

Introduction¹

Several papers have been written by Dr. Jack O. Whiteside, plant pathologist (ret.) (Citrus Research and Education Center, IFAS):

- Whiteside, Jack O. 1985. Canker threat: how serious a threat is canker to Florida citrus production? *The Citrus Industry* 66 (11) : 8, 10, 12-14, 16-17.
- Whiteside, Jack O. 1986. Citrus canker: some facts, speculations and myths about this highly dramatized bacterial disease. *Citrus & Vegetable Magazine* xx: 14, 55-56, 64.
- Whiteside, Jack O. 1988. The history and rediscovery of citrus canker in Florida. *Citrus & Vegetable Magazine* 51 (8): 121, 37-41.

In these non-refereed articles, several issues are raised regarding the underlying science of the Citrus Canker Eradication Program (CCEP) of the 1980-1990s and by extension to the current CCEP. The following is a brief discussion of some of those issues.

Disease Establishment and Spread

Based on his observations of the disease Asiatic citrus canker in Argentina and several years experience working on citrus canker, Dr. Whiteside (1985) expressed doubts whether citrus canker could ever become a serious problem in Florida. He states that the potential impact of citrus canker has been exaggerated since 1910 when Asiatic citrus canker was initially introduced into Florida. Dr. Whiteside also suggested that Florida lacks favorable weather conditions for the disease to establish, and that citrus canker could be easily controlled with additional copper sprays even if it established in Florida's citrus groves.

Contrary to Dr. Whiteside's prediction, Asiatic citrus canker has become a serious problem since it was reintroduced into Florida in 1986, 50 years after it was declared eradicated from Florida. Citrus canker quarantine has expanded from the original 14 square miles in Dade County (confirmed in October 1995 near the Miami International Airport) to over 1000 square miles in South Florida in 2000. Asiatic citrus canker has also been detected in citrus-growing areas of southwestern and Gulf coast Florida. During the citrus canker spread study in urban Miami, it took only 6-8 months for one of a few selected focal infected trees (a single 25-year old grapefruit tree with just a few infected leaves) to become heavily infected (lesions on over 80 per cent of leaves and fruit).

Under normal weather conditions in South Florida, the causal bacterium can be dispersed 1900 feet or more from an original infected citrus (Citrus Canker Spread Study in Urban Miami from 1998-1999). Further, disease spread over a long distance is facilitated by catastrophic weather events, such as hurricanes and tornadoes, which are very common in Central and South Florida.

The serpentine mines caused by larvae of the Asian citrus leafminer (*Phyllocnistis citrella*), a pest first detected in 1993 in Florida, provide ample wounding on new growth to greatly amplify Asiatic citrus canker infection. Wounding by the Asian citrus leafminer presents a significant new advantage for the spread of Asiatic citrus canker in Florida.

Florida experienced a severe canker outbreak in the Siboney grove (Hendry County) in February 1999, where over 4,000 grapefruit trees were initially found infected with Asiatic citrus canker

bacterium. Some trees that were heavily infected showed defoliated canopies and severely blemished fruit. Additional infected grapefruit, Hamlin sweet orange, and Rohde Red Valencia were found positive for canker a few months later as survey efforts continued. The infested trees in the grove served as an inoculum source for about four years to adjacent groves before all control actions for the Siboney grove were completed. Recently, a similar disease scenario was observed in the County Line grove (Hendry County) in late November 2000, where 2,587 Hamlin sweet orange trees were infected with the bacterium. Many severely blemished fruit were seen in the grove. According to the disease spread pattern, it appears that Tropical Storm Irene or a tornado that swept the grove at the end of 1999 contributed a great deal to the disease dispersal within the grove. These and other field observations of disease intensity demonstrate that Asiatic citrus canker is and will continue to be a serious citrus disease under Florida's subtropical weather conditions.

Damage Impact

Dr. Whiteside also suggests in his papers that Asiatic citrus canker is not deadly or devastating in any way, which has led the general public to believe eradication of this disease is unnecessary. However, the adjective 'deadly' is not totally inaccurate, because the disease has been reported to kill mature Key lime trees in the Maldives and kill young citrus in Japan. On the other hand, 'deadly' does not reflect the usual outcome of Asian citrus canker on most citrus. The adjective 'devastating' certainly applies both in the biological and economic sense, as it reflects the manner in which the disease can lay waste to the crop and ruin its potential value.

