EFFECT OF ROOTSTOCK AND PREPLANT FUMIGATION ON PLANT PARASITIC NEMATODE DEVELOPMENT IN WASHINGTON WINE GRAPES

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Abstract:

Context and purpose of the study - In Washington State, the majority of winegrape (*Vitis vinifera)* vineyards are planted to their own roots. This practice is possible due to the lack of established phylloxera populations, and is preferred due to the ease of retraining after damaging winter cold events. However, own-rooted *V. vinifera* is generally susceptible to most plant parasitic nematodes that attack grape. In Washington State, management of nematodes is dominated by preplant soil fumigation. One practice that may mitigate economic loss due to nematodes is the adoption of nematode-"resistant" rootstocks. There is little information on the performance of most rootstocks against northern root-knot nematode (*Meloidogyne hapla),* the main plant-parasitic nematode species in the state, and even less information on dual performance against dagger nematode (*Xiphinema sp.)*.

Material and methods - Partnering with a commercial vineyard, we established a 3 hectare, long-term trial evaluating currently-available rootstocks in 2015, with the intent to continue the trial through vineyard establishment to vineyard production maturity (until 2025). This vineyard was undergoing replanting after 20+ years of production in own-rooted *V. vinifera* 'Chardonnay'; the intent of the replant was to maintain vineyard infrastructure, but to manage for plant parasitic nematodes. The rootstocks being evaluated are: 101-14 Mtg, 1103 P, Harmony, Teleki 5C, an own-rooted control, and a self-grafted control. The scion is Chardonnay. All vines were certified through the Washington State Department of Agriculture's certification program. The rootstock treatments were planted in 4 replicated plots of soil treatments consisting of fumigated (metam sodium through the existing drip irrigation lines), nonfumigated, and nonfumigated inoculated with *M. hapla*, creating low, moderate, and high nematode pressure locations under which to evaluate rootstock performance.

Results - Preplant fumigation was only effective at reducing *M. hapla* population densities for the first 6 months after application, yet it reduced densities of *Xiphinema* for 2 growing seasons. Rootstocks were poor hosts for *M. hapla* relative to own-rooted *V. vinifera,* but all were acceptable hosts for *Xiphinema* sp. Several rootstocks (e.g., Harmony, 101-14, 1103 P) had greater shoot biomass at the end of year 3 (end of the establishment period) compared to own-rooted *V. vinifera,* indicating that longer-term impacts on vigor is likely a primary driver behind the resistance phenotype these rootstocks impart under nematode feeding pressure. The goal of this project is to understand the long-term performance of rootstocks and the impacts of nematodes on vineyard lifespan in Washington State.

Keywords: Rootstock, Vineyard Establishment, Nematodes, Preplant Fumigation, Resistance, Tolerance.

1. Introduction.

Effect of Rootstock and Preplant Fumigation on Plant Parasitic Nematode Development in Washington Wine Grapes

Viticulture and Enology Program

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INTRODUCTION

In Washington State, USA, the majority of winegrape vineyards are not planted on a rootstock. This practice is possible due to the lack of established phylloxera populations, and is preferred due to the ease of retraining after damaging winter cold events. However, *Vitis vinifera* is generally susceptible to most plant parasitic nematodes that attack grape. Damage from plant parasitic nematodes results in vine decline and general reduced productivity. Nematode damage is of particular concern in vineyard replant scenarios, where vineyard sites may host large populations of plant-parasitic nematodes.

Management strategies are currently dominated by pre-plant soil fumigation. Unfortunately, not many highly-effective nematicides remain on the market.

One practice that may mitigate economic loss due to nematodes is the adoption of nematode-"resistant" rootstocks. There is little information on the performance of most rootstocks against northern root-knot nematode (*Meloidogyne hapla*), the main plant-parasitic nematode species in the state, and even less information on dual performance against dagger nematode (*Xiphinema sp.*).

