Proc. Fla. State Hort. Soc. 111:163-165. 1998.

12-YEAR COMPARISON OF ORANGE LEAF NUTRIENT LEVELS IN THREE ADJACENT BLOCKS VARYING IN CITRUS BLIGHT INCIDENCE

HEINZ K. WUTSCHER[1]
U.S. Horticultural Research Laboratory
2120 Camden Road
Orlando, FL 32803

Additional index words. Yearly leaf analysis, tree decline, differences in leaf concentration of Ca, S, Zn, and Mn.

Abstract. **Of three adjacent blocks of orange trees (*Citrus sinensis* L. Osbeck) on rough lemon rootstock (*C. limon* S. Burm. f.), one was essentially citrus blight-free, and two were strongly affected. The three blocks were fertilized equally and irrigated from the same water source. The blight-free Grove 1 was planted on undisturbed soil, and Groves 2 and 3 were planted on filled-in land; Grove 2 was heavily limed in 1970 before planting. Annual analysis of leaves collected from healthy trees in July from 1986 to 1997 for 14 elements showed that the blight-free Grove 1 had lower leaf Ca and higher S, Zn, and Mn than the two blight-affected Groves 2 and 3. The leaves in Grove 2 had higher N, K, Na, Cl, and B concentrations than in Grove 3; P and Mg were lower. There were no significant differences in Ca, S, and the metal ions.**

The cause of citrus blight, a severe tree decline problem in humid citrus-growing areas, has never had an undisputed explanation (Childs, 1979; Wutscher, 1988; Timmer, 1990). Observations strongly indicate that soil influences the incidence of blight (Cohen, 1980; Wutscher, 1986; 1989b); pH has especially been implicated (Wutscher and Lee, 1988; Wutscher, 1989b; 1997). Heavy applications of basic slag and calcium hydroxide improved blight-affected trees but did not cure them (Wutscher, 1985; 1995). Abnormal leaf nutrient patterns, based on single-year determinations of low K (Anderson and Calvert, 1970), and low Zn (Smith 1974a), coupled with internal reallocations such as accumulation of Zn in the wood and the bark (Smith, 1974a; Wutscher and Hardesty, 1979) have been reported. Injection of water into the trunk (Cohen, 1974; Lee et al., 1984), zinc analysis of the outer trunk wood (Wutscher et al., 1977), and leaf analysis for characteristic proteins (Derrick et al., 1990) serve as diagnostic tests because visual symptoms are non-specific. Nutritional effects are best characterized by multi-year observations. Annual leaf analyses of three blocks of trees, located next to each other but varying sharply in blight incidence over a 12-year period, offered an opportunity to compare the leaf levels of 14 elements in blight-free and blight-prone blocks.

1.Mention of a trademark, warranty, proprietary product, or vendor does not constitute a guarantee by the U. S. Department of Agriculture and does not imply its approval to the exclusion of other products or vendors that may also be suitable.

Materials and Methods

The data presented are from three orange groves near St. Cloud in east central Florida under intense observation since 1977. Grove 1, 'Hamlin' orange (*Citrus sinensis* L. Osbeck) on rough lemon rootstock occupied two-thirds of a rectangular 42 acre (17 ha) block of land, planted on surface-tilled Tavares (hyperthermic uncoated Grossarenic Paleudult) sand in 1944 with 25 $\times$ 25 ft (7.5 $\times$ 7.5 m) spacing (Wutscher, 1986). In 1970, the level of the soil in the vacant eastern third of the block was raised by using the spoil from dredging a drainage ditch and 6 tons per acre (14 t/ha) of dolomite was incorporated to 5 ft (1.5 m) depth before planting. 'Hamlin' on rough lemon trees were planted with the same spacing and in line with the older trees in the block. On the east side of the drainage ditch the original Pomello (sandy, siliceous, hyperthermic Arenic Haplohumod) soil was also modified by drainage and raising the level of the 9 acres (3.8 ha) above the surrounding area before planting 'Valencia' orange (*C. sinensis*) on rough lemon rootstock in 1984. Groves 1 and 2 were irrigated by overhead gun, Grove 3 by microsprinklers. All groves were uniformly fertilized two or three times per year with various fertilizers at an annual rate of 190 lbs/acre (213 kg N/ha) with various dry materials (11 N-0 P-9 K, 14 N-0-12 K, 16 N-0 P-14 K) and one microelement (Mn, Zn) spray per year.

