Short Note 1.6

What is an Exposed Tree?

Defining Exposure

An exposed tree was defined within the 2002 citrus canker law of Florida (FS 581.184) as any citrus tree within 1900-ft of an infected tree. The 1900-ft rule has been regarded in the legal profession as a “bright line” or an unambiguous criteria, used to distinguished healthy and exposed trees. It is a label. If a tree is located at 1899.5 ft, it is exposed, but move it six inches, it is exposed.

My preference would call these trees, not as exposed, but simply “in-circle” trees as defined by law. The term “exposed” infers these trees are known to be less than healthy trees. There is no manner in which to simple test of a tree to determine if it has been exposed to citrus canker. The disease in local and not within the circulation system of the tree. However, a citrus tree thought to be exposed could be dug up and place it in a containment greenhouse, to see if symptoms to appear.

Throughout the program, the Department maintained that exposed trees would ultimately become diseased trees. When the program ended in January 2006, it is likely thousands or tens of thousands of exposed trees were left uncut. The Department never attempted to show how many of these trees ultimately became infected.

The Department also uses the terms, sub-clinically infected or asymptomatic infected plants in place of exposed trees. It is undeniable that in a laboratory setting, a citrus plant can be injected with a solution containing a high concentration of canker bacteria in a controlled environment and the tree is likely exposed to the bacteria as there is a high probability that the infection process will occur and lesions will appear at the surface. The act of injection has created an open wound, making egress of bacteria easier. It is also possible to retroactively state a tree was exposed to citrus canker in the past, if it develops symptoms of citrus canker.

It is a fact that in the two standard textbooks on plant disease epidemiology [1, 2], the word “exposed” is not used. However, it is a common word in environmental science and public health. In this context, one definition of exposure is as follows:

> **Exposure**: Contact of an agent with a target under conditions that will cause harm.

Exposure to toxic chemicals is a good example. If there is a discharge of a toxic chemical, and a person is close enough, there is can be certainty that harm has been done as the chemical is breathed in. Whether permanent damage to the lungs has occurred would typically involve more information on the particular chemical, the concentration of chemical, the likely dosage the person received, the time of contract and the physiology of the person.

In applying this definition to citrus canker, the agent may be considered the citrus canker bacteria, or “*Xac.*” But, does this bacteria really cause harm to the tree. Opponents will argue that the only harm is reduced profits of commercial grove owners, or the potential for trade embargos, which really never happened after January 2006. The tree's productivity might be affected, but this may not be a concern to homeowners.

The real problem with the term exposure, is it is impossible to tell if a healthy tree located a long distance from an infected one could become infected through windblown rain. Scientific experiments have been unable to identify any distance beyond 59-ft as documented in Chapter 6 of my book.

Long distance dispersal by windblown rain is either a very rare occurrence or impossible. There are many factors limiting transmission distances. Wet conditions are needed for both release and entry. The citrus host naturally resists infection. There is no guarantee of entry. The rain water may be too diluted to cause infection. The rain droplets coalesce on leaves and stems, and fall to the ground instead of leaving the canopy. This is more likely in a heavy rain and light wind. Generally, there are periods of susceptibility coinciding with new flushes on a citrus tree. Even the distance of 59-ft may be too high, as this experiment was done with a high density of seedlings, more representative of a nursery than a residential area.

Can an exposed tree be tested for the disease?

Generally, the Department would say no, but a small tree could be tested if dug up, and transported to a special containment greenhouse. It could be observed for a period of time, to see if canker lesions developed. The existence and strain of the citrus canker bacteria could be determined through laboratory testing. It would be a conclusive test. But there would have to be a thorough prior exam to show the tree had no symptoms.

Many residents have potted citrus plants, which the Department considered exposed by the 1900-ft rule. These plants could be been easily transported and tested in a containment greenhouse. According to the International Citrus Canker Research Workshop, a specially constructed containment greenhouse was located close to Okeechobee airport in Miami-Dade County. Symptoms of canker should appear within months according to the Department. It is noted that conventional sampling of plant tissue would not work, as citrus canker causes local infection. Testing of large citrus trees is impossible.

In the decades of eradication programs, there has been no known testing of trees within "exposed zones" by the Department. Certainly, if a sample of potted plants and dug up plants turned up positive for citrus canker and were in located within an eradication zone, it would help support the Department's claim. Many citrus trees were deemed exposed because they were inside multiple eradication zones. If these failed to show symptoms of canker, certainly it would be argued the 1900-ft zone is excessive.

The Department could have help demonstrated the labeling of trees within 1900-ft as exposed, is by taking advantage of the Broward Court case in November 2000, which prohibited the cutting of exposed trees within Broward County. From November 16, 2000 until June 20, 2001, the case was being appealed and the injunction was in effect. If they had monitored these exposed trees, it was possible to identify the percentage of trees which would become positive. In June 2000, Dr. Gottwald had presented the infamous 107 day time to maximum visibility to the International Citrus Canker Research Workshop, so it would be difficult to state that seven months or more, was insufficient time for exposed trees to turn positive. Also, it is noted the Department suspended cutting of exposed trees within Miami-

Dade County while the case was under appeal, providing them with a very extensive number of exposed trees.

Transmission Distances

Establishing transmission distances can be done through controlled experiments. The longest transmission distance ever established was 59-ft as described in Chapter 6 of my book.

However, Dr. Gottwald had testified in November 2000, that the 1900-ft rule was not based on any report, but rather the result of a consensus reached at an ad hoc meeting in December 1998.

