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TWENTIETH CENTURY DEVELOPMENTS IN HANDLING FLORIDA'S FRESH CITRUS FRUIT—AN OVERVIEW

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Abstract. **During the twentieth century many developments in handling fresh citrus fruit were seen. Improvements in methods of cleaning, decay control, color enhancement, separation of freeze-damaged fruit and waxing have been introduced. Most of these have resulted in improved appearance, and greater shelf life for Florida's fresh citrus fruit. An additional benefit of many of these improvements has been the reduction of dependence on hand labor in many operations.**

At the beginning of the Twentieth Century, the Florida Fresh Fruit industry was still recovering from the freeze of 1895, which killed most of the producing trees. Packinghouses were small and scattered. Paved roads outside metropolitan areas were nearly non-existent.

Transportation difficulties required that the fruit be packed near the grove and with easy access to navigable waterways or rail lines. Some packing was done in temporary packing facilities. Until paved roads became common, groves more than 10 miles from transportation had little impact on citrus production (Anonymous, 1985).

As production increased, packers became more concerned with increasing packing speed, reducing labor, improving the quality of the fruit and its keeping qualities. Each of these concerns have been addressed many times as each new advance in one area brought with it new concerns in others. During the twentieth century, the Florida citrus industry has seen advancement in machinery, degreening, storage, decay control and coatings.

Few records exist as to the actual practices in most packinghouses, but some records have survived down to this time. Surviving old photographs, the Files of the US Patent and Trademark Office (USPTO), pesticide registration records of the US Department of Agriculture (USDA), the Environmental Protection Agency (EPA), and the Proceedings of the Florida State Horticultural Society (FSHS), provide considerable insight into the state of the Florida fresh citrus industry in the early years of the century. As one reviews the material available, it becomes increasingly evident that lessons learned in past decades still have value today. Another valuable resource is the memories of persons that have been active in the industry for many years.

With all of these one must realize that many things proposed did not see general acceptance. The files of the US Patent office illustrate this very well. Many patented processes and machines never saw general commercial acceptance. In Table 1 several successful patents are listed for purposes of illustration.

At the turn of the century very little was done to prepare fresh fruit for market. The picked fruit was brought to the packing location and sorted to eliminate damaged and off color fruit. Crude sizing into small, medium and large sizes was often done but there was no standardization amongst packers, neither were their any standards for maturity, grade, or packaging. The fruit was rarely washed and waxing was not practiced.

From this small beginning, the Florida fresh citrus industry has grown significantly. In a paper of this nature it is impossible to cover every change and development. An overview of developments that have had an impact on the industry today will be reviewed. Each period has seen major changes, these will be considered chronologically.

In this examination it must be noted that packers were often slow to change. An exhibit at the Florida State History Museum in Tallahassee recreates a citrus packinghouse, using the original equipment from that house that operated up until the 1930s (Fig. 1). The equipment on exhibit and the processes used were at least 15 years out of date by the time the packinghouse closed. A major consideration for citrus packers then, as it is now is the cost of modernization. If a system operates satisfactorily, there is little incentive to change. The ability to market one's fruit was then and is now the primary consideration.

Table 1. Notable patents applicable to fresh citrus packing.

Date	US Patent No.	Title	Comments
July 11, 1911	997,468	Fruit Sizer or Grader	Early Parker Sizer, later improved
Oct. 16, 1923	1,471,732	Apparatus for Treating Fruit and the Like	Lateral brush bar waxer
Mar. 10, 1925	1,529,461	Art of Preparing Fresh Fruit for Market	Brogdex borax treatment
Sept. 7, 1926	1,598,697	Process For the Treatment of Fruit for the Prevention of Decay	Borax/Boric Acid, improved
May 8, 1934	1,957,964	Method and Apparatus for Treating Fruit and the Like	Transverse brush machine
Aug. 21, 1934	1,970,861	Process and Machine for Treating Citrus Fruit.	Transverse brush bar waxer
Dec. 1, 1936	2,062,903	Dyeing Process	Early Color-add
Jan. 19, 1937	2,068,081	Art of Coloring Fruit	Early Color-add
Sept. 15, 1936	2,054,392	Art of Preventing Decay	FMC SOPP patent
Feb. 23, 1937	2,072,022	Method of Coloring Fruits and Vegetables	Early Color-add
Sept. 7, 1937	2,092,091	Art of Coloring Fruit	Early Color-add
May 31, 1938	2,119,060	Method of Enhancing the Varietal Color of Whole Fruit	Early Color-add
May 19, 1942	2,283,372	Apparatus for Treating Fruit	Solvent waxer
Dec. 12, 1944	2,364,946	Preparation of Fresh Fruit For Market	"Snow Wax"

