

## 2025 SR SFC Grants Program Report

Assessing Novel Pierce's Disease Resistant *Vitis vinifera* Grape Cultivars for Sustainable Production in Alabama and the Southeast

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**Public Abstract:**

Pierce's disease (PD) is a serious threat to the cultivation of grapes in the United States, especially in the warmer southern regions. Presently, there is no known cure for PD, caused by the bacterium *Xylella fastidiosa* (*X.f.*). Because of the high PD pressure in Alabama and the Southeast, up until recently, grape production in the region was based exclusively on muscadine grape, which is a native plant with inherent

resistance to various diseases, including PD. In response to the PD's economic threat, UC Davis has developed PD resistant *Vitis vinifera* grape germplasm with a potential for sustainable production in some regions of the Southeast such as the USDA cold hardiness zone 8A and lower. Five of the new progeny have been recently released cultivars suitable for commercial production. The main **objectives** of this applied research project are to assess the vegetative growth, productivity and fruit quality attributes of the novel *Vitis vinifera* grape cultivars with superior resistance to Pierce's disease; to determine the rate and timing of potential PD infections; and to identify prevalent insect vector species known as efficient vectors of PD. Our findings during the 2025 season suggest the vines are growing well and the training system is being established. The fruit clusters were thinned out before bloom to promote better root establishment and vineyard longevity and no yield and fruit quality data was collected, but will resume during the next season. No positive *X.f.* infections were found to affect the vines in the experimental vineyard. Our results suggest that broad-headed sharpshooter (BHSS), *Oncometopia orbona* was the most abundant vector species captured on stationary yellow sticky traps arranged within the *vinifera* plots. For the first time, we reported the presence of the grapevine leafroll-associated virus-3 (GLRaV-3) virus in Alabama, highlighting the importance of purchasing clean material to prevent introduction of the disease in commercial vineyards.

## **Introduction:**

Pierce's disease is a serious threat to the cultivation of grapes in the United States, especially in the warmer southern regions (Wells et al., 1987; Anas, 2008; Sutton, 2005). Presently, there is no known cure for PD, caused by the bacterium *Xylella fastidiosa* (*X.f.*). This xylem-limited bacterium is also known to affect a wide range of crops and causes economic losses to several agricultural industries in North, Central, and South America (Chiou-Chu, Su, et al., 2013; Schwarczinger, Z., et al., 2018). *X. fastidiosa* causes a variety of plant diseases in an array of crops. In grapes, it causes Pierce's disease and leads to blockage of the vine xylem vessels which inhibits transpiration, delays vine growth and eventually leads to vine death. Pierce's disease on grapes is the major limiting factor for growing *Vitis vinifera* grapes in Alabama and southeastern U.S. Generally, PD infection causes vine decline, yield loss, and vine death typically occurs within two to three years of infection. Management efforts are focused on the development of grape selections resistant to this devastating bacterial disease and on effective insect vector control. Southern U.S. states with humid summers and relatively moderate winters have been incapable of cultivating *V. vinifera* wine grapes due to the vines' inherent susceptibility to PD infection; this has resulted in a wine and grape industry developed around muscadine grapes and hybrid bunch grapes which are resilient crops but secondary in consumer preference. PD, capable of surviving the mild winters, poses an overwhelming obstacle to vineyards in the Southeast. Piercing sucking insects serve as vectors in PD's pest, vector, and host complex, causing transmittance of the bacterium from native inoculum sources and infected vines to healthy grapevines. Glassy winged sharpshooters (*Homalodisca vitripennis* (Germar)) are the most acknowledged vectors of PD.

Presently, there is no known cure for PD, caused by the bacterium *Xylella fastidiosa*. PD on grapes is the major limiting factor for growing *Vitis vinifera* grapes in Alabama and the Southeast. The

disease causes considerable economic losses to the viticulture industry nationwide. Despite public control programs, PD costs the CA industry over \$104 million yearly (Tumber et al., 2014). Because of the high PD pressure in Alabama and the Southeast, up until recently, grape production in the region was based exclusively on muscadine grape (*Muscadinia rotundifolia* Michx.), which is a native plant with inherent resistance to various diseases, including PD.