In Chapter 7 of my book, I describe the field study results as meaningless for identifying the transmission distances. This is a result after thorough review of the method and results as in Appendix B and B1. Also, Dr. Gottwald indicated that the 1900-ft distance did not come from any report, so the connection to the field study is weak at best. Prior to the implementation of the 1900-ft rule, there were no reports made public. Chapter 9 in my book discusses the "miracle rain drop" which carries citrus canker over roofs, across roads and lakes, and is able to defy gravity, in order to infect another citrus tree in a residential areas up to 1900-ft away.

How Exposure Zones Concept began

When the eradication policy was challenged in court during Canker War II, the Department suggested that the citrus canker was similar to the "spreading decline" symptoms in citrus trees, whose causal agent is the burrowing nematode *(Radopholus similis).* [3] It was used in the Corneal case. The roots of the citrus tree are the food supply of this nematode. [3] The disease affects the citrus tree's vigor, growth and productivity. [3,4]

As nematodes reside in the soil, and will move with groundwater flow, there is no question of the spread of the disease. In fact, if there is a direction of groundwater flow based on elevation, then this is the direction the nematodes will flow. The soil can be sampled and the presence of nematodes can be determined.

> A typical spreading decline area consists of a group of trees all of which have the same non-thrifty appearance. The trees are stunted, have undersized leaves, sparse foliage, reduced terminal growth, lowered yields and extensive deterioration of the feeder root system below a depth of about 20 inches. Such trees remain in a non-thrifty condition indefinitely, but are not killed by this disease. Because of their deficient root system, diseased trees always wilt more readily during periods of drought than the adjoining healthy trees. They frequently show temporary improvement under favorable moisture conditions. The decline area is usually sharply separated from the healthy trees in the remainder of the grove, and the area may occur at any point in a grove. What distinguishes it from other declines is the fact that the area spreads continuously and about equally in all directions regardless of elevation or direction of rows and cultivation.
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> This constant spread in all directions is one of the most characteristic features of the disease and led to its name, "spreading decline." For years the measurable annual rate of spread was the most reliable characteristic for diagnosing spreading decline in a grove. The rate of spread of the decline condition to new trees varies from grove to grove and from year to year in the same grove, but the average rate of spread in 25 groves for 5 years was 1.6 trees per year on the margin, as reported by Suit and Ford (13). From centers of infection, spreading decline moves out in all directions in a grove and crosses wide mid-

> dles into other properties. So far, spreading decline has successfully crossed clay roads, asphalt roads with rights-of-way up to 100 feet wide and even railroad lines. Bridging these distances between groves is probably accomplished by root contact or near contact. At the edges of groves, the roots of rough lemon stocks have been traced outward for as much as 50 and 60 feet. The characteristics of spreading decline as outlined above are sufficient to differentiate it from other types of decline such as foot rot, water damage and psoriasis, which in some cases may produce trees of the same appearance but which do not spread in the same way.

It spreads in all direction. Its movement is observable as the soil can be sampled. It is systemic to the citrus tree, beginning with the roots. The harm is easily observed. Unique characteristics make identification easy.

The soil provides a continuous medium for the nematodes to spread. Eventually, the nematode will disperse in the soil and come in contact with their target, the citrus canker roots, and reduce the overall health of the plant. Interestingly, there is no need to identify exposure distances for spreading decline disease. There are a wide variety of treatments for nematodes. [3]

Comparison to the Citrus Canker Disease

An early pioneer in epidemiology, Ernst Gaumann wrote in 1946 (see Campbell [1] , page 16):

> Every epidemic develops by its own rules, changes its character, expands and becomes malignant, decreases and becomes milder: it has an appearance of its own, its own morphology, its own *genius epidemicus.*

Almost every aspect of the burrowing nematode is different from the citrus canker disease. The only common element is that they both result undesirable symptoms on a tree. The nematodes attack the root system, thus the health of the entire tree is affected. In contrast, citrus canker bacteria cause local lesions.

As far as determining exposure to other trees, it is a comparison of “the beauty and the beast.” The burrowing nematode is identifiable because all trees in the area have a non-thrifty appearance. It is predictable. It expands as it moves outward in all directions.

In contrast, citrus canker is elusive, symptoms often are difficult to find in dense canopies, and may be mistaken for other diseases. The environment for movement with ACC is discontinuous. Rain drops carrying citrus canker bacteria may go short distance before they land on the ground. They may never come in contact with another citrus tree particularly in a residential area. In short, the dissemination pattern of canker is described as patchy or scattered and unpredictable.

Summary

Public health literature discusses exposure, in terms of an agent coming in contact with a target, with a reasonable expectation of this event occurring under normal circumstances, and the harm to be significant. Inhalation of a toxic fumes from a chemical plant is a perfect example.

These criterion for the exposure definition are lacking with citrus canker. The field study is an observational study. A review of the results, in Appendix B, concluded the results were meaningless. Transmission distances as far as 1900-ft are not supported by controlled experimental studies.

Only consistent experimental data obtained under representative controlled conditions should be used to determine an exposure zone. For the citrus canker eradication program, there were no experiments conducted to determine dispersal distances.

References

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3. Duncan, L.W., Noling, J.W and Inserra, R.N., 2016 Florida Citrus Pest Management Guide, Ch. 14 Nematodes. Available online at http://edis.ifas.ufl.edu/cg010.
4. DuCharme, E.P., 1954, Cause and Nature of Spreading Decline of Citrus, Florida State Horticultural Society Proceedings. Available online at: http://fshs.org/proceedings-o/1954-vol-67/75-81%20(DUCHARME).pdf
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http://www.nationalaglawcenter.org/wp-content/uploads/assets/bibarticles/adamsetal_citrus.pdf

Also, see UF/IFAS Publication, on the burrowing nematode:

http://entnemdept.ufl.edu/creatures/NEMATODE/Radopholus_similis.htm