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REEVALUATION OF HEATER PROTECTION FOR CITRUS PLANTINGS

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Abstract. **The decade of the 1980s was one of the most devastating in citrus losses because of freezes in 1981, 1982, 1983, 1985, and 1989. Abandonment of grove heaters in the late 1970s, largely because of unacceptable cost increases and air pollution regulations is challenging the economic framework of citrus management. The specter of large citrus trees killed to the ground, the mass abandonment of frozen groves once highly productive, and the general reluctance to reinvest in new plantings after repeated freeze kill vividly illustrate the large void brought about by the nonavailability of systems to protect highly valued, producing trees during critical winter periods. Past and present successes in heater protection, introduction of new citrus cultivars and greater competition in world markets suggest that a partial return to grove heating may be a viable option in some instances regardless of stringent DER and EPA regulations and unstable petroleum prices.**

During the past decade, five freezes have largely brought the Florida citrus industry to an uncertain stage of transition. Estimated Frozen Can Orange Juice production losses of 42% for the 1989 freeze alone and at least six counties declared freeze disaster areas (9, 11) reflected economic hardships in the loss of livelihoods and a growing passiveness to regain world leadership in citrus production lost to Brazil. Growers in Citrus, Hernando, Lake, Marion, Orange, Pasco, Polk, Seminole, Sumter, and Volusia counties are making decisions which for the moment they wish they could avoid. Once unthinkable, growers now express sentiments that growing citrus is no longer a viable economic option in counties such as Orange, and that it probably is better to pursue other land uses in view of repeated freeze kills coinciding with accelerating urban growth (6). There are already economic comparisons where "pros" and "cons" are being weighed for growing citrus in the southern vs. northern counties of Florida (10, 23). Evidence is rather overwhelming that growers are faced with extremely complex long-term vs. short investment/management decisions that involve climatic, economic, and political concerns. Decisions, being made every day and for the next 10 years because of the freeze impact, will largely position the industry and set its course into the 21st Century. Whether the path will be one of an aggressive competitor or a passive player in world citrus markets is a troubling challenge to the individual grower. For it is the grower who is the keystone of the Florida citrus industry spectrum that ranges from research to economic vitality.

Grower Concerns

This is not the first time, nor the last time, that Florida citrus growers will be making crucial decisions for world leadership in citrus production. The frequency and severity of freezes in the 1980s were totally unexpected. Predictability was increasingly more difficult because of unusual atmospheric conditions, probability tables were misleading, and freeze protection resources were not adequate at the local, state, nor federal level. Much of the "safety net" disappeared in the late 1970s when the general consensus of the industry was to abandon grove heating because of unacceptable cost increases and unreliable availability of petroleum fuels. This made producing groves in freeze-prone areas extremely vulnerable to freeze damage with only site location, trunk protection measures, and existing scion/

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rootstock selections providing some measure of survival. The 1977 freeze helped to lull the industry into a state of complacency on the expectation that another severe freeze would not occur until the mid-1980's. Freezes in 1981, 1982, and 1983 essentially opened the door for Brazil to take the world leadership in citrus production. Extensive freeze damage in the industry, plus that to come in 1985, was essentially set aside by the highly emotional find of citrus canker in the state (18). Eradication programs that rapidly drained local, state, and federal money reserves sharply divided involved interests as well as the scientific community.

The industry was in poor condition to cope with yet another freeze in 1989. Economic hardships were widespread; recommended cultural practices (19) were not especially evident in any cold protection programs; research expectations in developing cold-hardy types (4) were not yet realized; frost protection chemical sprays and foams (28) were still suspect; and efforts to protect the canopy and fruit of producing trees were minimal, even at the research level, because of decreased support. Even the find of bacteria that could cause early freezing in citrus trees (20, 28) was of no help, and scientific evidence continued to mount that natural cold hardening of citrus trees was largely a function of a thermal window which as yet no applied substance has been able to mimic under natural conditions. In brief, the grower was depending on favorable cold-hardening temperatures where days would not exceed 70°F and nights were as low as 35°F, and that such conditions would prevail for approximately 4 weeks immediately before a damaging freeze (28). The other gamble was that a damaging freeze would not occur. The odds for this were favorable since four serious freezes had already occurred in the 1980's.

