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LONG-TERM PATTERNS OF WATER UPTAKE IN SYRINGE INJECTION AND WOOD ZINC LEVELS OF BLIGHT-AFFECTED ORANGE TREES

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Abstract. **Ten blight-affected 'Hamlin' orange, *Citrus sinensis* (L.) Osbeck, trees on rough lemon, *C. limon* Burm. f., in a grove near Holopaw, Florida, were tested for water uptake into the trunk by injection with a syringe every 30 days for 3 yr when the trees, were 16 to 18 yr old. Wood zinc was determined 9 times over a 12-yr period. Five healthy trees in the same part of the grove were tested by water injection for 4 yr, and 5 healthy trees in an older, 45-yr-old part of the grove with different soil conditions were also tested for 2 yr. The 3-yr mean of the water uptake of the 10 blighted trees fluctuated slightly from month to month with a peak in uptake in the summer during the rainy season. The water uptake of individual trees fluctuated widely from test date to test date, from near 30 ml/min to less than 1 ml/min. the water uptake of healthy trees also varied, with uptake as low as that of blighted trees (1 ml/min) in some months to more than 50 ml/min in others. The concentration of Zn in the wood remained in the 14-20 ppm range in blighted trees, and between 2-3 ppm in healthy trees. Ten 35-yr-old 'Valencia', *C. sinensis* trees on rough lemon rootstock near Arcadia, Florida, tested 9 times during 1985-88, showed similar variation in water uptake.**

The most important advance in work on citrus blight has been diagnostic tests which permit distinguishing trees affected by blight from trees declining from other causes. The lack of reliable, distinctive visual symptoms make identification of blighted trees highly uncertain. Cohen's discovery in 1974 that it was nearly impossible to inject liquids into the trunks of blighted trees by gravity injection led to the development of the water injection test (2). The injection of water from suspended bottles for 24 hr (2) was modified into injection of water with a syringe (3), which greatly reduced the time needed for the test and made it possible to examine greater numbers of trees. Smith (4), also in 1974, showed that zinc accumulated in the outer layers of the trunk wood of trees with blight (4) and this became the foundation of wood analysis for zinc as a diagnostic test (5). Combining the 2 tests sharply increases the accuracy of blight diagnosis. The question of whether the results of the tests remain constant over long periods of time has never been answered. Data from long-term monitoring programs based on repeated testing of the same trees are the subject of this report.

Materials and Methods

Data were collected in a 'Hamlin' on rough lemon grove, planted 7.5 × 7.5 m, near Holopaw in east central Florida. Two-thirds of the block, almost blight-free, was planted in 1944 on undisturbed soil; one-third, which now has a high incidence of blight, was planted on filled-in, heavily limed soil in 1970. Soil and plant analyses and other details were reported in 2 recent papers (7,8).

Ten blighted trees in the filled-in, heavily limed area were injected with water approximately every 30 days from April 1985 to June 1989 with a slight modification of the method described by Lee et al. (3). A 3-ml syringe containing 2.5 ml water was used, with application of pressure for 30 seconds. When there was a sharp difference in water uptake compared to the preceding month, the injection was repeated to rule out procedural errors. The results are reported in ml/min. Five healthy trees in the filled-in area and 5 healthy trees in the 45-yr-old part of the grove were monitored similarly between May 1986 and May 1989.

Wood samples from the same 10 blighted trees were first taken in March 1977, when only 2 of the trees showed signs of blight and the rest were still healthy (6), and again in June and Sep. 1985, June 1986, Feb. and May 1987, Jan. 1988, and in Mar. 1989 . Between 1986 and 1989, the wood of the healthy trees in the old part of the grove was sampled 3 times, and wood of those in the new part, 4 times at irregular intervals. Collection and analysis procedures were described earlier (5,6). The rainfall data used are from the NOAA reporting station in Kissimmee, 25 km from the grove site.

A similar monitoring program was carried out in a 35-yr-old 'Valencia' orange on rough lemon planting in Arcadia in southwest Florida. Ten blighted trees were tested for water uptake in Apr. and Aug. 1985, in June, July, and Aug. 1986, in Aug. 1987, and in June and Oct. 1988. The wood was sampled in Apr. 1985, in June 1986, Apr. 1987, and June 1988. Two to 4 healthy trees were also included.

