Virginia Wine Board Grant
Final Report

8/30/2023

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Title: Spotted lanternfly affecting Virginia vineyards: Expansion, and control of egg masses
Proposal Number: 467456
Project Type: ☒ Research ☐ Education ☐ Marketing
Is this a multi-year grant? ☒ Yes ☐ No
If yes, which year does this report address? While funded one year at a time this is the third year of this project

Original Funding Amount: $55,675
Remaining Balance: $4,094.36

Objectives and Results:
Main areas of accomplishment in 4th Quarter:

This project represents the third year of a doctoral program of Mr Jason Bielski. Jason made progress in his research on ovicides and *Beauveria bassiana* as a control tool for SLF. A presentation of his research to date for an international scientific society, the Society of Invertebrate Pathology, received a third-place award. Jason took his earlier lab trials on malathion as an ovicide, where it was equivalent to the now-banned chlorpyrifos in mortality to SLF eggs, into the field. While control hatch was greater than 90%, hatch in malathion-treated egg masses was less than 5%. Jason has shown that treatment of SLF egg masses before hatch with Beauveria can lead to infection of nymphs after hatch from treated eggs. In the course of his research in our quarantine lab, a mite new to Virginia, *Aculops ailanthi*, was found on potted TOH. This mite may be a biocontrol agent for tree-of-heaven. A manuscript reporting this find, and what is known of the biology of the mite, has been submitted to Proceedings of the Washington Entomological Society. We are in communication with researchers in Italy regarding development of *A. ailanthi* as a biocontrol agent. Knowledge of current status of spread was incorporated into both extension and research presentations.

An earlier student, Mr. Andrew Dechaine was funded in part by Wine Board funds early in the course of the project (we were able to obtain Forest Service funds to support Andy, before Wine Board funding was in place. One of Andy's publications dealt with differential impact of feeding on several forest tree species (second reference section) but his work on phenology related to timing of management in Virginia vineyards (first reference section).

Objective 1: Follow the expansion of geographical range of SLF relative to our vineyards
Objective 2: Conduct evaluations of potential ovicides against SLF egg masses, with comparison of applications at beginning of overwintering with approaching hatch in spring and utility of added penetrants.

Objective 3: Evaluate distribution of SLF eggs within vineyards and optimize ovicide spray timing
Objective 4: Determine efficacy of *Beauveria bassiana*, an entomopathogen that is naturally occurring as well as commercially available, against SLF.
Objective 5: Print SLF educational posters for posting at vineyards and wineries.

Objective 1: Follow the expansion of geographical range of SLF relative to our vineyards

In 2022, the number of vineyards with SLF rose to from 4 to ca. 11 (final number not firm yet). After the discovery of SLF in Winchester in 2018, a quarantine zone was erected - the insect was first found in Winchester and County, but as it spread, the quarantine zone expanded. In 2022, the zone was significantly expanded. The list of counties now infested includes (**BOLD** indicates additions since the last report): Albemarle, **Amherst**, Augusta, **Bedford,** Carroll, **Campbell**, Clarke, **Culpeper, Fairfax, Fauquier, Roanoke,** Frederick, **Loudoun,** Nelson, **Orange,** Page, Prince William, **Rappahannock,** Rockingham, Rockbridge, Shenandoah, **Stafford,** Warren and Wythe Counties, plus the cities of Buena Vista, Charlottesville, Harrisonburg, Lexington, Lynchburg, Manassas, Manassas Park, **Radford, Richmond,** Staunton, Waynesboro and Winchester (Fig. 1 (Updated in July 2023): Red counties reflect quarantine zone, orange counties additional areas with reproducing populations).

The infestation zone now includes most of the Virginia vineyard acreage. Since the main period of SLF dispersal comes during and after August, the current number of infested vineyards is not known.