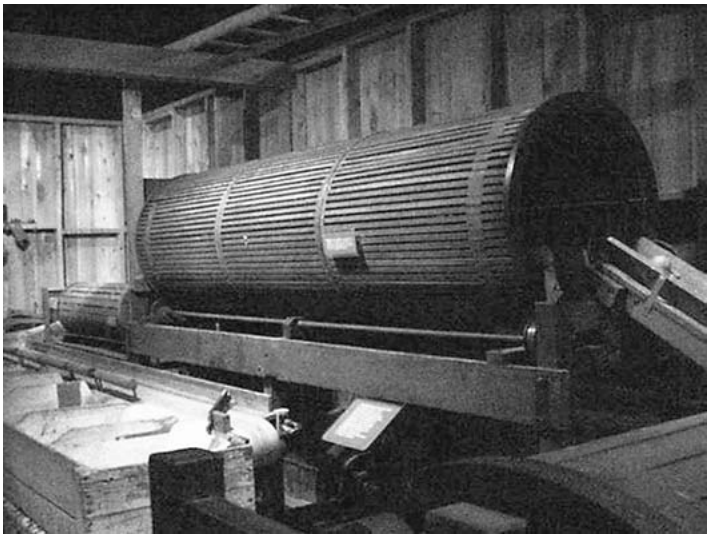

Fig. 1. Dryer, Waxer and Sizer/Pack Tables from early packline (Florida State Historical Museum, Tallahassee).

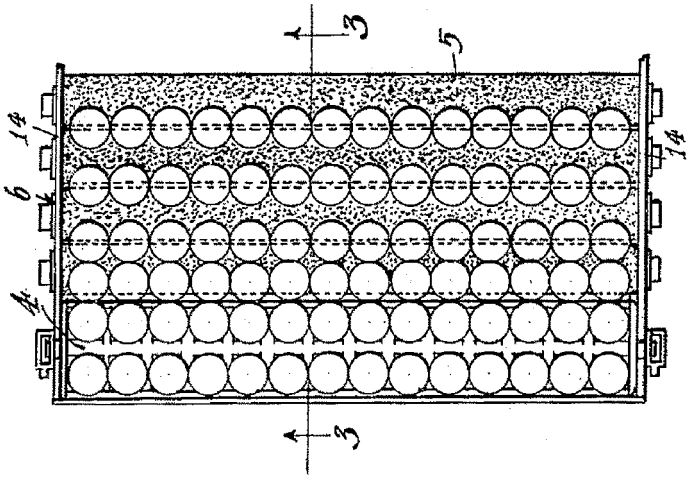

Fig. 3. Transverse brusher. Fruit movement is from bottom to top. Fruit moves by pressure from incoming fruit and rotation of brushes. Entire top surface of brush comes into use (From US Patent 1,970,861).

In an overview of the Florida citrus packing industry one cannot consider every development or innovation tried. Those developments that have led to the state of the industry today will be considered and a brief examination of those that have endured. Of necessity certain companies and brand names are mentioned when they have had a significant effect on the state of the current industry or had a significant impact at the time. This should not be construed as a criticism or endorsement, but merely a reporting of facts as I see them. Opinions expressed are my own.

1901-1920. With the passing of the Food and Drug Act in 1906 packers were required make sure that the fruit shipped was packed using only safe products for cleaning, decay prevention and coatings. As time passed further refinement in regulations caused changes that continually improved the quality of Florida's fresh citrus.