Results and Discussion

The 3-yr mean water uptake in syringe injections of 10 blighted trees on filled-in land in Holopaw varied from month to month, with a small peak in the spring and a larger peak in Aug. (Fig. 1). Rainfall peaks coincide with

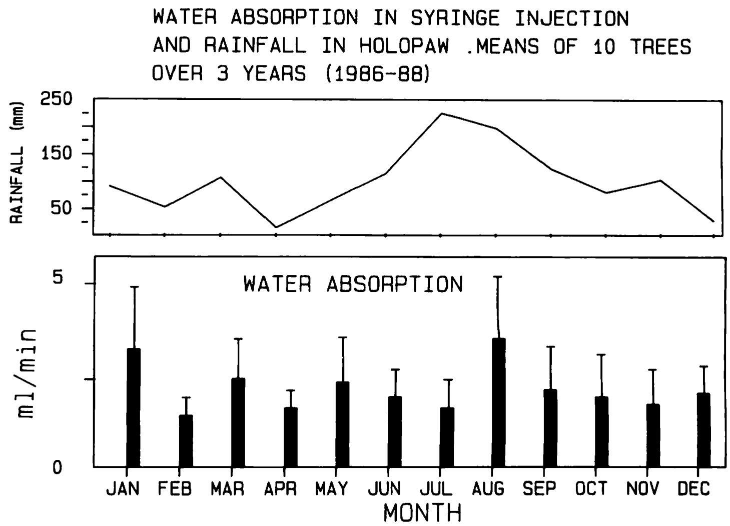

Fig. 1. Three-yr means of water uptake in syringe injection of 10 blight-affected, 16- to 18-yr-old 'Hamlin' on rough lemon trees on filled-in, limed land in Holopaw. The trees were tested every 30 days. Lines on top of the bars show standard error of the mean.

improved water uptake, an effect that has been observed in various places (unpublished information). Water absorption of the younger, healthy trees on filled-in land was lower than that of the older trees on undisturbed land, indicating that the younger trees on filled-in land were no longer truly healthy, with a tendency toward lower water uptake in the fall (Fig. 2). The wood zinc level in the blight-affected trees varied relatively little between 1984 and 1989 (16-19 ppm). At the first sampling in 1977, 8 of the 10 trees had low, normal wood Zn levels (2-3 ppm); of the 2 trees high in Zn, 1 showed visual symptoms in 1977 (19 ppm Zn), the other in 1979 (10 ppm Zn). The wood Zn level in healthy trees was about the same on both soil types (Fig. 3).

The relatively small variations from month to month in mean water absorption mask large variations in water absorption of individual trees in both healthy and blighted trees on filled-in land (Fig. 4). In the old, healthy part of the grove, the water uptake changed little with time and remained uniformly high. Healthy trees in the new, blight-affected part of the grove often changed their water uptake from near normal levels to minimal uptake during the 30-day intervals. The changes seemed to occur at random, not in unison in all trees, tested which seems to rule out a weather-related cause. On many occasions, the healthy trees on filled-in land took up no more water than the blighted trees, as low as 1 ml/min. Sharply reduced water uptake in whole groves of apparently healthy trees, at least

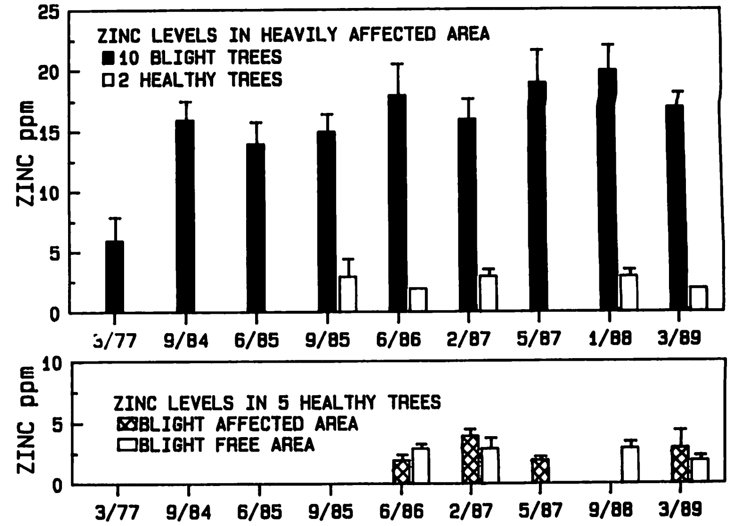

Fig. 3. Wood zinc levels of 10 blighted and 2 healthy trees on filled-in land and 5 healthy trees on filled-in and undisturbed land. Lines on top of the bars show standard error of the mean.

