Mating disruption for grape mealybug, *Pseudococcus maritimus* (Ehrhorn) in Washington State

Stephen Onayemi and Doug Walsh, Department of Entomology, Washington State University IAREC, Prosser, Washington.

Abstract

We have conducted a three-year study on mating disruption for *Ps. maritimus* by deploying twist-tie and Cidetrak® pheromone-imbibed dispensers on grapevines in an even spatial manner of 0, 10, 30, 60, and 100 dispensers and 32 and 50 dispensers per acre respectively. We included sentinel traps baited with the sex pheromone of grape mealybug in two replicates (twist-tie) and three replicates (Cidetrak®) on 5-acre blocks per deployment rate in commercial grower vineyards in WA from May to August of 2021 to 2023. Our results are positive demonstrating great potential for successful mating disruption of grape mealybug in Washington State vineyards.

Introduction

Washington State is the second-largest wine-producing state with over $8 billion annual revenue (WSWC 2021). Grape mealybugs (GMB) are the primary vectors of grapevine leafroll-associated viruses (GLRaVs) (Jarugula et al. 2010). Grapevine leafroll disease (GLD) caused by grapevine leafroll-associated viruses (GLRaVs) is the most economically destructive viral disease (Naidu et al. 2014). GLD accounts for approximately 60% of vineyard yield loss (O'Hearn and Walsh 2021). GMB can be a late-season direct pest of fruit clusters (Bahder et al. 2013). One infected grape mealybug crawler can transmit 10-20% GVLRaV-3 (O'Hearn and Walsh 2021)Growers are reporting resistance and/or field failures with imidacloprid (O'Hearn and Walsh 2020).

Objective and Hypothesis

Our objective was to deploy pheromone emitters in grapevines. Our goal is to use mating disruption as an alternative IPM strategy to slow down the spread of GLRaVs. We hypothesized that mating disruption using pheromone dispensers will achieve a near shut-down of the capture of male *Ps. maritimus*

What is mating disruption?

Mating disruption is the use of artificially synthesized pheromone at a high concentration in a confined area to prevent the ability of females and males to communicate with each other-hence preventing mating and blocking their reproductive cycle (Carde and Minks 1995, Miller and Gut 2015). Here, we used the artificial female pheromone which the female mealybug uses to call the male for mating embedded in this twist-tie emitter, slowly emitted in high concentration to confuse males from locating the original female calling via plumes (Miller and Gut 2015).

Fig. 1 – Twist-tie pheromone dispenser

Fig. 2 – Cidetrak® pheromone dispensers

Fig. 3 – Male grape mealybug (x30)

Fig. 4 – Female grape mealybug (x30)

Methods

From 2021 to 2023, we deployed Pacific Biocontrol's twist-tie pheromone dispensers on grapevines, distributing them evenly with 0, 10, 30, 60, and 100 dispensers in two replicates. In 2022 and 2023, we utilized Trécé's Cidetrak® dispensers, placing 32 and 50 per acre in three 5-acre replicates. To monitor mating disruption, we deployed two sentinel traps with GMB sex pheromone lures in 5-acre blocks for each deployment rate across all treatments in WA vineyards. Traps were monitored weekly from late May to late October 2021 and early April to late October 2022 and 2023.

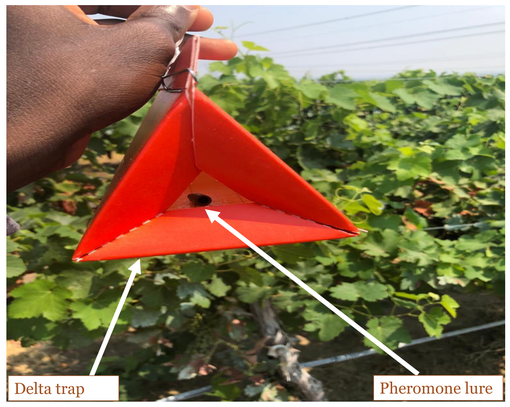

Fig. 5 – Sentinel trap with pheromone lure for monitoring grape mealybug males

Fig. 6 – Late season Grape Leafroll Disease symptoms on white (left) and red (right) wine grapes cultivars

What category of mating disruption is this?