Fortunately, efforts did not stop on protecting young trees when grove heating was abandoned. Insuring survival of the tree by protecting the budunion was largely the only widespread freeze protection evident throughout the industry. Singly, and in combination, a variety of insulator wraps and microsprinkler irrigation technology have proven invaluable during the 1980's (7, 24, 25). These choices, plus soil banks, have essentially solved the problem of young tree freeze survival within reasonable economic limits. However, the problem of limited water resources, electrical failures, and possible water-user fees help to confound the extension of existing technology to large-tree protection via sprinkler irrigation methods. Possible other alternatives for the grower are few. One option is to abandon citrus and seek an alternative crop (9) or some nonagricultural use for the land. Another option is to replant with cold protection in mind using every cultural benefit known to avoid freeze damage. A third option is a partial return to grove heating practices in combination with carefully selected cultivars to complement site characteristics and available protection resources.

Past Grove Heating Systems

The successes and failures of grove heating systems are well documented in the science and technology of freeze protection of citrus trees (13, 26). Records of published and unpublished test results in Florida since 1964 are on file at the Fruit Crops Department, University of Florida, and the USDA/ARS Horticultural Laboratory, Orlando. Of all the systems/heaters used in the past, the return stack and "Spot" heaters are still occasionally seen in citrus plantings. Both are petroleum-fuel survivors of the movement away from grove heaters in Florida citrus freeze protection. Their use is most evident in research and budwood source plantings and, on a smaller scale, in highly valued citrus types that command top market price in fresh fruit. These heaters are examples of a "safety-net" for perpetuating budwood for the industry and providing some insurance of business survival during severe freezes. Both return stack and "Spot" heaters, along with others, are listed with the Florida Department of Pollution Control and received approval numbers in 1971 and 1972. Their availability and approval status need to be updated.

It was shortly after the 1962 freeze in Florida that petroleum companies catalyzed a flurry of activity in developing grove heaters. Some of the different types, excluding return stack and spot heaters, that were being promoted and investigated during the 1960's included:

A. Grove candles (Fig. 1) — solid paraffin, generally cylindrical in shape, approximately 10 inches high and 8 inches in diameter, fiberglass wick, and a metal bottom. Candles were difficult to light during windy conditions, needed to be kept dry and required pickup of metal bottom after freeze. Evaluation was unfavorable.

B. Tralite[R] (Fig. 2) — solid petroleum wax in galvanized steel pans 12 inches wide, 17 inches long and 3 inches high with a central wick of rock wool. There were problems with loose lids and misshapen pans, lighting was difficult in the wind, level placement was needed to prevent spillage and provide uniform burning, pans were not reusable, and smoke was excessive. Evaluation was unfavorable.

Fig. 1. Burning grove candle and melted paraffin under a citrus tree.