During this period innovations toward mechanization began to be introduced. Mechanical sizers of different types were introduced. These all used the principle of dropping or rolling the fruit through a slot of variable width and were reasonably accurate with essentially round fruit. Washing was not universally practiced until an outbreak of Sooty Mold in 1909 made it necessary. Even then there was resistance to the practice as it had been demonstrated that washing greatly increased decay in packed fruit (Ramsey, 1912).

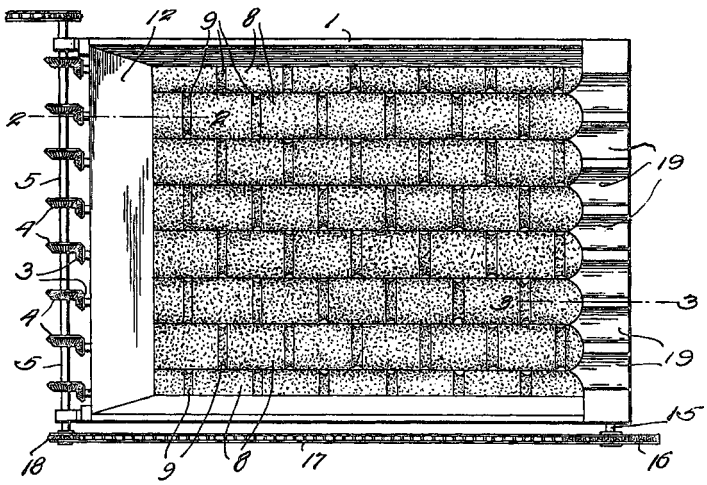

Fig. 2. Lateral brusher. Fruit travels along brush groves from left to right. Often sloped downhill to encourage fruit movement (From US Patent 1,417,266).

The fruit was normally packed in wooden boxes with a nailed lid. Each packer apparently had his own standard as to box size and configuration (Mote, 1909). It was common practice to over fill the box so that the slats would bulge about one and a half to one and three quarters inch at the center (Anonymous, 1985). This practice was, even then, recognized as damaging to the fruit, but was still occasionally practiced with paperboard cartons down to the end of the century.

This period saw the beginning of standardization. In 1909 the Florida Citrus Exchange (now Seald Sweet Growers, Inc.) was formed (Anonymous, 1985). This voluntary association ushered in the beginning of size and grade standards for the industry.

In that same year the Florida State Horticultural Society began presenting a Symposium titled either "Methods of Packing and Shipping Citrus Fruits" or "Preparing Citrus Fruits for Market" at their annual meeting. These Symposia continued until 1916.

During this period the use of postharvest fungicides had not come into use. None of the products we are familiar with now had been introduced. Postharvest decay control was accomplished by careful handling, grading, hardening fruit (letting the fruit set for three to four days between picking and packing), and by the use of tissue paper wraps.

At the FSHS 1911 meeting a report on washing citrus reported good results at the Winter Park packinghouse of Wilcardo Fruit Co., by using a continuous supply of cold water from deep wells (Temple, 1911). This continuous flow of fresh water would minimize the risk of spreading infection and at the same time would pre-cool the fruit. At the 1912 meeting L. B. Skinner suggested adding bluestone (Cupric sulfate) to the wash water for oranges and potassium permanganate for grapefruit. The amount was not specified (Skinner 1912). This latter appears to be one of the first uses of postharvest fungicides. There is no evidence that either of these methods gained general acceptance.

In 1913 an FSHS report indicated that some rail cars bound for northern markets were being iced, but that the practice was not common. The following year, Polk county citrus growers began a road-building project in order to bring more citrus to market. This project, the first in the State, had completed 217 miles of paved road by 1920.

In 1915 the FSHS symposium reported the successful use of alkaline heated washes for cleaning fruit. Although not reported, this process would have made waxing a necessity.

In 1917 the Citrus Research and Education Center at Lake Alfred was established. In time this was to become an important resource for Florida's citrus industry.

