Susceptibility of Citrus Cultivars to Impietratura

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THIS PAPER deals with a 4-year-long investigation of impietratura, which was carried out to determine: a. the effect of the disease on the production of certain species and varieties of citrus; b. whether impietratura virus is localized in tissues of affected fruit; and c. the response to infection of some citrus cultivars not previously tested as hosts of the virus. Preliminary results have been published (3, 4).

Procedures

Inoculum sources consisted of 4 trees of Ovale sweet orange (Ov2, Ov5, Ov7, and Ov8), each with a different range of symptoms. Inoculum from each source was placed in from 2 to 4 trees of each variety tested, with no tree receiving inoculum from more than 1 source. In November 1965, a total of 96 trees of the 12 cultivars listed in Table 1 were inoculated in their 1–2-year-old stems with bark grafts from the source trees. Four additional trees of each cultivar were kept without inoculation as controls. The test trees of 10 cultivars were 2 years old on sour orange rootstocks. The remainder, volkamer lemon and sour orange, were 3 years old on their own roots. Many of the grafted

trees had leaf symptoms of psorosis and probably were also infected with exocortis virus since this virus is widespread in Sicily. In 1968 and 1969, some trees showed early symptoms of cristacortis.

Yields of the test trees were recorded each year; fruit were carefully peeled to detect symptoms. More than 10,000 fruit were examined during 1967, 1968, and 1969—a minimum of more than 500 fruit of grapefruit and a maximum of more than 2,000 fruit of mandarin. Two criteria were used for evaluating the severity of disease in each cultivar: the frequency (F), which is the percentage of diseased fruit of those examined, and an infection rating (I). To calculate I, fruit were grouped into 3 classes with numerical ratings as follows: 1. those with very slight symptoms such as thin, diffuse gum deposits in the albedo, not detected in fruit without peeling them; 2. moderate symptoms such as large gum deposits in the albedo, visible only in peeled fruit, frequently localized under the calyx; and 3. severe symptoms such as small, malformed, stonelike fruit with swollen areas filled with gum. The infection rating was then calculated (1) as follows:

$$I = \frac{\text{sum of all numerical ratings} \times 100}{\text{total number of fruit produced} \times 3},$$

which gives a comparable index of disease severity.

TABLE 1. PERCENTAGE OF DISEASED FRUIT (F) AND INFECTION RATING (I)[a] IN VARIOUS CULTIVARS AT VARIOUS TIMES AFTER INOCULATION WITH IMPIETRATURA VIRUS

Cultivar	1967	1968		1969		1968–1969	
	F	F	I	F	I	F	I
Marsh grapefruit	73	57	41	74	52	65	46
Volkamer lemon	0	18	14	40	40	35	33
Avana mandarin	0	1	1	1	0	1	0
Clementine mandarin	0	1	0	2	2	2	1
Sour orange	0	1	0	1	0	1	0
Feminello S. Teresa lemon	0	1	0	0	0	0	0
Sweet orange vars.							
Valencia	11	30	26	41	34	37	31
Sanguinello comune	7	26	19	22	19	23	19
Tarocco	3	14	9	13	9	14	9
Sanguinello moscato	23	15	7	11	7	12	7
Moro	0	4	4	8	5	6	4
Washington Navel	11	7	3	13	11	12	9

a. See text for equation.

Results

FREQUENCY OF SYMPTOMS (F) AND INFECTION RATING (I) IN VARIOUS CULTIVARS.—The first significant crop was that of 1967, but only F was determined because only a few trees fruited. Values for both F and I were obtained in 1968 and 1969. The data averaged according to years are in Table 1. Noninoculated trees remained symptomless during the course of the work.

The inoculated grapefruit and sweet orange trees dropped many fruit during summer; most of the dropped fruit had gum deposits under the calyx. Inoculated lemon, Clementine mandarin, and Avana mandarin trees dropped a few fruit. The inoculated trees of volkamer lemon and sour orange did not drop any.

In other experiments only 17 fruit of Clementine mandarin (2 per cent) and 4 fruit of Avana mandarin (1 per cent) showed symptoms, but 64 per cent of Tarocco sweet oranges were affected.