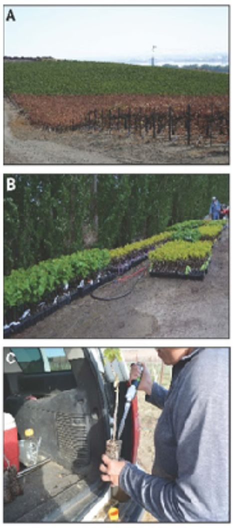

Figure 1 - (A) *The existing vineyard was treated with foliar glyphosate in Fall 2014 to kill vines and roots, followed by a drip-applied treatment with metam sodium. This has since been shown to be a best-practice for nematode management (Moyer et al. 2017). (B) The new vineyard was planted in May 2015 using rooted, grafted (or own-rooted) vines grown in plugs. (C) Prior to planting, 10 vines per rootstock replicate in non-fumigated subplots were inoculated with* Meloidogyne hapla *to ensure sufficient nematode pressure to evaluate vine performance over the subsequent years.*

EXPERIMENTAL VINEYARD DESIGN

In Fall 2014, an existing 30 yr-old *Vitis vinifera* 'Chardonnay' block in southeastern Washington State was treated with foliar glyphosate (**Fig. 1A**). In addition, sections of the vineyard were also treated with drip-applied Vapam (metam sodium) to reduce nematode populations. Vines were removed in the winter of 2014-2015.

In May of 2015, the 3-hectare vineyard was replanted to four different rootstocks and two controls with a Chardonnay scion (**Fig. 1B**; **Table 1**) for a total of six different rootstock treatments. The vineyard was planted in a randomized block design, with whole rows dedicated to a single rootstock. The treatments were replicated four times. Soil fumigation was nested within each row. In the non-fumigated subplots, 10 vines were inoculated with *M. hapla* at the time of planting (**Fig. 1C**).

This vineyard has been routinely monitored since 2015 for the presence of both root-knot and dagger nematodes, as well as vine performance (growth, yield). It will continue to be monitored until 2025.

Table 1 - Rootstocks selected for the trial. Most nematode resistance testing and screens have been done against root-knot and dagger nematode species not found in Washington (*M. incognita* and *X. index*).

Rootstock	Selection Reasoning
Teleki 5C (*berlandieri x riparia*)	Decent nematode (except dagger) and phylloxera resistance. Tends to moderate vigor, and earlier ripening.
101-14 Mtg (*riparia x rupestris*)	Moderate to high nematode resistance. Bonus of phylloxera and crown gall resistance. Tends to low vigor and earlier ripening. Lower drought resistance.
1103 Paulsen (*berlandieri x rupestris*)	Susceptible to dagger nematode, but moderate to high resistance to root-knot nematode. Tends to high vigor, but is relatively drought resistant.
Harmony ([*solonis* x Othello] x Dogridge)	Specifically bred for nematode resistance. It is not phylloxera resistant, but it is crown gall resistant.
Own-Rooted (*vinifera*)	Industry standard control.
Self-Grafted (*vinifera*)	Grafting control.

NEMATODE MANAGEMENT

Dagger nematode: Pre-plant fumigation, coupled with a glyphosate treatment, was an effective control option for dagger nematode (**Fig. 2**). By Fall 2018, fumigation still had an effect on dagger nematode densities (p = 0.0003). In non-fumigated scenarios, the rootstocks evaluated here would not be good alternative management choices if the target was to control for dagger nematode.

Northern root-knot nematode (RKN): Fall 2014 fumigation reduced RKN through Fall 2015 (p<0.0001) (**Fig. 3**) but the fumigation effect was gone by Spring 2016 (p=0.12, data not shown). From Spring 2016 on, the choice of rootstock significantly influenced total RKN (p<0.0001). Teleki 5C hosted significantly fewer RKN that the self-grafted and own-rooted controls. All other rootstocks hosted fewer nematodes than the self-grafted control, but hosted a similar number of nematodes as the own-rooted control. Interesting, by Fall 2018, there were fewer RKN in non-fumigated plots than fumigated plots (**Fig. 3**).