By the end of this period some packers were regularly waxing their fruit. These waxes were mostly based on paraffin and carnauba waxes. Various systems were tried including dissolving the wax in kerosene for application, sprinkling powered wax on the fruit over brushes and applying a spray of molten wax.

1921-1940. In 1921 degreening of citrus using kerosene stoves was begun and by 1923 it is reported that over 100 Florida citrus packinghouses were equipped with coloring rooms having a capacity of from one to eight cars each (Barger, 1923). In 1923 ethylene was identified as the functional component of kerosene fumes that was responsible for the coloring of citrus and that as little as 1 part per million was sufficient for most uses (Table 1). It was recommended, since it was readily available as a compressed gas in cylinders and the quantity was more easily regulated, that packers convert to its use. Despite these advantages kerosene stoves continued in use over the next three decades (Ellis, 2003; Grierson, 2003).

In 1922 the Brogdex Company was formed. This was to be the first of the service companies that have greatly affected the direction that Florida's fresh citrus industry has taken during the twentieth century. These service companies have, by their competition with each other, lent a stability and uniformity to packinghouse operations. In time their laboratories, design teams and manufacturing facilities have been responsible for most major developments in fresh fruit packing. Also by providing modern equipment to larger packinghouses on a lease or royalty basis they have encouraged the rapid adoption of advanced methods.

In the early 20s packers became more concerned with the appearance of their fruit. Most packers began using waxes on their fruit. Harsher washing and higher volume handling, which was rougher on the fruit, made it almost mandatory. The service companies began competing for a share of this market and many different methods were tried. One that has endured was what is sometimes called "Bar Waxing". In this method, a slab of wax is pressed against the underside of one or more brushes over which the fruit travel. The wax picked up from these brushes was then spread and polished by subsequent brushing. Many formulations of wax were tried, formulas calling for paraffin, beeswax, carnauba, spermaceti, and other ingredients were tried (Hall, 1981b). This process is known to have been in use up into the mid-90s by at least one small packer.

Another important development of this era was the recognition that packinghouse sanitation had a significant effect on postharvest decay. Cleaner packinghouses, removing decaying fruit, using fresh clean wash water, and keeping equipment clean all resulted in fewer decays at market (Gumprecht, 1923).

Two other developments came into prominence in fresh fruit packing in the early to mid-20s. The first was the widespread use of Parker's modification of the belt and roll sizer. While the basic idea was not his and many other versions have been produced his name has endured. In the same way the basic idea of the belt and roll sizer has endured through the end of the twentieth century and many large packinghouse still use this basic machine. The other development was the use of heated borax solutions as a decay control method (Fulton, 1925). Solutions (2-3%) of borax and boric acid were heated to about 110°F and the fruit exposed in a tank for 3-5 min. Fruit thus treated had a lower rate of decay than average and was favored by the buyers in northern markets. At that time the Brogdex Company had a patent on the process and packers using this process displayed "Brogdex Fruit" on their box labels.

In the mid 30s a major innovation in citrus packinghouse machinery was introduced by a service company, the Food Machinery Corporation. Up to this time citrus packlines used brushes mounted parallel to the flow of the fruit. Fruit would run down the grove formed by two brushes side by side or by a brush and a rail. By mounting the brushes across the path of fruit flow, these transverse brush washers and wax applicators greatly improved the cleaning and waxing operations. By the simple expedient of having the fruit contact not only the valleys between brushes, but also the top surface as it moved through the machine, a machine had about 50 to 80% greater capacity than the same number of brushes in a parallel brush machine. While this was a great improvement, it took about 20 years before the earlier equipment was completely replaced (Grierson, 2003).

At about this time the color-add process began to be used in Florida. Although the formulations used have changed over the years, the process is essentially the same as it was when first introduced. A number of patents were issued in 1936, 1937 and 1938 and some of these are listed in Table 1. The basic equipment design from the early 1950s is the same as is in use today.

