Changing Patterns of Disease in California Citrus

E. C. Calavan

Summary

The early years of the California citrus industry found few important citrus diseases which were troublesome to growers. The primary disease problems present were phytophthora gummosis and psorosis. As the industry has grown, other diseases have become important and may ultimately have a large impact. These diseases include dry bark and sieve tube nucrosis of lemon trees, tristeza and stubborn disease.

Introduction

Few of today's citrus diseases were very important in the last century during the early years of California's developing citrus industry. When citrus plants were imported into California many diseases (but not all) were left behind. Among citrus diseases present during the early years were phytophthora gummosis and psorosis (called scaly bark) but the causes of both diseases were unknown until about 1913 when Dr. H. S. Fawcett found the cause of much of the severe gumming on citrus roots and trunks to be phytophthora fungi, mostly *P. citrophthora* and *P. parasitica.* By that time, phytophthora had threatened to wipe out the lemon industry in California and had killed or damaged thousands of citrus trees of various other varieties.

Treatments for the prevention and cure of gummosis, including copper-containing fungicides, keeping irrigation water away from the trunks and careful regulation of irrigation, were soon devised and were put into practice by many growers. Growers also used gummosis-resistant sour orange rootstock for new plantings and thereby set the stage for a tristeza epidemic several decades later.

Psorosis

Psorosis had become an important citrus disease problem by 1900 in Florida and California. It was first described by Swingle and Webber in Florida in 1896 and had probably originated in the Orient. We assume that several diseases of the psorosis group, including crinkly leaf, infectious variegation, blind pocket and concave gum were introduced with early imports of citrus trees and budwood.

The nature of psorosis diseases was unknown until 1933 when Fawcett discovered that psorosis has leaf symptoms like a virus and is graft transmissible. This discovery boosted interest in virus-free stock and led to the first citrus registration program a few years later. It was soon possible to buy nursery trees propagated from parent trees registered as psorosis-free. By that time psorosis was the most destructive disease in many mature orange and grapefruit orchards. The development by Dr. J. M. Wallace of a short-term index for psorosis was a great step forward but this test was not used on all registered citrus trees until many years later after index methods were developed for other diseases.

Lemon trees, although frequently damaged by phytophthora fungi, had experienced relatively little damage from psorosis, except when grown on sweet orange rootstock. The lemon industry thrived within about 50 miles of the coast but it developed problems of its own. Old lemon trees showed a strong tendency to greatly overgrow their sour orange rootstocks and compress the bark at the bud union, thus effectively girdling the tree and causing its extensive deterioration. In later years when some mandarin orange rootstocks were used, this kind of girdling became even more severe. The problem still exists, especially in lemon trees of very vigorous budlines. The cause is believed to be the faster growth rate of the lemon compared with that of the stock.

Dry Bark of Lemon Trees

A very severe problem called dry bark developed in lemon trees during the 1940's. This disease proved to result from fungus infection of trunks and large branches, especially at the sites of shell bark lesions. The shell bark disorder is associated with exocortis infection but there is no proof that shell bark is the direct result of exocortis virus infection. Among the fungi involved in

the dry bark complex are *Dothiorella gregaria, Botrytis cinerea, Diplodia* sp., and *Phomopsis citri. P. citri* was once believed to be the cause of shell bark but it is now known that shell bark often occurs in the absence of phomopsis or other fungus pathogens. Fungi of various types do invade dying bark and under moist conditions cause gummosis lesions or contribute to the dry bark complex.

Treatment and prevention of dry bark involves moderate to severe pruning on a regular basis as suggested by Calavan and Batchelor. Pruning provides better aeration and stimulates the production of new bark.

Sieve Tube Necrosis

Another very important disorder of lemon trees, called sieve tube necrosis or lemon decline and collapse, damaged or destroyed thousands of lemon trees from 8 to 20 years old during the 1940's and 1950's. The anatomy of this problem was studied by Dr. H. Schneider, who showed that it is much more severe in some budlines than in others. The most susceptible trees should not be planted in locations where the problem is severe. Regular moderate pruning appeared to reduce the severity of this disorder but sieve tube necrosis, apparently due to an inherent weakness, remains an important problem in many coastal and coastal-valley lemon orchards. It does not seem to be greatly influenced by the kind of rootstock used.

