technicians and scientists perform pathogen testing in the laboratory. Inspectors evaluate budwood sources, provide training and conduct arboretum tours. Secretarial personnel process budwood orders and enter nursery and foundation grove information into databases. Computerization is critical for keeping accurate records of budwood cut and pathogen testing results of source trees. The bureau started with its first personal computer (IBM PC) in August 1985 and slowly added additional PC’s that were networked together in 1996. Today 11 PC’s are networked together for data management. The amount and diversity of work going into managing a budwood protection program cannot be simply stated in this brief historical overview.

Computerization Becomes Invaluable

The value of the budwood program to growers goes beyond providing source material for producing productive disease free trees. The budwood office provides useful information to growers looking for trees. Growers often call the office looking for specific nursery trees. Data kept by the bureau makes it possible to identify hard to find scion/rootstock combinations from Bud Cutting Reports and Nursery Plats. Nursery propagation information is computerized and electronically stored by fiscal year. Bureau data makes it possible to report statewide nursery trends in rootstock and cultivar usage. Database software has made four transitions between 1985 and 2000. The first database used was “dBase”, followed by “Smart”, “Paradox” and then changed to “Microsoft Access”. The reason it is mentioned in the history of the program is because data transition was a
monumental job for employees as new software had to be learned and customized for bureau use. Data information systems were all designed in house, as bureau employees maintained total control over the information and were able to fix systems as problems occurred. Detailed information on all program trees are kept in a database. All test results are kept in separate tables, which are linked so that the complete testing history of every tree can be reviewed. Accessibility and sharing of information is critical for employees to check tree status and follow various expiration dates of pathogen tests. Today, the bureau is investigating sending inspectors out into the field with Personal Digital Assistants (PDAs). Laboratory personnel use a PDA for recording observations on greenhouse indicators and that data can be directly loaded to the database without the worry of transcriptional errors. Field trials have been made using handheld PDAs for retrieving tree and testing databases so that accurate up to date information is available on the spot.

Employees

The dedicated hard work of bureau employees was instrumental in reaching this 50-year milestone of the budwood program. Bureau employees did all sorts of construction projects from building pump houses, sheds, fences, pole barns, greenhouses and installing irrigation systems. The ability to do it all has been a vital part of the history of this bureau as it has always been a part of farming since day one. Bureau personnel have been blessed with the ability to work with wood, masonry, metal and build what needs to be built and repair what needs repairing. Bureau personnel carried out pollination work to develop new nucellar budlines. Office clerical staff performed fruit maturity testing and tests to determine peel oil content on many bud-sources, especially lemon and lime types. Two of the bureau employees invented a new injection tool (using large hypodermic syringe) to measure water uptake in blighted trees. Office personnel contributed their organizational skills and used their abilities to develop computer databases and web pages. Laboratory personnel contributed much technical expertise in plant microorganisms and serological and molecular diagnostics. Perhaps the greatest contribution was the keen eye of inspectors in looking for that which was not normal. Accuracy had to be job one in all phases of certification work as a mistake could be reproduced to the degree that the propagations from one substandard plant being multiplied thousands fold.
Summary

Today the budwood program regulates 71 commercial citrus nurseries and registers close to 6 million propagations a year. Over 931 participants have been involved in growing registered budwood or nursery trees throughout the past 50 years. Enough registered trees have been produced since 1953 to plant the entire citrus producing acreage of the state. The budwood office annually distributes several hundred thousand budeyes for industry and homeowner use. The program keeps track of variety and rootstock usage in nurseries and reports nursery industry data annually.

As the Florida budwood program reached its first half-century, the wisdom of the early pioneers of clean stock certification becomes more evident with each passing year. The list of newly discovered citrus diseases has grown considerably in the last 50 years and the knowledge of others has been greatly expanded. Knowledge of virus and viroid detection has also been accelerating so that it is imperative for testing programs to evaluate and adopt the necessary techniques to be able to have an early, quick detection process in place. Several new devastating citrus pathogens have been found in other citrus growing areas of the world in the past few years. Florida has a history of newly introduced insects such as the brown citrus aphid (1995) and Asian citrus psyllid (1998), which are vectors of important citrus pathogens. It is extremely important to protect Florida from exotic pathogens and insects. Your Florida budwood program is your first line of defense in keeping unwanted pathogens out of the commercial propagating channels. As man is the best vector of diseases, your budwood program is the best predator of graft-transmissible diseases in citrus.