POST-PLANT NEMATICIDE TIMING FOR NORTHERN ROOT-KNOT NEMATODE IN WASHINGTON WINE GRAPES

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Abstract:

Context and purpose of the study – Vigor declines in older vineyards and poor vine establishment in replant situations have been attributed to plant-parasitic nematodes. The northern root-knot nematode, *Meloidogyne hapla*, is the most prevalent plant-parasitic nematode species found in Washington wine grape vineyards. Management for nematodes in established vineyards is limited to the application of post-plant nematicides. We are evaluating new nematicides that are currently not registered in grape for their efficacy in controlling *M. hapla* and a part of that evaluation includes improving the alignment of nematicide application timing with the vulnerable second-stage juvenile (J2) life stage of *M. hapla*. Work done concurrently with this research found that *M. hapla* J2 are at their lowest density in midsummer, increase to a maximum density between October and March, then decline over spring and early summer (East et al., in press). The influence of product timing on its efficacy will be presented.

Materials and methods – Five vine plots in a *Vitis vinifera* 'Riesling' vineyard were soil sampled for *M. hapla* J2 in spring 2016 to establish baseline nematode densities. Nematicide treatments of fluazaindolizine (Salibro, total acre rate) and fluensulfone (Nimitz, treated acre rate) were applied according to manufacturer recommendations once in spring 2016; each treatment had four replicate plots. In spring 2017, an additional three spring Salibro treatments, calculated from treated acre rather than total acreage were added: full rate, half rate, and half rate applied twice; and a Nimitz treatment (half rate applied in spring and fall). In spring 2018, a second vineyard site planted to 'Chardonnay' was added, with Salibro treatments calculated from treated acre: full rate in spring, half rate in spring, full rate in fall, and half rate in spring and fall. Soil was sampled in each plot to measure *M. hapla* J2 densities in spring and fall from 2016 through 2018. Dormant pruning weights and whole vine yield were measured to assess effect of nematicide treatments on vine growth.

Results – The total acre rate of Salibro had lower densities of *M. hapla* J2 than the untreated control in fall 2016, 2017, and 2018 at the Riesling vineyard. Unfortunately, this is not a rate that will be legally registered. The half rate applied twice spring treatment was only effective starting fall of 2018, after two years of application. In fall 2018, both full rate in spring and half rate in spring treatments reduced J2 densities at the Chardonnay vineyard. No other Salibro or any of the Nimitz treatments reduced *M. hapla* J2 densities. Vine parameters were not affected by nematicide treatments. Spring 2019 results will be available at time of presentation, and we are particularly interested in the longer-term effects of fall-applied treatments.

Keywords: Root-knot nematode, *Vitis vinifera*, *Meloidogyne hapla*

1. Introduction.

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INTRODUCTION

The northern root-knot nematode (*Meloidogyne hapla*) is a major nematode pest in Washington vineyards (Moyer and O'Neal 2013). *M. hapla* infects grape roots as a second-stage juvenile in the soil. In the root, it develops into an adult female that causes root galling and lays eggs in or on the root (**Fig. 1A, B**). The soil-motile juvenile stage is the best target for chemical control (**Fig. 1C**).

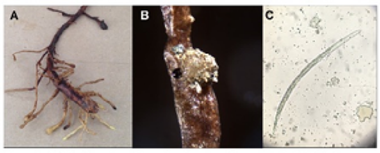

Figure 1 – (**A**) *Root showing galling and proliferation of fine roots typical of* M. hapla *infestation in* V. vinifera. (**B**) M. hapla *egg mass on the outside of a* V. vinifera *root.* (**C**) M. hapla *juvenile (J2), the infective stage.*

Post-plant nematicide options are limited, and with phase-out and changing certification of many products, evaluation of efficacy is essential for developing control strategies. Our work described here is aimed at evaluating different post-plant nematicides (new and old) for their efficacy, and using a life-cycle model (grey box below; East et al. 2019) we developed concurrently for this nematode to improve timing of management intervention.

Figure 2 - (**A**) *Cup drip application method. Product is pipetted into cups suspended under drip emitters.* (**B**) *The diluted product drips out of holes near the top of the cup.*

METHODS

- Nematicides Salibro (fluazaindolizine) and Nimitz (fluensulfone) were applied to the soil through drip irrigation (**Fig. 2**) to a commercial 30-year old *V. vinifera* 'Riesling' vineyard starting spring 2016.
- Three additional treatments were added in 2017 to test different spring rates of Salibro (**Table 1**).
- A second trial was added in 2018 in a 3-year old 'Chardonnay' vineyard to compare variable spring and fall applications (**Table 1**).
- Soil cores were collected in spring and fall to sample *M. hapla* J2. Soil was processed using a semi-automatic elutriator (Seinhorst 1962) and sugar-centrifugation (Jenkins 1964) to clear samples for counting *M. hapla* J2.

