2023 Progress Report R-25

Title:
Evaluating Stress Tolerances Among Pierce‘s Disease Tolerant Bunch Grape Cultivars

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Objectives:
The overall objective of the project is to compare the drought, heat, and cold tolerance of Pierce‘s disease tolerant bunch grape cultivars currently grown in South Mississippi. The goal is to determine the difference in tolerance among these cultivars and if they are sustainable for production in southern Mississippi and surrounding areas.

Justification and Description:
With the expansion of the grape and wine industry throughout the United States, there is a significant need to explore better methods of sustainably growing bunch grapes in Mississippi and surrounding areas. The interest from growers and winemakers is evident, but current high quality grape production is low. The main issues that limit the choice of cultivars in the region are disease prevalence and difficult growing climate.

The most serious disease pressure in the region is Pierce‘s disease (PD) (*Xylella fastidiosa*), which can lead to the death of vines - especially those of *Vitis vinifera*. However, some interspecific hybrid grapes that were bred in the South have shown better tolerance to this disease and have become the standard southern cultivars. Still, these cultivars are not always top performers in terms of quality and production. In recent years, there are a few new cultivars that have been released that may have potential in the region. Some new cultivars that were released from the University of California-Davis, such as ‘Ambulo Blanc‘, are both resistant to PD as well as contain a high percentage of *V. vinifera*, with wine quality and high production comparable to their ancestors. However, there is no information on how these vines would perform against the climate of the Gulf South region as opposed to California, where they were initially tested.

Water availability and temperature are important abiotic factors that influence growth and development of grapevine, but changes in precipitation and temperature patterns as a result of climate change are likely to produce more frequent, unpredictable, stressful events, such as water deficiency, extreme heat, and extreme cold. These events could lead to an increase in demand for freshwater or controlled environment space; however, these are not maintainable solutions. Since the climate of South Mississippi is considered subtropical, one could assume that southern-grown grape cultivars have the ability to acclimate to hot, humid, rainy summers and mild, dry winters, but unexpected drought, summer heatwaves, and spring frosts can affect photosynthesis and transpiration processes and/or cause damage to primary buds, which can lead to reductions in grape yield. It has been noted that different species have their own way of responding to environmental factors, so some cultivars may have better tolerance to these extreme events than others. Our goal is to identify which ones can tolerate these extreme events as well as the already difficult climate of South Mississippi.

Materials and Methods:
This research took place at the Mississippi State University South Mississippi Branch Experiment Station in Poplarville, MS from late May to early September in 2023. The experiment was based on nine interspecific hybrid bunch grape cultivars or selections: 'Ambulo Blanc', 'Black Spanish', 'Blanc du Bois', 'Lomanto', 'MidSouth', 'Miss Blanc', 'Muench', OK392, and 'Victoria Red'. Different data was collected both in the field and from collected 2.54 cm leaf disks that underwent a 4-hour drought or heat simulation in a growth chamber set at a constant 27 °C, 85% humidity, and 200 $\mu mol/m^2s$ or increasing from 25 °C to 45 °C with constant 85% humidity and 200 $\mu mol/m^2s$, respectively, and included:

- Outdoor temperatures, precipitation, humidity, solar radiation, growing degree days
- Dates of vine phenological stages
- Stomatal density by examination of leaves under microscope
- Water loss (WL) based on weights after leaf dehydration
- Electrolyte leakage (EL) by conductivity meter
- Stomatal conductance (SC) by LI-600
- Transpiration (T) by LI-600
- Vapor pressure deficit (VPD) by LI-600
- Chlorophyll fluorescence (CF) by LI-600

The following data will be collected from December 2023 through March 2024:

- Mean low temperature exotherm of bud tissues by differential thermal analysis (DTA)
- Lethal cold temperatures to 10%, 50%, and 90% of bud tissues by DTA

Results:
Monthly weather data reveals that August had the highest temperatures, solar radiation, and growing degree days and lowest precipitation and humidity of the months in the conducted study (Table 1).

Examination of the phenological stages of each cultivar reveals that 'Muench', 'MidSouth', and 'Lomanto' were the quickest in their progression, while 'Ambulo Blanc' was the slowest (Fig. 1).

Stomatal counts revealed that 'Miss Blanc' and OK392 had the highest stomatal density, while 'Black Spanish' had the lowest (Fig. 2).

