Nonrandom Distribution of Trees with Citrus Blight*

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Citrus blight disease (young tree decline) has been studied in Florida for about 100 years, but its etiology is still not understood. In many cases trees with blight are scattered through citrus plantings in apparent random fashion (Childs, 1953). Often trees will remain healthy for years adjacent to others with citrus blight. In some locations, however, definite nonrandom patterns, often related to soil type, can be seen. Rhoads (1936) found that blight was more common on shallow sandy soils than on deeper, finer textured soils. He also associated the disease with locations underlain with lime rock. Nemec *et al.* (1976) described some groves in which incidence of citrus blight increased as depth of soil to hardpan decreased. It also has been observed (Smith, 1974) that trees are affected earlier and in greater numbers on shallow flatwood soils than on deeper sands. My report concerns a number of specific locations where the distribution of trees with blight is distinctly nonrandom.

MATERIALS AND METHODS

Locations mentioned in this report were found through personal grove visits, aerial surveys, and growers' reports. Each site was chosen because tree decline or tree loss did not occur in the apparent random pattern which characterizes many instances of citrus blight. After a location was discovered, the area was visited and a number of trees were studied using previously described methods (Cohen, 1974; Wutscher *et al.*, 1977) to establish whether trees in decline fit the criteria for citrus blight. Soils were examined to characterize soil types on which trees in decline and adjacent healthy trees were located.

RESULTS AND DISCUSSION

A. **Contiguous trees in decline in an area of uniform soil.**

1. Pineapple orange block, Agricultural Research Center, Fort Pierce. Trees are on Cleopatra mandarin rootstock. Blight decline of nine trees occurs in a row near the center of a 16-year-old block of 380 trees, which contains only nine additional scattered trees with blight. Trees in decline are located on Wabasso fine sand, a type of soil with an organic hardpan 75 cm below the soil surface. In 1967, a shallow well, 6 m deep was drilled in this area, then capped. In 1973, three trees with blight appeared east of the well. Additional trees east and west of the original three have shown blight symptoms so that by 1979 there were nine declined trees in line, with the well located between the two westernmost trees. The connection, if any, between the drilling of the well and the appearance of blight is under investigation.
2. Edsall grove on Oslo Road, Vero Beach. Blight decline occurs in a solid group of 17 Ruby grapefruit trees on Cleopatra mandarin rootstock near the SE corner of a 360-tree block containing about 45 other declined trees in a scattered pattern. Decline began on a few trees about 1973 when the planting was about 15 years old. No soil variations were observed.

B. **Tree survival associated with highly organic or fine textured soils.**

1. Northern portion of Cloud Grove, St. Lucie County. About 150 large 17-year-old Valencia orange trees

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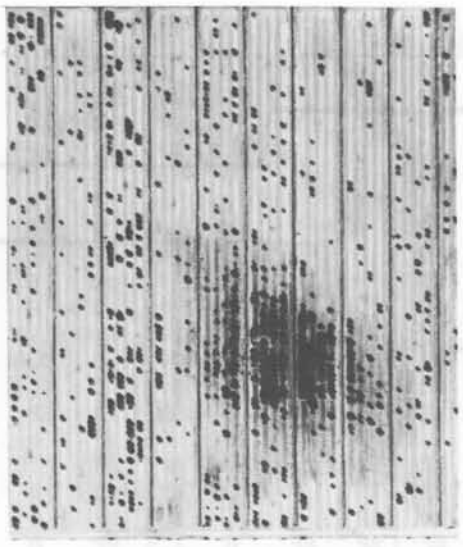

Fig. 1. Aerial view showing survival of Valencia trees on rough lemon rootstock in small area of peat-like, highly organic soil on the Coca-Cola Cloud Grove near Fort Pierce. Area is surrounded by sandy soil in which the typical scattered distribution of trees lost to blight is evident.

on rough lemon survived with relatively little blight decline in a 1-hectare area of peat-like organic soil which contrasted greatly with the surrounding Felda fine sandy soil (fig. 1). About 75 per cent of the trees on the Felda soil have been removed because of blight disease. This location was pointed out in an aerial photograph survey by Carlos Blasquez of the Agricultural Research and Education Center, Lake Alfred. The area is difficult to work agriculturally because tractor-drawn equipment tends to mire in the soft spongy soil. This site is also under study by Dr. D. V. Calvert, Soil Chemist at the Agricultural Research Center, Fort Pierce.