Table 1 - *Nematicide timings and product rates. 'x' indicates during which year treatments were applied.*

Year	Riesling vineyard							Chardonnay vineyard				
		Salibro				Nimitz			Salibro			
	Untreated Control	High Rate Spring	Full Spring	Half Spring	Half Twice Spring	Spring	Spring and Fall	Untreated Control	Full Spring	Half Spring	Full Fall	Full Spring and Fall
2016	x	x				x						
2017	x	x	x	x	x	x	x					
2018	x	x	x	x	x			x	x	x	x	x
Number App. / year	0	3	1	1	2	1	2	0	1	1	1	2
Total app. / year (L/Ha)	0	33.68	4.49	2.24	4.49	11.70	8.18	0	4.49	2.24	4.49	8.98

Full: Label rate Salibro, 4.49 L/Ha or 61.4 fl. oz/acre; Half: Half label rate Salibro, 2.24 L/Ha or 30.7 fl. oz/acre

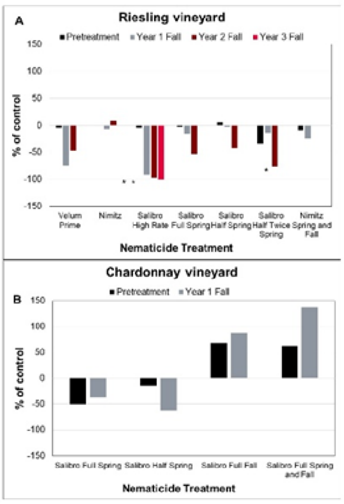

Figure 4 – *Change in* M. hapla *J2 as a response to nematicides as relative to control treatments in* (A) *a* Vitis vinifera *'Riesling' vineyard in Mattawa, WA and* (B) *a* Vitis vinifera *'Chardonnay' vineyard in Alderdale, WA.*

Negative values indicate a reduction in M. hapla *as compared to control, and positive values increases in* M. hapla *as compared to control. "*" indicates significance between treatment and control at p=0.05 using Dunnett's post-hoc test.*

RESULTS

Nematicide applications were made during the time period indicated by the red boxes in **Fig. 3 (right)**, when *M. hapla* J2 are at or below 50% of their potential maximum soil density. All nematicide applications were performed after the J2 peak in spring and before the J2 peak in fall.

Of the drip-applied nematicides, only the high rate of Salibro had significantly reduced J2 populations starting at years 2 and 3 post-application, and the Salibro half rate applied twice at year 2 as compared to the untreated control (**Fig. 4A**; Dunnett's p=0.05).

However, the high rate is 7.5x the label rate, as it was calculated as total acreage rather than treated acreage. This high rate is unlikely to be allowed for commercial use. Both of these treatments had multiple application dates in spring, which may be part of why they were more effective.

Given these initial results (years 1 and 2), e chose to add a second field site with multiple applications in spring and fall, to determine if one or both is effective (**Fig. 4B**). Data shown in **Fig 4B.** is from a new site added in 2018 and are the result of one year of applications; the trial will continue through 2019.

USING PEST BIOLOGY TO TIME MANAGEMENT

Our recent modeling efforts have demonstrated that peak *M. hapla* J2 populations occur in the fall and overwinter as J2. The J2 then decline in the spring before reaching a minimum mid-summer. To maximize efficacy of products that target J2, it is likely best to time their application hen J2s are readily accessible in the soil.

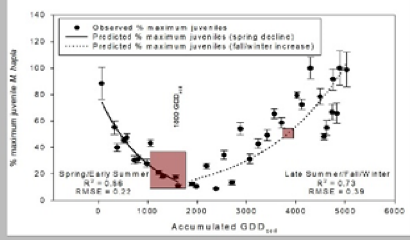

Figure 3 – (From East et al. 2019) *Soil temperatures can predict when the J2 stage of* M. hapla *is present in the soil. Red boxes indicate the timing of our nematicide applications relative to the percent maximum J2s present at the time of application.* .

Nimitz was ineffective when applied at both spring and spring and fall timings. This nematicide reduces egg hatch and viability (Kearn et al. 2014) and peak *M. hapla* egg production is midsummer (East et al. 2019). Given that, a midsummer application of Nimitz may be more effective than at spring and/or fall, which would be a change from the current manufacturer's recommendation. This adjustment is being considered in future trials with this product.

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