In the initial drought treatment, ‘Lomanto’ showed the most WL, while ‘Victoria Red’ had the least (Fig. 3A). ‘Muench’, ‘Lomanto’, and ‘Black Spanish’ displayed the highest SC and T (Fig. 4A and 5A). Conversely, ‘Blanc du Bois’ had the lowest SC and the highest VPD, with ‘Muench’ having the lowest (Fig. 4A and 6A). In the second round, ‘Muench’, ‘MidSouth’, and ‘Lomanto’ experienced the highest WL, while ‘Ambulo Blanc’ and ‘Victoria Red’ had the least. ‘MidSouth’ exhibited the highest SC and T, while OK392 had the lowest (Fig. 4B and 5B). However, OK392 showed the highest CF, and ‘Lomanto’, ‘MidSouth’, and ‘Black Spanish’ had the lowest values (Fig. 7B). In the third round, ‘Miss Blanc’ recorded the highest VPD, while ‘Black Spanish’, ‘Victoria Red’, ‘Muench’, and ‘MidSouth’ had the lowest (Fig. 6C). OK392, ‘Muench’, and ‘Victoria Red’ exhibited the highest CF, contrasting with ‘Blanc du Bois’, which had the lowest (Fig. 7C). In the fourth round, ‘MidSouth’ and ‘Lomanto’ experienced the most WL, and ‘Ambulo Blanc’ had the least (Fig. 3D). ‘Muench’, ‘Black Spanish’, and ‘Lomanto’ maintained the highest SC and T, with OK392 recording the lowest (Fig. 4D and 5D). ‘Ambulo Blanc’ exhibited the highest VPD, while ‘Muench’ displayed the lowest (Fig. 6D).

In the first round of the heat treatment, EL could not be measured due to limited deionized water supply. ‘Lomanto’ exhibited the highest SC and T, while OK392 and ‘Blanc du Bois’ had the lowest (Fig. 9A and 10A). ‘Blanc du Bois’, ‘Miss Blanc’, and OK392 had the highest VPD (Fig. 11A). ‘Blanc du Bois’ and ‘Black Spanish’ had the highest CF, while ‘Ambulo Blanc’ had the lowest (Fig. 12A). In the second round, ‘MidSouth’ had the highest EL, and ‘Black Spanish’ had the least (Fig. 8A). Additionally, ‘MidSouth’ had the lowest VPD, while OK392 had the highest (Fig. 11B). ‘Miss Blanc’ and ‘MidSouth’ had the highest CF, and ‘Ambulo Blanc’ had the lowest (Fig. 11B). ‘Muench’ had the highest EL in the third round (Fig. 7B). ‘Lomanto’ exhibited the highest SC and T, and OK392 exhibited the lowest (Fig. 9C and 10C). ‘Miss Blanc’ had the highest VPD, with ‘MidSouth’ having the lowest (Fig. 11C). ‘MidSouth’ had the highest CF, while ‘Lomanto’, ‘Muench’, and ‘Ambulo Blanc’ had the lowest (Fig. 12C). In the fourth round, ‘Muench’ had the highest SC and T and the lowest VPD (Fig. 9D, 10D, and 11D), and ‘Ambulo Blanc’ had the lowest CF (Fig. 12D).

Despite variations in gas exchange measurements, most cultivars tended to follow similar trends within each round of drought and heat treatment. This research will provide valuable insights into southern grapevine responses to water and heat stress, but further analysis, such as determining specific correlations, is ongoing.

Table 1. Average temperature, humidity, and solar radiation and cumulative precipitation and growing degree days within each month of the conducted study (2023).

Month	**Temperature (°C)**	**Precipitation (cm)**	**Humidity (%)**	**Solar Radiation (Langley’s)**	**Growing Degree Days (10 °C)**
May	23.8	13.3	73.9	507.5	427
June	27.0	9.9	75.2	519.6	511
July	28.8	7.8	74.3	508.5	581
August	31.2	0.0	65.3	535.9	656
September	27.2	3.5	68.6	422.8	515

