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NEMATOLOGICAL PROBLEMS IN GRAPEVINE AND USE OF ROOTSTOCKS IN INTEGRATED PLANT-PARASITIC NEMATODES MANAGEMENT

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John H. Weinberger was a USDA breeder of tree and vine crops at Fresno, CA. By 1956 he released nemaguard peach rootstock. Its resistance mechanism involved a hypersensitive response (HR) that did not halt nematode entry into roots but consistently halted eventual reproduction by all *Meloidogyne* spp. in California. This mechanism still performs today.

Ten years later Drs. Weinberger and Harmon released root knot nematode resistance in grapes via Harmony and eventually Freedom rootstocks. Their extra vigor coupled with HR resistance mechanisms against nematodes during root entry provided 20 to 30 years of oftentimes useful resistance against *Meloidogyne* spp. and *Xiphinema index* nematodes. By 1984 resistance to *M. incognita* and *M. arenaria* was failing as root galls appeared larger and closer together (Cain et.al., 1984). A year later root knot juveniles were found on Harmony roots at low numbers, galls were absent but vine damage was noticeable (McKenry, unpublished). There was usually a mixture of *Meloidogyne* spp present but root grinding within a blender was needed to identify buried adult females of *M. chitwoodi* as part of the root knot mixture in sandiest soils.

Resistance breakage across several thousand hectares of Harmony and Freedom rootstocks occurred within three decades. Meanwhile, loss of nemaguard peach resistance in what is currently ½millon prunus hectares had still not occurred. This apparent powerful difference between resistance mechanisms plus knowledge of other nematodes becoming more common in vineyards charted our research direction toward grapes as well as prunus, walnut, and pistachio.

By 1986 our search for improved grape rootstocks had begun. Dr Safdar Anwar with histochemical expertise could now be found in my lab. Dr David Ramming had become the plant breeder in charge of Weinberger's 520 grape selections. We also knew field locations for a dozen virulent nematode populations and the need to separate hidden resistance mechanisms from the more common HR mechanisms (Table 1). We also knew that resistance meant fewer than 0.2 nematodes per gram of young roots sampled over a two-year period and to always keep the rootstock failure sites as sources for virulent inoculum.

The attached Table 83.5 summarizes our findings in layman's terms and includes two subjects also associated with nematode damage. This table summarizes facts and figures from a dozen detailed research publications on nematodes of grape. For example, the virulent category for *Meloidogyne* spp includes *M. arenaria* and *M. incognita* virulent to Freedom and Harmony; *M. chitwoodi* from locations hundreds of kilometers apart and *M. javanica* found to be virulent to 20-yr-old Ramsey along the coast. *Mesocriconema xenoplax* was collected from the cooler coast and the hotter Parlier, CA location. Subtle differences can play a role in resistance performance. Reliance on data from only one or two virulent populations can yield gaps in resistance.

Grape rootstocks ready for field evaluation include: 10-17A (*Vitis simpsoni* x Edna), 10-23B *Vitis doaniana*, RS-3 or RS-9 (Ramsey x Schwarzmann) and RSD-34 (RS-3 x 10-23B). When replanting without soil fumigation we would only choose 10-17A. When searching for the Meloidogyne resistance mechanism very similar to that in nemaguard peach choose RSD-34 or 10-23B but the latter does not propagate easily. Where fumigation or other biocides are unavailable kill the old vines and roots and wait up to four years if root rejection is present in your region (McKenry, 1999). All these selections also protect roots from Vine Mealybug.

Old grape roots remaining in soil do not disappear for 8 years after vine removal. During this period *X. index* and GFLV will survive on or in old roots. For those who fallow only 6 years appearance of *X. index* can occur the first year after replanting. Fumigation can kill roots and soil borne nematodes 1.5m deep. Glyphosate properly applied can kill roots in California only when applied in February and March but provide minimal protection against soil-borne nematodes.

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Without adequate nematode and root reduction the new nematode resistance mechanisms can be exposed to tens of millions of challenging nematodes. If this is permitted with Freedom rootstock its resistance will be lost in 3 years and its extra vigor gone in 6 years. Rootstock10-17A is a great choice against *X. index* unless GFLV is present in the vineyard.