2. United Grove Caretakers, St. Lucie County. Trees survived with little loss from blight on 0.8 hectare of highly organic soil which was less soft and spongy than soil in the Cloud Grove. Trees were 16-year-old Pineapple orange on trifoliate orange and Troyer citrange. Blight was severe on the surrounding sandy soil (fig. 2).
3. Rootstock experiments planted in 1950 by Dr. H. J. Reitz at the Agricultural Research Center, Fort Pierce on two contrasting adjacent soil types. The soils were Wabasso fine sand (previously described) and Parkwood fine sandy loam, a fine textured soil without hardpan. About 75 per cent of the Valencia orange trees on rough lemon on the Wabasso soil have succumbed to blight but only 13 per cent were lost on the Parkwood soil. A similar contrast between high incidence of blight on a sandy soil (Gainesville sand) and low incidence on Parkwood fine sandy loam was described by Rhoads (1936). The Gainesville sand was underlain with coquina limestone.

C. **Tree survival not associated with soil type..**

1. Ald-Comp Grove on Canal C-23, St. Lucie County. A high incidence of decline from blight in 16-year-old Marsh grapefruit trees on trifoliate orange occurred in 4 hectares of this grove. Some areas of the planting were less than 15 per cent affected while more than 90 per cent of the trees were in decline with citrus blight in other areas. With the cooperation of Frank Watts, a soil classification specialist of the Soil Conservation Service (USDA), an attempt was made to associate soil type with incidence of decline, but changes in soil type did not coincide with changes in blight incidence.
2. Orange-Co. Grove on Canal C-25, St. Lucie County. A contrast, similar but less extreme than the example above, occurred in this grove of 17-year-old Valencia orange trees on rough lemon.

	Pine./Trif.								Pine./Troyer					
	61		60		59		58		57		56		55	
32	0	RP	0	RP	RP	2.0	0	0	0	RP	0	0	RP	RP
31	0	RP	0	1.5	0	0	RP	0	2.0	0	0	RP	2.0	0
30	0	0	0	RP	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	1.0	RP	.5	RP
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	RP	RP	0	.5	0
24	0	0	0	0	0	0	0	0	0	0	RP	0	0	0
23	0	0	0	0	0	0	0	0	0	RP	RP	0	0	0
22	0	0	0	0	0	0	0	0	RP	0	2.0	2.5	1.0	.5
21	0	0	0	0	0	0	0	RP	RP	RP	RP	0	0	3.0
20	0	0	0	0	0	2.5	0	RP	1.5	RP	RP	3.0	0	1.0
19	0	0	0	0	0	0	0	RP	RP	1.0	0	0	RP	RP
18	0	0	0	0	0	0	2.0	1.5	0	X	0	0	RP	0
17	0	0	0	0	RP	0	RP	RP	RP	2.0	1.0	RP	0	1.0
16	0	0	0	0	0	0	0	RP	RP	0	0	RP	0	RP
15	0	0	0	0	0	RP	1.0	0	RP	0	0	1.5	RP	0
14	0	0	0	0	0	0	RP	RP	RP	RP	0	1.5	RP	0
13	0	0	0	0	0	RP	0	2.0	RP	.5	.5	RP	1.5	0
12	0	0	0	0	0	0	RP	0	RP	2.5	0	RP	0	0
11	0	0	0	0	0	RP	0	RP	RP	RP	.5	0	0	0
10	0	0	0	0	1.0	RP	0	0	1.0	RP	RP	0	0	0
9	0	0	0	RP	0	RP	RP	RP	RP	1.5	RP	0	RP	RP
8	0	0	0	0	RP	RP	RP	0	X	RP	RP	0	1.0	RP
7	0	0	0	0	RP	RP	RP	RP	RP	RP	RP	RP	0	0
6	0	0	0	0	RP	RP	RP	RP	RP	0	RP	RP	0	RP
5	0	0	0	0	0	RP	0	RP	RP	0	1.5	RP	0	0
4	0	0	RP	0	0	0	RP	0	1.5	0	RP	0	RP	RP
3	RP	0	0	0	1.0	0	0	1.0	RP	RP	0	0	0	RP
2	0	0	RP	RP	RP	0	RP	RP	RP	1.0	RP	0	RP	0
1	RP	0	RP	RP	0	RP	RP	0	RP	3.0	RP	RP	0	0