According to Miller and Gut (2015), there are two major categories of mating disruption: competitive and noncompetitive. Under competitive disruption, there is no disruption or impairment experienced from the male, female, or signal from females. Males can respond to females, (sentinel) traps, and pheromone dispensers. Competitive disruption is considered to be a numbers game such that the ratio of dispensers to females and traps is very important which makes this control method pest density dependent. There is a chance that some females may be mated by the males since this mating disruption category is pest density dependent. It appears that mating disruption with GMB is competitive and was achieved at approximately 60 to 100 twist tie and 32 to 50 Cidetrak® dispensers per acre.

Results

There are two mating flight periods. The first in early May/June and the second in late July/August. Dispensers deployed at 60 to 100 twist tie and 32 to 50 Cidetrak® dispensers per acre nearly shut down the capture of male *Ps. maritimus* in sentinel traps. Peaks in figures 7-11 (on the right) show the two mating flight periods.

Results (*Cont'd*)

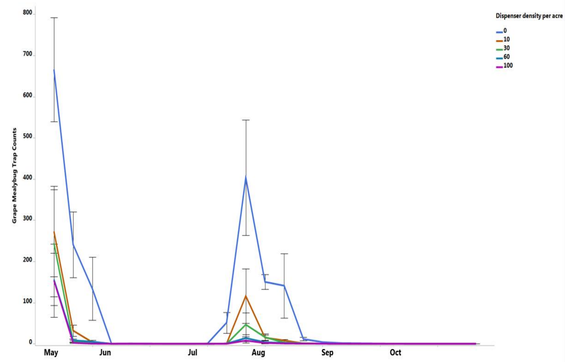

Fig. 7 - Sum of male grape mealybug trap counts on conventional and organic vineyards in 2021 using Pacific Biocontrol twist-tie dispensers

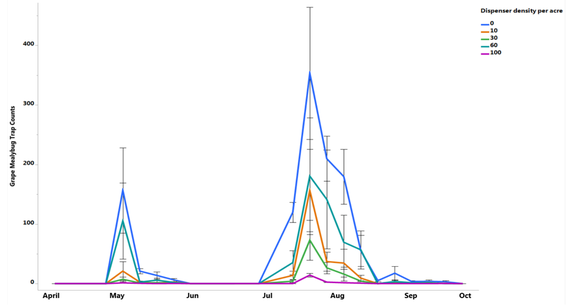

Fig. 8 - Sum of male grape mealybug trap counts on conventional and organic vineyards in 2022 using Pacific Biocontrol twist-tie dispensers.

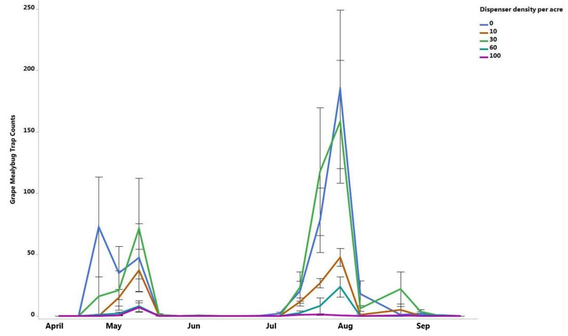

Fig. 9 - Sum of male grape mealybug trap counts on conventional and organic vineyards in 2023 using Pacific Biocontrol twist-tie dispensers.

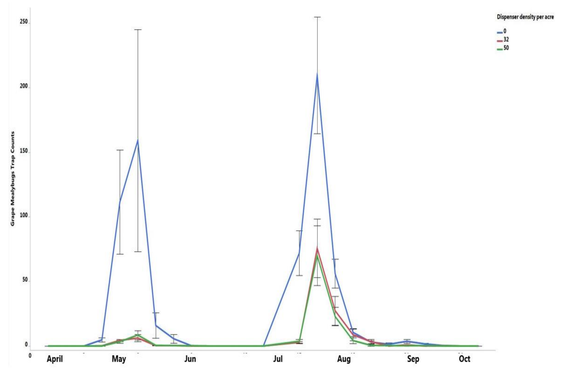

Fig. 10 - Sum of male grape mealybug trap counts on conventional and Concord vineyards in 2022 using Trécé Cidetrak® dispensers .