In response to the PD's economic threat, UC Davis has developed PD resistant *Vitis vinifera* grape germplasm with a potential for sustainable production in some regions of the Southeast such as the USDA cold hardiness zone 8A and lower. Five of the new progeny have been recently released cultivars suitable for commercial production: (<https://www.ucdavis.edu/food/news/uc-davis-releases-five-new-wine-grape-varieties/>).

**'Camminare Noir'** is 50% 'Petite Sirah' and 25% 'Cabernet Sauvignon'. This variety is one of the earliest to break dormancy in California conditions, and it also blooms and ripens early. The berries are relatively large, and the well-filled clusters are medium in size. This cultivar has been repeatedly tested in greenhouse screenings and is rated as highly resistant to PD. It is one of the few grapevines released at the 94% *V. vinifera* level.

**'Passeante Noir'** is 50% 'Zinfandel', 25% 'Petite Sirah', and 12.5% 'Cabernet Sauvignon'. This red wine grape is 97% *V. vinifera* and is highly resistant to PD. In California it blooms relatively late but ripens mid-season. The berries are medium-sized and the clusters are well-filled and relatively large. Although this variety is spur fruitful it typically has only one cluster per shoot and is more productive with cane pruning.

**'Errante Noir'** is 50% 'Sylvaner' and 12.5% each of 'Cabernet Sauvignon', 'Carignane', and 'Chardonnay'. This red grape is 97% *V. vinifera* and is also highly resistant to PD in repeated greenhouse and field evaluations. It has a mid-season bloom and ripening period and has relatively large berries and loose clusters. It is highly productive.

**'Ambulo Blanc'** is 62.5% 'Cabernet Sauvignon', 12.5% 'Carignane', and 12.5% 'Chardonnay'. This white grape is 97% *V. vinifera* and highly resistant to PD after repeated greenhouse evaluations. It has an early bloom and the fruit ripens early. It has small-to-medium berries and relatively large clusters. It is also highly productive.

**'Caminante Blanc'** is 62.5% 'Cabernet Sauvignon', 12.5% 'Chardonnay', and 12.5% 'Carignane'. This white grape variety is also highly resistant to PD after repeated greenhouse evaluations. It has small berries and small compact clusters. It blooms relatively late and ripens mid-season. The vine has medium productivity.

**'Lomanto'** American bunch grape is included as a standard cultivar in the study. The 'Lomanto' grape vine is a vigorous, disease-resistant hybrid grape. It is well-suited for hot climates and loamy soils and is known for its prolific, high-quality fruit, which can be used for making red wine, juice, or jelly. The vine produces medium-to-large, black berries in compact, conical clusters and has a good tolerance to heat and Pierce's disease. 'Lomanto' vines are included as a standard in the study.

On-going research in Coneva's lab is evaluating innovative bunch grape production technologies with the goal of diversifying fruit and grape production in the state by introducing novel grape species that can provide both - a sustainable production method and a new product for the local market (Coneva,

2016; Coneva et al, 2019; Svyantek et al., 2020). The outcome of predominantly *Vitis vinifera* grape research in Alabama is encouraging and led us to establish a new research plot designed to test the performance of the newly released PD resistant *V. vinifera* cultivars.

The main **objectives** of the proposed applied research project are: 1). To assess the productivity and fruit quality attributes of five novel *Vitis vinifera* grape cultivars with superior resistance to a deadly bacterial disease, namely Pierce's disease (PD); 2). To determine the rate and timing of potential PD infections; and 3). To identify prevalent insect vector species known as efficient vectors of PD.

The evaluation of PD resistant predominantly *V. vinifera* grapevines is critical for increasing the sustainability of southern agriculture. In California, the average annual value of vines lost to PD was \$56M in 2014 (Tumber et al., 2014). To combat the threat of PD, several regions instituted area wide treatment to control PD insect vectors, despite costing more than \$20,000,000 to implement (Jetter, 2014). Cultivation of disease resistant vines is the most sustainable production method as it eliminates the need for chemical sprays such as Imidacloprid to control insect vectors of PD. This can lead to chemical and labor cost savings; improved soil and water conservation practices; better-quality of surface and underground water, resulting in sustainable grape production.