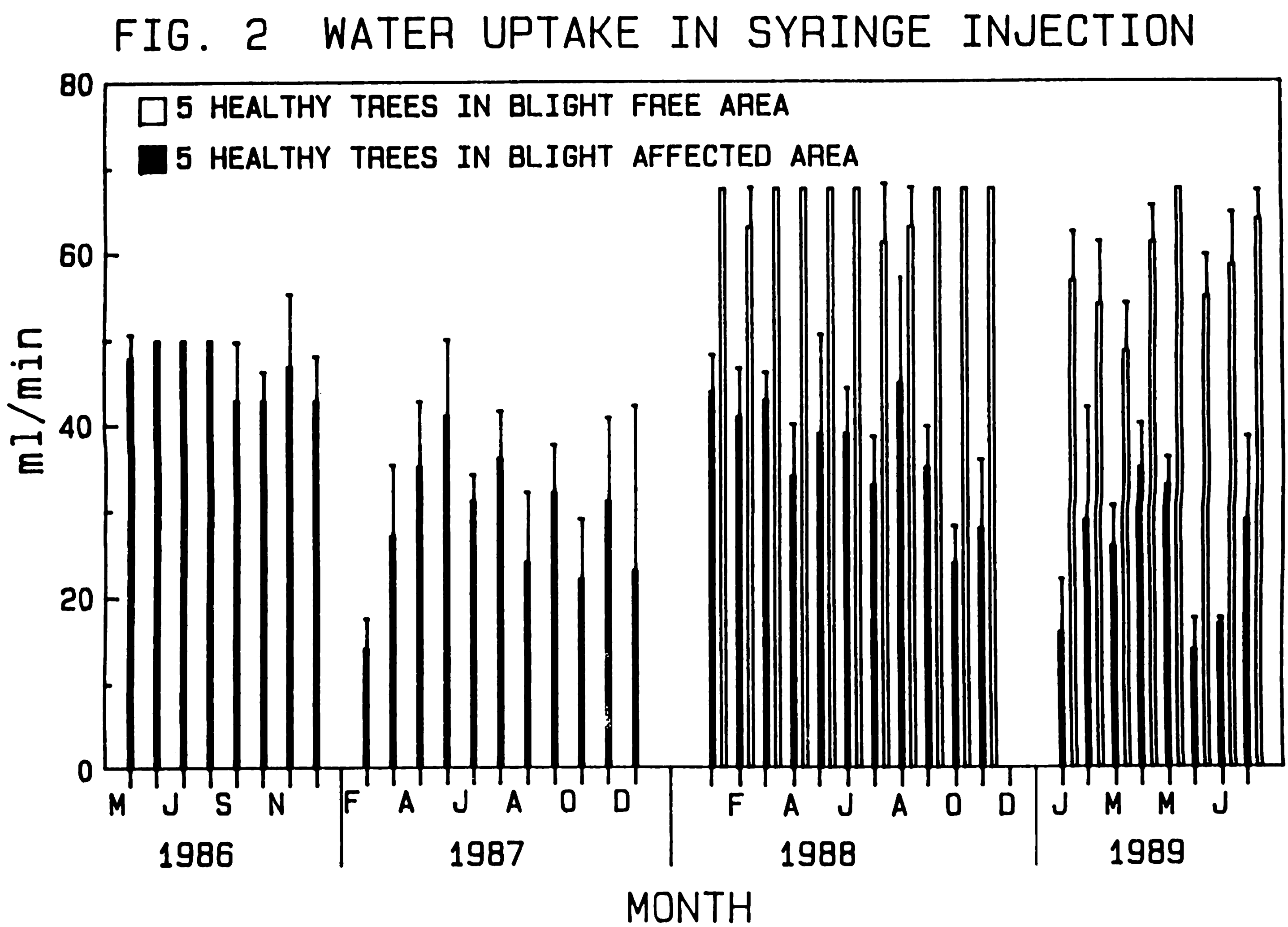

Fig. 2. Means of water uptake in syringe injections of 5 healthy, 19-yr-old trees on filled-in land over 4 yr and of 5 healthy, 45-yr-old trees on undisturbed land. Lines on top of the bar show standard error of the mean.