It is notable that in 1935 all Florida citrus research and experimental work was moved to Lake Alfred. By concentrating all citrus research in a single location, more cooperation among scientist was made possible.

During this period Florida decay control received a significant postharvest fungicide. Biphenyl impregnated tissue paper wraps were introduced in the late 1930s. More of a sporulation suppressant than a decay preventative, it added to the tissue wraps ability's to isolate decaying fruit from others in the carton, thus increasing marketability. Later developments lead to the use of biphenyl pads for use in cartons without wraps. This and increasing problems with disposal of used solutions seems to have brought the borax system to an end in Florida.

The Food Machinery Corporation in 1936 (Table 1) patented the use of another postharvest fungicide, Sodium Ortho-PhenylPhenate (SOPP). This was the first fungicide that gave significant control of stem-end rot. Stem-end rot had become a significant decay of Florida's fruit once the use of degreening had become common (Winston and Bowman, 1923). SOPP did not come into general use at this time because it caused severe phytotoxicity when not used within strict parameters (Hopkins and Loucks, 1950).

1941-1960. In the late 30s-early 40s the appearance of the fruit became more important as evidenced by developments in the field of waxing. Two prominent services companies introduced competing systems of waxing (Hall, 1981b). Brogdex's "Snow Wax" was an adaptation of the earlier bar wax wherein the wax mixture was sprayed as a molten fog into a

heated chamber over brushes, the wax would adhere to the cold fruit and then be polished by a series of brushes. At about the same time the Food Machinery Corporation introduced their Flavorseal solvent wax system. In this system the fruit were pre-polished by horsehair brushes until dry, then a petroleum solvent containing a resin was sprayed on the fruit in a special applicator (Table 1; Hall, 1981b).

Each of these systems existed side by side for a while. Packers using either system would often include a Logo on their label stating either "Flavorseal Protected" or "Brogdex Reduces Decay - Retards Shrinkage". In time the Snow wax system fell out of favor and the solvent wax (Principally Flavorseal) gained dominance in Florida. By the early 80s approximately 90% of Florida's Fresh citrus was shipped with solvent wax coatings.

In 1945 the construction of the Packinghouse Research Building at Lake Alfred brought packinghouse concerns to the fore as a legitimate area of research for university personnel. This now meant that the needs of packers would receive the attention of scientist interested in more than commercial gain. While up to this time the service companies had done much to improve packinghouse operation, their motives must be recognized as driven by self interest.

In 1948 a division of the Johnson's wax company introduced a wax based upon an emulsion of carnauba wax and containing SOPP. This could be considered the first successful water wax for Florida citrus. Since the supplier of this product acted more as a vendor than as a service company this product did not see widespread use. Some users of this wax placed the Johnson's wax "Certifresh" logo on their labels. This product had moderate success in Florida, being used, at least, up until 1976.

In 1950 the introduction of a safer way to use SOPP could be considered as the beginning of the modern era of citrus packing for Florida. By adding hexamine to the solution citrus could be safely treated to prevent postharvest decays without significant danger of phytotoxicity (Hopkins and Louck, 1950). This treatment came to be called the Dow-Hex treatment and involved immersing the fruit in a solution of 2% SOPP tetrahydrate (Dowicide A) and 1% hexamine for 2 to 3 minutes, followed by brushing.

The mid 1950s saw several developments. The first is illustrative of the persistence of old ideas in that kerosene stoves were still in use well up into the 1950s (Ellis, 2003; Grierson, 2003). In 1956 the USDA began the registration of pesticides. Their initial standard was that the pesticide be "safe and effective". One of the first pesticides, affecting Florida citrus, to be registered was biphenyl.

1961-1980. This period saw much activity affecting the packing of fresh citrus. Bagging of citrus has gained much popularity by this time and several companies have introduced machinery to assist in filling bags. At the same time paperboard cartons have replaced the wooden boxes and wirebound crates that had been the standard of the industry. With printed paperboard cartons era of the glued paper label came to an end.