## **Materials and Methods:**

For the first time, recently released PD resistant predominantly *V. vinifera* grapevine cultivars have been assessed in Alabama conditions to determine their productivity and fruit quality attributes.

An experimental vineyard established in 2024 at the Chilton Research and Extension Center located in Chilton County, AL, USDA Plant Hardiness Zone 8A (Fig. 1) was utilized to evaluate the growth, yield, and fruit quality of the newly released PD resistant *Vitis vinifera* cultivars in a region notable for unrelenting, high Pierce's disease pressure (Sutton, 2005). The experimental vineyard design is a completely randomized block with 5 blocks composed of 3 plants per block. The in-row planting distance is 7', and the between row distance 12'. Grapes are trained to a divided canopy Watson training system utilizing a crop wire and a cross-arm with 4 additional canopy supporting wires. The system was selected to provide better air movement and faster drying time in order to prevent fungal disease development. Watson system was also utilized to prevent sun scald and to ease crop harvesting. Vines are grafted on the '1103P' ('Paulsen') rootstock and planted into a Dothan sandy loam soil. A supplemental irrigation system was installed prior to planting.



**Figure 1.** An experimental vineyard established at the Chilton Research and Extension Center near Clanton, AL, 2024.

During the 2025 season, we continued to develop the Watson training system and the experimental vines were dormant pruned to retain six spurs per cordon with two buds per spur for a total of twelve spurs per vine and a grand total number of 24 buds per vine according to the balanced pruning theory (Smart and Robinson, 1991).

Canopy management continued with tying each individual expanding new shoot to the first crossarm wire of the training system, followed by tying the shoots to the second supporting wire as they grew longer during the season (late March to mid-April). Shortly after inflorescence emergence all except one flower cluster per vine were removed in April prior to the bloom stage. A single cluster per vine was retained to monitor for differences in flowering season and veraison progression as to determine the timing for tissue sample collection for nutrient analyses.

Since the vines were de-clustered in order to encourage the young vines to establish a better root system and to improve vineyard longevity, productivity traits such as yield per vine and number of clusters/vine, and fruit quality attributes including pH, titratable acidity (TA), and soluble solid content (SSC) will be measured in consecutive seasons using a 50 berry subsample per vine.

Nutrient status of vines was determined at veraison stage on a 50-leaf petiole sample per experimental vine. Conducting a tissue nutrient test at bloom stage was not feasible as the vines were de-clustered earlier in the season as noted above.

Leaf area was recorded by measuring 20 recently matured leaves per vine using a LI-COR LI-3100 Area Meter. Tissue chlorophyll content was determined by measuring 10 fully developed leaves per vine using a SPAD meter.

Monitoring for disease incidence was conducted on a regular basis throughout the season. Vines were visually assessed for PD symptoms including scorching, matchstick, and green island symptomatology. Additionally, tissue samples were collected from each vine to determine a positive *X.f.*

infection. Real-time PCR tests were conducted to determine the presence of *X. fastidiosa* infection on a sample of 6 petioles per vine in late September.