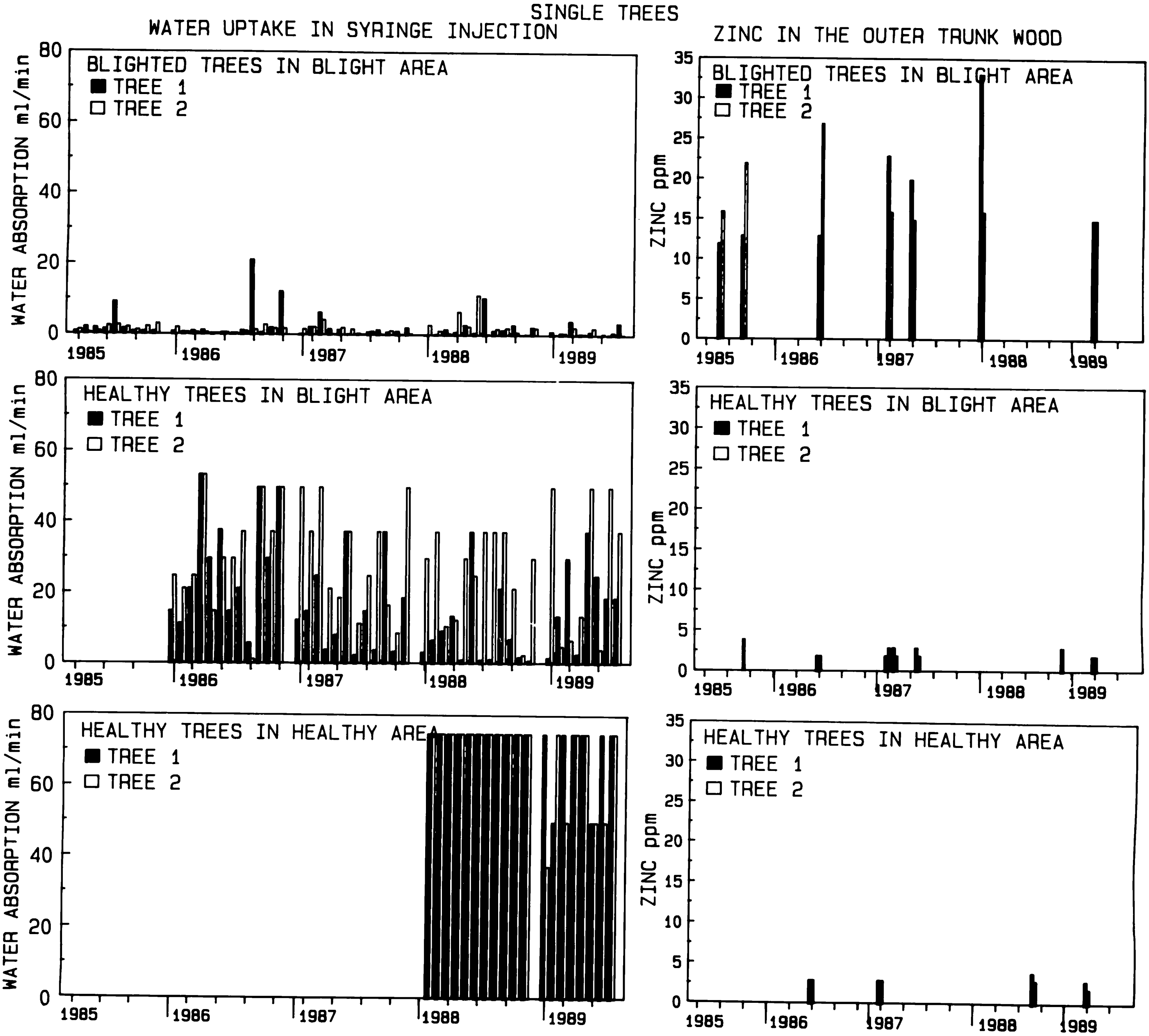

Fig. 4. Water uptake in syringe injection and wood zinc levels of 2 individual trees each, blighted and healthy, on filled-in land (19 yr old) and healthy on undisturbed land (45 yr old).

temporarily, can be found frequently (unpublished information).

The variable water uptake was also found at the second site in Arcadia (Fig. 5), in a uniform grove of trees with 'Valencia' instead of 'Hamlin' scions. The lower water uptake of healthy trees on filled-in land in Holopaw, younger than those in the older part but of the same scion and rootstock combination, and receiving identical grove care, indicates an influence of the soil. Drastic changes in uptake in 30-day intervals are difficult to reconcile with an effect of vessel plugging on water uptake in trunk injections (1), because vessel obstructions could not change fast enough to explain the rapid changes in water uptake.