Thirty-leaf samples were collected from healthy trees only every July, from 1986 to 1997. Five trees were sampled in Groves 1 and 2 (only two in Grove 2 in the last 4 years because the other three developed blight); four composite samples were collected in Grove 3 each year. The source trees were monitored frequently by blight diagnostic tests, mostly by water injections into the trunk (Lee et al., 1984) and analysis of the outer trunk wood for Zn and K (Wutscher et al., 1977, Wutscher and Hardesty, 1979), and in some cases also by a leaf protein test (Derrick et al., 1990).

The leaves were washed, dried at 70°C, ground to 20 mesh and analyzed for N by micro-Kjeldahl, P by a molybdivanadophosphoric acid method (Barton, 1948), for B colorimetrically (Dible et al., 1954), S nephelometrically (Quin and Woods, 1976), Cl by electrometric titration, K and Na by flame emission, and Ca, Mg, Fe, Mn, Zn, Cu, and Mo by atomic absorption. The data were analyzed using an SAS program for analysis of variance and the means separated by the Newman-Keuls multiple comparison test.

Results and Discussion

The three sets of trees used for the comparison were on the same blight-susceptible rootstock (Smith, 1974b) but they were of different ages and in the case of Grove 3 a different scion cultivar. There were also differences in soil preparation and irrigation method, but because citrus blight is unpredictable and cannot be induced, it has to be worked with where it appears spontaneously. The three blocks of trees were next to each other and always received the same fertilization.

Grove 1 was blight-free except for three trees at the end of rows where grove care practices created a much higher pH than in the interior of the grove (Wutscher and Lee, 1988). Testing at 30-day intervals over a three-year period (Wutscher 1989a) and intermittent testing since then has shown that there has been no spread of citrus blight in this grove. This in sharp contrast with the third of the rectangular block (Grove 2) planted in 1970 on heavily-limed filled land. When the first seven irregularly distributed blighted trees were identified in 1977, the soil pH ranged from 6.1 to 7.2. By 1990, 80% of the original trees had been removed because of citrus blight and replaced by replants and blight still spreads among the few remaining trees. The soil pH at the beginning of the observation period was 5.9 in Grove 2 compared with 5.1 in Grove 1 (Wutscher 1986; Wutscher and Lee, 1988).

The soil pH in the 'Valencia' grove (Grove 3), has remained in the 5.0 to 5.4 range since the trees were planted (Wutscher, 1995). The first blighted tree was diagnosed in this grove when the trees were only 3 years old, which is unusual because citrus blight rarely appears before trees are 5 years old. The annual tree loss rate was about 3% a year until 1994, but sharply increased to 10% in 1997. A total of 32% of the original trees have been lost.

Four elements clearly followed a different pattern in the blight-free Grove 1 compared to blight-affected Groves 2 and 3 (Fig. 1; Table 1). Calcium was lower, and S, Zn, and Mn were higher in the trees in the blight-free area than in the blighted areas. These and slightly higher magnesium in Grove 2 were the only elements different between the two groves which together formed a rectangular block. Lower leaf Ca in Grove 1 than in Grove 2 has been reported earlier (Wutscher, 1986) and higher soil Ca under blighted trees has been reported repeatedly (Casafus et al., 1984; Wutscher and Lee, 1988; Wutscher, 1989b). Zinc deficiency symptoms in the leaves in response to lower than normal zinc levels in the leaves are the most noticeable visual symptoms of citrus blight (Smith 1974b); there was more water soluble sulfate in the soil under healthy trees than under blighted trees (Wutscher, 1981). The leaves in Grove 2 had higher N, K., Na, Cl, and B concentrations than in Grove 3; P and Mg were lower. There were no significant differences in Ca, S, and the metal ions. High peaks of these elements are probably due to leaf sprays of these elements which the grower usually applied in the summer (Fig. 1). In some years the leaf samples were collected after the summer microelement spray. Why Grove 3 had consistently lower leaf Cl levels is hard to explain. It was separated from Groves 1 and 2 only by a drainage ditch and all three groves were irrigated with lake water with a low mineral content. Elevated leaf chloride levels are characteristic of citrus blight (Wutscher and Hardesty, 1979), but there was no difference between Groves 1 and 2. Long-term leaf analysis records in combination with citrus blight incidence determinations are rarely available, therefore, the universality of the leaf nutrient effects reported is uncertain, but the high significance of the differences in Ca, S, Zn, and Mn could provide leads to the solutions of the problem.