INOCULATION OF OTHER CITRUS CULTIVARS.—A small portion of the albedo from a severely affected Marsh grapefruit tree was inserted under the bark of a test plant to see whether impietratura virus could be detected in the fruit. Six seedlings of 2-year-old volkamer lemon, 6 of 2-year-old Rangpur lime, and 3 of 3-year-old Marsh grapefruit were inoculated in this manner. Two years later, impietratura symptoms were observed in the fruit of some of the inoculated plants of volkamer lemon (Fig. 1) and grapefruit.

Discussion and Conclusions

The results obtained in this investigation reveal differences among citrus cultivars in tolerance to impietratura virus. The high degree of susceptibility of grapefruit and sweet orange was confirmed, and volkamer lemon was revealed to be highly intolerant. Thus, volkamer lemon would seem to be a good indicator plant to use for impietratura; it can be inoculated in the seedling stage and will bear fruit in 2–4 years, whereas grapefruit and sweet orange cannot be used as indicator plants until 2–3 years after grafting.

Clementine mandarin, Avana

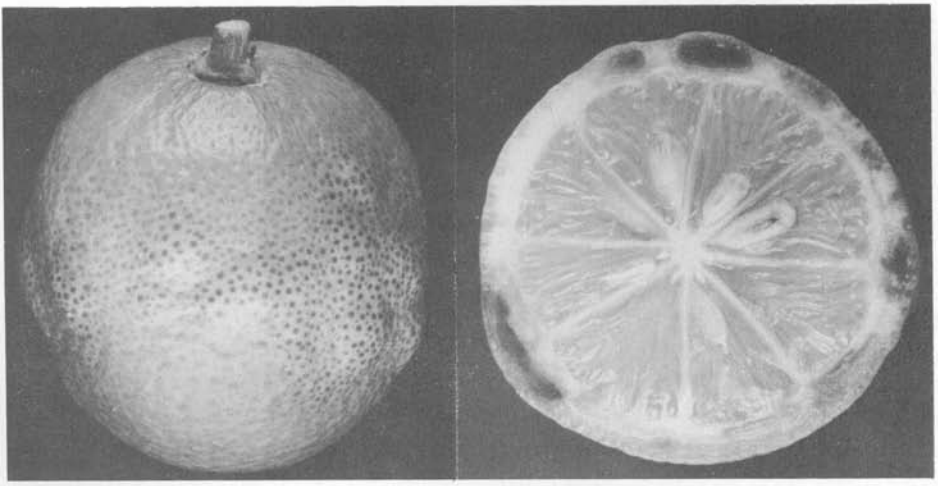

FIGURE 1. *Symptoms of impietratura in fruit of volkamer lemon. Swollen areas with enlarged oil glands are visible on the left; gum pockets underneath such areas can be seen in the cut fruit on the right.*

mandarin, and Femminello S. Teresa lemon are considered to be highly tolerant of impietratura virus; symptoms were observed in only a few fruit of these cultivars, never in unpeeled fruit except 1 or 2 fruit of Clementine mandarin.

The frequency of diseased fruit and the infection rating varied with the source of inoculum, Ov2 seeming to be the most virulent source. The variation suggests that different strains of a virus or different virus complexes may be responsible for impietratura.

The results also confirm an extreme variability in incubation period and severity of symptoms. Some trees bearing a few fruit had no symptoms before 1968 or 1969, or symptoms were detectable only by peeling the fruit. It thus appears that at least 2–3 years are needed to index a candidate tree.

The results do not permit a precise evaluation of the effects of the disease on yield and average weight per fruit, but a rough estimate of the losses due to the disease can be made on the basis of the percentage of diseased fruit, considering the fact that these are of poor quality and practically nonmarketable. In addition, trees of susceptible species infected with impietratura virus drop many fruit during summer, thereby adding to the losses.

The evidence that impietratura virus moves through infected trees into fruit tissues suggest the hypothesis that gum production in diseased fruit is a cytopathogenic reaction of host cells to infection rather than the blocking of some metabolic pathway—such as that for boron—in infected trees (2).

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