CANKER THREAT

How Serious a Threat is Canker to Florida Citrus Production?

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Canker is often regarded as one of the worst hazards that could befall the Florida citrus industry. In this article, I will discuss the reasoning for this presumption and consider if these fears are scientifically justified.

To appreciate current philosophy on the potential seriousness of canker to citrus trees and fruit, the subject first has to be considered in a historical perspective. Where did the fear of canker really begin? It began in Florida back in the early teens of this century. What were the original justifications for this fear? This is a more difficult question to answer, but it seems to have arisen from the following sequence of events.

In 1912, Berger (1) observed a new disease in some Florida citrus nurseries and concluded it was introduced on seedlings of trifoliate orange imported from Japan in 1910. At first, the disease was considered to be an unusual form of scab—a disease which was already widespread in Florida. It was soon realized that the disease was behaving differently from scab, and in 1914 it was given the name canker. In 1915, it was determined to be a bacterial disease (3).

Canker caused so much concern, particularly in South Florida, that in 1914 some growers in Dade County began a campaign on their own to try and eradicate the disease by destroying all infected trees in their groves. This decision was made either because of observations made by the growers themselves or because of fears expressed by plant pathologists or other government employees. The published reports of the times are not clear on this matter. In 1915, a statewide eradication program was initiated and organized under a newly formed State Plant Board, which became responsible, in conjunction with the U.S. Department of Agriculture, for regular inspection of nurseries and groves for canker, the destruction of trees in canker-infected groves and nurseries, and quarantine measures.

In a paper presented to the Florida State Horticultural Society in 1915, Stevens (7) gave some reasons why canker was considered more serious than the other citrus diseases then known. He concluded that, unlike other diseases, it attacked all parts of the trees: larger limbs, trunks and exposed roots, as well as leaves, fruit and young stems. He also concluded that it was impossible to control canker with copper spray materials. These conclusions are now known to have been incorrect. Canker is not injurious to roots, trunks or limbs, and it is now known that, with appropriate spray timing, canker is controllable with copper sprays. Published records from the teens showed that the major impetus for proceeding in 1915 with an eradication campaign to control canker was based on a belief that the citrus industry would be unable to live with the disease.

After 1920, there was only one further report of canker in Florida and that was at Ft. Lauderdale in 1927 (6). In 1933, Florida was declared free from canker. The elimination of citrus canker from Florida, and eventually from all the other Gulf Coast citrus-growing states, is one of the outstanding success stories in plant pathology. It is the only recorded example of a disease affecting a tree crop that has ever been eradicated by the on-site destruction of visibly infected trees and a specified area of apparently healthy trees around the infection focus. This success story was undoubtedly due to the thoroughness with which the surveys and destruction measures were undertaken. Success was achieved despite the four to five years that elapsed between the time the disease was thought to have been introduced into

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Florida in 1910 and the time the eradication measures began in 1915. Nevertheless, there may have been another side to this success story. The Florida climate might have helped the eradication effort, particularly if the prevailing conditions were unfavorable for the permanent establishment of canker in citrus groves.

Despite the great fears expressed over the years about canker, there is no certainty that the disease could create a serious problem in Florida. During the years before 1915 that canker had free reign, it appeared in many nurseries, and it was found in many new plantings that originated from these infected nurseries. There was, however, little mention of it in bearing groves. This suggests that the conditions for infection and survival of the pathogen might have been less favorable in groves than in nurseries.

The only published report I am aware of that refers to substantial fruit infection in a Florida grove was by Stirling (8) in 1914. He referred to a heavily infected seven-year-old grapefruit grove in Dade County in which he "would have had no trouble whatever in picking 50 boxes of diseased fruit" from an affected four-acre grove. This may have been an exceptional case because Berger (1) in the same year stated "there has been no opportunity to observe it (canker) on larger trees bearing considerable quantities of fruit."

Reports from observers in the teens as to the effect of canker on the trees themselves, mentioned canker-induced defoliation, but otherwise they were speculative. Stevens (7) in 1915 summarized the situation as follows: "what the ultimate effect of the disease on the tree might be we do not know at present, for we have not had badly infected trees under observation long enough to tell. Our observations show that when trees are badly attacked, there is a falling of the younger leaves and a perceptible stunting of the young twigs. Continual defoliation by the disease would finally result in the death of the tree, or soon render it worthless." Such potentially devastating effects on the tree are now known to have been exaggerated. While a heavy attack on foliage could be debilitating to the tree, particularly if frequently repeated, there is no reason to believe the effects would be any worse than those caused by severe attacks of greasy spot or melanose, or by the host-specific Alternaria brown spot disease that is so common on Dancy tangerine and Minneola tangelo trees. Nevertheless, the idea that canker can have devastating effects on whole trees has persisted to this day, with repeated references to canker as a deadly or tree-killing disease.