Table 1. Twelve-year means of concentrations of 14 elements in the leaves of healthy trees in Groves 1, 2, and 3 and statistically significant differences between them.

	Percent						mg/kg					
Grove	N	P	K	Ca	Mg	S	Na	Fe	Mn	Zn	Cu	Cl
1 (blight free)	2.85	0.132	1.55	2.57	3.92	0.363	459	49	25	28	15	50
2 (blight)	2.78	0.122	1.54	3.45	0.341	0.274	462	49	20	21	12	52
3 (blight)	2.70	0.149	1.38	3.65	0.411	0.268	290	53	18	19	9	22
	Newman-Keuls multiple comparison test (probabilities)											
1 vs. 2	NS[1]	NS	NS	0.001	0.05	0.001	NS	NS	0.05	0.05	NS	NS
1 vs. 3	0.01	0.01	0.05	0.001	NS	0.001	0.001	NS	0.01	0.01	NS	0.00
2 vs. 3	0.05	0.05	0.05	NS	0.01	NS	0.001	NS	NS	NS	NS	0.00

[1]NS = Not significant at the p = 0.05 level.

Acknowledgment

The author is indebted to Mr. Orie Lee for making the land and trees available and for collection of tree loss data.

Literature Cited

Anderson, C. A. and D. V. Calvert. 1970. Mineral composition of leaves from citrus trees affected with declines of unknown etiology. Proc. Florida State Hort. Soc. 83:41-45.

Barton, C. Y. 1948. Photometric analysis of phosphate rock. Anal. Chem. 20:1068-1073.

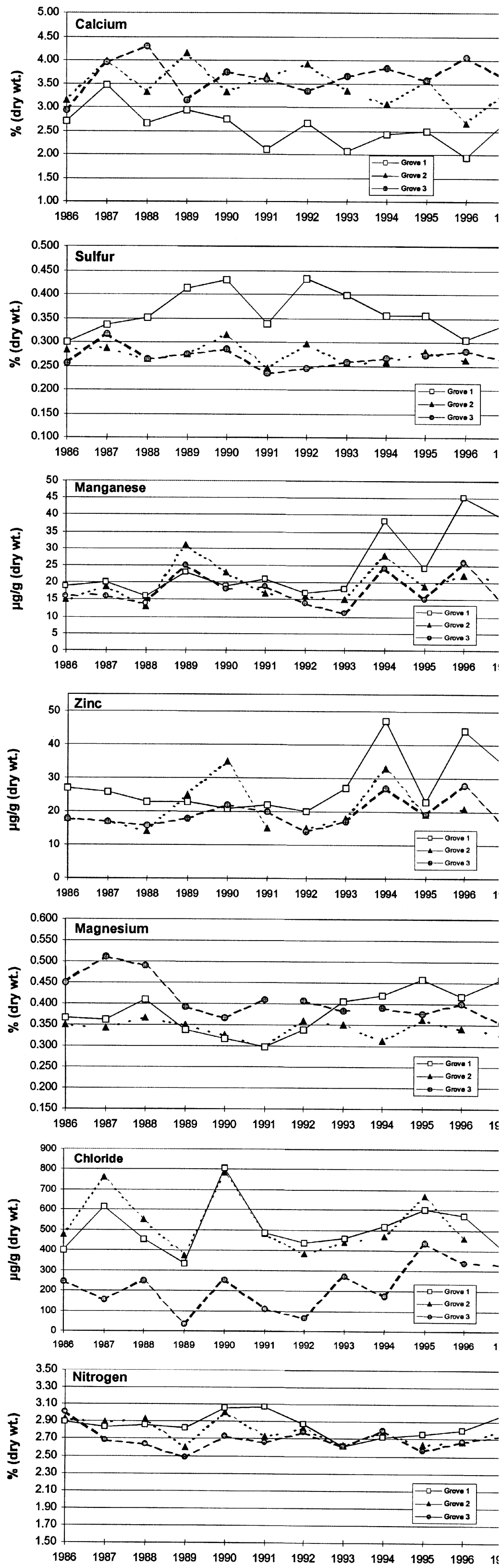

Figure 1. Leaf concentrations of Ca, S., Mn, An, Mg, Cl, and N in th groves varying in blight incidence.

