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# Observations on Impietratura Disease Symptoms in Four Citrus Species

A. Caruso, M. Davino and G. Terranova

**ABSTRACT.** Citrus impietratura disease affects citrus cultivars in the Mediterranean Basin. The indexing of impietratura disease is based on symptoms on indicator plants such as Volkamer lemon or grapefruit or on the inspection of the trees in the field. This requires many years. In this paper the effects of a severe isolate of impietratura on sweet orange, Volkamer lemon, rough lemon and Marsh Seedless grapefruit is reported. Our observations indicate that rough lemon is a better indicator of fruit symptoms than Volkamer lemon, grapefruit and sweet orange.

*Index words.* biological assay, albedo gumming, rough lemon.

In Italy *cristacortis*, concave gum and impietratura are widespread in commercial orchards. The causal agents of these diseases have not been characterized and their detection is still by means of biological assays.

Due of its excellent bioagronomic and marketing character, in Italy the cultivation of the Navelina sweet orange spread rapidly in many citrus-growing areas by growers, despite the fact that the first trees imported presented very mild flecking symptoms on the leaves. These symptoms attributed to very mild psorosis strains are widespread in Italy, especially on sweet orange. Since they do not negatively influence tree development and production, they did not limit the dispersal of Navelina and the lack of rapid and certain impietratura tests, such as ELISA, SSEM, gel electrophoresis or molecular hybridization meant that the Navelina sweet orange was already widely cultivated in Italy when impietratura was diagnosed. Impietratura symptoms will develop after inoculating 3-yr-old Volkamer lemon seedlings bearing fruits with bark patches on twigs near the flowers. Three to four indicator plants are required per candidate tree (4). Alternative indicators are nucellar grapefruit or sweet orange grafted on sour orange rootstock or rough lemon seedlings. Symptoms of the disease generally appear 6 to 18 months after inoculation, if the indicator plants bear enough fruit. Symptomless trees must be kept under ob-

servation for at least three years. Difficulties in timely indexing of old line Navelina trees planted in Italy between 1970 and 1985 resulted in the high percentage of infection (>30%) by impietratura, concave gum and psorosis A (4,6,13).

Rough lemon was initially considered to be tolerant to impietratura disease (9), but later studies showed it to be susceptible (7, 8, 12) and Catara and Scaramuzzi (5) suggested its use as an alternative indicator.

This paper therefore compares rough lemon with three other impietratura indicators.

## MATERIALS AND METHODS

Marsh Seedless grapefruit, Florida rough lemon, Sanguinello sweet orange and Acireale Volkamer lemon plants were used for this study. The rough lemon and Volkamer lemon plants were ungrafted seedlings and the grapefruit and sweet orange nucellar lines were grafted on sour orange. Three years later in 1987 in the spring they were inoculated with two bark patches of a Sanguinello Moscato sweet orange infected with a severe impietratura isolate on twigs near the flowers.

Five trees per indicator species were used in the experiment and six twigs (diameter 0.8 cm) on each tree were inoculated. Young leaves and fruit were all inspected for symptoms one year after inoculation.

In June 1988 nets were laid under each tree to collect the dropped fruits

TABLE 1  
EFFECTS OF IMPIETRATURA AGENT INOCULATION ON YIELD AND PERCENTAGE OF  
AFFECTED AND DROPPED FRUITS ON CITRUS

Species <sup>2</sup>	Year								
	1989			1990			1991		
	a <sup>3</sup>	b	c	a	b	c	a	b	c
Marsh Seedless grapefruit	20	79.6	57	32	90.9	60	37	78.9	59
Florida rough lemon	15	89.8	3	18	91.3	1.2	23	93.9	5.3
Sanguinello sweet orange	18	80.1	43	25	82.3	47	32	88.4	57
Acireale Volkamer lemon	12	85.2	20	16	89.7	28	21	91.2	26

<sup>2</sup>All trees were graft-inoculated with a severe impietratura isolate collected from Sanguinello Moscato sweet orange.

<sup>3</sup>a = yield in kg (mean of 5 trees); b = percentage of fruit affected; c = percentage of fruit dropped.

which were then carefully examined for any impietratura gumming symptoms. In November all the fruits were harvested, weighed and peeled. These procedures were repeated in 1989, 1990 and 1991.

