J. M. WALLACE, A. L. MARTINEZ, and R. J. DRAKE

Further Studies on Citrus Seedling Yellows

CITRUS PLANTS with symptoms of seedling yellows are infected with a virus mixture comprised of two distinct components. Both components are present in all inocula which will induce the symptoms of seedling yellows. The letters "SY" are used by the writers to designate the virus mixture. One of the components which we have identified as "SYT" can be separated from the mixture. A second component, at least when combined with SYT virus, is responsible for the seedling yellows symptoms. It has not been obtained free of, or separated from, SYT virus. It commonly disappears from infected plants of lemon and sour orange which recover from symptoms of seedling yellows.

There seem to be many strains of the SY virus mixture which differ in virulence on citrus host plants and in other characteristics. Ten sources of seedling yellows inducing virus have been studied. These are identified as SY1 to SY10. After plants recover from yellows symptoms the virus remaining in them will cause the lime reaction (vein clearing and stem pitting) but it will not cause yellows symptoms on lemon [*Citrus limon* (L.) Burm. f.], sour orange (*C. aurantium* L.), or grapefruit (*C. paradisi* Macf.). This phenomenon permits the separation of this virus from the SY complex or mixture. The SYT components associated with seven of the ten sources of SY mentioned above were studied experimentally and are identified as SYT1 to SYT7, the numerals indicating the SY strain from which the SYT strains originated.

Wallace and Drake (2) reported that after recovery from symptoms of yellows and the loss of the yellows-inducing virus, lemon plants had a high degree of resistance or protection against reinfection with seedling yellows virus. Further study corroborated this, but it was found that

the degree of protection depends upon the strain of SY from which a plant recovers; in other words, the strain of SYT remaining in the recovered plant and the strain of SY virus used for the challenge inoculation. An example of this is that SYT6 in recovered plants gave complete protection against SY8, whereas plants that recovered from SY5 and were carrying SYT5 were quite severely affected when reinoculated with SY8. It was also of interest to find that plants carrying SYT3 after recovery from symptoms produced by SY3 had no protection against any of five strains of SY used for reinoculation.

The primary aim of these studies was to explore further the nature of the seedling yellows virus complex and to identify its components and their relationships to the naturally occurring tristeza (T) virus in California.

When strains of SYT and T viruses were inoculated into healthy lemon seedlings, the only effect was a gradual reduction in growth. The SYT strains usually stunted the plants somewhat more than the tristeza (T) virus strains. When lemon seedlings infected by direct inoculation with SYT and T viruses were challenge-inoculated with SY virus there was a temporary protection. Seedling yellows symptoms were slow in appearing and differed somewhat from those on healthy plants inoculated with SY virus. However, on the basis of size of plants after eight months most of the reinoculated seedlings were as severely affected as the healthy plants inoculated only with SY virus. For a period of time following reinoculation with SY virus, the SYT-infected seedlings appeared to have more resistance than the T-infected seedlings, and this was reflected to some extent at the end of the experiment when the green weights of the plants were recorded.

Evidence was obtained that sour orange is a better host for SYT virus separated from the seedling yellows complex than for T virus obtained from naturally-infected field trees in California. This suggests a difference between the two viruses, but more extensive studies may reveal that there are strains of both SYT and T viruses to which sour orange reacts the same.

It was shown experimentally that aphids (*Aphis gossypii* Glover) can transmit the seedling yellows complex from yellows-infected plants and the seedling-yellows-tristeza (SYT) component from SYT-infected plants. Also it was demonstrated that the aphids can selectively transmit the SYT component from plants carrying the seedling yellows complex. Thus the same insect species can transmit separately the virus complex

responsible for seedling yellows and the seedling yellows tristeza and tristeza viruses.

It was clearly demonstrated that both the SY virus complex and the SYT virus component cause the lime reaction. Most sources of seedling yellows studied caused more severe symptoms on lime seedlings than the field sources of tristeza, but there were exceptions to this. In some instances, strains of SYT virus caused symptoms on lime as severe as those caused by the SY strains from which they were separated but, in general, the SYT strains induced milder symptoms on lime than the strains of SY from which they originated.

Inoculations of tristeza-sensitive budded trees with SY strains and corresponding SYT strains of virus demonstrated that both cause typical tristeza decline. Different SY strains varied as widely in virulence on budded trees as did different strains of tristeza. In all instances the SY strains were more virulent on budded indicator trees than the respective SYT strains separated from them. There were instances where the SYT component from one source of SY virus caused symptoms more severe than the symptoms caused by other sources or strains of SY virus. Also some strains of tristeza (T) virus were more virulent than some of the strains of SY and SYT.

The writers suggest that the symptoms of seedling yellows may result from infection with two viruses which are probably distinct and unrelated. One of these is certainly closely related to the tristeza virus. The other can be a virus which has no effect on citrus hosts unless it is combined with the tristeza-like virus. This presupposes that seedling yellows symptoms result from a synergistic reaction of tristeza virus and an unidentified virus.

Evidence supporting the suggestion that this unknown virus is not related to tristeza virus is found in the fact that it regularly disappears from plants which grow out of the yellows symptoms. None of many strains of tristeza (T) and seedling-yellows-tristeza (SYT) viruses so far studied has been found to disappear from infected Eureka lemon plants. In other words, the non-persistence of the yellows-inducing virus in hosts that are extremely sensitive to it is believed to support the idea that this component of the seedling yellows virus mixture differs widely from the tristeza virus.

These studies have demonstrated that the seedling yellows complex, the SYT virus separated from seedling yellows, and the naturally-occurring tristeza virus strains in California each cause the lime reaction

and the tristeza decline of budded trees. Therefore, these reactions do not support the contention of Fraser (1) that the seedling yellows virus is the cause of tristeza (decline of budded trees) and that the accompanying virus causes the stem pitting of citrus trees.

Literature Cited

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