From reports published about the occurrence and severity of canker when it previously occurred in Florida, it is impossible to conclude how severe the disease might have become if it had not been eradicated. Therefore, to try and forecast how much of a threat canker really is to Florida citrus groves it is necessary to consider how the disease behaves in other countries.

Canker probably originated in the home of citrus, in east Asia. Today, canker is present in many Asian citrus-producing countries, and mostly without causing serious disruption of citrus production. The predominant cultivars grown in many of these countries are mandarins, which are moderately to highly resistant to the disease. Thus, it could be argued that what happens in Asian countries has little bearing on what could happen in Florida if canker became established in this state. Incidentally, while it could be suggested that mandarins are commonly grown in Asia because of canker, a more likely reason is that they are grown there more because of consumer preference, climatic or traditional reasons.

There is only one major citrus-producing country in the world that has had canker for many years and grows many of the same cultivars that we do in Florida, and that is Argentina. In Entre Rios, Corrientes, and Misiones Provinces in northeast Argentina, relatively large acreages of sweet orange and grapefruit are grown, and they are grown under conditions that are somewhat similar to those in Florida citrus groves, in terms of total rainfall and the cultural practices used.

In March 1985, I visited Argentina for two important reasons: (1) to assess from the behavior of canker in Argentina how severe canker might become in Florida if current attempts to eradicate the disease should fail and (2) to consider how many spray treatments might be needed in Florida to control canker if we had to live with the disease.

In Argentina, grapefruit and lemon fruit are more severely attacked than those of the other commercially grown varieties. Star Ruby grapefruit is particularly prone to attack. Canker can also be troublesome on the fruit of early-maturing oranges, but much less so than on grapefruit. Mandarins and Valencia oranges are affected very little by the disease. Canker-induced defoliation seems to be important only on young grapefruit trees.

Canker becomes less of a problem in Argentina groves as trees grow older. As the tree canopies enlarge, they provide

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more mutual protection from wind. Protection from wind by the citrus trees themselves as they grow larger or by windbreaks has an extremely important role in reducing the severity of canker attack, and more will be said about this subject later in this article. Another important feature of older trees is that they develop a more distinct growth flushing habit: producing two or three growth flushes per year with long intervals in between when there is no young susceptible growth on the tree. Thus, younger trees suffer more than older trees from canker, partly because they produce growth flushes continuously. On young trees, some susceptible growth will be present, except during winter, almost every time that climatic conditions are favorable for infection, thereby promoting a more certain build up of inoculum than is possible on older trees. In Florida, a parallel situation concerning the availability of susceptible shoot growth occurs with scab. This causes scab to be more prevalent on younger than on older trees.

In infected Argentine grapefruit groves, four applications of copper usually provide adequate protection of the fruit. The first application is made during the emergence of the spring growth flush. This is mainly to prevent a possible build up of inoculum on the Spring growth flush and, hence, to reduce inoculum pressure on the fruit. Up to three copper spray treatments are applied after bloom at monthly intervals, beginning soon after petal fall (2).

Valencia oranges and mandarins commonly receive three copper fungicide treatments: one prebloom, one at two-thirds petal fall and another postbloom. However, the first two treatments are applied primarily for scab control. Hamlin oranges also receive these copper treatments for scab control, but, where canker exists, one or two additional postbloom copper spray treatments may be needed.

In comparing peninsular Florida with the canker-affected areas of Argentina, there are some important climatic differences which could signify much less of a canker problem here than in Argentina. These differences relate particularly to rainfall frequency and the wind speeds during rainfall.

I have compared in Table 1 rainfall data for the Experimental Station at Concordia, Entre Rios province, Argentina and

the Citrus Research and Education Center, Lake Alfred, Florida to illustrate the differences in rainfall frequency. I have assumed that rainfall of less than 0.2 inches would probably be inconsequential in terms of canker spread or infection. I have also assumed that March 1 at Lake Alfred would correspond seasonally with September 1 at Concordia. However, even if this approximation is several weeks off, as it could be in some years, the same conclusions could still be drawn from the data. On average, there would be about 25 per cent fewer raindays in March and 50 per cent fewer raindays in April in Lake Alfred than for the equivalent periods in Concordia. The number of raindays at Lake Alfred for May and at Concordia for November are about equal. From thereon until the early Fall, the number of raindays at Lake Alfred is greater than at Concordia.