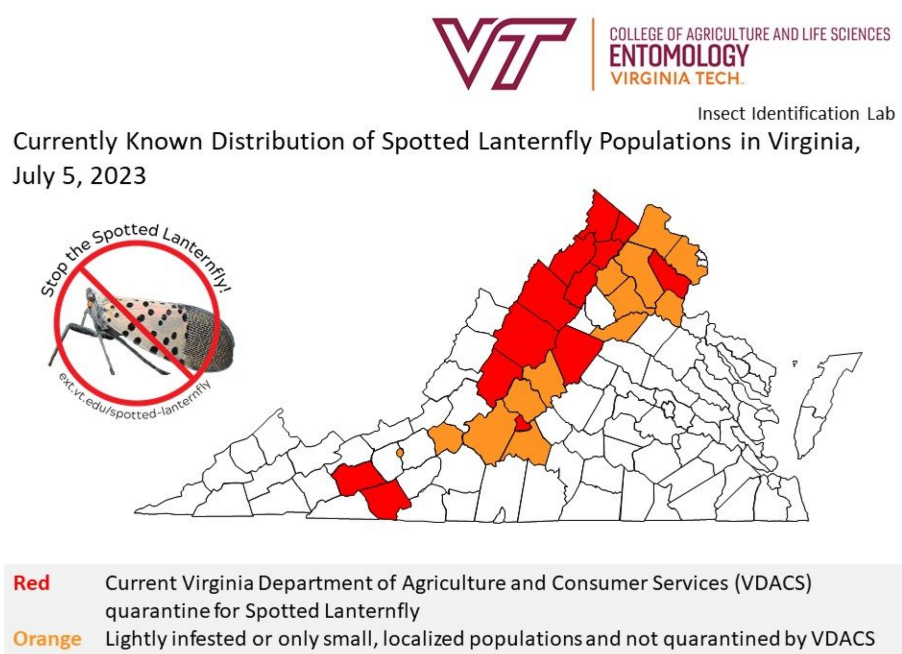

Fig. 1. Distribution of spotted lanternfly in Virginia as recorded using Survey123, as of Oct 2022. Actual range exceeds official quarantine zone.

Objective 2: Conduct evaluations of potential ovicides against SLF egg masses, with comparison of applications at beginning of overwintering with approaching hatch in spring and utility of added penetrants.

Our previous research showed only moderate activity of several synthetic insecticides against SLF eggs (ovicidal activity). There were two notable exceptions. Chlorpyrifos (Lorsban) provided total mortality of eggs (previously known from studies in South Korea and Pennsylvania). This product is now banned. However, very high levels of mortality were also provided by malathion, another organophosphate, will lower vertebrate toxicity. This was a new observation.

In spring 2023, two field sites isolated by 50 m were located in Winchester, VA, and 50 SLF egg masses were found and flagged for use in field trials. Each field site was allocated to one treatment: untreated control or Malathion 8 Flowable (malathion). Treatments were applied with a 1 L hand sprayer until runoff using the maximum label rate. SLF egg masses were treated in late April and observed for hatch. Hatch rates of treated SLF egg masses were visually quantified one month following the first hatch. We found a significant reduction in the hatch rate of those SLF egg masses treated with Malathion compared to the untreated control. Specifically, while hatch rates of the untreated control were greater than 90%, we found that a single application of Malathion before hatch reduced hatch rates below 5%. This field trial indicates the comparable efficacy of Malathion to Chlorpyrifos for ovicidal control of SLF.

Objective 3: Evaluate distribution of SLF eggs within vineyards and optimize ovicide spray timing

During much of the year, SLF is in the egg stage. Eggs are laid not only on tree of heaven, but the bark of other trees, as well as inanimate objects. In vineyards with established populations, egg masses may be seen in high numbers on trellis posts. In one vineyard in northern Virginia, masses were seen in high numbers on treated wood end posts, shown here. Note how the presence of protective covering over the eggs deposited by the female varies from complete to absent.

One troubling observation was the concentration of egg masses in the inner (concave) surfaces of roll-formed steel trellis posts (Fig. 2). This protective behavior will likely result in difficulties in achieving spray coverage with the development of effective ovicides.

Since the main period of SLF dispersal is in August – November, spread of this year's SLF adults is not included.

Fig. 2. Spotted lanternfly egg masses laid on inner (concave) surface of roll-formed steel trellis posts.

