Living with Stubborn Disease in Central California Citrus

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ABSTRACT. Central California's citrus industry is at risk from *Spiroplasma citri* (stubborn disease) with its insect vectors, *Circulifer tenellus* and *Scaphytopius nitridus*. During recent new plantings, questions were raised as to the suitability of the district for long term production. Was central California destined to failure due to stubborn disease? Were mature groves infected? Could pruning help? Was culling and replanting a waste of time? Answering the needs of the citrus industry required methods to determine rates of field spread, risk determination for new or old groves and successful production programs. Plant pathology research provided methods for survey and detection. Vector entomology described risk factors. Five year detection surveys in newly planted candidate orchards indicated infections occurring as trees were small but lessening in frequency as they grew larger. Replants in mature orchards rarely became infected, vectors favoring open land. Pruning did not eliminate infections. Surveying, culling and replanting proved practical for good management.

Stubborn disease continues to elude active control where inoculum and vectors are well established (4). The potential loss from stubborn disease caused by *Spiroplasma citri* Saglio *et al.* and spread mainly by the beet leafhopper, *Circulifer tenellus* (Baker), represents one of the more probable uncontrollable disease risks to the citrus grower of central California (2, 3).

Considerable research has been directed toward gaining knowledge of the disease, the responsible pathogen, local insect vectors and toward testing orchard management strategies to cope with the problem (3). The apparent rate of disease spread suggested to some workers that the industry faced a potential of one million infected trees. It was deemed important that the hazard of stubbon be quantified under commercial orchard conditions.

MATERIALS AND METHODS

Several sites in Tulare County, California were evaluated for orchard environments that would permit study of stubborn disease problems. Two orchards were selected in the county, one south of Porterville and the other near Lindcove.

The Porterville orchard was planted to 12-yr-old navel oranges on rough lemon rootstock and had trees with symptoms typical of stubborn disease (5). It was surrounded by citrus plantings in all directions. The trees had been grown in a southern San Joaquin Valley nursery. Cultural practices in the area were non-tillage soil management and several pest control sprays each season.

The Lindcove planting was 2-yr-old navel oranges on Troyer citrange rootstock with various young trees showing leaf and shoot symptoms of stubborn. These trees originated from a central Tulare County nursery. One side of this grove faced a vineyard that had summer weeds and winter cover crops.

Both candidate blocks were mapped for presence of stubborn disease using a four grade scheme for symptoms. Following the mapping tissue samples were collected from each side of suspect trees at an optimum time for laboratory culturing (3). These dual method surveys were repeated annually to obtain rate of spread information.

Pruning therapy was tried on several older trees where culturing results indicated that infections were limited to part of the tree canopy. Regrowth was tested for the presence of the stubborn agent.

Yield comparisons were made between some randomly selected check trees and stubborn-positive trees during one season.

TABLE 1
STUBBORN-LIKE TREES IN PORTERVILLE ORCHARD
12-YR-OLD NAVEL ORANGES

Time & Method	Tree Grade			
	Normal	Slight	Moderate	Severe
1980 visual	635	33	28	14
1981 culture	652	15	28	14
1982 culture	649	18	culled	
1986 visual	649	18	—	—

The owners removed most of the obvious stubborn trees which were mapped as severe. Such trees were obviously different and produced less fruit. A few moderately affected trees were permitted to remain for long term observations.

RESULTS AND DISCUSSION

Porterville orchard. The incidence of stubborn disease based on visual mapping and later validated by laboratory cultures and remapping is described in table 1.

The information in table 1 suggests this "adolescent" orchard had a fairly low rate of spread. Visual symptoms were useful for culling diseased trees. Repeated and thorough observation was needed to insure detection of partially infected trees. Repeat mapping also helped overcome "over culling" where symptoms were indistinct. Yield information supported the rationale of this approach.

In the crop year 1982-83, yields were collected from eight of the 18 candidate trees and four normal ones as determined by culturing. Results are shown in table 2 with the tree grades being divided into slight and moderate classifications based on visual symptoms. The tree replicates were clumped so orchard variability would be minimized. The samples were not sufficient for statistical treatment but yield behavior augments a judgement call by a grower based on appearance. In other words, where the symptoms including yield reduction become obvious, cull the tree. The apparent yield effect for slight stubborn symptoms is probably due to insufficient sample size.

The pruning therapy effort was not successful in eliminating the organism from the portions of the trees known to be infected.

Lindcove orchard. The grower's own map of this orchard indicated a potentially severe problem with stubborn within a year of planting. The first mapping showed nearly 15% infection which implied unconfirmed infection in the nursery. In a block of nearly a thousand trees, a 104-tree sampling block was used to test for natural spread. This unit was tested for 5 yr by laboratory culturing and results are reported in table 3.

TABLE 2
NAVEL ORANGE YIELDS FROM
STUBBORN TREES

Tree	Stubborn Symptoms		
	Normal	Slight	Moderate
1	3.5[z]	4.3	3.0
2	5.2	7.0	4.5
3	5.0	5.5	3.5
4	3.2	5.5	3.0
Avg.	4.2	5.6	3.5

[z]Yield in 24-kg boxes per tree.

TABLE 3
STUBBORN INCIDENCE IN A 104-TREE
SAMPLE PLOT OF NAVEL ORANGES,
PLANTED 1975, LINDCOVE

Year	Normal	Stubborn	%	Spread rate
1978	78	26	25	—
1979	77	27	26	+1%
1980	73	23/8[z]	30	+4
1981	72	24/8	31	+1
1982	71	25/8	32	+1

[z]Eight trees removed, replants still normal.

Infections appeared rapidly in this planting during the first 3 yr with 25% of the trees affected after that time. Another 7% developed symptoms over the next 4 yr. This slow down in infection rate may be associated with a change in vector activity in open vs. orchard habitat as suggested by entomologists.

Both orchards had fewer new infections with time. This is also reported elsewhere (1). The reduced rate of spread is encouraging enough to advocate continued culling and replanting with clean nursery stock (3). This study indicates it is still possible to produce commercial citrus crops in California's San Joaquin Valley where stubborn inoculum and vectors are present. Production volume for the district continues to increase and the stubborn risk is being managed by following recommendations derived from plant pathology and entomology research.

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