Accentuation of Satsuma Dwarf Symptoms by Seedling-Yellows Virus

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WHEN SATSUMA DWARF virus (SDV) was transmitted mechanically from a satsuma mandarin tree to kidney bean and then from kidney bean to satsuma seedlings by injecting them with partially purified sap, the symptoms produced were milder than those in the original satsuma tree from which SDV was obtained (1). This mildness of symptoms—together with the fact that the original field tree was shown (3) to carry seedling-yellows virus (SYV) as well as SDV—suggested the possibility that the presence of SDV and SYV is necessary to induce typical SD symptoms. This possibility was tested by the following experiment.

Materials and Procedure

The source of the SDV was a satsuma seedling that had been infected by injection with partially purified sap from an infected kidney bean plant (1). The source of SYV was a diseased field tree of the Silverhill variety of satsuma mandarin.

In September 1967, buds from the source trees were grafted into satsuma seedlings to obtain plants inoculated with each of the following: SDV alone, SYV alone, and SDV plus SYV. Five seedlings were used for each combination and 5 more as controls.

The test seedlings were kept in a screenhouse from Sept. 1967 to May

1969, when they were severely pruned and transferred to a biotron maintained at 18°C at night and 23°C during the day, these temperatures are suitable for development of severe symptoms of SD. A final evaluation of symptoms in the test seedlings was made in September 1969.

Results

Characteristic symptoms of SD in naturally infected satsuma trees include shortening of internodes and malformation of leaves. The malformations involve boat-shaped, spoon-shaped, and crinkled leaves. Crinkling of leaves may appear alone or be associated with either boat-shaped or spoon-shaped leaves. The percentages of leaves with the different malformations and the length of shoots as determined in May and September 1969 are summarized in Table 1.

It is evident from the results that neither the control plants nor those inoculated with SYV developed typical symptoms of satsuma dwarf and that average shoot length in the 2 groups was about equal. Seedlings inoculated with SDV alone developed small percentages of typical boat-shaped and spoon-shaped leaves and had less shoot growth than normal. Those inoculated with both SDV and SYV developed large numbers of boat-shaped and spoon-shaped leaves—totaling more than 50 per cent of all leaves in both growth periods—and produced shoot growth about one-third that of control plants. The doubly inoculated seedlings showed about the same intensity of symptoms as field trees naturally infected with both viruses (Fig. 1).

Crinkling, a condition present in presumably healthy trees of satsuma mandarin, appeared in 17 per cent of the leaves of the control plants and in 25–33 per cent of the leaves of trees inoculated with either SDV or SYV alone. When both viruses were present, the percentage of crinkled leaves was about doubled.

TABLE 1. SYMPTOMS RESULTING FROM SINGLE AND DUAL INFECTIONS OF SATSUMA DWARF (SD) AND SEEDLING-YELLOWS (SY) VIRUSES IN SATSUMA MANDARIN

Virus inoculated	Boat-shaped (%)	Spoon-shaped (%)	Crinkle (%)	Length of shoots, mean (mm)
		May		
SYV	0	0	25	
SDV	5	11	33	
SDV + SYV	16	46	62	
Control	0	0	17	
		September		
SYV	0	0	32	65
SDV	2	11	26	47
SDV + SYV	48	33	81	28
Control	0	0	0	72

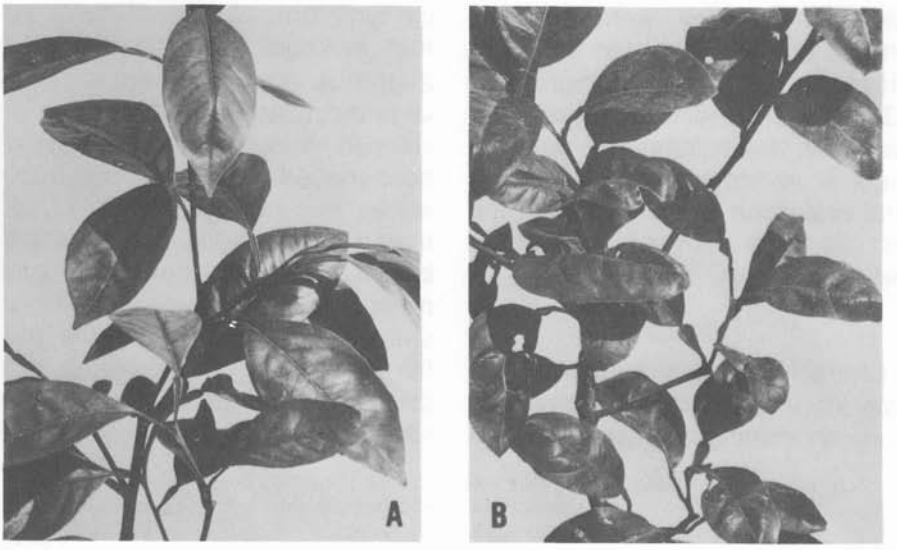

FIGURE 1. *Accentuation of satsuma dwarf symptoms in seedlings of satsuma mandarin by seedling-yellows virus. A. Healthy. B. Infected with a combination of satsuma dwarf and seedling-yellows viruses.*

Discussion

The results make it clear that SYV, shown by Yamada and Tanaka (3) to be symptomless in satsuma mandarin on trifoliate orange rootstock, strongly accentuates the symptoms of SDV in satsuma. The results lead to the conclusion that a synergistic reaction between SDV and SYV occurred—a synergistic reaction comparable in some respects to that which Weathers (2) reported for dual infections with vein-enation virus and yellow-vein virus on the one hand and for vein-enation virus and psorosis virus on the other.

The crinkly-leaf symptom, found both in control and inoculated plants, requires further study. Although crinkly leaf has previously been ignored as a virus disease symptom, the moderate to high percentages found in plants inoculated either singly or jointly with SDV and SYV suggest that crinkly leaf may be either a symptom of virus infection or an inherent genetic factor capable of being accentuated by a virus infection.

Literature Cited

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