Resistance of Some *Vitis* Rootstocks to *Xiphinema index*

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Abstract: Thirty-eight grapevine (Vitis spp.) rootstocks were screened in pots for resistance to the dagger nematode, *Xiphinema index*, from 1979 to 1981. Resistance ratings were based on visible root symptoms and on changes in the nematode populations over 16 months. Nineteen of the 23 Californian hybrid rootstocks tested were resistant, as were 'Harmony,' 'Freedom,' 'Schwarzmann,' and '3309.' Two hybrids of *V. rufotomentosa*, '171-52' and '176-9,' were possibly immune to *X. index*. The rootstocks 'ARG 1,' '110 R,' '1202,' and '1616,' which are used commercially for phylloxera resistance were susceptible. *Key words:* grapevine, dagger nematode, hybrid, symptoms, populations.

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The dagger nematode, *Xiphinema index* Thorne & Allen, is one of the world's most damaging pests of grapevines, both directly (12, 14) and as a vector of grapevine fanleaf virus (GFV)(5,10). Preplant fumigation of vineyard soil does not eradicate *X. index*, nor is it satisfactory in deep, wet, or clayey soils (4,9). Even when fumigation gives good initial reduction of nematode numbers, the residual population may be sufficient to transmit GFV to newly planted vines, and the nematodes often increase to damaging levels within a few years (9). There is, therefore, a need for a better control method for *X. index* in replant vineyards. Resistant rootstocks would provide protection from nematode damage for the life of the crop. Resistance ratings of some *Vitis* species and cultivars have been reported (1,8,11) according to both visible root symptoms and to changes in numbers of *X. index* in pots.

This paper reports the results of screening 38 rootstocks for resistance to *X. index*, based on these two parameters. The experiment was conducted in pots in a greenhouse at Wahgunyah, Victoria, Australia, from 1979 to 1981.

MATERIALS AND METHODS

Twenty-three Californian hybrid rootstocks, imported to Australia in 1974,

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were compared with 15 clonal rootstocks which have been, or are likely to be used commercially for their resistance to nematodes or phylloxera (Table 1).

The experiment was conducted using the methods described by Kunde et al. (8), except where indicated otherwise. Dormant cuttings of the virus-tested rootstocks were collected from the Sunraysia Horticultural Research Institute in August 1979, dipped in a 0.5% solution of the surface sterilant CHINOSOL W (Hoeschst)(67% 8-hydroxyquinoline sulphate + 30% potassium sulphate) for 4 hours, and planted in pots of steam-pasteurized soil in a greenhouse propagation bed. The rootlings were transplanted into steam-pasteurized Barmera sandy loam (6) in 14-cm-d plastic pots and maintained in a greenhouse at 21–24 C for 20 months. The vines were allowed to enter dormancy during winter. Three replicate pots of each rootstock were inoculated between December 1979 and January 1980 with 100 hand-picked, nonviruliferous *X. index* obtained from cultures on fig (*Ficus carica* cv. Black Isha) and grapevine (*V. rupestris* cv. St. George). However, conclusions were based on the replication which had either the most severe root symptoms or the greatest increase in nematode population, or both. This follows the method adopted by Kunde et al. (8). A fourth plant of each rootstock was left as an uninoculated control. The percentage recovery of nematodes by the screening and funneling technique was established by inoculating 100 *X. index* into five pots, each containing 400 ml of the same soil, then extracting the nematodes.

Three sets of control pots were established. One contained *V. vinifera* cv. Chasselas, a nematode-susceptible wine variety, inoculated with *X. index*. A second contained *V. vinifera* cv. Sultana, also susceptible, but not inoculated, to determine whether cross contamination occurred during the experiment. A third set of control pots contained no plants, but the soil was inoculated with 100 *X. index* to determine whether the nematodes could survive the duration of the experiment without host plants.

The fresh weight of roots, severity of root damage and numbers of nematodes extracted were determined for each pot in April–May 1981. The root damage and resistance ratings (Table 1) were based on those of Kunde et al. (8).

RESULTS

The results are summarized in Table 1. Root weights differed greatly between rootstocks, but showed no relationship to either degree of root damage or numbers of *X. index*. The mean recovery of *X. index* obtained by the screening and funneling technique was 62% (S_x 4.1), and this figure was used as the basis for determining changes in nematode populations. Although 'Chasselas" and "ARG 1" had greatly swollen roots, as described for rating 3, they were rated as 2 because they had many lateral roots.