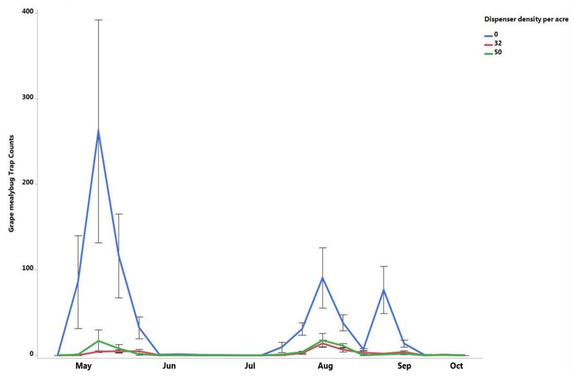

Fig. 11 - Sum of male grape mealybug trap counts on conventional and Concord vineyards in 2023 using Trécé Cidetrak® dispensers .

Discussion and Conclusion

In our first-year study (2021), we couldn't deploy pheromone dispensers in early May due to time constraints. However, with the second flight, we had a near-complete trap capture shut down at 60 and 100 dispensers per acre (Figure 7). In 2022 and 2023, we placed dispensers in late April. We achieved a complete shutdown at 32 and 50 Cidetrak® dispensers per acre in both years. However, in 2022, it was 100 and 30 twist-tie dispensers per acre, and in 2023, it was 100 and 60 twist-tie dispensers per acre (Figures 8 - 11).Comparing twist tie results from 2021-2023, 60 dispensers per acre were less effective in 2022 than in 2021. Surprisingly, 30 dispensers per acre in 2023 also showed inefficiency, possibly due to an unknown field effect.

Study Limitation: Supply chain constraints led to limited repeatability with fewer twist ties and Cidetrak® dispensers from 2021-2023.

Significance of the Study: Mating disruption of mealybugs could be crucial in vineyard pest management. Our findings suggest that 60 (twist tie) or 32 (Cidetrak®) dispensers per acre offer the best and most cost-effective options for growers. This alternative strategy aims to:

- Slow down GLRaV spread
- Mitigate insecticide resistance
- Protect beneficial insects
- Reduce pre-harvest and re-entry intervals in fields
- Prevent potential secondary pest outbreaks from insecticide use.

References

Carde, R. T., and A. K. Minks. 1995. Control of moth pests by mating disruption: successes and constraints. Annual review of entomology. 40: 559–585.

Jarugula, S., O. J. Alabi, R. R. Martin, and R. A. Naidu. 2010. Genetic Variability of Natural Populations of Grapevine leafroll-associated virus 2 in Pacific Northwest Vineyards. Phytopathology®. 100: 698–707

Miller, J. R., and L. J. Gut. 2015. Mating Disruption for the 21st Century: Matching Technology With Mechanism. Environmental Entomology. 44: 427–453.

Naidu, R., A. Rowhani, M. Fuchs, D. Golino, and G. P. Martelli. 2014. Grapevine Leafroll: A Complex Viral Disease Affecting a High-Value Fruit Crop. Plant Disease. 98: 1172–1185

O'Hearn, J. S., and D. B. Walsh. 2020. Effectiveness of imidacloprid, spirotetramat, and flupyradifurone to prevent spread of GLRaV-3 by grape mealybug, *Pseudococcus maritimus* (Hemiptera: Pseudococcidae). J Plant Dis Prot. 127: 805–809

O'Hearn, J. S., and D. B. Walsh. 2021. Grapevine Leafroll-associated Virus 3 Vectored by *Pseudococcus maritimus* at Low Population Levels. Journal of Entomological Science. 56: 106–110

Washington State Wine Commission. 2021. Fast Facts: Washington State Wine Fast Facts. Retrieved from: https://www.washingtonwine.org/fast-facts/

Acknowledgments

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