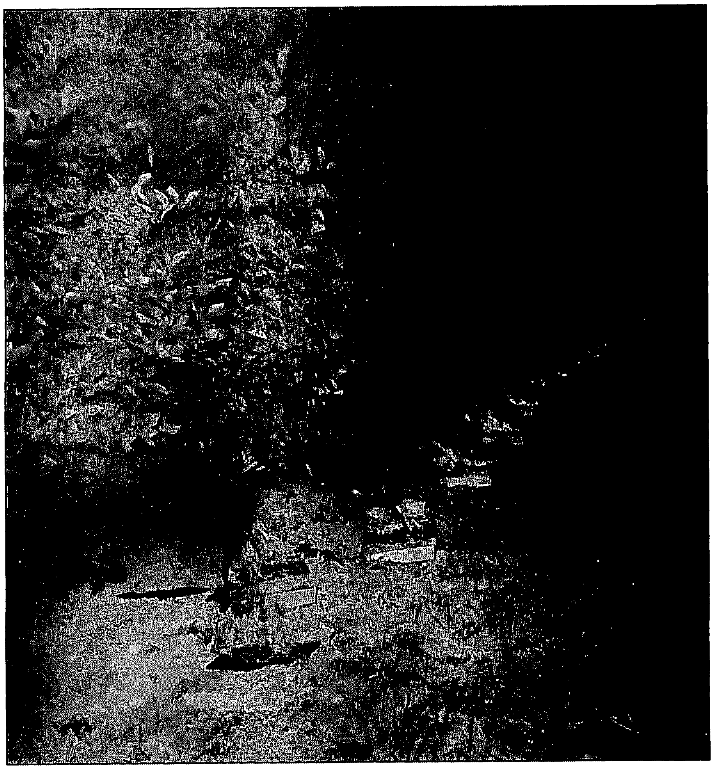

Fig. 2. Burning Tralite^{R} heaters in a citrus planting.

C. "Flambeau" — diesel oil in 19-inch-square and 6-inch-deep truncated metal pans. These had serious problems in pan sturdiness, uncontrolled and excessive flame height, and numerous safety hazards. No favorable features were found.

D. Tree Heet^{R} (Fig. 3) — mixture of petroleum coke pressed into 2-lb bricks shipped in pairs that were wrapped with paper and sealed in polyethylene bags. These were found to be inadequate to protect tree canopies and more suited for budunion protection. Both radiant and convective heat were emitted.

E. Bornstein^{R} (Fig. 4) — chopped pieces of auto tires that were burned under a 24-gauge galvanized steel truncated cone with 3/4-inch circular perforations. Excessive flame height, smoke and fumes posed serious safety hazards that resulted in an unfavorable rating. These same hazards now exist in years of stockpiling automobile tires throughout the state.

F. Environ-Trol^{R} (Fig. 5) — propane gas, convective heat-type metal burner housing unit with individual control valves and underground supply lines connected to 1,000-gallon tanks. Installation costs were high, but burning was clean and system was easy to operate. Other types, such as Frost-Guard^{R}, had more radiant heat because of disk-shaped burner heads.

Many of these heaters, plus others, commanded special attention by the editor of the "American Fruit Grower" magazine in 1967, who published performance characteristics and operation costs (1). Studies in Florida contributed to additional knowledge (27, 29), and some of the more comprehensive economic analyses of grove heating were done for apple growers in the state of Washington (3) and for citrus in California (2) and Texas (26). However, in 1973, there was sufficient cause to suspect that grove heaters were rapidly losing favor in freeze protection because of accelerating costs and decreased availability of petroleum fuels, increased vulnerability to urban litigation, and more stringent pollution control regulations. Florida started to ban and regulate certain heater types in the early 1970's (5) and, today, one must receive approval from the Florida Department of Pollution Control before any outside burning is used to protect agricultural crops. Various environmental protection agencies are concerned not only about the amount of particulate matter exhausted into the atmosphere, but also about fuel spills that may contaminate the state's aquifer, existing water channels and reservoirs. Small spills are virtually unavoidable in the refueling and moving of oil heaters (Fig. 6). However, advances in automation and more durable and flexible supply lines are

Fig. 3. Burning Tree Heet^{R} bricks and Tralite heaters under a citrus tree.

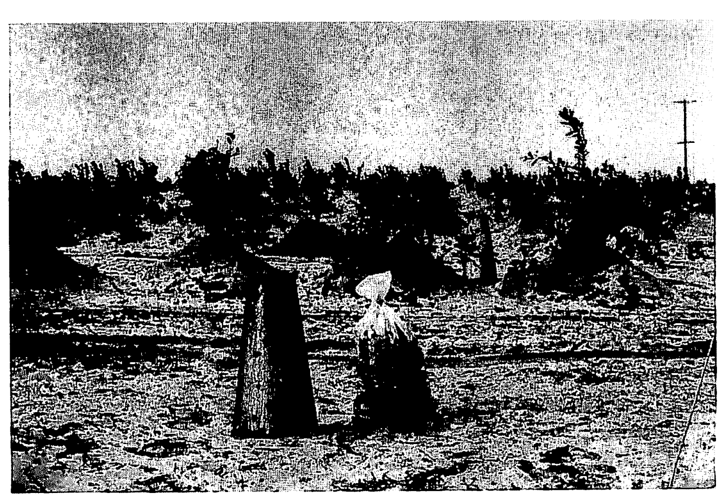

Fig. 4. Bornstein^{R} heater with truncated perforated steel cone and chopped pieces of automobile tires in plastic bags for fuel.