Objective 4: Determine efficacy of *Beauveria bassiana*, an entomopathogen that is naturally occurring as well as commercially available, against SLF.

2022

***Beauveria bassiana* winter survivability on SLF egg masses**

SLF egg masses were conveniently sampled from Fruit Hill Orchards in Winchester, VA, in January 2022. The egg masses were delicately removed from tree bark using various knives and chisels and only used in the trial if the protective waxy covering of the egg mass was intact. Collected SLF egg masses were inventoried, randomly assigned a treatment number, and stored in sterile Petri dishes. There were 6 - 16 SLF egg masses per treatment. Treatments were applied with a 100 ml plastic hand sprayer at 20 and 2 weeks before the predicted SLF hatch. All treatments were applied until runoff to mimic typical insecticide bark application. This study used two commercially available *B. bassiana* strains, GHA and ANT03. Additionally, two formulations of each *B. bassiana* strain were used, wettable powders and emulsifiable concentration/solution. Each treatment was compared to an untreated check. SLF egg masses were stored outside to mimic natural overwintering conditions or held in an environmental chamber to limit extraneous environmental factors. SLF egg masses stored in an environmental chamber were exposed to 10°C, 65% relative humidity, and an 18:6 hr light-dark cycle. SLF egg masses stored outside and exposed to natural winter conditions were held at a field site in Hamburg, PA (LABServices). Additionally, another group of egg masses was not treated 28 weeks before they hatched. They were treated 2 weeks before the hatch and were not exposed to field conditions to act as a positive control for spore germination. After 28 weeks of exposure to natural or simulated winter conditions, the SLF egg masses were rinsed of any remaining spores using a 0.05% organosilicon surfactant (Silwet - L-77). Spores were removed by gently rolling a sterile cotton swab, moistened with Silwet, against the egg mass, then transferring any collected spores into a solution of 0.05% Silwet. Two hundred spores were randomly counted from each replicate and visually inspected for evidence of germination. Those spores that successfully germinated were considered to have survived the treatment exposure. This method of sampling SLF egg masses was destructive to the SLF egg mass. The spores and viability of all *Beauveria* treatments were confirmed (by Stefan Jaronski) before treatments were applied.

To determine statistical differences between treatments during each application timing, a Kruskal-Wallis nonparametric ANOVA was utilized because of the discrete Poisson distribution of the data set. If statistical differences were found, a Dunn post hoc test was performed for multiple pair-wise comparisons. A Bonferonni correction was performed because of the high number of pair-wise comparisons performed and used to determine significant differences between treatments ($\alpha = 0.05$).

Efficacy of commercial *Beauveria bassiana* applications on overwintering SLF egg masses treated before hatching