What does this mean in terms of infection possibilities? Theoretically, there would be a 25 per cent less chance of infection of the Spring growth flush in Florida than in Concordia. The Spring growth flush in Florida normally emerges during the first half of March and therefore, it should become resistant by the end of that month. As for fruit infection, there should be about half as much chance at Lake Alfred as at Concordia of this occurring during the first four weeks after petal fall which generally begins in Florida in late March or early April. This could be a very important difference because it is the very early infection that results in the formation of the larger and particularly disfiguring type of canker lesion (5). The greater number of raindays in Florida than in Concordia during the Summer might be considered alarming. It should be realized, however, that the fruit becomes progressively

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more resistant to attack as it develops. Consequently, rainfall during the Summer is less conducive to fruit infection than in the Spring.

The major path of penetration of bacteria into leaves, stems and fruit is through the stomata. Bacteria have to be suspended in water to proceed through the stomatal pores and this process is enhanced when water hits the rind surface with force (4). Therefore, much more infection occurs when rainfall is accompanied by high winds than when conditions are relatively calm.

A major reason for believing that canker would be much less of a problem in Florida than it is in Argentina relates to the differences in wind speeds when it rains. To understand these differences it is necessary to consider the types of weather systems that promote rainfall. Rainfall in Argentina is associated characteristically all-year-round with the northward movement of cold fronts. Winds of 20 to 40 mph or more are often sustained throughout much or all of the precipitation period. The weather systems that promote rainfall in Argentina can be likened to cold front-induced rainstorms in Florida. An important difference, however, is that in Florida such systems are largely confined to the Winter when foliage and fruit are resistant to attack. During those times of year in Florida when there is susceptible fruit on the tree, the rainfall is mostly associated with localized convective-type short-lived thunderstorms. Gusty winds often precede such storms, but calmer conditions, with winds of less than 10 mph, usually return soon after the precipitation begins. Thus, when it rains there should be much less chance of infection occurring in Florida groves than in those of northeast Argentina.

In Argentina the effects of a windbreak planted on the south side of a citrus grove in controlling canker are spectacular. Even a single row of pine or Eucalyptus trees planted on the edge of the grove greatly reduces the incidence and severity of canker. This does not necessarily mean shelter belts would be needed to help control canker in Florida groves. The windspeeds experienced in windbreak-protected Argentine groves would probably still be greater than those generally experienced during rainstorms in unprotected Florida groves.

So far, I have only considered the risks of canker attack in citrus groves. The situation could be different in citrus nurseries, because of the frequent use of overhead sprinkler irrigation and the greater risks of disease spread and infection by workers touching the plants and brushing against the foliage.

In Florida, there are major differences in the severity of certain existing foliar diseases between a nursery and a grove. For example, scab can cause much concern in the nursery; yet when infected trees are planted in groves, scab quickly decreases in severity, and on less susceptible cultivars it usually soon disappears. A parallel situation might occur with canker if canker-infected nursery trees happened to be planted in a grove.

If canker became established in Florida, and it behaved no worse than it does in Argentina, we might have to increase the current number of copper treatments in some groves. Overall, however, the number of extra treatments needed would not be very great. In fact, on most cultivars, canker would probably turn out to be only a rind-blemishing disease, needing control only on certain cultivars grown for the fresh market.

In many grapefruit groves in Florida managed for fresh market production, three copper fungicide sprays are already routinely applied to assure a

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Table 1. Average number of days per month with rainfall exceeding 0.2 inches at Lake Alfred, Florida and for the seasonally equivalent months at Concordia, Argentina.

Lake Alfred			Concordia		
	No. raindays*			No. raindays	
Month	Range	Average	Month	Range	Average
Jan	0-5	2.6	July	1-6	3.4
Feb	1-9	4.0	Aug	1-6	3.2
Mar	1-9	3.4	Sept	1-8	4.6
Apr	0-5	2.3	Oct	2-10	4.9
May	2-8	5.0	Nov	1-8	5.1
June	3-12	6.9	Dec	1-7	3.9
July	4-14	7.7	Jan	1-9	5.3
Aug	4-13	8.2	Feb	4-15	6.1
Sept	1-15	6.6	Mar	1-10	4.6
Oct	1-7	2.8	Apr	1-10	4.0
Nov	0-6	2.6	May	1-8	4.1
Dec	0-6	2.7	June	1-7	3.6

*Data is based for each location on a 14-year period from 1971 to 1984.