In 1961 the Brogdex company introduced their version of "Skinner Gas" under the trade name Quick Color. This product was a mixture of methylene chloride and 1,1,1-trichlorethylene. Vaporized into a degreening room it was claimed that it suppressed decay during degreening. There were no other suppliers of similar products. Whether this was because of cost, lack of faith in the product or the existence of a patent (Table 1) is not known.

In 1962 the First Packinghouse Day was conducted at Lake Alfred. This became an annual event giving a forum where packinghouse personnel could interact with research scientist to learn the latest developments in packing. The next important development in communicating developments in citrus packing was in 1965. In that year publication of the Packinghouse Newsletter was begun (Grierson, 1965).

Fungicidal foam washing was introduced in the mid 60s (Harding and Savage, 1965). This allowed the treating of citrus with fungicide in much less time (30 to 45s) than the minimum of 2 min needed for the Dow-Hex treatment.

The problem of accurately sizing flattened or non-spherical fruit was addressed by several manufacturers. Punch belt sizers proved too slow and unforgiving and other simple gap type sizers were no better than the basic belt and roll sizer. These deficiencies were addressed by the diverging roll, "4-point" sizers (Table 1). In this system, a fruit was supported by a roll with grommets supporting the fruit at 4 places. As the rolls gradually spread apart, the fruit would drop through. While more accurate and gentler on the fruit, these were mechanically complicated and initially very expensive. Few of these were installed.

In 1969 decay control gained a great boost with the introduction of thiabendazole (TBZ). This fungicide was ideal for the Florida packer in that it is very effective against stem end rots, can be incorporated into the shipping wax and is relatively inexpensive to use. TBZ also made possible the practice of treating the fruit with a fungicide before degreening.

Pallet box drenchers came to Florida in the early 70s and initially gave good results. This method was used for of treating fruit before degreening. Some drawbacks with the system included the necessity of using chlorine in the drencher solution to prevent the spread of sour rot, constant agitation to keep the TBZ in suspension, and the lack of a simple way of maintaining the fungicide at a concentration desired. By the mid 80s these were out of use.

In 1972 a second fungicide, Sec-butylamine, was introduced for use in Florida. This product was soluble in water, which was a clear advantage over the insoluble TBZ. Unfortunately it was not nearly as effective as TBZ in controlling Penicillium molds or stem-end rot. It greatest advantage was in that its mode of action was different from TBZ and could be used when TBZ resistance developed (Hall and Bice, 1977).

In 1974 safety concerns resulted in the cancellation of "Skinner Gas" The next year saw the approval of the fungicide Benomyl. This fungicide was also a benzimidazole fungicide, which put it in the same class as TBZ. It quickly became the fungicide of choice for Florida packers because it was initially cheaper than TBZ, its activity when fresh was greater than TBZ, so could be used at a lower level, and its spectrum of activity was the same as TBZ.

1981-2000. In the late 70s and early 80s much attention was given to individual shrink wrapping of Florida citrus. Several trials were conducted and at least one packinghouse attempted commercial applications of the method (Albrigo et al., 1981). This system not only protected the fruit, it also contained the decay of fruit that did spoil, thus preventing soiling of other fruit in the carton. In this it did much the same job as did tissue wrapping. Unfortunately the equipment available at the time required much maintenance labor and proved to be too slow for regular commercial use.

During the mid-80s Florida packers began to treat fruit with fungicides while it remained in pallet boxes on the truck.

The first of these drenchers was located in Groveland at the B. G Harmon packinghouse. A single header, with nozzles, sprayed a benomyl suspension over the load as the driver slowly drove through. The suspension drained into a catch basin and was recirculated during the treatment. The truck was then unloaded into degreening rooms. This system did not prove entirely satisfactory as it was difficult to train drivers to drive slowly enough for thorough treatment and to wait long enough for adequate draining of excess suspension. Subsequently dedicated drenchers were built. In these, the truck was parked and the entire load drenched at the same time (Brown et al., 1988), Using timed control lights or gates, adequate time for draining is obtained. Several of these are currently in operation using either thiabendazole or imazalil.

