

# Resistance to Grape Fanleaf Virus in Muscadine Grape Inoculated with *Xiphinema index*

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## ABSTRACT

Bouquet, A. 1981. Resistance to grape fanleaf virus in muscadine grape inoculated with *Xiphinema index*. Plant Disease 65:791-793.

Muscadine grapes did not show any symptoms of grape fanleaf virus (GFV) 3 yr after inoculation with infective *Xiphinema index*. Plants were assayed by green-grafting with the indicator host *Vitis rupestris* 'St-Georges,' mechanical inoculations on *Chenopodium quinoa*, and serologic tests. Muscadine grapes are highly resistant to GFV transmitted by nematode feeding but not by graft-inoculation with infected scions, indicating that muscadine grapes are not immune to GFV.

In 1958, Hewitt et al (5) reported that the dagger nematode, *Xiphinema index* Thorne and Allen, is the vector of the soilborne grape fanleaf virus (GFV). Since then, this nematode has been considered one of the most important viticultural pests in France, California,

and other grape-growing areas throughout the world.

In a degenerating vineyard, land infested with *X. index* needs to lay fallow 10 yr before it is replanted with selected healthy clones, but a long fallow period is impractical in most of the valuable grape-growing areas. The problem can be partially overcome by fumigation, but this control measure is costly and does not guarantee success, especially if infestation is deep. Grape stocks resistant to *X. index* are obviously needed, but all commercial rootstocks tested are susceptible (1,6).

In 1978 Boubals and Pistre reported

that plants of muscadine grape (*Vitis rotundifolia* Michx.) did not show symptoms of GFV 5 yr after inoculation by infective *X. index*, unlike all other grape species and rootstocks (1). Moreover, populations of *X. index* apparently did not maintain their initial level on the roots (L. A. Lider, unpublished). Because virus infection was not assayed on these plants, however, the possibility of complete tolerance (muscadine grapes as symptomless carriers) could not be eliminated.

## MATERIALS AND METHODS

The muscadine grapes in this experiment were mainly open-pollinated seedlings growing in the greenhouse in 15-cm clay pots containing heat-sterilized soil. Virus-free *X. index* were obtained from pots containing heat-sterilized soil and rooted cuttings of fig. The original source of the nematodes was a soil sample from a Blanquefort vineyard near Bordeaux, France.

Nematodes were allowed to feed for 4 mo in clay pots containing heat-sterilized

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soil and rooted cuttings of GFV-infected *V. rupestris*. The infected plants were obtained from the virus collection of the Viticultural Research Station and checked serologically for GFV.

After the acquisition period, nematodes were extracted from the soil by a simplified sifting and gravity method (4). A concentrated suspension of all stages of viruliferous *X. index* was diluted to about 2,000 nematodes per 100 ml. This amount was pipetted into three holes in the soil around each test plant. Twenty vigorous 1-yr-old plants of muscadine grape were inoculated; six plants without nematodes were kept as controls. Six rooted cuttings of virus-free *V. rupestris* 'St-Georges' were similarly inoculated and used as bait plants to check virus transmission. Inoculations were made in April 1977 and in April 1978.

Plants were assayed for virus from 1977 to 1980. In July 1977, healthy scions of *V. rupestris* 'St-Georges' were grafted as indicator hosts onto the inoculated and control plants. Well-known graft-incompatibility between muscadine

grapes and bunch grapes was overcome by the green-grafting method (3). Moreover, strong reactions develop when indexing tests are done with the green-grafting technique to check for GFV in diseased plants with mild symptoms (9). An additional indexing test was done in July 1978. Healthy plants of *V. rupestris* 'St-Georges' used as stocks were green-grafted with *V. rupestris* and *V. rotundifolia* scions cut from the inoculated and control combinations.

Indexing results obtained at Pont-de-la-Maye on *V. rupestris* 'St-Georges' were checked in 1979 and 1980 by mechanical inoculations on *Chenopodium quinoa* and by serologic tests, ie, enzyme-linked immunosorbent assay and protein A coated latex linked antisera. Tests were done at the plant pathology station of Colmar. Extracts of young leaves of *V. rupestris* and *V. rotundifolia* were used.

An additional small-scale experiment was made to find if the virus could propagate in tissues of *V. rotundifolia* inoculated by ways other than by *X. index*. Eight muscadine grape plants were

simultaneously green-grafted with infected and healthy scions of *V. rupestris*. Tests for virus detection were as mentioned.

## RESULTS AND DISCUSSION

Results are summarized in Table 1. In 1978, 1 yr after the first inoculation, leaves of the six bait plants (combinations of *V. rupestris* on *V. rupestris*) showed severe symptoms of GFV. Presence of GFV in two plants that had milder symptoms was confirmed by serologic tests and was convincing evidence of successful virus transmission by *X. index*. Other bait plants were not tested serologically.