That blight does not always lead to rapid decline is shown by one of the trees in the 10-tree group in Holopaw (Tree 1 in Fig. 4). It had visual blight symptoms and high wood Zn in 1977, but its present condition is no worse than 12 yr ago. Wood Zn was 19 ppm in 1977, 15 ppm in 1989. Water absorption in March 1989 was 4.2 ml/min. The tree with high wood Zn in 1977 (10 ppm) and visual symptoms in 1979 (Tree 2 in Fig. 4) is also still alive, but has declined more than the other tree (wood Zn 15 ppm, water uptake 2.4 ml/min in March 1989).

The data show that in blight-affected areas water uptake in injection tests is highly variable in both blighted and healthy trees and that healthy trees can have periods of low water absorption and revert to normal again (~ 50 ml/min). Wood Zn, on the other hand, is relatively stable. Water uptake seems to be affected before zinc accumulation occurs. A single water injection may give an erroneous

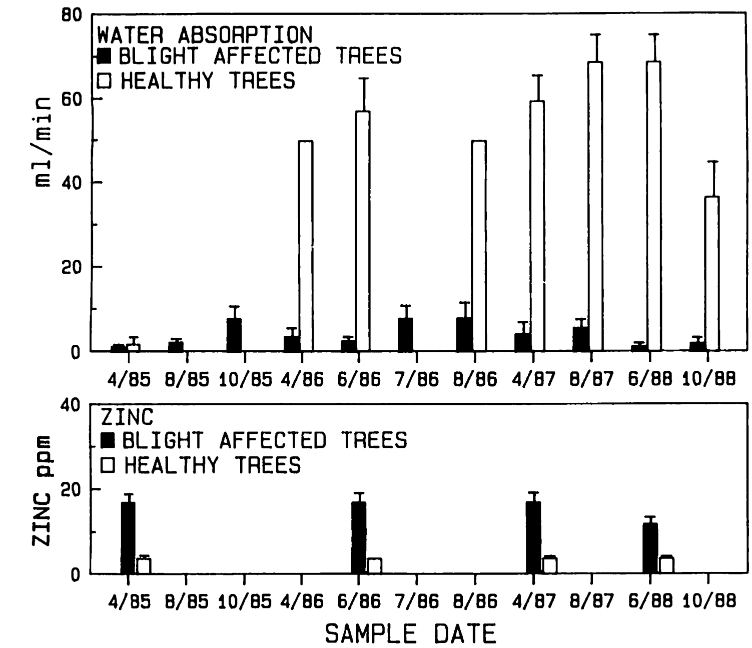

Fig. 5. Water uptake in syringe injection and wood zinc levels of 'Valencia' on rough lemon trees in Arcadia. Lines on top of the bars show standard error of the mean.

diagnosis of tree status when there are no visible symptoms and when the water injection test is not backed up with a zinc test. The cause for variation in water uptake is not clear and probably will not be found until the cause of blight is known.

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ECONOMIC COMPARISON OF SOUTHERN AND NORTHERN CITRUS PRODUCTION IN FLORIDA

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Abstract. **After the December 1983 and January 1985 freezes, Florida's Citrus Industry was in a state of transition with respect to planting decisions. Central to production decisions was the relative efficiency of Florida versus other supply sources. In addition, the freezes prompted Florida growers to question the relative advantages of production in northern and southern locations. The long-run aspect of investment in citrus for the competing regions in the state was addressed in a 1985 FSHS paper. This paper discusses the relative costs of production, provides detailed budgets, and re-evaluates some of the important risk factors associated with production in the two areas. New data has allowed for improved analysis of grower investment decisions among production areas.**

Beginning with the four tree-killing freezes of the early-to-mid 1980's, the Florida Citrus Industry has experienced a wide variety of changes in the past decade. With change comes uncertainty, and uncertainty impacts directly on the decision-making environment confronted by citrus growers and others considering investing in citrus.

Examples of change include the rapidly-expanding citrus plantings in South Florida on the flatwood soils of the lower east coast and Southwest areas of Florida in conjunction with the replanting of frozen groves in North Florida, also known as the "Interior" production area. The industry has also witnessed changes in cultural practices which have had unprecedented impacts on grove productivity in the past five years. These changes include denser tree-spacing, topping and hedging, microsprinkler and drip irrigation and fertigation, cold protection and new varieties and rootstocks.

Changes occurring beyond the grove also impact citrus investment decisions. Consumer issues are becoming more

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