In 1983 the fungicide imazalil was approved by the EPA. This new fungicide provided another option for Florida packers (Anonymous, 1980). Its solubility and compatibility with water waxes has made it a versatile addition to the postharvest decay control arsenal.

During the mid 80s increasing oil prices and concerns over air and water pollution accounted for the loss of two systems commonly used in preparing fresh citrus for market. Up until this time many packers used the so-called oil separators for eliminating light (freeze damaged) fruit. These worked by preparing an emulsion of odorless mineral spirits with a specific gravity designed to cause sound fruit, higher specific gravity, to sink while the lighter fruit would float to be skimmed off the top (Hall, 1981a). While water separators, using the principle of greater buoyancy of lower specific gravity, fruits had been introduced many years earlier (Wardowski and Grierson, 1971), these had not gained universal acceptance as they were considered too expensive for the occasional use they would receive.

By the mid-80s solvent wax was quickly disappearing from Florida packinghouses. Rising solvent prices, air pollution concerns, safety concerns, the inability to combine fungicides with the wax, and opposition to some ingredients by foreign markets all contributed to this decline. At the same time water based waxes had made great improvement in shine and application methods. Along with this, their compatibility with various fungicides made them more desirable.

In 1984 the discovery of citrus canker caused several changes in the operation of Florida's citrus packinghouses. State quarantine regulations forced packers to adopt methods of operation that ultimately were beneficial in some respects. Up to this time chlorine had rarely been used as part of packline sanitation due to its corrosive nature. Canker regulations mandated a sanitizer be used on the fruit and chlorine was the choice of most packers. Since an exposure time was also mandated, packers were forced to slow down their operations which resulted in gentler handling of the fruit. Many packers noted an immediate reduction in decay claims, thus confirming something that had been known since the beginning of the century, gentler handling and packinghouse sanitation results in less decay.

In 1987 sec-butylamine was canceled. The decision of the manufacture was not based upon safety concerns, but economic ones. Faced with expensive data generation costs for re-registration, the fact that their largest potential market, Florida, did not use the fungicide to any extent meant that they had little prospect of recovering their costs. The main reasons that sec-butylamine did not have much use in Florida was its cost, its lower efficiency and its use, which consisted primarily to combat benzimidazole resistant fungicides. While resistance to postharvest fungicides has been nearly disastrous for the California citrus industry, it has not been a factor in Florida.

About this same time the value of drenching was once again recognized. The double handling involved with the old pallet box drenchers was a major factor in the fact that few were adopted. When the B. G. Harmon Fruit Company successfully drenched fruit with benomyl while still on the truck, interest was rekindled in the concept. Soon a drencher was designed to treat a whole load while still on the truck (Brown et al., 1988). After this several other drenchers have been built. Since a single drencher is capable of treating 6 to 10 loads an hour, the owners of some of these also treat fruit for other packers for a fee.

In 1991 benomyl was canceled for postharvest use on citrus. Its loss has not proved significant for the Florida citrus industry because TBZ has the same spectrum of activity against postharvest diseases yet is stable in water, wax and in the presence of chlorine, which was always a concern with benomyl (Hall, 1980).

In 1992 the use of fungistat biphenyl was cancelled. Once again safety was not a concern but economic factors were. Faced with $7 to $15 millions estimated cost to satisfy the EPA's new data requirements, the prospect of cost recovery was minimal. The last supplier ceased operations in that year.

Pallet bins had been in use in Florida since the early 60s and by the 1980s had totally replaced the old picking boxes in commercial packinghouses. Up the mid 80s the majority of these were made of wood. The increased use of chlorine proved to be detrimental to the wood and metal fittings of these bins. The introduction of a practical plastic pallet bin has begun to change the industry. So far these have proved to be gentler on the fruit and easier to clean. They are also resistant to the sanitizing chemicals used today.

In 1995 two new types of postharvest fungicides were introduced to Florida. Sold under the names Biosave and Aspire they are based on a bacteria and yeast respectively. Up to now they have not proved to be commercially effective but this first generation postharvest fungicides are in their early days.