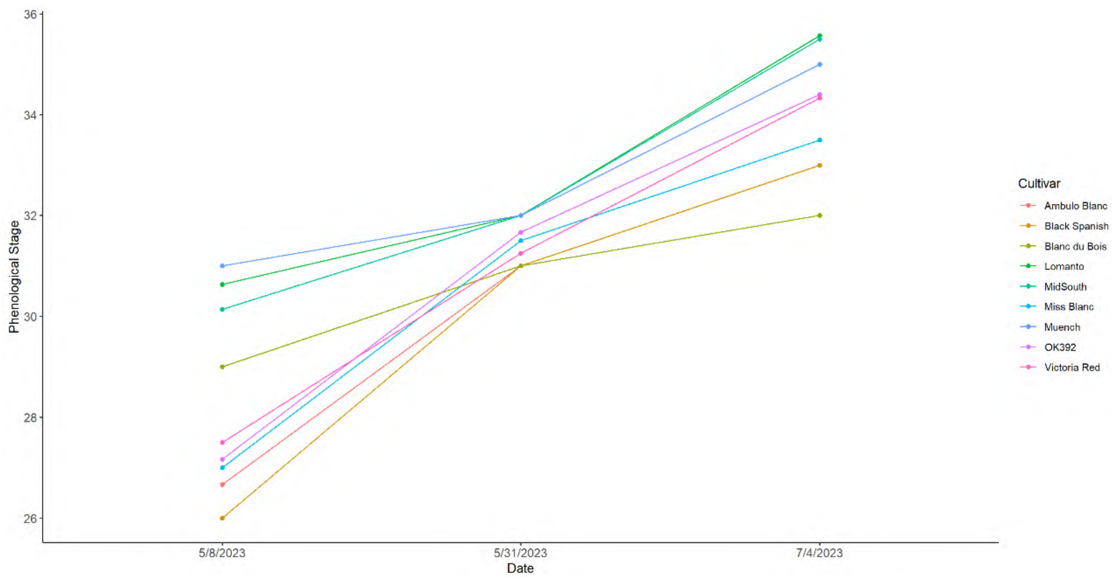

Figure 1. Dates and phenological stages for nine interspecific hybrid bunch grape cultivars (2023).

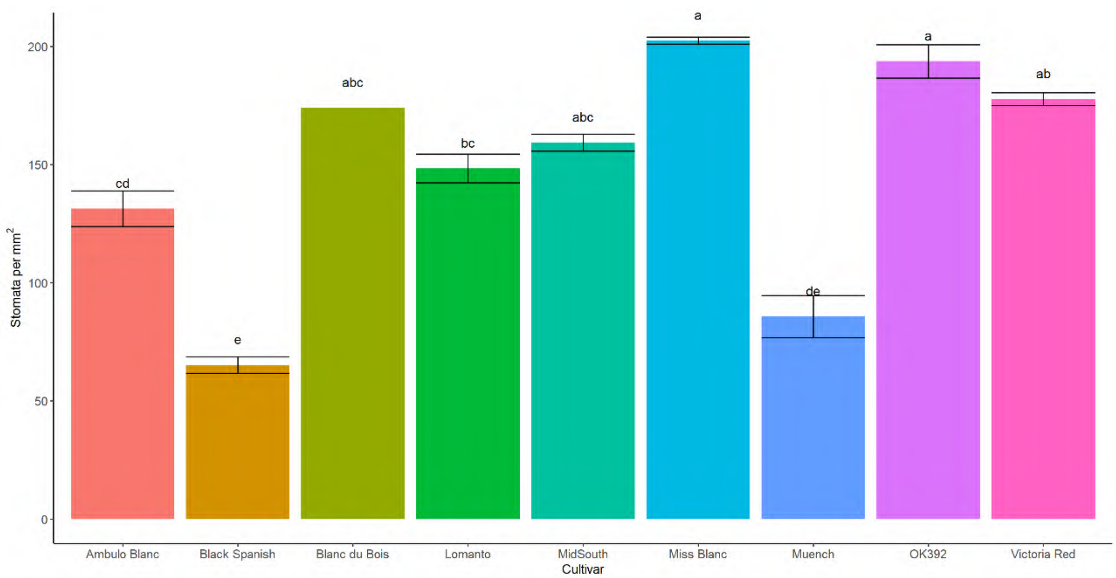

Figure 2. Number of stomata per mm^2 of nine interspecific hybrid bunch grape cultivars. Different lowercase letters represent significant differences between cultivars (2023).