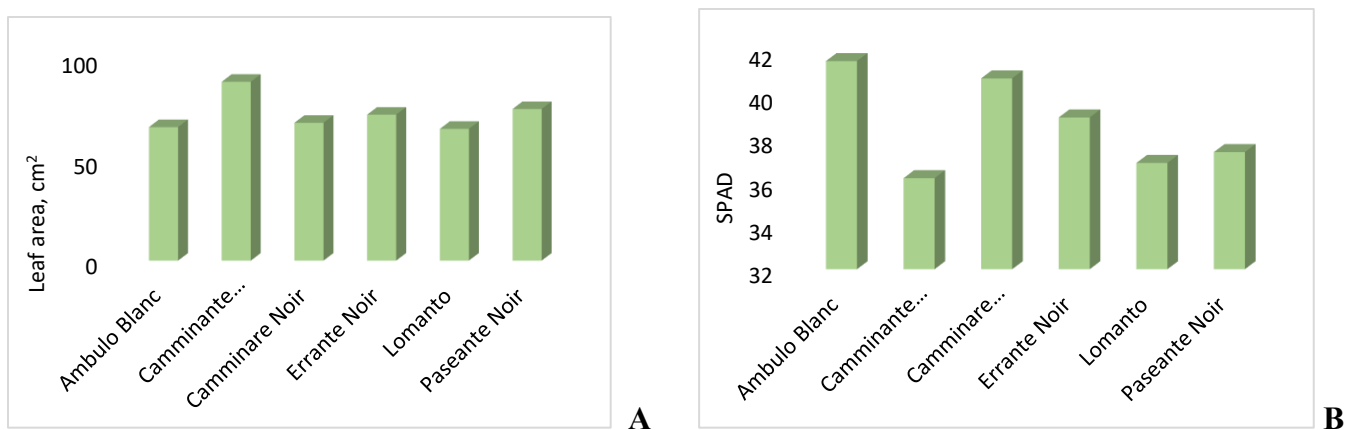
In June, an experimental grapevine showed leaf symptoms of red blotches. To investigate if these symptoms were caused by a pathogen, a sample was sent to Agdia, Inc. (Elkhart, IN, USA), where leaves, midrib, and petiole were subjected to ELISAs for multiple pathogens, including: alfalfa mosaic virus (AMV), arabis mosaic virus (ArMV), grapevine fanleaf virus (GFLV), *Phytophthora* (Phyt), peach rosette mosaic virus (PRMV), strawberry latent ringspot virus (SLRSV), tomato ringspot virus (ToRSV), and tobacco ringspot virus (TRSV). Additionally, GLRaV-3, grapevine pinot gris virus (GPGV), grapevine red blotch-associated virus (GRBaV), and *Xylella fastidiosa* (*X.f.*) were screened using the isothermal amplification method. The sample tested negative for all tested pathogens except for GLRaV-3. To confirm GLRaV-3, RT-PCR was utilized (Shehata et al., 2025).

Yellow sticky traps (7.6 x 12.7 cm) were used to determine the time when the insect vectors emerge and to identify the prevailing leafhopper species. Traps were deployed at the perimeter of the vineyard and replaced approximately over two-weeks interval. Insect monitoring started at the beginning of May and continued until August.

## Results and Discussion:

Our 2025 vegetative growth results indicate the young experimental vines grew well in their second season in the open field and continue to develop the plant divided canopy Watson training system. The leaf area of the cultivars under test varied between 65.2 cm<sup>2</sup> for ‘Lomanto’ and 88.5 cm<sup>2</sup> for ‘Caminante Blanc’ (Fig. 2A).

Chlorophyll levels in grape leaves varied between 36.2 for ‘Camminante Blanc’ and 41.6 for ‘Ambulo Blanc’ (Fig. 2B) suggesting that although ‘Caminante Blanc’ had the largest mean individual leaf area, it also had the lowest chlorophyll content. This result indicates that cultivar ‘Camminante Blanc’ might require a higher level of nitrogen fertilization, but additional research is needed to confirm and determine the optimal rate.



**Figure 2.** (A,B). Cultivar effect on: A) the mean individual leaf area, and B) leaf chlorophyll content of selected PD resistant predominantly *V. vinifera* grape cultivars grown at the CREC, Clanton, AL, 2025.

**Tissue nutrient status:**

The nutrient test results revealed that cultivar had a significant effect on K, Mg, P, B, Fe, Na, and N leaf tissue content of tested cultivars (Table 1). From the macro elements tested, Mg and P rates slightly exceeded the rates of 0.13 -0.40%; and 0.2-0.60% respectively, while N content of all cultivars was below the recommended sufficiency range of 1.6-2.8% at the veraison stage, indicating a clear N deficiency during a critical ripening stage, even though no crop was grown during the season. This could be partially explained by the heavy rain events during the season, especially from May through July. From the micro elements tested, the levels of B were below the recommended range of 25-50 ppm, while Cu rates exceeded the range of 5-10 ppm, likely a result of the necessary fungicide spray applications applied in accordance with the SRSFC IPM Bunch Grape Production Guide.