SLF egg masses were conveniently sampled from Fruit Hill Orchards in Winchester, VA, in January 2022. The egg masses were delicately removed from tree bark using various knives and chisels and only used in the trial if the protective waxy covering of the egg mass was intact. Collected SLF egg masses were inventoried, randomly assigned a treatment number, and stored in sterile Petri dishes. There were 10 SLF egg masses per treatment at each treatment time. Treatments were applied with a 100 ml plastic hand sprayer at one of three timing intervals: 28, 12 2 weeks before the egg masses artificially induced hatch. All treatments were applied until runoff to mimic typical insecticide bark application. The spores and viability of all *Beauveria* treatments were confirmed (by Stefan Jaronski) before treatments were applied. Egg masses were briefly removed from cold storage to apply treatments if needed. SLF egg masses were stored in an environmental chamber at 10C, 65% relative humidity, and an 18:6 hr light-dark cycle. After a minimum of 100 days of cold storage, egg masses were removed from the cold storage conditions and induced to hatch by changing the temperature to 25C. All egg masses were allowed two months to hatch fully. Once hatch occurred (generally less than 2 weeks after removal from cold storage), individual egg masses were moved to caged (18x18x24” mesh cage) tree-of-heaven (TOH) saplings. The TOH saplings were a minimum of 1-year-old, healthy potted (3 gals) trees, approximately 18-24” in height. The pot was covered with a mesh paint strainer to prevent the nymphs from walking on the soil medium or falling into the water runoff tray. SLF nymphs were left in cages for one week before being collected. Due to space limitations, we staggered the SLF egg masses' hatch periods; the treatments were artificially induced to hatch by the treatment timing group. Artificial hatch started with the 2 wk treatment timing, followed by the 28 wk and 12 wk, respectively. We artificially killed the SLF nymphs after one week using cold exposure, then stored the nymphs in a freezer to preserve possible *Beauveria* infection. After 1 wk, we assumed that the *Beauveria* spores the insects came in contact with on the egg mass would have penetrated the cuticle and exoskeleton and be within the insect, eventually resulting in death (Citation for assumption). We also assume that the SLF nymph would not likely pick up viable *Beauveria* spores from the treated egg mass surface after that time window or after the first molt. SLF nymphs were then surface sterilized by submerging and agitating nymphs in (10% bleach). Excessive bleach solution was removed from the surface-sterilized SLF nymphs with a vacuum pump and filter. Surface sterilized nymphs were then transferred to a dodine and potato dextrose agar. Plated nymphs were 18 hr to allow any internal *Beauveria* infections to sporulate if it was present within the insects. The SLF cadavers were observed for signs of *Beavueria* sporulation; if present, the insect would be assumed infected. The mean proportion of SLF to hatch and become infected for each treatment was collected. The mean proportion of SLF infected excluded those that did not hatch from each replicate.

A simple linear regression model was used to determine if the number of days in cold storage affected the mean proportion of SLF to hatch. The linear regression model pooled all replicates used in the trial. To determine statistical differences between treatments during each application timing, a Kruskal-Wallis nonparametric ANOVA was utilized because of the discrete Poisson distribution of the data set. If statistical differences were found, a Dunn post hoc test was performed for multiple pair-wise comparisons. A Bonferonni correction was performed because of the high number of pair-wise comparisons performed and used to determine significant differences between treatments ($\alpha = 0.05$).

2022 RESULTS

***Beauveria bassiana* winter survivability**

A total of 130 SLF egg masses were used across the various treatments and environmental exposure. We found significant differences between all treatments and mean percent germination independent of application timing; 28 wk application timing + winter exposure, 28 wk application timing + no winter exposure $H(4) = 65.207$, $p = <.001$, 2 wk application timing + no winter exposure $H(4) = 27.609$, $p = <.001$, $H(4) = 22.165$, $p= <.001$. Between all application timings, all untreated checks resulted in no germination. The positive control (2 wk application timing + no winter exposure) resulted in the greatest mean percent germination across all treatments at rates greater than 80%. Additionally, when SLF egg masses were treated 28 wk prior to hatch and not exposed to winter conditions, we saw greater mean percent germination than when exposed to natural winter conditions. SLF egg masses treated 28 wk prior to hatch and not exposed to winter conditions resulted in mean percent germination rates ranging from 27-79%, with Bioceres EC not significantly different from the untreated check. Likewise, SLF egg masses treated 28 wk prior to hatch and exposed to winter conditions mean percent germination rates ranged from 11-51%, with Bioceres EC not significantly different from the untreated check. At all treatment timings, we found that the Botanigard 22WP resulted in the greatest mean percent germination ranging from 51-86%. Bioceres WP was statistically similar to Botanigard 22WP, with mean percent germination ranging from 42-86%.

Efficacy of commercial *Beauveria bassiana* applications on overwintering SLF egg masses treated before hatching

A total of 200 SLF egg masses were used across all treatments and application timings. The SLF egg masses were exposed to cold storage for 139-209 days. A simple linear regression of all treatments was calculated to predict the proportion of SLF hatch based on days in cold storage, b = -0.787, t(198) = 19.611, p<.001; a significant regression equation was found F(1,198) = 322.678, p<.001 with an R^2 of 0.620.