Fig. 2. Grove map (United Grove Caretakers) showing sharp separation between area of healthy trees and area where most trees were removed because of blight or show blight decline symptoms. Healthy tree area contains black peaty, highly organic soil; soil in decline area is sandy. Trees are Pineapple orange on trifoliate orange and Troyer citrange rootstocks. (Symbols: 0 = healthy tree to 3.0 = almost dead; RP = replant trees; X = missing tree).

Blight affected 14 per cent of trees in one area and 67 per cent of the trees in an adjoining area. No soil differences were observed.

D. **Decline adjacent to ditches and roads.**

1. United Grove Caretakers. Different stock-scion combinations were planted in 3- to 8-hectare blocks in this large 16-year-old grove. Most of the blocks of Valencia orange trees on rough lemon rootstock were characterized by severe tree loss from blight on the periphery of the blocks adjacent to roads and ditches, and by relatively good survival of trees on the inside (fig. 3). All blocks were bordered by irrigation canals dug into the highly calcareous subsoil of the area. This distribution of declining trees is reminiscent of a condition called "roadside decline" which is usually considered to be the same as citrus blight (Childs, 1953).

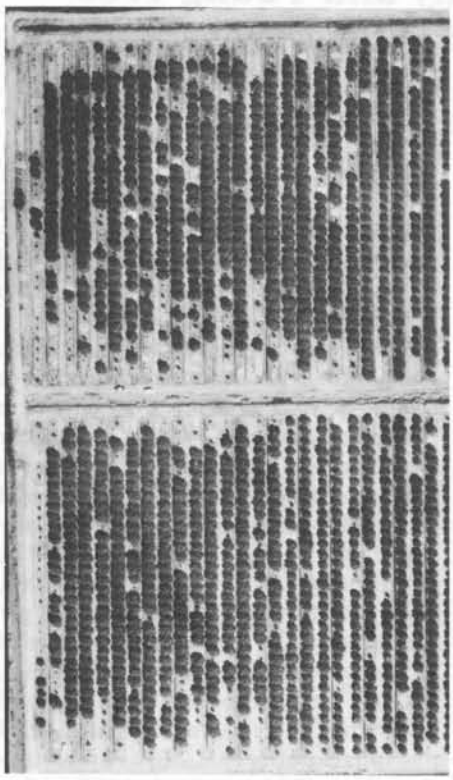

Fig. 3. Two blocks of Valencia trees on rough lemon (United Grove Caretakers), Fort Pierce, from the air. Tree loss to blight along the roads and ditches at the sides of the blocks is much more severe than within the blocks.

CONCLUSION

The existence of blighted trees in nonrandom distribution patterns has important implications for further investigations of citrus blight. Distribution of diseased trees is often suggestive of the mechanism which produces the disease. For example, early random distribution of trees in decline may indicate the operation of one set of mechanisms such as vectoring of the disease by insects, infection of plants from a distant source of disease spores, or similar causes. Nonrandom distribution of affected trees, especially where soil factors seem to be involved, suggests that another set of factors could be responsible for the appearance of the disease, such as the presence of fungus toxins, nutrient deficiencies, or toxicities. Thus each location with an unusual distribution of affected trees provides a site for intensive testing of hypotheses on the cause of the problem. Where trees in decline in different orchards fall into two distinctly different distribution patterns, it is also possible that two different causes of decline may exist. Only intensive research can develop the objective evidence which is needed for a proper understanding of the nature of the problem.

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