Table 1. Cultivar effect on tissue nutrients of selected PD resistant *Vitis vinifera* cultivars , 2025

Cultivar	Ca (%)	K (%)	Mg (%)	P (%)	Al (ppm)	B (ppm)	Cu (ppm)	Fe (ppm)	Mn(ppm)	Na(ppm)	Zn(ppm)	N (%)
Errante Noir	1.9 A	2.4 A	0.7 AB	0.8 B	33.8 A	21.2 A	33.1 A	72.5 A	46.3 A	441.4 B	63.8 A	0.6 B
Passeante Noir	1.8 A	1.8 B	0.6 B	0.6 C	27.1 A	18.7 B	18.1 A	44.6 B	57.2 A	419.3 B	68.7 A	0.6 B
Lomanto	2.1 A	1.8 B	0.8 A	1.1 A	24.7 A	20.0 AB	14.1 A	59.9 AB	65.0 A	691.9 A	62.4 A	0.8 A
Camminare Noir	2.0 A	2.0 AB	0.7 A	0.9 AB	27.2 A	19.9 AB	17.0 A	56.3 AB	53.1 A	499.8 B	64.2 A	0.7 AB
P-Value	0.0696	0.0004	0.0101	<0.0001	0.4687	0.0138	0.4305	0.0124	0.3068	<0.0001	0.8401	0.0009

**Insect-vector trap capture and population abundance:**

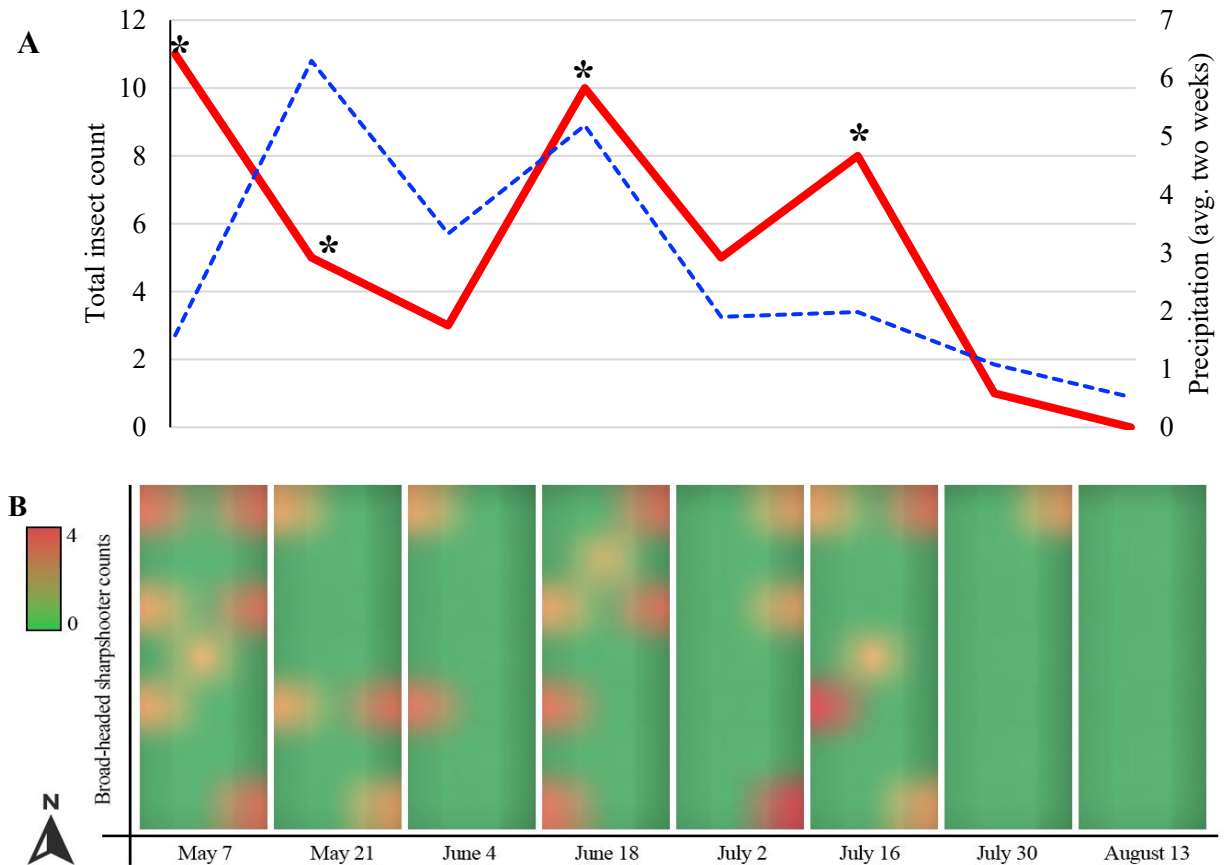
The most abundant vector species captured on stationary yellow sticky traps arranged within the *vinifera* plots, over approximately two-week intervals between card replacements, was the broad-headed sharpshooter (BHSS), *Oncometopia orbona*. This species has been previously reported by the PI’s lab as present in relatively low numbers on various fruit crops throughout the state (Ma et al., 2010). The BHSS was consistently reported as one of the most common sharpshooters found in grapes in this region over the past decade (Blaauw, 2019). On trap collection days, significant differences were detected among sampling dates (Friedman test,  $\chi^2 = 21.57$ ,  $p = 0.003$ ), particularly during early-season captures on May 7 and May 21, and later peaks on June 18 and July 16 (Fig. 3).