There has never been a completely uninhibited occurrence of Asian citrus canker in Florida to establish its full potential for damage under our environmental conditions. Since the diseased trees are removed as soon as possible, no yield reduction studies have been done under such conditions. However, when Asian citrus canker has been present in an area of Florida for several years before being detected and dealt with by the regulatory agencies, the escalating damage to the more susceptible cultivars of citrus is very obvious and severe. This level of damage is consistent with damage evaluations from areas with climates similar to Florida. Damage does occur even though disease control strategies are employed.

Economic Costs

Assessments of the economic impact of Asian citrus canker in Florida have been extrapolated from field research in Argentina (Muraro 1986, 2000). These studies enumerate several additional production expenses (copper sprays - \$56 per acre per application, one to several applications may be required; windbreak installation and maintenance - \$45 to \$65 per acre per year; sanitation - \$40 to \$45 per acre per year; grove and packinghouse inspection - \$30 and \$31.50 per acre per year respectively). Even with these measure in place, fresh fruit crop losses were estimated at \$80 to \$160 per acre per year for early oranges, \$31 to \$79 per acre per year for mid-season oranges, and \$69 to \$137 per acre per year for grapefruit. The total additional costs may be as low as \$202 per acre to a high of \$357 per acre. These figures did not include the cost of equipment to apply the pesticides in a timely manner, nor did it include the lost revenues because of quarantines on exported fruit.

Mr. Kenneth Keck¹ (Florida Citrus Mutual) provided some economic conclusions if the eradication program was to be abandoned for residential and commercial citrus areas in Florida. The annual total cost of living with Asiatic citrus canker could reasonably approximate \$93.4 million in additional outlays by growers to contain canker, \$78.2 million in lost on-tree revenue to growers, and \$170.4 million lost F.O.B value of citrus shipments. Combined, this equals \$342 million annually. The citrus industry in Florida is estimated to impact the state's economy in the range of \$9 billion annually. Over 126,000 full time equivalent jobs rely directly or indirectly on the citrus industry.

Pesticides

Dr. Whiteside states that copper sprays have been effective on controlling citrus canker in Argentina and there has been an established copper spray schedule (three times a year) in Florida to control other citrus diseases. He suggests that one to two additional copper sprays should be sufficient to control citrus canker and other citrus diseases.

Although being widely used for the leaf spot type of bacterial plant diseases, copper compounds used as preventive bactericides have their limitations due to phytotoxicity, pollution, vulnerability to the environment, low duration, and high probability of inducing copper-resistant strains. Their efficacy greatly depends on type of pathogens, host they affect, pathogenesis, and environmental factors involving in the disease development. In Japan, copper compounds may have to be sprayed every week during the active growth of new shoots to prevent primary bacterial inocula from attacking spring shoots.

An earlier study conducted by Dr. Atherton Lee in Philippine and Japan in 1917 demonstrated that control of Asiatic citrus canker, including the use of copper spray on the very susceptible lime and grapefruit varieties, was not "economically feasible", but might be practical on the less susceptible varieties such as Navel sweet orange.

Reoccurrence or Reintroduction

Dr. Whiteside (1988) speculated that the disappearance of citrus canker from Florida in 1933 was not because of the eradication effort alone, but probably due to the incapability or difficulties of the disease to establish itself in Florida and the difficulties of thoroughly inspecting the foliage for canker lesions, particularly on larger trees.

There was almost 50-year span between the declaration of citrus canker eradication in Florida in 1935 and reappearance of the disease in Manatee County. Recent findings on the survivability of the citrus canker bacterium suggests there is no likelihood that the bacteria survived and went unnoticed this length of time. Also, if the bacterium causing citrus canker in Palmetto area (1984 and 1997), Miami area (1995), and Wellington area (1999) were actually the one left from the first citrus canker eradication campaign in 1910-1930s, the genotypes of the current pathogen should have an uniform genomic background. According to DNA fingerprinting performed by University of Florida and the Florida Department of Agriculture and Consumer Services, three genotypes of A-strain citrus canker bacterium have been detected since 1984. Each genotype represents a separate introduction of the pathogen.

¹ Keck, Kenneth O. 2001. Industry Costs of Living with Canker: The Legal, Public Policy and Dollar Implications of Halting the Eradication Effort. Florida Citrus Mutual, Lakeland, FL. 8 p.

Conclusion

There is a strong evidence indicating that recent Asiatic citrus canker outbreaks were not caused by any residual bacterium from the first occurrence of Asiatic citrus canker in Florida. Also, if Asiatic citrus canker were to become endemic in Florida there would be significant negative impact on the citrus resource, commercial and residential properties.

¹ Prepared by Dr. Xiaoan Sun, Dr. Timothy Schubert, and Dr. Wayne N. Dixon, Division of Plant Industry, Florida Department of Agriculture and Consumer Services. 12 April 2001