A major new process to come to Florida in the 90s is the use of high-pressure washing to clean the fruit (Petracek et al., 1998). This system has proved to be an efficient method of removing sooty mold from the fruit without the need for special cleaning compounds.

Other developments at the end of the twentieth century were aimed at improving the handling of fresh citrus with a minimum of injury. Some of these gentler methods of handling include the use of flexible belts to turn corners rather than using drops or shears. Dumping of fruit was made gentler with the introduction of the bin tipper, which slowly feeds the fruit without letting it fall. A final development introduced has been weight volume sizing, using cameras to measure the true volume of the fruit and sensors to determine the weight to a fraction of a gram, these sizers use a computer to calculate not only the size but also the specific gravity. In this latter function the sizer may also act as a freeze damaged fruit separator.

The future. As to the future of Florida's fresh citrus industry one can only speculate. However, some developments promise to have a great impact on the future of citrus packing. Judging from the past it is safe to say that some will take hold rapidly while others may be slow to be adopted and may never gain universal acceptance.

We are certain to see greater emphasis on packinghouse sanitation. Many chain store buyers are pressing their suppliers to use outside auditors to ensure safety from human pathogens. This greater emphasis on sanitation is sure to impact the packinghouse operation.

Grading of fruit is sure to see great improvement in the future. Photoelectric graders are already in use as a pre-grading system. With improved recognition systems and computer operations it may well be possible to do the majority of fruit elimination automatically.

Another area that is beginning to receive attention is in the area of energy efficiency. With climbing energy costs, packers can ill afford to continue using older inefficient equipment. Tests being conducted in California are attempting to recover the energy, in the form of heat, from the packinghouse cold room heat exchangers (Sorenson, 2002). A packinghouse's survival may well be dependent upon its getting the maximum benefit from all energy purchased.

Up to now the biological postharvest fungicides have had minimal success. Since researchers continue to work on this concept, it is reasonable to assume that future developments will be more successful.

Another development that holds promise for the fresh fruit industry is inline sensing of the brix value of citrus fruit (Miller and Zude, 2002). This sugar sensing could well cause the development of a different method of marketing fruit whereby the packer could guarantee a minimum sugar content or sweetness.

Of particular interest to Florida citrus packers are ways of extending the season for their fruit. At this time the period from June through August is one of relative inactivity for fresh fruit packers. Development of new varieties has provided an earlier start to the season as compared to the beginning of the twentieth century. Some packers have stored fruit in order to extend their shipping season by approximately one month, but the volume of fruit involved is small and there are special problems with these. A method of extending Florida's fresh fruit availability to year round is desirable, but new problems such as the fungicide resistant mold problems experienced in California could accompany it.

Innovations in packaging are also being investigated as a method of marketing more fruit. Bagged citrus has long been available in 5 and 8 lb bags but, 3 lb bags are being found acceptable to consumers. One packer is experimenting with packing two grapefruit in a single bag for customer convenience. The elimination of the standard paperboard carton may also be in the near future. Many shippers are providing bagged fruit in a pallet sized paperboard container, preprinted with display advertising for use at the point of sale. With potential advances in machinery a return to individual film wrapping is also feasible.

Improved methods increasing the eye-appeal of fresh citrus fruit is always desirable. In the beginning of the twentieth century this has been a goal of packers. Washing, waxing, and packaging methods have all been part of that aim. The customer buys with their eyes. Competition among the service companies has caused many improvements in these areas and this is likely to continue.

One aspect of fresh citrus packing in Florida that is sure to seen an increase in the near future is the packing of organic fruit. Under the National Organic Program (NOP) of the US Department of Agriculture, standards have been set that define what constitutes organic produce. This once small segment of the industry is growing rapidly as consumer concerns about the safety and wholesomeness of food grows. During the 1990s organic food sales in the United States grew at the rate of 24% annually reaching $7.8 billion by 2000 and are projected to reach $20 billion by 2005 (Anonymous, 2002).

As to other developments, one can only guess and my crystal ball is out for repairs and they are having difficulty getting parts.

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