Overall, BHSS captures tended to increase during relatively drier periods following rainfall pulses, which may reflect post-rain adult dispersal or emergence rather than a direct positive effect of precipitation (Fig. 3A). An additional factor to consider is the potential for trap washing from direct rainfall, as heavy rain can physically remove insects from adhesive cards or reduce card stickiness, thereby artificially lowering capture numbers. In terms of spatial distribution, captures were generally more concentrated along the plot borders, a pattern consistent with the edge colonizing movement typical of sharpshooters and leafhoppers, which often invade field margins before moving inward (Puterka et al., 2003; Pavan et al., 2012) (Fig. 3B). Ultimately, a possible contributing factor to the mid- to late-season decline in BHSS or other sharpshooter species could be the increased application of insecticides (mainly organophosphates)

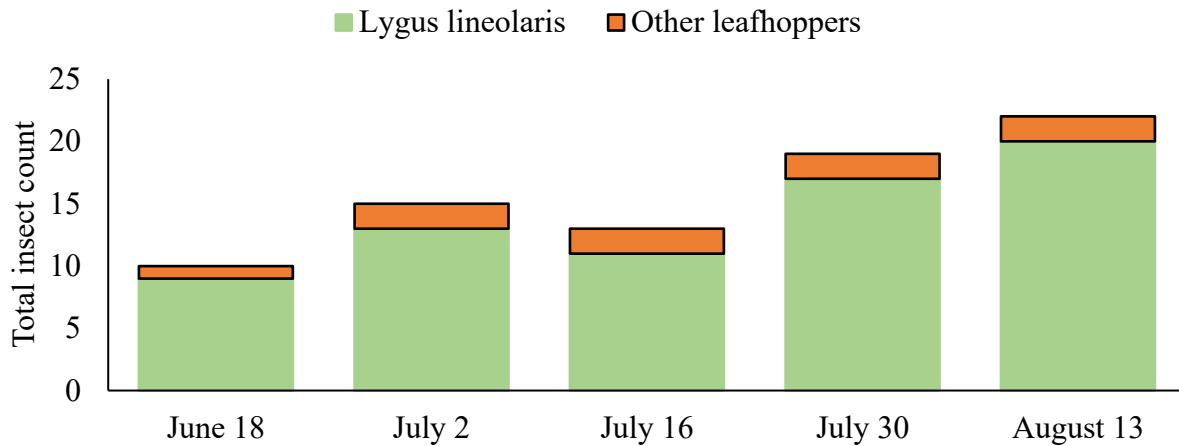
in nearby crops (though not within the grape plots themselves) for management of the invasive two-spot cotton leafhopper. These products have known knockdown activity and may influence dispersal dynamics within the surrounding agroecosystem.

