# Epidemiology of Citrus Leaf Mottling in the Philippines

R. E. CORTEZ and C. S. CELINO

THIS PAPER presents the results of country-wide surveys launched by the Philippine Bureau of Plant Industry, with the technical assistance of FAO, to determine the incidence and epidemiology of citrus leaf mottling, a viruslike disease. First observed near Lipa City in 1957, leaf mottling was subsequently shown to be caused by a pathogen distinct from tristeza, and to be transmitted by the citrus psylla *Diaphorina citri* Kuw. (2, 3). It spread rapidly until the citrus industry of Batangas Province, the major citrus region of the country, was practically wiped out. The first survey was made in 1965–66, the second in 1968–69. The second survey also included observations on the populations of the insect vector. A total of 105 orchards and nurseries were observed in the first survey, a total of 38 in the second.

## *Materials and Methods*

The disease was diagnosed by general growth of the trees and by symptoms on leaves and fruit. Bud sticks taken from representative trees with distinctive symptoms, and from adjacent apparently healthy trees when such were present, were grafted into healthy indicator seedlings in a screenhouse at the Lipa Experiment Station, 5 or more trees of each grove being indexed in this manner. The indicator varieties used included Madam Vinous sweet orange, Sexton tangelo, and rough lemon.

All the indicator varieties developed symptoms within 3 months. Infected seedlings of Madam Vinous sweet orange became stunted; their young leaves were yellowed. As the leaves matured, a distinctive zinc-deficiency pattern, with prominent veins, developed.

Infected seedlings of Sexton tangelo were markedly stunted; their young leaves turned white or light yellow. As the leaves matured, they developed zinc-deficiency patterns with prominent veins.

Young leaves of infected rough lemon seedlings were chlorotic and subsequently developed a measles-like mottling. The symptoms did not, however, persist as the seedlings grew older.

Symptoms on seedling indicator plants maintained in a screenhouse were more severe during hot summer months than at other seasons.

Incidence of the insect vector was determined by examination of 100 young shoots from citrus trees selected at random in each grove visited. The incidence is expressed as a percentage of young shoots infested.

TABLE 1. RESULTS OF INDEXING FOR LEAF-MOTTLE VIRUS IN 1965–66

| Region | Number of groves surveyed | Number of groves indexed positive |
|---|---|---|
| Batangas, Laguna, Quezon, Rizal, and Cavite | 58 | 47 |
| Bicol | 20 | 1[a] |
| Mindanao | 12 | 0 |
| Mountain Province | 10 | 0 |
| Mindoro | 5 | 1[b] |

a. One of the 5 representative trees from a grove in Tigaon, Camarines Sur, was positive.
b. One of the 5 representative trees from a grove in Calapan was positive.

## *Results*

Data from the first survey (Table 1) suggest that leaf mottling occurs only in well-defined areas, notably Batangas, Laguna, Quezon, Rizal, and Cavite provinces, and in one orchard each in Oriental Mindoro and Camarines Sur.

Many trees in orchards of the Bicol region and in Mindanao had symptoms resembling those of leaf mottling, but those tested indexed negative. It is presumed that these symptoms were not caused by an infectious agent but rather by a soil factor.

Data obtained in the second survey (Table 2) indicate that, thus far, the disease is a problem only in South Central Luzon, consisting of the provinces of Batangas, Laguna, Quezon, Rizal, and Cavite. Actually, the Philippines can be divided into 3 zones on the basis of the incidence of leaf mottling.

Zone 1 consists of the province of Batangas in south-central Luzon. It is a region with a high incidence of disease and large populations of the vector. Nucellar trees that are planted in the zone do not prosper and usually die before reaching bearing age.

Zone 2 is a region with an interme-

TABLE 2. RESULTS OF THE SURVEY FOR THE VECTOR *Diaphorina citri* KUW., JULY 1968–JUNE 1969, AND INDEXING FOR LEAF-MOTTLE VIRUS

| Location | No. of groves surveyed | Total no. trees indexed | No. trees positive | Insect population (mean of means[a]) |
|---|---|---|---|---|
| South-central Luzon | 10 | 135 | 72 | 18 |
| Bicol region | 11 | 125 | 6 | 9.1 |
| Mindoro | 4 | 70 | 3 | 10.9 |
| Mindanao | 6 | 90 | 4 | 6.1 |
| Cebu | 2 | 10 | 1 | 38.2 |
| Northern Luzon | 5 | 40 | 1 | 0.7 |

a. The figures represent the means of the percentages of young shoots infested of those examined.

diate incidence of disease and populations of psylla ranging from low to high. It includes the provinces of Laguna and Cavite in south-central Luzon, certain locations in the province of Camarines Sur, General Santos City in Cotabato, and Mandawi in Cebu. Declining trees in this zone were found only in young groves. Nucellar trees planted in the zone within the past 5 years have grown well.

Zone 3 consists of areas in which there is no natural spread of leaf mottling because either the virus or *Diaphorina citri* is not present. Infected trees in the area consist only of those introduced from zone 1 as seedlings, budded or not budded. This zone consists of those citrus-growing regions of the Philippines not included in zones 1 and 2.

Results of the survey also reveal that leaf mottling has spread to areas previously rated as disease-free. The high rate of spread, particularly in Batangas, is the result of the widespread occurrence of reservoirs of the pathogen and the high populations of the vector. Natural spread is not taking place in many other areas because either the vector or the pathogen does not occur there.

## *Discussion*

*Diaphorina citri* is widely distributed in the Philippines, but its population density varies considerably. According to Catling and Anneke (1), the main factors regulating the population of *Trioza erytreae* (Del Guercio), a psyllid closely related to *D. citri,* are flushing rhythm and quality, natural enemies, and extremes of climate. If there is indeed a correlation of flushing rhythm and population of *D. citri,* trees in the rainy areas of Oriental Mindoro and Davao would be expected to have more insects—the trees flush there throughout the year—unless other factors control the population. The actual situation is the reverse (Table 2), there being a higher population in Batangas than in Davao.

In South Africa, high temperatures (above 30°C) and low relative humidity are lethal to eggs and young instars of *T. erytreae* (1). *Diaphorina citri* is not subject to such climatic extremes in the Philippines; variability in its population density must result from other factors. One such factor could be natural enemies, which undoubtedly exist in the Philippines. Their relationship to the vector, as well as the effects of climate on the insect, merit further study.

The evidence is clear that citrus groves in zones 1 and 2 are facing extinction within the foreseeable future. An ideal control program for these zones would be the use of tolerant varieties, but no really tolerant varieties are known to exist. A search for such tolerance is under way at the Lipa Experiment Station where studies are being conducted on numerous nucellar varieties introduced from abroad.

Another approach to a practical control program for leaf mottling is control of the vector. Whereas there is little likelihood that the citrus psylla can be eradicated, it may be possible

to hold its populations to a low level by a rigid spray program. As a matter of fact, the only psyllids found in Davao and Cotabato were in non-sprayed groves.

Investigations directed toward biological control of the vector should also be undertaken since there are indications that significant transmission of leaf mottling requires a high concentration of vectors. Predators of *D. citri* do exist in the Philippines. Their study is now being pursued.

## *Literature Cited*

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