During the study, no symptoms were observed on leaves of the combinations of *V. rupestris* on *V. rotundifolia* inoculated with GFV-infective *X. index*. The additional indexing test on *V. rupestris* 'St-Georges' was negative for 19 plants and positive for one, but the oil spot symptoms on the indicator were mild and inconspicuous and were not followed by fanleaf symptoms characteristic of the chronic stage of the disease. Thus GFV infection of this plant must be considered doubtful. Unfortunately, this plant died back during the 1979-1980 winter and could not be tested serologically. This mortality, which was observed on six other inoculated combinations and on combinations used as controls, can be related to delayed graft-incompatibility between muscadine and bunch grapes. Noticeable differences in the graft-compatibility between some cultivars of muscadine grape and European grape *V. vinifera* 'Cabernet-Sauvignon' have been reported (2). All serologic tests and mechanical inoculations on *C. quinoa* done at Colmar in 1979 and 1980 on the controls and some combinations of *V. rupestris* on *V. rotundifolia* inoculated by nematode feeding gave negative results and confirmed the validity of the readings on *V. rupestris* made at Pont-de-la-Maye. Thus, muscadine grapes appear to be highly resistant to GFV transmitted by nematode feeding.

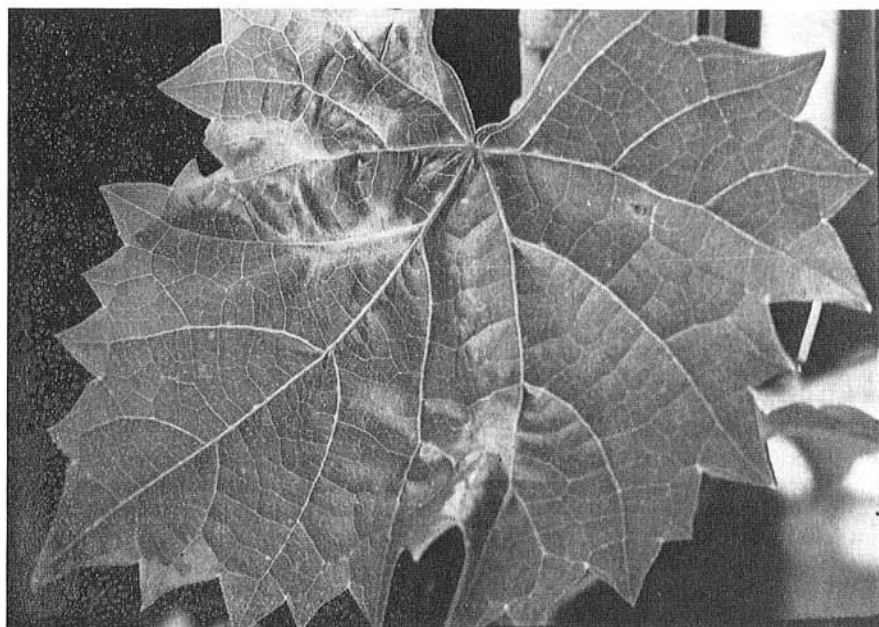
Among the eight plants of muscadine grape inoculated by grafting, transmission of the virus was evident in only two plants with severe oil spot symptoms on their leaves (Fig. 1). Indexing tests on *V. rupestris* 'St-Georges' were positive for the two plants and serologic tests confirmed GFV in one plant; the other could not be tested. Successful transmission of GFV by grafting shows that muscadine grapes are not immune to the virus.

Considering the genetic diversity of the muscadine grapes used, absence of symptoms on the other graft-inoculated plants and negative results of the indexing and serologic tests can be related to GFV resistance. But growth of GFV-infected scions was weak, and some

**Table 1.** Results of indexing *Vitis rupestris* plants with grape fanleaf virus (GFV) inoculated by infective *Xiphinema index* or by grafting

<i>V. rupestris</i>	Plants (no.)	Symptoms on <i>V. rupestris</i>	
		Scion (1977-1980)	Stock (1978-1979)
GFV-infected source plants	2	+	+
Virus-free	1	-	-
On <i>V. rupestris</i> inoculated by <i>X. index</i>	6	+	+
On <i>V. rotundifolia</i>			
Controls	6	-	-
Inoculated by <i>X. index</i>	20	-	- <sup>a</sup>
Graft-inoculated	2	+	+
	6	-	-

<sup>a</sup>One of these plants had an inconspicuous mild positive reaction.



**Fig. 1.** Oil spot symptoms and dissymmetry of leaf of *Vitis rotundifolia* graft-inoculated with grape fanleaf virus.

died back a few weeks after grafting. Thus graft-inoculation might fail on some plants and GFV resistance could be overevaluated. If that were the case, the high GFV-resistance of *V. rotundifolia* after inoculation by nematode feeding could be related to the inability of *X. index* populations to thrive or maintain their levels on the roots of this species, as noted previously (Lider, unpublished; 1). The possibility that imperfect feeding behavior of *X. index* might affect virus transmission needs further investigation because genes for resistance to nematode parasitism that would preclude virus transmission are less "perishable entities" than genes for virus resistance.

*V. rotundifolia*, introduced into France at the end of the 19th century, has failed as a rootstock despite its complete resistance to Phylloxera. Poor rooting ability, lack of graft-compatibility with *V. vinifera*, extreme lateness of the growth cycle, and susceptibility to cold injury are primarily responsible for this

failure. Since then, high resistance to root-knot nematodes has been reported in muscadine grape (7,8), although some cultivars have recently been found to be rather susceptible to *Meloidogyne hapla* Chitwood (A. Dalmasso, unpublished). Resistances to *X. index* and GFV justify the use of the muscadine grape in rootstock breeding through hybridization with *V. vinifera* and classic rootstock varieties. A breeding program is under way in France.

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