SLF egg masses treated 28 wk and 12 wk before hatch resulted in low mean proportion hatch rates, ranging from 0.00-8.08% for all treatments. The 12 wk treatment application timing resulted in virtually no hatch, with only 0.30% of the Botanigard 22WP treated SLF egg masses hatching. We found significant differences between the mean proportion hatch when treatment applications were made 2 wk before the SLF hatch, H(6) = 22.998, p<.001. Specifically, all *B. bassiana* treatments made 2 wk before the artificial SLF hatch resulted in mean percent hatch rates ranging from 18 - 36%. We did not observe a statistically significant difference between the mean percent hatch of the UTC, water check, and oil check when egg masses were treated 2 wk before hatch (50 and 68%).

None of the UTC, water, or oil checks resulted in infection from surface sterilized SLF cadavers. We found significant differences between treatments and the mean percent infection when the SLF egg masses were treated 28 wk and 2 weeks before hatch, H(5) = 18.804, p=0.002, H(6) = 29.766, p=<.001, respectively. During the 28 wk before hatch, we observed that the Bioceres WP treatment had 44% mean percent infection and was significantly greater than all treatments except the Bioceres EC (16%). We saw the greatest overall mean percent infection when SLF egg masses were treated 2 wk before hatching, ranging from 18-43%. We observed that the Botanigard 22WP resulted in a significantly greater mean percent infection, at 43%, although it was not significantly different from the other *B. bassiana* treatments.

2023

The objective of research in 2023 was aimed at repeating laboratory experiments from 2022 and taking those successful treatments from 2022 to field trials. The primary focus of these trials was to investigate the efficacy of conventional insecticides and biopesticides against SLF egg masses. Lab trials in 2022 suggested that a single application of malathion (organophosphate) sprayed on SLF egg masses at various timings during the overwinter life stage reduced SLF hatch rates comparable to chlorpyrifos. Additionally, two strains and two formulations of commercially available *Beauveria bassiana* demonstrated efficacy at infecting newly hatched SLF nymphs.

In winter 2023, field sites with heavy spotted (SLF) overwintering populations were located in Winchester, VA. In early April, SLF egg masses were conveniently collected from tree bark and heavily infested tree limbs for use in laboratory experiments. Gathered SLF egg masses were held in cold storage until trials began. In late April, SLF egg masses were removed from cold storage and treated with two strains and two formulations of *B. bassiana*. Treatments were applied using a 1 L hand sprayer until runoff with the maximum label rate. Treated SLF egg masses were placed in cages with two potted tree-of-heaven (TOH) seedlings. After the hatch occurred, SLF nymphs were allowed to feed for a week, then were collected and artificially killed by cold exposure. Collected SLF nymphs were surface sterilized, plated on selective agar, incubated for four days, then observed for *B. bassiana* infection. In 2023 lab trials, SLF egg masses were only treated approximately two weeks before hatch. We found that all four *B. bassiana* treatments resulted in infection of SLF cadavers, while no infection was detected in the untreated and water controls. Reduced infection rates were observed in SLF treated two weeks before hatch when laboratory data from 2022 and 2023 were compared. This lab trial indicates that applications of *B. bassiana* treatments applied before hatch can successfully infect SLF nymphs in laboratory conditions.

In spring 2023, two field sites isolated by 50 m were located in Winchester, VA, and 50 SLF egg masses were found and flagged for use in field trials. Each field site was allocated to one treatment: untreated control or Botanigard ES (*B. bassiana* GHA). Botanigard ES treatments were applied with a 1 L hand sprayer until runoff using the maximum label rate. SLF egg masses were treated in late April and observed for hatch. One week following the hatch, SLF nymphs were sampled from the area surrounding the treated egg masses. Collected SLF were artificially killed with cold exposure, then they were surface sterilized, plated on selective agar, incubated for four days, and observed for signs of infection of *B. bassiana*. Infection levels greater than 30% were detected in those SLF sampled from the Botanigard ES field site, while no infection was seen in the untreated control. Additionally, hatch rates were visually quantified for each replicate egg mass in each field site. We found a significant difference between the hatch rate of the untreated control and Botanigard ES treatments, though hatch rates for both treatments were greater than

90%. This field trial indicates that applications of Botanigard ES applied before the hatch can successfully infect SLF nymphs under natural field conditions.