## RESULTS

One year after inoculation, typical leaf flecking symptoms (2) were observed on most of the new growth. Leaves on four twigs of Volkamer lemon and

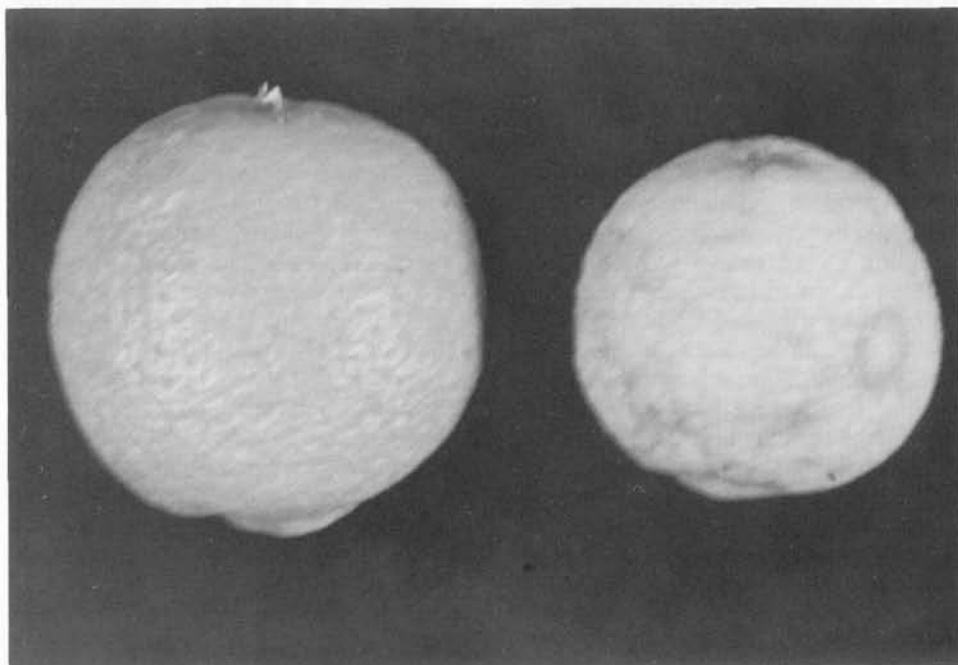


Fig. 1. Difference in color and size of Volkamer lemon fruit harvested on healthy (left) and impietratura disease affected (right) trees.

rough lemon showed symptoms, while leaves on only three twigs of grapefruit and Sanguinello showed flecking. Fruit symptoms (albedo gumming) were only detected on three fruits of rough lemon and two fruits of Volkamer lemon. The following year leaves on all the inoculated twigs showed flecking and gum deposits in their fruits. The yield and percentages of affected fruit for each species are shown in Table 1. A high percentage of the fruits in all four citrus species showed symptoms, the highest being for rough lemon.

The maximal fruit dropping during August was observed in the grapefruit trees, follow by sweet orange and Volkamer lemon. Fruit dropping in rough lemon trees was very low. Additional observations indicated that the Volkamer lemon fruits with albedo gumming did not show the normal reddish color typical of healthy fruits, but remained pale yellow (Fig. 1). It is noteworthy that the gum deposits in the affected fruits which measured about 1 cm in diameter were scattered over the albedo. Up to 6-7 deposits per fruit were observed on Volkamer lemon grapefruit and sweet orange fruits. In the rough lemon the gum was mostly deposited along the equatorial part of the fruits and formed a round, green, 3-4 cm area which did not change color even at full ripening (Fig. 2).

## DISCUSSION

The results of the transmission experiments reported here confirm the high susceptibility of rough lemon, Volkamer lemon, grapefruit and sweet orange to impietratura disease. Movement of the disease agent in the trees seems slow, as symptoms were ob-

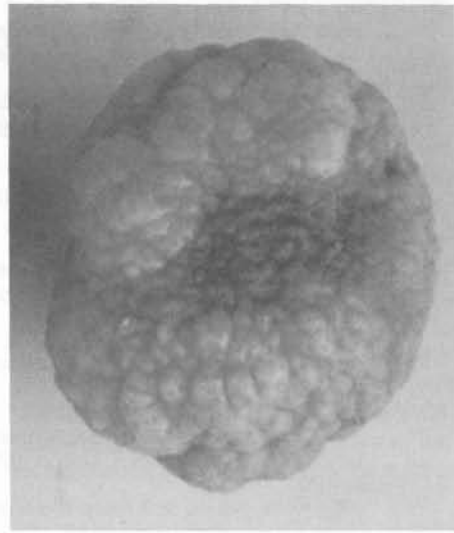


Fig. 2. Typical green and round gum pocket (about 3-4 cm in diameter) laying along equatorial part of rough lemon fruit.

served in some inoculated trees only 2 yr after inoculation as reported in previous studies (1,7,11).

The results indicate that the rough lemon trees are highly susceptible to impietratura and are suitable as indicator trees. In addition the fruit drop observed in the rough lemon is very low. It will therefore be easier to detect the symptoms on rough lemon trees compared to Volkamer lemon, grapefruit or sweet orange where fruit drop may reach 60% in August and the remaining fruits on the tree are frequently symptomless. The substantial fruit drop observed in Volkamer lemon, grapefruit and sweet orange may be caused by localized gumming under the peduncle which occludes the vessels and eventually results in fruit drop.

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