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good packout: two are applied postbloom to provide more reliable control of melanose than is possible with the more usual single treatment, and another treatment is applied in June or July to control greasy spot rind blotch. The timing of all these treatments should be appropriate for canker control. In grapefruit groves with canker, an additional copper fungicide treatment might be desirable prebloom during the expansion of the spring growth flush. According to Argentine experience, this would best be applied about 14 days after this growth flush begins to emerge (5). From the practical standpoint, it would be possible to spray only a relatively small acreage of Florida grapefruit groves at the optimum time. However, because the chances of infection of the spring flush should be low in Florida groves, omitting the early treatment might not be as consequential as in Argentina.

Hamlins for the fresh market might need one or two extra copper treatments in addition to the one already applied for melanose control. No additional treatments would probably be needed for Temples, Murcotts or Dancy tangerines. Currently, copper fungicides are seldom needed for any purpose on Valencias grown solely for processing. Probably, there would continue to be no need for copper fungicides in most groves of this variety, even if canker did become established in them.

At present, the preceding discussion on the possible needs for additional copper fungicide treatments if canker became established in Florida is best regaded as academic, because there is no reason to believe that canker could be as severe in

Florida as it can be at times in Argentina.

None of us wants any further leaf or fruit spotting diseases to become established in Florida citrus groves. For this reason alone, current efforts to eradicate the recent outbreaks of a bacterial disease in Florida citrus nurseries, that has been classified as canker, seem logical. Nevertheless, it is obviously necessary to keep the potential danger of canker to the Florida citrus industry, and the additional costs that might be involved in controlling it, in perspective. Much of the present anxiety over canker seems to be based on a fear of the unknown, compounded by some alarming and unfounded statements, suggesting it can be a killer disease. Such alarm dates back to the teens: yet there seem to be no reports from those times to indicate that it really behaved in such a devastating manner. In those days there was much speculation as to how severe the disease might have become if not eradicated, but such tales of doom were never substantiated. Canker is certainly not a killer disease in Argentina. In that country, it does sometimes cause excessive fruit drop, but mostly it is important only as a rind-blemishing disease.

Probably the best way to estimate how severe the disease could become in Florida is to look at the situation in the canker-affected provinces of Argentina. While one can never be absolutely certain how canker might behave in a new environment, there are several reasons, as outlined in this article, for doubting whether this disease could ever become as serious a problem in Florida as it can be at times in some Argentine citrus groves.

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CALENDAR OF EVENTS

NOV	**NOV. 3-6—Florida State Horticultural Society Annual Meeting,** Holiday Inn Airport, Tampa, FL. Contact: (813) 967-0596.	**NOV. 12-14—Potash & Phosphate Institute and Foundation for Agronomic Research,** Workshop on intensive crop management systems. St. Louis, MO. Contact: (217) 762-2074.	**NOV. 17-21—Irrigation in Action,** trade conference and exposition, Fresno, CA. Contact: Frank Carmody (415) 543-1123 or Mark Baechtel (301) 871-1200
thru	**NOV. 23-20th—Anniversary Bar-B-Que for Redlands Christian Migrant Assn.** 2-30-7:00 Leland Young's barn, Alturas. Contact: Wendell Rollason (813) 657-3362.	**December 4-6—U.S. International Food Show,** Los Angeles Convention Center, California. Contact: Gerard V. Parker, (415) 381-8206.	**Dec. 6-7—Fla. Irrigation Society Winter Meeting & Trade Show.** Location to be announced. Contact: Mike Hardy (904) 372-3394.
FEB	**Feb. 11-13, 1986—California Farm Equipment Show and Internatl. Exposition.** Tulare, Calif. Contact: Nikki Accord (209) 688-1751.	**Feb. 16-19, 1986—United Fresh Fruit and Vegetable Association 82nd Annual Convention and expo., and "The Fresh Parade."** New Orleans, LA. Contact: 703/836-3410.	**Feb. 18-20—Southeastern Agribusiness Computer Conference and Trade Show,** Lakeland Civic Center. Contact: Dr. James L. App 904/392-1763.