The Distribution of Greening in Citrus Areas of South Africa

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THIS PAPER reports a survey of the distribution of greening disease in the citrus areas of South Africa and a comparison of the symptoms of infected trees grown under different conditions. Schwarz (3) and McClean and Oberholzer (2) recently showed that greening disease is caused by an insect transmitted virus.

Materials and Methods

In the major citrus-growing areas of the Transvaal, the Cape, and Natal, more than 300 sweet orange [*Citrus sinensis* (L.) Osb.] orchards

were inspected in 1965 and 1966. Special attention was concentrated on nurseries, orchards with trees that originated in nurseries in greening areas, orchards experiencing abnormal growth of trees, and orchards with trees bearing abnormal fruit. Diagnosis of greening was based on leaf, fruit, and general growth symptoms. As a further aid to diagnosis, 20 fruits from each orchard were halved and examined under ultraviolet light for the specific violet fluorescence of the albedo (4).

Results and Discussion

INCIDENCE OF GREENING IN THE PROVINCES.—The greening survey shows that the disease occurs mainly in the Transvaal; it is especially serious in the localities of White River, Tzaneen, and Rustenburg, where the citrus psylla (*Trioza erythreae* del Guerico) is plentiful or has been plentiful in past years.

The Orange River district of the northern Cape was found to be free of greening. In the western and eastern Cape, only a few orchards contained diseased trees, and in every case such trees came from nurseries in greening disease areas of the Transvaal. The citrus psylla occurs in the Cape Province, but only sporadically and in small numbers. There was no evidence of secondary spread in the Cape Province.

Greening was found in Natal in several orchards having trees that also came from nurseries in "greened" areas. There was evidence of secondary spread at three places, Muden, Pietermaritzburg, and Richmond, where psyllids were plentiful.

The survey showed that nurseries located where greening is prevalent were responsible for distributing infected trees to many citrus areas previously free of the disease. This dispersion apparently occurred during the past six to eight years. Many orchards in the Cape Province were established with trees purchased from Transvaal nurseries. Of 23 such orchards planted between 1935 and 1950, none were found to contain diseased trees. However, most orchards established after 1955 contained diseased trees. The percentage of diseased trees varied from 3 to 100. The latter orchard was established in 1963. The survey also showed that the number of infected trees supplied from nurseries in "greened" areas of the Transvaal increased sharply between 1958 and 1963. This correlates well with the occurrence of severe infestations of citrus psylla where the nurseries are located.

VARIATION IN THE SEVERITY OF GREENING SYMPTOMS.—Leaf symptoms of greening are more pronounced in winter than in summer and show up more clearly in the high, cool areas than in the low, hot areas. Con-

sequently, a survey for greening should be made in the coolest season of the year, and at that season fruit symptoms can be used as an additional criterion. Such fruit symptoms would include lopsidedness and off-color as well as internal indicators such as aborted seeds and the specific fluorescence in the albedo.

ALBEDO FLUORESCENCE TEST.—The albedo fluorescence test described by Schwarz (7) distinguishes between zinc deficiency due to a high pH in the soil and the zinc deficiency symptoms caused by greening. The albedo fluorescence test was negative in all fruits from trees showing severe zinc deficiency in the Orange River area, an area with very alkaline soils, but was positive in many cases when fruits from zinc deficient trees in the Transvaal were tested. In low, hot areas, where the symptoms are masked to a considerable extent, the test was especially useful.

GENERAL SUGGESTIONS ON GREENING SURVEYS.—In the early stages of a survey other methods should be used to ascertain whether greening is present in an area, as follows:

(a) Suspected trees should be indexed on sweet orange or tangelo seedlings by bud- or graft-inoculations. Because of the low percentage of positive transmissions occasionally obtained, a rather large number of transmissions should be attempted. Calavan and Christiansen (1) suggest a similar procedure for indexing stubborn. About 3 to 4 months is required for greening symptoms to appear.

(b) Cucumber was the only herbaceous host to react after inoculation with greening (8). The first symptom, which appears about 8 days after inoculation, consists of yellow lesions on the cotyledons. Later, the yellow areas spread and the cotyledons collapse. About 12 to 15 days after transmission, the veins of the first true leaf show yellowing and later become necrotic. In most cases, the upper leaves do not develop symptoms, but the vigor of the plant is reduced. The success of mechanical transmissions varies considerably, depending on the virus strain, the temperature at which the transmission is attempted, and the time of the year at which the leaf material is taken.

(c) Trap plants, glasshouse-raised sweet orange seedlings, were exposed to insects for certain periods (5, 6). This method can be applied only in areas where the psylla vector is common. The psylla vector was often more efficient in transmitting the disease than was either bud- or graft-inoculation. As many as 80 per cent of the trap plants became infected when exposed for one season in an affected orchard, whereas graft inoculations with material from the same orchard caused infection of only 5 to 10 per cent of the seedlings.

The present survey has given valuable information on the distribution of the disease and also important data on factors affecting symptom expression and the spread of the disease.

A more detailed report of this survey will be published in the South African Journal of Agricultural Science.

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