Six red maple trees, each infested with SLF egg masses, were located at an additional field site in Winchester, VA. Three trees were randomly assigned to two treatment groups: untreated control or Botanigard ES. Treatments were applied as the SLF hatch was detected at the field site. Nymphs were collected, and three-minute visual counts of SLF populations on each tree were performed at 0, 5, and 10 days after treatment (DAT). Collected SLF were artificially killed with cold exposure, then they were surface sterilized, plated on selective agar, incubated for four days, and observed for signs of infection of *B. bassiana*. Infection levels greater than 40% were detected in those SLF sampled from the trees treated with Botanigard ES, while no infection was seen in the untreated control. Visual time counts indicated that after 10 DAT, SLF populations crashed, regardless of treatments. This suggests the applicability of applications of *B. bassiana* to hatching SLF on red maple. Furthermore, red maple would make a good trap tree to infect the high population densities of SLF nymphs before they disperse to more suitable host material.

Table 1: Treatment list

Active ingredient	Trade name	AI(%)	Max label rate on grape per ac (US)	Rate per ac (g or ml) 100 gal/ac	CFU per mL diluted product
Untreated check	-	-	-	-	-
Beauveria bassiana GHA	Botanigard 22WP	22.00	2 lb	907	4.80E+10
Beauveria bassiana GHA	Botanigard ES	11.30	1 qt	946	5.00E+10
Beauveria bassiana ANT03	BioCeres WP	20.00	3 lb	1361	3.27E+10
Beauveria bassiana ANT03	BioCeres EC	10.00	1 qt	946	4.73E+10

Water check	-	-	-	-	-
Oil check (2.5%)	-	100.00	-	9463	-

Table 2: Mean germination of Beauveria using four formulations at different treatment times.

	Mean germination (%)[a]		
	28 wk	28 wk	2 wk
Treatment	No winter exposure	Winter exposure	No winter exposure
Untreated check	0.00a	0.00a	0.00a
Botanigard 22WP	79.42d	51.94c	86.92b
Botanigard ES	33.42bc	14.17b	80.67ab
BioCeres WP	60.33cd	42.43bc	86.00b
BioCeres EC	27.58ab	11.30ab	78.50ab

[a]Data were rank transformed for Kruskal-Wallis analysis; untransformed mean percent germination data are shown

Data within columns followed by a letter in common are not significantly different; $P < 0.05$.

Table 3: Mean hatch rate of SLF and mean infection rate following treatment of eggs at differing dates.

	Mean hatch (%)[a]			Mean infection (%)[a]		
Treatment	28 wk	12 wk	2 wk	28 wk	12 wk	2 wk
Untreated check	8.08a	0.00a	68.74a	0.00a	0.00a	0.00a
Botanigard 22WP	7.62a	0.30a	23.94b	3.00a	0.30a	43.09b
Botanigard ES	3.13a	0.00a	36.57ab	11.00a	0.00a	18.12ab
BioCeres WP	8.63a	0.00a	18.04b	44.00b	0.00a	28.86ab
BioCeres EC	6.01a	0.00a	25.67b	16.00ab	0.00a	26.07ab
Oil check	-	0.00a	50.8ab	-	0.00a	0.00a
Water check	0.00a	0.00a	55.55ab	0.00a	0.00a	0.00a

[a]Data were rank transformed for Kruskal-Wallis analysis; untransformed mean percent hatch data are shown

Data within columns followed by a letter in common are not significantly different; $P < 0.05$.

New mite feeding on tree-of-heaven

In the course of this work, we found an eriophyid mite, *Aculops ailanthi* (Fig. 3), feeding on young tree of heaven in the growth room. This is new record for Virginia and we are pursuing this as 1) an obstacle to lab rearing of TOH, and 2) a potential biological control agent for TOH.