Fig. 5. Burning propane gas Environ-Trol[R] heater with Tree Heet bricks under a citrus tree.

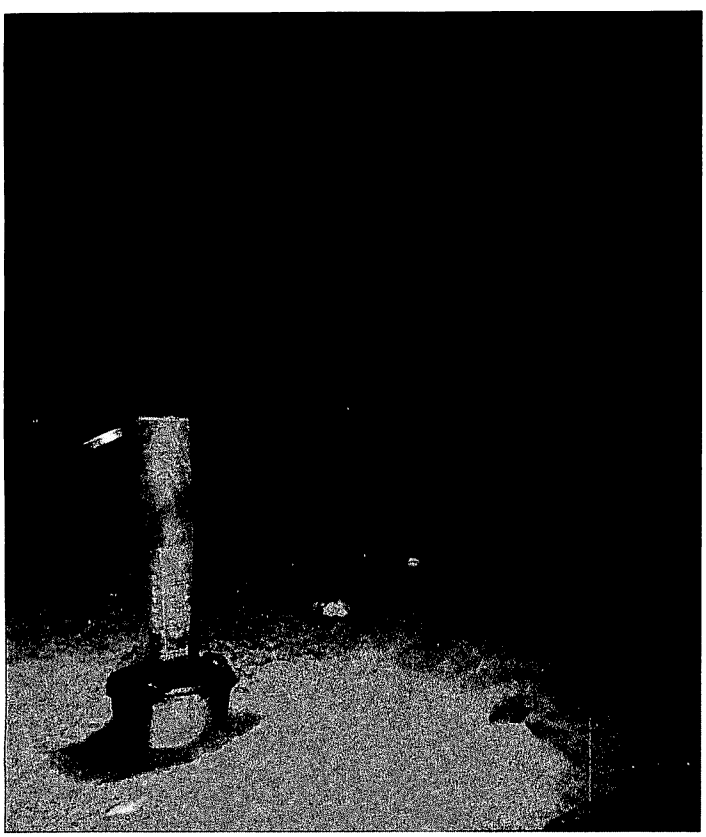

Fig. 6. Burning return stack heaters with oil spill on ground during filling operations in a citrus planting

helping to minimize the problem. Large spills, such as leaking storage tanks, pose the greatest concern to state agencies and required containment basins are costly.

Why Reevaluate the Use of Grove Heaters?

The grower needs choices. It is apparent that the way of doing business is changing rapidly and decisions are essentially customized to individual situations, interests, and concerns. Blanket acceptance of singular or fashionable approaches are no longer tenable in today's stewardship of individual and national welfare. The grower needs to be aware of all alternatives for his consideration and implementation. There is reason to believe that growing citrus in Florida is reaching a new stage of entrepreneurship, and regardless of challenges in overcoming economic pressures, once highly productive groves turned into idle nonproducing acreage is an unacceptable condition. Selling out to urban development, planting alternative crops, placing areas in permanent water recharge areas, or continued speculation on nonfreeze years are adventurous decisions even for the hardiest of citrus growers.