Lately our search has been for totally soluble non-fumigants to provide 1-2 years of resistance mechanism relief. A good pre-plant biocide plus broad rootstock resistance for your region can protect resistance mechanisms and may reduce the one full year of fallow required when using the "Starve and Switch" strategy as a fumigant alternative.

Table 1

Soil pests	Pest source	Inocul[illegible] per [illegible]
Meloidogyne incognita Race-3 (Kofoid & White, 1919) Chitwood 1949	Wide host ranges but only root-knot nematode that attacks *Gossypium hirsutum* cv. Acala, which is a common crop to precede grapes	2,300
Meloidogyne javanica (Treub, 1885) Chitwood 1949	Single egg mass from roots of Thompson Seedless collected from Dinuba, CA. It is an aggressive population associated with yield reductions of Thompson Seedless, whereas mixed *Meloidogyne* spp. is not expected to be aggressive.	1,100
Meloidogyne arenaria pt. Harmony (Neal, 1889) Chitwood 1949	Single egg mass of galling root-knot nematode found to attack Harmony rootstock by Cain et al. in 1984.	800
Mixed *Meloidogyne* spp.	Mixture of *Meloidogyne incognita*, *M. javanica*, and *M. arenaria*, which is very common in Fresno, Kingsburg, and Madera areas of California.	9,900
Phylloxera + mixed *Meloidogyne* spp.	Mixture of phylloxera, *Meloidogyne incognita*, *M. javanica*, *M. arenaria*, *Xiphinema index* and *Pratylenchus vulnus*. This mixture is associated with shallow hardpan soil near Malaga and Delano, CA.	1,800
Xiphinema index Thorne & Allen, 1950	Population collected from Soledad, CA, and reared on *Ficus carica* for one year and free of grape fan leaf virus	1,300
Xiphinema americanum sensu stricto	Population collected from Kearney Agricultural Center inoculated into microplots planted to Sudan grass, *Sorghum halepense* cv. Piper, one year before trial established.	900
Pratylenchus vulnus Allen & Jensen, 1951	Population collected from roots of plum, *Prunus*, and reared on walnut, *Juglans nigra*.	660
Tylenchulus semipenetrans Cobb, 1913	Population collected from *Citrus sinensis* L. cv. sour orange, Sanger, CA.	7,500
Meloidogyne chitwoodi pt. 1613	Populations collected from Dinuba and Livingston, CA.	1900
Mesocriconema xenoplax (Raski), Luc & Raski, 1981	Population collected from peach orchard located near Parlier, CA.	1,700/250 cm³ of soil

Table 83.5 below (McKenry, 2013) provides rootstock separation.

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Table 83.5. Rootstock responses to selected soilborne pests and problems

Pest or disease	Rootstocks							
	Harmony	Freedom	039-16	RS-3	RS-9	10-17A	Borner	99R
Meloidogyne spp.	R-T	R-T	S-IT	R	R	R	S	S
virulent *Meloidogyne* spp.	HS-IT	HS-IT	S-IT	R	R	R	S	S
Pratylenchus vulnus	S	MR-T	S-IT	R	R	R	—	—
Tylenchulus semipenetrans	S	S-T	S-IT	SS	SS	SS	SS	SS
Xiphinema americanum	S	S	S	S	S	S	S	S
Xiphinema index	R	R	R	MR	R	R	MR	S
Mesocriconema xenoplax	S	S	MR	MR	S	S	MR	S
grape fanleaf virus	IT	IT	T	T	?	IT	T	—
rejection component, RP	IT	IT	T	IT	IT	T	IT	—

Key:
R = Resistant, < 0.2 nematodes/g of root or soil counts < 2% of own-rooted
MR = Moderately resistant, 0.21 to 0.6/g of root or soil counts 2 to 5% of own-rooted
SS = Slightly susceptible, 0.61 to 3.0/g of root, specifically with *T. semipenetrans*
S = Susceptible, 3.1 to 180/g of root or soil counts from 5 to 180% of own-rooted
HS = Highly susceptible, > 180/g of root or soil counts > 180% of own-rooted
T = Tolerance to pest or problem
IT = Intolerance to pest or problem
— No data