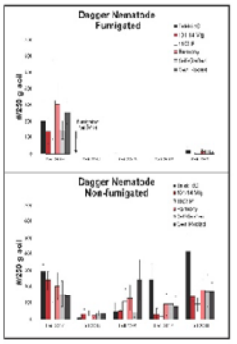

Figure 2 - (*Top*) *Fumigation controlled dagger nematode for over 3 years.* (**Bottom**) *The rootstocks evaluated in this trial were not resistant to Xiphinema sp.*

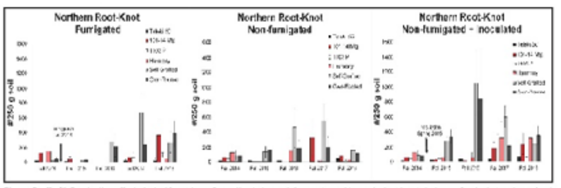

Figure 3 - (**Left**) *Fumigation effects lasted for at least 6 months, but populations returned to equivalent levels between fumigated and non-fumigated plots by Fall 2016.* (**Center**) *By Fall 2018, there were more RKN in non-fumigated plots compared to fumigated plots (Left) in the self-grafted and own-rooted controls.* (**Right**) *Inoculation of additional nematodes did result in increased population pressure during all four years of the study.*

VINE PERFORMANCE

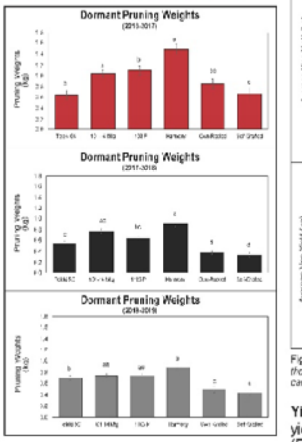

Figure 4 - *Influence of rootstock on scion development. Letters denoted significant differences between rootstocks (Tukey's HSD, α=0.05).*

Pruning Weights: Non-*vinifera* rootstocks significantly, but not excessively increased scion vigor (**Fig. 4**). In all three years, inoculation of nematodes into non-fumigated plots resulted in significantly lower pruning weights (p=0.009, 0.0087, and 0.0006, respectively).

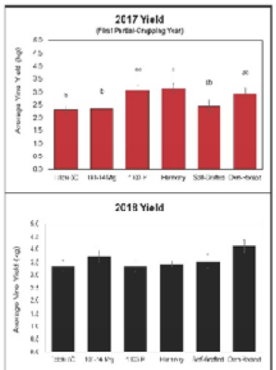

Figure 5 - *Influence of rootstock on yield. The 2017 vintage was the first partial crop, with full crop in 2018. Letters denoted significant differences between rootstocks (Tukey's HSD, α=0.05).*

Yield: In 2017, fumigation did not influence yield (p=0.5), but rootstock did (p=0.003) (**Fig. 5**). As a side note, in 2017, the site was heavily crop-thinned at bloom, so the differences seen may have been due to differential thinning between the rootstock rows by the field crew. In 2018, the first full-cropping year, there was minimal rootstock effect (**Fig. 5**, p=0.06), but fumigated plots had significantly higher average yields than non-fumigated inoculated plots (p=0.02).

ADDITIONAL RESOURCES

- Hoheisel, G.A. and M.M. Moyer (eds). Pest Management Guide for Grapes in Washington. Updated annually. WSU Extension Publication # EB0762.
- Moyer, M.M. and S. O'Neal (eds). 2014. Field Guide for Integrated Pest Management in Pacific Northwest Vineyards: Pocket Version (Spanish English). Pacific Northwest Extension Publication #PNW664.
- Moyer, M.M., A.N. Bolan, and J.M. Tarara. 2017. Dual Fumigant and Herbicide Use Optimizes Replanting Preparation in a Virus and Nematode-Affected Vineyard. Catalyst: Discovery into Practice 2: 55-61.

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