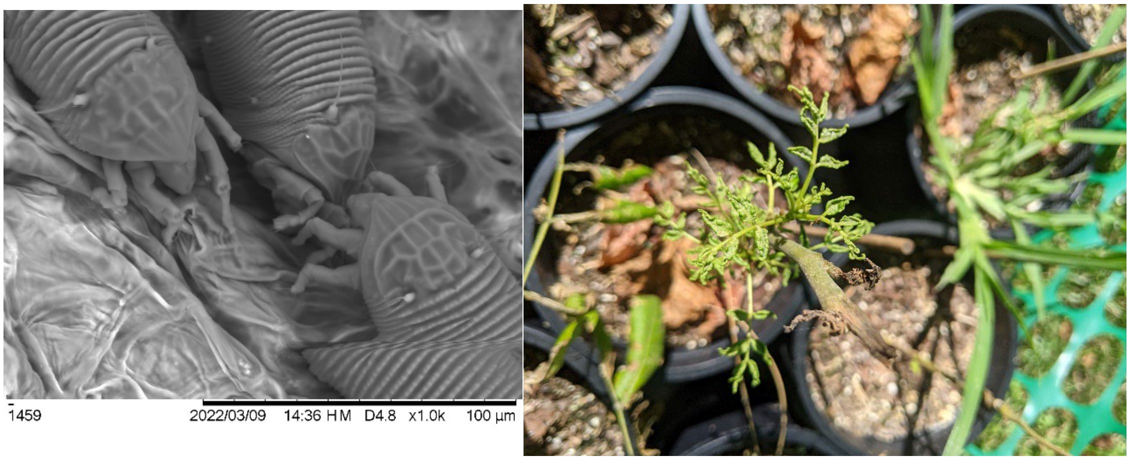

Fig. 3. An eriophyid mite, *Aculops ailanthi*, reported for the first time in Virginia, and deformed tree-of-heaven leaf growth resulting from mite feeding.

Overall Benefit for Virginia Wine Industry:
Spotted lanternfly poses a severe threat to Virginia viticulture. In Pennsylvania, where SLF was first introduced, the insect was responsible for death of many grapevines. With current knowledge, we can prevent this level of loss. However, for the time being, it will be at the cost of a greatly elevated insecticide load, especially of broad spectrum insecticides like pyrethroids. There is an important repercussion of such high insecticide use generally induces secondary pest outbreaks. A key group of secondary pests includes mealybugs, the vectors of grapevine leafroll virus. It will be critical to devise pest management programs that a) control SLF without excessive applications, and b) are less likely to flare secondary pests like mealybugs. Our work on Beauveria may lessen the pest severity of SLF, and the work on an ovicide offers the possibility of greatly reducing the population of SLF within a vineyard (and possibly in the environs) before nymphal feeding starts.

Publications and Activities Associated with Project:
Bielski, J., D. Pfeiffer, R. Ochoa and A. Ulsamer. Submitted. New state records of *Aculops ailanthi* (Lin, Jin, and Kuang) (Acariformes: Trombidiformes: Prostigmata: Eriophyidae), in USA; a pest or biological control agent of *Ailanthus altissima* (Mill.) Swingle? Proc. Entomol. Soc. Wash.

Dechaine, A. C., M. Sutphin, T. C. Leskey, S. M. Salom, T. P. Kuhar and D. G. Pfeiffer. 2021. Phenology *of Lycorma delicatula* (Hemiptera: Fulgoridae) in Virginia, USA. Environ. Entomol. 50: 1267-1275. (https://academic.oup.com/ee/article/50/6/1267/6382325)

Pfeiffer, D. G., A. B. Baudoin, K. B. Rice and M. Nita. 2023. Grapes: Diseases and Insects in Vineyards. p. 3-1 – 3-14. *In*: 2023 Pest Management Guide for Horticultural and Forest Crops. Va. Coop. Ext. Pub. **456-017**.