Tristeza

A new and very catastrophic disease, tristeza, began to make itself felt in Los Angeles County in 1939 when some sweet orange trees on sour orange rootstock declined quickly and died. A massive research effort by the University of California showed, a few years later, that the cause was tristeza virus, the same pathogen that was killing many thousands of trees in Brazil and Argentina. The vector in California was shown to be *Aphis gossypii,* the melon or cotton aphid, which proved to be a relatively inefficient vector, unlike the efficient aphid, *Toxoptera citricidus,* in South America. Nevertheless, the disease was well established when discovered and gradually spread throughout sweet orange orchards in the Los Angeles basin during the 1940's, 1950's and 1960's. I estimate that southern California lost 3 million trees to tristeza. Had it not been for new subdivisions in the Los Angeles area the loss would have approached 8 million trees, for about 50% of all orange trees were on sour orange rootstock and, therefore, were very sensitive to tristeza virus. Sour orange rootstocks, which saved the orange industry from phytophthora gummosis here and abroad, made it an easy victim of tristeza.

A quarantine on the tristeza-infested area in California has slowed the progress of the disease and has saved about 3 million orange trees/sour orange in the Central Valley from destruction. Suppression and eradication measures have held down the spread of the disease and distribution of diseased plants in non-quarantined areas. The inadvertent planting of more than 12,000 infected but tolerant tristeza-infected trees in the protected Central Valley about 1961 was followed by an intensive suppressive effort, which removed the infected trees and continues to look for more infection, but now finds relatively little. In contrast, most orange trees in the Los Angeles basin are now tristeza-infected and clean young trees usually become infected within a few years after they are planted. In the Los Angeles basin and throughout the state, most new plantings of oranges are on tristeza-tolerant rootstocks, especially 'Troyer' and 'Carrizo' citrange, trifoliate orange, 'Cleopatra' mandarin and sweet orange.

The susceptibility of the citranges and trifoliate orange to exocortis virus makes it advisable to use exocortis-free scions on these rootstocks. Clean scions are easily obtained, especially from nucellar budlines, in the registration and certification program. In most situations the citranges have been satisfactory rootstocks but in some coastal valleys trees on citrange rootstocks are being badly damaged by tristeza virus. In some orchards it may be necessary to use sweet orange or mandarin rootstocks, and control the phytophthora, in order to avoid the ravages of virus diseases. We appear to have come almost full circle in using rootstocks to combat citrus tree diseases.

Stubborn Disease

A disease called stubborn now looms as the greatest threat to orange, grapefruit and tangelo production in California and Arizona. Stubborn has been present at least since 1915 but was of minor importance when most citrus was grown near the coast. As the citrus industry expanded inland into hot valleys the importance of stubborn increased until now there are about 2 million stubborn trees in California and the disease, already present in all citrus areas, obviously is spreading - spreading slowly in some areas and rapidly in others. The vectors are believed to be leafhoppers but this remains to be proved.

Stubborn appears to be caused by a pleomorphic mycoplasmalike organism, smaller than most bacteria, called *Spiroplasma citri* because of its tiny spiral filaments. The spiral stage of the organism is motile and can be seen by phase microscopy of living cultures. The organism has been cultured from stubborn citrus phloem and from insects. It is absent in phloem of normal trees.

Some orchards have 50% or more stubborn trees and the disease is so bad in some localities that production of grapefruit and navel oranges is extremely low there. Some orchards are uneconomic because of stubborn. The industry is, therefore, faced with the problem of controlling and preventing stubborn and controlling the vectors of stubborn or of taking extensive losses in some areas because of stubborn.

An attempt is now being made to detect stubborn in budwood source trees, in the nursery, and in young orchards. If successful, this will hold down the amount of stubborn in new plantings. Stubborn is primarily a disease of young trees, except in the hottest valleys where mature orange and grapefruit trees are sometimes lost to stubborn. Elsewhere, trees that escape stubborn while they are small usually remain free of it indefinitely. In the future the citrus industry must use clean budwood and eliminate stubborn-diseased young trees or risk being overwhelmed by stubborn.

There is one bright spot with respect to stubborn; lemon trees, although susceptible, are rarely attacked by the stubborn pathogen. Moreover, there is apparently little natural spread of stubborn in the coastal area where the majority of our lemons are grown.

The California citrus industry certainly has had its share of destructive diseases and, despite changes in rootstocks and scions, it continues to suffer losses from phytophthora diseases, stubborn, tristeza, exocortis, dry root rot and some other diseases. Still, we are fortunate indeed to have no greening disease, mal secco, black spot, canker, scab, cristacortis, or impietratura, and apparently no young tree decline although we occasionally lose mature orange/rough lemon trees for unknown reasons.

Although millions of lemon trees/Alemow could be ruined by tristeza and sweet orange or grapefruit on any rootstock is subject to heavy damage by stubborn or stem pitting tristeza we believe we can meet the challenge of these diseases by continued research, the cooperation of the citrus industry, and a sound registration and certification program.