Casafus, C. H., G. N. Banfi, N. B. Costa and R. W. Drescher. 1984. Influence of liming on the appearance of delinamiento symptoms in citrus trees, p. 287-289. *In*: S.M. Garnsey, L. W. Timmer and J. A. Dodds (eds.). Proc. 9th Conf. IOCV, University of California, Riverside.

Childs, J. F. L. 1979. Florida citrus blight. Part 1. Some causal relations of citrus blight. Plant Dis. Rep. 63:560-564.

Cohen, M. 1974. Diagnosis of young tree decline, blight, and sand hill decline of citrus by measurement of water uptake using gravity injection. Plant Dis. Rep. 58:801-805.

Cohen, M. 1980. Nonrandom distribution of trees with citrus blight, pp. 260-263. In: E. C. Calavan, S. M. Garnsey and L. W. Timmer (eds.). Proc. 8th Conf. IOCV, Riverside, CA.

Derrick, K. S., R. F. Lee, R. H. Brlansky, L. W. Timmer, B. G. Hewitt, and G. A. Barthe. 1990. Proteins associated with citrus blight. Plant Dis. 74:168-170.

Dible, W. T., E. Truog and K. C. Berger. 1954. Boron determination in soil and plants. Anal. Chem. 26:418.

Lee, R. F., L. J. Marais, L. W. Timmer and J. H. Graham. 1984. Syringe injection of water into the trunk: a rapid diagnostic test for citrus blight. Plant Dis. 68:511-513.

Quin, B. F. and P. H. Woods. 1976. Rapid manual determination of sulfur and phosphorus in plant material. Commun. Soil. Sci. Plant Anal. 12:719-731.

Smith, P. F. 1974a. Zinc accumulation in the wood of citrus trees affected with blight. Proc. Fla. State Hort. Soc. 87:91-95.

Smith, P. F. 1974b. History of citrus blight in Florida. Citrus Industry 55(9):13-19, (10):9-14, (11):12-23.

Timmer, L. W. 1990. Blight—An infectious disease of citrus trees, p. 195-209. *In*: L.C. Donadio (ed.). Proc. 1st Int'l Seminar on Citrus Rootstocks, Bebedouro S.P., Brazil.

Wutscher, H. K. 1981. Seasonal levels of water-extractable cations and anions in soil under blight-affected and healthy citrus trees. Commun. Soil. Sci. Plant Anal. 12:719-731.

Wutscher, H. K. 1985. Positive effect of slag application on citrus blight-affected 'Hamlin' orange trees. Proc. Fla. State Hort. Soc. 98:1-3.

Wutscher, H. K. 1986. Comparison of soil, leaf, and feeder root nutrient levels in the citrus blight-free and citrus blight-affected areas of a 'Hamlin' orange grove. Proc. Fla. State Hort. Soc. 99:74-77.

Wutscher, H. K. 1988. Nutritional and soil factors affecting trees with citrus blight. Proc. 6th Int'l. Citrus Congr. 2:1013-1022.

Wutscher, H. K. 1989a. Long-term patterns of water uptake in syringe injection and wood zinc levels of blight-affected orange trees. Proc. Fla. State Hort. Soc. 102:24-27.

Wutscher, H. K. 1989b. Soil pH and extractable elements under blight-affected and healthy citrus trees on six Florida soils. J. Amer. Soc. Hort. Sci. 105:74-76.

Wutscher, H. K. 1995. Changes in pH of a Florida citrus soil in response to basic slag and calcium hydroxide applications, p. 601-604. *In*: R. A. Date (ed.). Plant Soil Interactions at low pH. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Wutscher, H. K. 1997. Soil acidity and citrus blight. Commun. Soil Sci. Plant Anal. 28:603-612.

Wutscher, H. K. and C. Hardesty. 1979. Concentrations of 14 elements in tissues of blight-affected and healthy 'Valencia' orange trees. J. Amer. Soc. Hort. Sci. 104:9-11.

Wutscher, H. K. and O. N. Lee. 1988. Soil pH and extractable mineral elements in and around an isolated citrus blight site. Proc. Fla. State Hort Soc. 101:70-72.

Wutscher, H. K., M. Cohen and R. H. Young. 1977. Zinc and water soluble phenolics in the wood for the diagnosis of citrus blight. Plant Dis. Rep. 61:572-576.