DISCUSSION

The resistance of the Californian hybrid rootstocks corroborates the selection by Kunde et al. (8) of the five resistant species, *V. candicans, V. solonis, V. arizonica, V. rufotomentosa,* and *V. smalliana.* All of the hybrids were resistant except '122-16,' '182-7,' and '200-92.' Although these three hybrids, together with '1613,' showed no root damage, one replicate of each had a nematode count which indicated possible multiplication, and it may be significant that they share *V. longii* as a common parent. These vines may be described as tolerant of *X. index,* rather than partially resistant, if tolerance is defined as the ability of the host to support the parasite without the host becoming diseased. They may be useful rootstocks for planting in infested vineyards if they are also horticulturally suitable.

Tolerant rootstocks will prevent crop losses caused by nematode damage, but American species of *Vitis* are susceptible to GFV (1), and they render *V. vinifera* scions grafted on them susceptible (3). Nematode tolerant rootstocks may become infected with GFV after brief feeds by *X. index,* because the vector can acquire and transmit GFV within an access time of 15 min (2). Rootstocks, therefore, also need to be either tolerant of GFV or immune (i.e., exempt from infection, completely re-

Table 1. Nematode survival, severity of root damage, and resistance of *Vitis* rootstocks after 16 months in pot culture.

Rootstock and clone	Cross or species	Accession number (7)	Mean root weight (g)	No. of *X. index*	Root damage*	Resistance rating†
86-10	*V. slavini* × *V. riparia* Gloire	—	11	27	0	A
88-113	*V. slavini* × *V. rupestris* Metallique	I.V.75.2423	12	25	0	?‡
91-39	*V. riparia* Gloire × *V. candicans*	I.V.75.2424	11	3	0	A
101-9	*V. arizonica* × *V. candicans*	I.V.75.2425	12	5	0	A
101-56	*V. arizonica* × *V. candicans*	I.V.75.2426	16	32	0	A
106-38	*V. longii* × (*V. riparia* Gloire × *V. champini* Ramsey)	I.V.75.2427	14	16	1	A
112-2	(*V. riparia* Gloire × Dog Ridge) × 1613	I.V.75.2428	33	7	0	A
112-71	(*V. riparia* Gloire × Dog Ridge) × 1613	I.V.75.2429	23	12	0	A
116-11	*V. candicans* × 1613	I.V.75.2430	20	18	0	A
116-60	*V. candicans* × 1613	I.V.75.2431	11	12	0	A
122-16	*V. rupestris* Metallique × 1613	I.V.75.2432	18	83	0	B
142-40	*V. rufotomentosa* × *V. candicans*	I.V.75.2433	15	2	0	A
142-50	*V. rufotomentosa* × *V. candicans*	I.V.75.2434	3	2	0	A
150-5	*V. rufotomentosa* × *V. longii*	I.V.75.2435	9	0	1	A
171-13	*V. rufotomentosa* × *V. vinifera*	I.V.75.2436	7	2	0	A
171-52	*V. rufotomentosa* × *V. vinifera*	I.X.75.2437	16	0	0	A
176-9	*V. rufotomentosa* × *V. rupestris* Metallique	—	8	0	0	A
182-7	*V. solonis* × *V. longii*	I.V.75.2439	16	96	0	B
187-24	*V. solonis* × *V. candicans*	I.V.75.2440	29	4	0	A
200-92	*V. solonis* × *V. riparia* Gloire	I.V.75.2441	26	143	0	B
513-4	*V. rufotomentosa* × *V. riparia* Gloire	I.V.75.2442	23	2	0	A
514-11	*V. rufotomentosa* × (*V. riparia Gloire* × Dog Ridge)	I.V.75.2443	10	1	0	A
515-1	*V. rufotomentosa* × (*V. riparia* Gloire × *V. champini* Ramsey)	I.V.75.2445	12	5	0	A
AGR 1 (syn.AXR1); FV A13 V21	*V. vinifera* × *V. rupestris*	I.V.62.2046	30	339	2	C
Dog Ridge; FV A6 V8 (H99)	*V. champini*	I.V.59.2011	Dead	0	Dead	. . .
Freedom; FV D11 V1	1613 × Dog Ridge	I.C.77.8281	11	36	0	A
Harmony; FV A10 V7	1613 × Dog Ridge	I.V.66.2134	16	35	0	A
K51-32;FV D13 V14	*V. champini* × *V. riparia* Gloire	I.S.74.8072	33	156	1	B
Ramsey;NF A11 V2	*V. champini*	I.V.64.2065	11	11	0	?‡