Pfeiffer, D.G., E. R. Day and T. A. Dellinger. 2022. Spotted lanternfly, *Lycorma delicatula* (White) (Hemiptera: Fulgoridae). Va. Coop. Ext. Publ. ENTO-180NP. 3 p. (https://pubs.ext.vt.edu/ENTO/ENTO-180/ENTO-180.html) (enhanced electronic version: http://digitalpubs.ext.vt.edu/vcedigitalpubs/9322249259597133/MobilePagedReplica.action?pm=1&folio=1#pg1)

Pfeiffer D. G., E. R. Day, T. Dellinger, and M. Sutphin. 2022. Spotted lanternfly in Virginia vineyards: *Lycorma delicatula* (White) (Hemiptera: Fulgoridae). Va. Coop. Ext. Publ. ENTO-323NP. 3 p. https://www.pubs.ext.vt.edu/ENTO/ENTO-323/ENTO-323.html

Pfeiffer D. G., E. R. Day, T. Dellinger, A. Dechaine*, M. Sutphin and B. Sastre. 2019. Mosca linterna con manchas (Spotted Lanternfly) en viñedos de Virginia: *Lycorma delicatula* (White) (Hemiptera: Fulgoridae). Va. Coop. Ext. Pub. ENTO-323S. 2 p. https://www.pubs.ext.vt.edu/ENTO/ENTO-323S/ENTO-323S.html

Future Work:
The work will continue, with funding sought from other sources. While the Board opted not to support the project further, I am obligated to support the graduate student involved, in pursuit of his accepted objectives. Work will emphasize field use of *Beauveria* in the field. I will work with growers near newly established SLF infestations as I learn of them in order to better manage this pest. I aim to work on solidifying action thresholds. With successful demonstration of the efficacy of malathion against SLF eggs in the field, this will be entered into the next revision of the Pest Management Guide.

Final Budget and Justification:

Item Type	Original Awarded Amount	Final Amount Spent
Personnel	32901	4737.14
Fringe	3095	470.13
Travel	2700	-2327.73
Supplies & Materials	1500	-1,389.31
Contractual	[$0.00]	-197.49
Other	15479	23,00
Total	55,675.00	4094.3600

[How does the original budget relate to the final? Discuss any differences. Please include source and amount of other supporting funds, facilities, and personnel, if applicable.]

References: [List all references.]

RESEARCH PUBLICATIONS

Bielski, J., D. Pfeiffer, R. Ochoa and A. Ulsamer. Submitted. New state records of *Aculops ailanthi* (Lin, Jin, and Kuang) (Acariformes: Trombidiformes: Prostigmata: Eriophyidae), in USA; a pest or biological control agent of *Ailanthus altissima* (Mill.) Swingle? Proc. Entomol. Soc. Wash.

Dechaine, A. C., D. G. Pfeiffer, T. P. Kuhar, S. M. Salom, T. C. Leskey, K. C. McIntyre, B. Walsh and J. H. Speer. *In press*. Dendrochronology reveals different effects among host tree species from feeding by *Lycorma delicatula* (White). Frontiers in Insect Science. Invited.

Dechaine, A. C., M. Sutphin, T. C. Leskey, S. M. Salom, T. P. Kuhar and D. G. Pfeiffer. 2021. Phenology *of Lycorma delicatula* (Hemiptera: Fulgoridae) in Virginia, USA. Environ. Entomol. 50: 1267-1275. (https://academic.oup.com/ee/article/50/6/1267/6382325)

EXTENSION PUBLICATIONS

Pfeiffer, D. G., A. B. Baudoin, K. B. Rice and M. Nita. 2023. Grapes: Diseases and Insects in Vineyards. p. 3-1 – 3-14. *In*: 2023 Pest Management Guide for Horticultural and Forest Crops. Va. Coop. Ext. Pub. **456-017**.

Pfeiffer, D.G., E. R. Day and T. A. Dellinger. 2022. Spotted lanternfly, *Lycorma delicatula* (White) (Hemiptera: Fulgoridae). Va. Coop. Ext. Publ. ENTO-180NP. 3 p. (https://pubs.ext.vt.edu/ENTO/ENTO-180/ENTO-180.html) (enhanced electronic version: http://digitalpubs.ext.vt.edu/vcedigitalpubs/9322249259597133/MobilePagedReplica.action?pm=1&folio=1#pg1)

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