Very few other leafhopper individuals were captured, and none belonged to species commonly associated with Pierce’s disease transmission. Within this secondary group, the most abundant and economically relevant species was the tarnished plant bug, *Lygus lineolaris*, which represented approximately 87% of all non-vector leafhopper captures. Noticeable increases in *L. lineolaris* numbers were only observed beginning June 18, with proportional increases through early August (Fig. 4). This rise likely corresponds to the availability of strawberry plants and other hosts at the facility during their seasonal growth period, providing a suitable host and contributing to local population buildup.

For future studies, plans to evaluate rain-protected or sheltered trap designs can be implemented, since rainfall can reduce the effectiveness of sticky cards and lower capture reliability. Complementing these traps with active scouting approaches, such as sweep netting, aspirators/vacuum sampling, and targeted visual inspections along plot borders, would improve the detection of sharpshooters and other potential Pierce’s disease vectors in grape plantings.



**Figure 3.** Trap capture of *Oncometopia orbona* using adhesive yellow cards in *V. vinifera* grapes, CREC, Clanton, AL, 2025. A) Total insect counts (red solid line) and precipitation (blue dashed line); asterisks indicate significantly higher counts (Friedman test). B) Spatial heatmap.



**Figure 4.** Trap capture for non-Pierce disease vector leafhoppers in vinifera grapes, CREC, Clanton, AL, 2025.

**Disease occurrence: *Xylella fastidiosa*:**

Tissue samples collected from each experimental vine in the fall of 2025 revealed no positive *Xylella fastidiosa* infections.

**Disease occurrence: GLRaV-3 identification:**

In addition to the RT-PCR test utilized (Shehata et al., 2025) to confirm the GLRaV-3 infection and to rule out a potential phosphorus or potassium deficiency causing similar leaf symptoms on grapes, a tissue nutrient test was also conducted (Table 1). The test results indicate no P or K deficiencies were found for any of the vines and cultivars in our plot where Errante Noir vines had slightly above the recommended P sufficiency range of 0.20 to 0.60% and K level was within the recommended sufficiency range of 1.50 to 5.0%.

Grapevine leafroll-associated virus-3 (GLRaV-3) is considered the most predominant cause of grapevine leafroll disease (GLD), one of the most destructive viral diseases affecting grapevines and wine production worldwide (Maree et al. 2013). Our findings constitute the first report of GLRaV-3 in Alabama, highlighting the importance of purchasing clean material to prevent introduction of the disease in vineyards, a crop with a total impact of \$1.5 billion in Alabama (Good, T. 2023).

**Literature Cited:**

Anas, O., Harrison, U. J., Brannen, P. M., and Sutton, T. B. 2008. The effect of warming winter temperatures on the severity of Pierce's disease in the Appalachian mountains and Piedmont of the southeastern United States. Online. Plant Health Progress doi:10.1094/PHP-2008-0718-01-RS.

Blaauw, B. (2019). Sharpshooter monitoring and management. UGA Extension – Viticulture Team, Blog communication. <http://viticulture.uga.edu/2019/05/sharpshooter-monitoring-and-management/>

Chiou-Chu Su, Chung Jan Chang, Che-Ming Chang, Hsien-Tzung Shih, Kuo-Ching Tzeng, Fuh-Jyh Jan, Chin-Wen Kao, Wen-Ling Deng. 2013. Pierce's Disease of Grapevines in Taiwan: Isolation, Cultivation and Pathogenicity of *Xylella fastidiosa*. *Journal of Phytopathology*, 161-6:389-396. <https://doi.org/10.1111/jph.12075>.