Roostock and clone	Cross or species	Accession number (7)	Mean root weight (g)	No. of *X. index*	Root damage*	Resistance rating†
Schwarzmann; ex Western Aust.	*V. riparia*	A.V.70.2252	8	45	0	A
S04;FV A6 V18	*V. berlandieri* × *V. riparia*	I.V.66.2136	18	153	1	B
34 EM	*V. berlandieri* × *V. riparia*	—	17	121	1	B
101-14	*V. riparia* × *V. rupestris*	—	34	65	1	B
110R (syn. Richter 110); OF 4-11 (H102)	*V. berlandieri* *V. rupestris*	I.V.64.2083	23	96	1	C
1202;FV A7 V13(H62)	*V. vinifera* Mouvédre × *V. rupestris*	I.V.66.2135	15	572	3	C
1613;FV A9 V5	*V. solonis* × Othello i.e. *V. longii* × (*V. vinifera* × [*V. labrusca* × *V. riparia*])	I.S.74.2066	47	75	0	B
1616; FV A9 V21	*V. solonis* × *V. riparia*	I.V.64.2082	17	795	2	C
3309;ex Rutherglen	*V. riparia* × *V. rupestris*	—	5	48	0	A
Control 1 (Chasselas; FV C11 V1.100 *X. index*)	*V. vinifera*	I.V.62.2049	7	990	2	C
Control 2 (Sultana; M12. No *X. index*)	*V. vinifera*	A.C.70.8162	40	0	...	...
Control 3 (100 *X. index*. No plants)				0		

* Root damage ratings: 0 = no symptoms; 1 = few localized swollen or curved root tips; 2 = obvious and general swelling of root tips; 3 = large and intensive swellings few or no lateral roots.

†Resistance ratings: A = slight or no root damage, *X. index* population decrease; B = slight root damage and/or possible *X. index* population increase; C = moderate to severe root damage, *X. index* population increase.

‡Rootstocks were not rated because only one replicate was assessed.

sistant) to the nematode to prevent crop damage due to GFV. *Vitis rotundifolia* is resistant to the nematode and does not develop symptoms of GFV (1), but it was not included in the rootstocks tested in the present study.

Vitis rufotomentosa is apparently a good source of resistance to *X. index*, because all of its progeny except '150-5' supported fewer than six nematodes and showed no root injury. Two of its hybrids, '171-52' and 176-9,' are possibly immune. These vines would remain free of GFV if their immunity to *X. index* was manifested in the prevention of even a probe with the nematode's stylet. If these vines are suitable in other characteristics for use as rootstocks, they would be invaluable for planting where one wanted either to reduce a *X. index* population or to prevent spread of GFV.

Where GFV-susceptible grapevines are to be replanted, it may be possible to first eliminate the virus reservoir in the old roots by applying a suitable systemic herbicide. Replanting of *X. index*-resistant rootstocks would then need to be delayed only until viruliferous adult nematodes died, because GFV does not persist through the egg or moult (13). In view of the failure of fumigation to eliminate the virus from soil (9), this hypothesis deserves testing.

The rootstocks 'AGR 1,' '110 R,' and '1202,' which are often used for their phylloxera resistance, were susceptible to *X. index*, but 'Harmony,' Schwarzmann,' '3309,' and 'Freedom' were resistant. The results of this experiment generally concur with those of Kunde et al. (8). Resistance ratings could not be allocated to 'Ramsey' or '88-113,' because only one replicate of each survived; their small root systems may account for the small nematode populations. Other authors (1,8,11) reported that 'Salt Creek' (sic.) (probably 'Ramsey') and Dog Ridge were susceptible.

The results of this experiment indicate that many of the rootstocks warrant further testing, particularly for susceptibility to GFV. An experiment is being conducted to test their field performance in a nematode- and phylloxera-infested vineyard at Rutherglen, Victoria.

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