Is there money in cold protection? An outstanding authority on cold protection for citrus thought so in 1968 (12). The answer today may not be so clear. However, isolated experiences suggest that there are opportunities for big returns based on circumstantial evidence at the USDA A. H. Whitmore Citrus Research Foundation Farm near Leesburg. It was here that diesel fuel heaters were used to protect the highly rated new release, 'Ambersweet,' (14) during the 1989 freeze. Two nights of 18°F minimum temperatures, winds up to 20 mph, freezing rain, and 28 hours of temperatures 26°F and lower, did little damage beyond scattered leaf kill at the top of 20-feet-tall trees. It is unclear how much of this outstanding survival during all of the 1980 freezes is attributed to heaters and how much to the natural cold hardiness of 'Ambersweet.' Regardless, the success of this heating approach kept growers supplied with budwood during critical times and exemplifies possible monetary gains in having near-normal fruit yields and undamaged trees immediately after a severe freeze. It is difficult to foresee how duplication of such successes can be achieved with other means. Cold protection programs are always changing (22), and there is hope for breakthroughs. However, there are no signs on the horizon that superior cold-hardy types capable of replacing present commercial types are forthcoming in the near future ('Ambersweet' may be an exception). Development of cold protection sprays is no longer a significant effort at research levels. Tree covers and water applications are limited to young and nonproducing trees (8, 25). Heated irrigation is being tested (21). Growing citrus under cover is not yet an economic reality in Florida. Electrostatic heating has not progressed beyond research observations (16), and cultural practices alone will not do the job.

Although it is the perception of the growers that cold protection is their most serious problem (17), it is apparent that they can expect little assistance from local, state, and federal levels because of strong competitive forces for limited funds. Priorities are confounded with parochial interests, and sense of self is difficult to overcome in public stewardship positions. More often than not, the rationale is to focus on long-range solutions which may come too late for the industry to be a formidable competitor in world citrus markets. Grove heaters may or may not be a viable option in some instances to meet immediate needs in cold protection. However, in the sentiments of some citrus extension agents, heaters merit reconsideration if for no other reason than their ability to warm the ambient air (Fig. 7) (29), and the large void that exists today in systems to protect highly valued, producing groves.

There are some sentiments that suggest growers abandoned heaters partly because they were convinced that it was not economical to try to protect the fruit crop. This may have been correct under then existing economic conditions. However, growers generally did not expect freezes that would destroy mature, bearing trees if they were not heated. Now that mature groves have been destroyed, the grower may well reevaluate the value of heating to protect his investment in the trees as well as the fruit.

Combining heaters with successes in microsprinkler irrigation, freeze protection is one possibility being discussed among growers/extension people/researchers to extend freeze protection to large fruit-bearing trees. Successful freeze protection by Nick Faryna of Umatilla, who elevated microsprinklers to a height of 2 feet and next to the trunk of 2- to-3-year-old mandarin and orange trees (15), vividly demonstrates the ability of growers to adapt available technology to avoid and profit by severe freezes. Cautionary rules discussed by Faryna are well taken in addressing accountability with actions taken. Similar rules would apply with supplementary heater protection. Hypothetically, heater protection would be concentrated on large, canopied, high-valued trees that have early-maturing fruit, some degree of cold resistance, and growing in small manageable areas where high net inputs are offset by high returns on fruit sales.

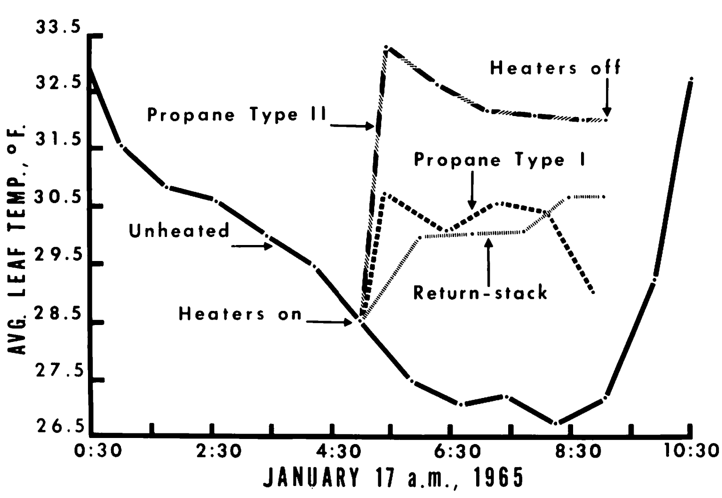

Fig. 7. Warming of citrus leaves with heat from different types of heaters in a citrus planting during a freeze night.

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