Coneva, D. Elina. 2016. Growing Pierce's Disease Resistant 87.5% *V. vinifera* Grapes in Alabama. *Acta Hort.* 1115, 75-82. DOI: 10.17660/ActaHortic.2016.1115.12. <http://dx.doi.org/10.17660/ActaHortic.2016.1115.12>

Coneva, E.D., Hu, Y., Svyantek, A. and Vinson, E. 2019. Growth and development of Pierce's disease-tolerant hybrid bunch grapes in the southeastern USA. *Acta Hort.* 1248, 561-566 DOI: 10.17660/ActaHortic.2019.1248.75. <https://doi.org/10.17660/ActaHortic.2019.1248.75>

Good, T., 2023. Wine America. "State Profile: Alabama Wine Country." *Wine America News*, 5 Jan. 2023. <https://wineamerica.org/news/state-profile-alabama-wine-country/>

Maree, H. J., et al. 2013. *Front Microbiol.* 4:82. <http://doi:10.3389/fmicb.2013.00082>

Jetter, K.M., 2014. The cost of the glassy-winged sharpshooter to California grape, citrus and nursery producers. *California Agriculture*, 68(4).

Ma, X., E. Coneva, H. Fadamiro, J.F. Murphy, Charles Ray, and F. Dane. 2010. Seasonal occurrence and abundance of sharpshooter leafhoppers in Alabama Orchards and Vineyards. *International Journal of Fruit Science* 10:341-354. <https://doi.org/10.1080/15538362.2010.510428>

Maree, H. J., et al. 2013. *Front Microbiol.* 4:82. <http://doi:10.3389/fmicb.2013.00082>

Pavan, F., Mori, N., Bigot, G., & Zandigiacomo, P. (2012). Border effect in spatial distribution of Flavescence dorée affected grapevines and outside source of *Scaphoideus titanus* vectors. *Bulletin of Insectology*, 65(2), 281-290.

Puterka, G. J., Reinke, M., Luvisi, D., Ciomperik, M. A., Bartels, D., & Glenn, D. M. (2003). Particle film, Surround WP, effects on glassy-winged sharpshooter behavior and its utility as a barrier to sharpshooter infestations in grape. *Plant Health Progress*, 4(1), 7.

Quinton A. 2019. UC Davis releases 5 grape varieties resistant to Pierce's disease. Retrieved from: <https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=39023> Accessed: October 2024.

Schwarzinger, Z. Bozso, A. Szatmari, S. Sule, Z. Szabo, G. Nagy, and L. Kiraly. 2018. First Report of Bacterial Leaf Spot Caused by the Quarantine Pathogen *Xanthomonas arboricola* pv. *pruni* on Peach in Hungary. *Plant Disease* 102-18, <https://doi.org/10.1094/PDIS-12-17-1952-PDN>

Shehata H.A., Coneva E.D., Conner K., and Martin K. 2025. First Report of Grapevine Leafroll-Associated Virus-3 Infecting *Vitis vinifera* L. Grape in Alabama. *Plant Disease*, Published Online: 26 Nov 2025. <https://doi.org/10.1094/PDIS-09-25-1829-PDN>

Smart, R., and M. Robinson. 1991. *Sunlight Into Wine: A Handbook for Winegrape Canopy Management*. Wine titles.

Sutton, T.B. 2005. Progress report: Pierce's disease risk zones in the Southeast. NCSU. Available at:

[http://www.smallfruits.org/SRSFCReserchFunding/Research05/Sutton\\_ProgressReport05.pdf](http://www.smallfruits.org/SRSFCReserchFunding/Research05/Sutton_ProgressReport05.pdf)

Svyantek, A.W., Elina D. Coneva, J. Raymond Kessler, James D. Spiers, Edgar L. Vinson III, M. Andrew Walker, and James A. Pitts. 2020. Assessment of Pierce's Disease Resistant 87.5% *Vitis vinifera* L. Selections in Central Alabama. *Catalyst: Discovery into Practice*. (4:2) 74-81.

Tumber, Kabir P., Julian M. Alston, and Kate Fuller. Pierce's disease costs California \$104 million per year. *California Agriculture* 68.1-2 (2014).

Wells, J.M., B.C. Raju, H.-Y. Hung, W.G. Weisberg, L. Mandelco-Paul, and D. J. Brenner. 1987. *Xylella fastidiosa* new-genus new-species Gramnegative xylem-limited fastidious plant bacteria related to *Xanthomonas* spp. *International Journal of Systematic Bacteriology*. 37:136-143.