Combined Effects of Greening and Seedling-Yellows Pathogens in Citrus

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THIS PAPER describes studies of the reactions between the pathogens of greening (leaf-mottle-yellows) and seedling yellows. Preliminary results of the studies have been published (4).

Concurrent infections with certain unrelated viruses are known to induce more severe effects or injury in the host plant than infections with a single virus (5, 6, 7, 8, 9). Weathers (8, 9) demonstrated that citrus plants dually infected with yellow-vein and vein-enation viruses exhibited more severe yellow-vein symptoms than plants infected only with yellow-vein virus. He also demonstrated that plants doubly infected with viruses of psorosis and yellow vein developed more severe leaf symptoms of psorosis and more stunting than those infected with psorosis virus alone (9).

Materials, Methods, and Results

Young budlings of Ladu, ponkan, and Szinkom mandarin on calamandarin and Florida rough lemon rootstocks were inoculated with the seedling-yellows and greening pathogens, some plants being inoculated with one or the other of the pathogens alone and others with the two together. Noninoculated budlings of each stionic combination were maintained as controls.

Budlings inoculated with seedling-yellows virus alone were slightly stunted and had smaller leaves but developed no other symptoms. Those inoculated with the greening pathogen alone became severely yellowed, mottled, and stunted. Budlings inoculated simultaneously with seedling-yellows and greening pathogens were more yellowed, mottled, and stunted than those inoculated with the greening pathogen alone (Fig. 1). Moreover, a large number of the doubly infected plants collapsed earlier than those infected with the greening pathogen alone. No symptoms were observed in the control plants.

In another test, healthy budlings of the same stionic combinations as those used in the first experiment were treated similarly except that the double inoculations were made by introducing one of the pathogens first and the other 3 or 4 months later. Results of these tests were the same as with the simultaneously inoculated plants: budlings with combined infections exhibited more severe symptoms and more stunting than those with single infections.

Discussion and Conclusions

Dual infections with greening and seedling-yellows pathogens resulted in more severe leaf symptoms and more stunting than infection with the

FIGURE 1. *Budlings of Szinkom on calamandarin, from left to right: no inoculation; inoculated with seedling-yellows virus alone; inoculated with the greening pathogen alone; and the rest, inoculated simultaneously with seedling-yellows and greening pathogens. Note the combined effect of these two infectious agents on this stionic combination.*

greening pathogen alone. Dually infected plants generally collapsed earlier than singly infected plants. Increase in severity of leaf symptoms and retardation in growth, as well as sudden collapse of plants with double infections, are apparently additional effects, or an increased activity of the greening pathogen in the presence of seedling-yellows virus. Various workers have reported interactions between viruses that bring about an increase of one virus in the presence of another (5, 6, 7, 9). The reactions between greening and seedling-yellows pathogens are similar to those reported for the viruses of yellow vein and vein enation and for the viruses of psorosis and yellow vein (8, 9). In doubly infected plants, seedling-yellows virus may have stimulated an increase in the multiplication rate of the greening pathogen. In the absence of techniques for measuring concentration of the respective pathogens, it cannot, however, be determined whether such an increase actually occurs. Increase in severity of symptoms may result simply from an additive effect of the 2 pathogens. Severe strains of tristeza and seedling-yellows viruses

have detrimental effects, even though slight, on most tolerant stionic combinations. Combining this injury with that caused by the greening pathogen may result in more severe effects and earlier collapse of trees.

It has been established that greening is responsible for much of the decline and death of citrus trees in the Philippines since 1957 (2, 3, 4). Because it has been demonstrated that a combination of greening and seedling-yellows pathogens causes more severe effects than either pathogen alone, it is now evident that the latter has been contributing to some extent to deterioration of orchard trees in Batangas province. Seedling-yellows virus is widely distributed in the Philippines (1); it was found in all orchard trees that were indexed. It has not therefore been possible to measure the effects of the greening pathogen alone in orchard trees. It is undoubtedly the primary cause of the serious tree decline in the Philippines, but it is also evident that seedling-yellows virus speeds up the decline, at least when combined with greening virus.

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