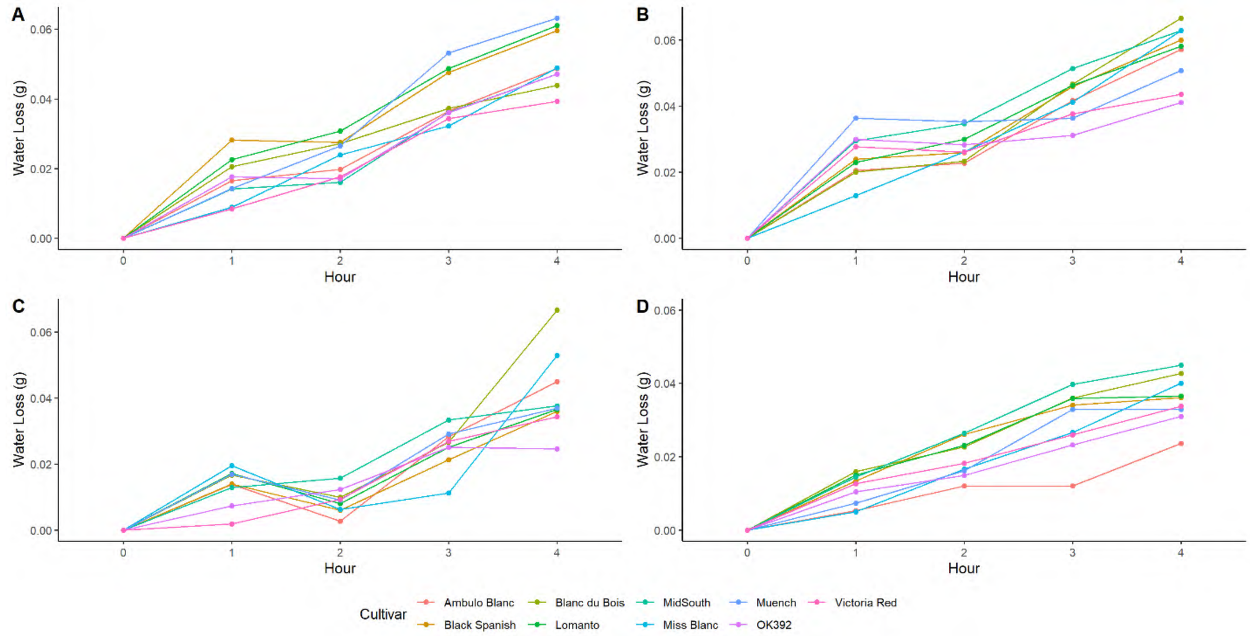

Figure 3. Water loss during each round of drought simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 1 on May 31. (B) represents round 2 on July 4. (C) represents round 3 on August 9. (D) represents round 4 on September 9 (2023).

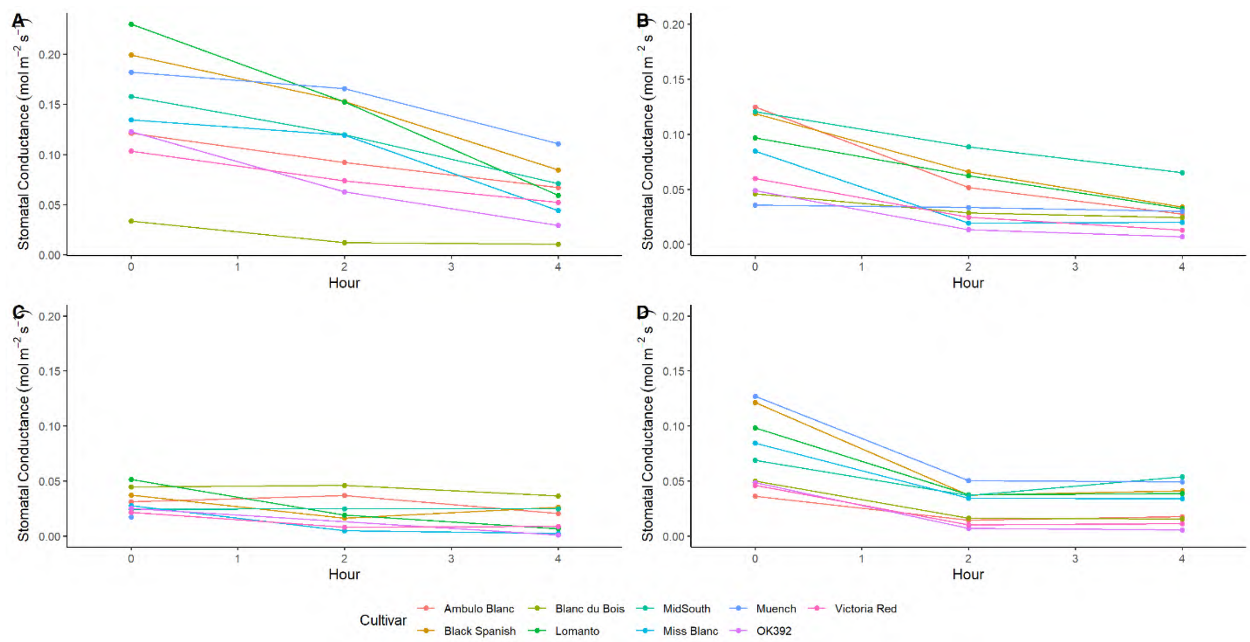

Figure 4. Stomatal conductance during each round of drought simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 1 on May 31. (B) represents round 2 on July 4. (C) represents round 3 on August 9. (D) represents round 4 on September 9 (2023).

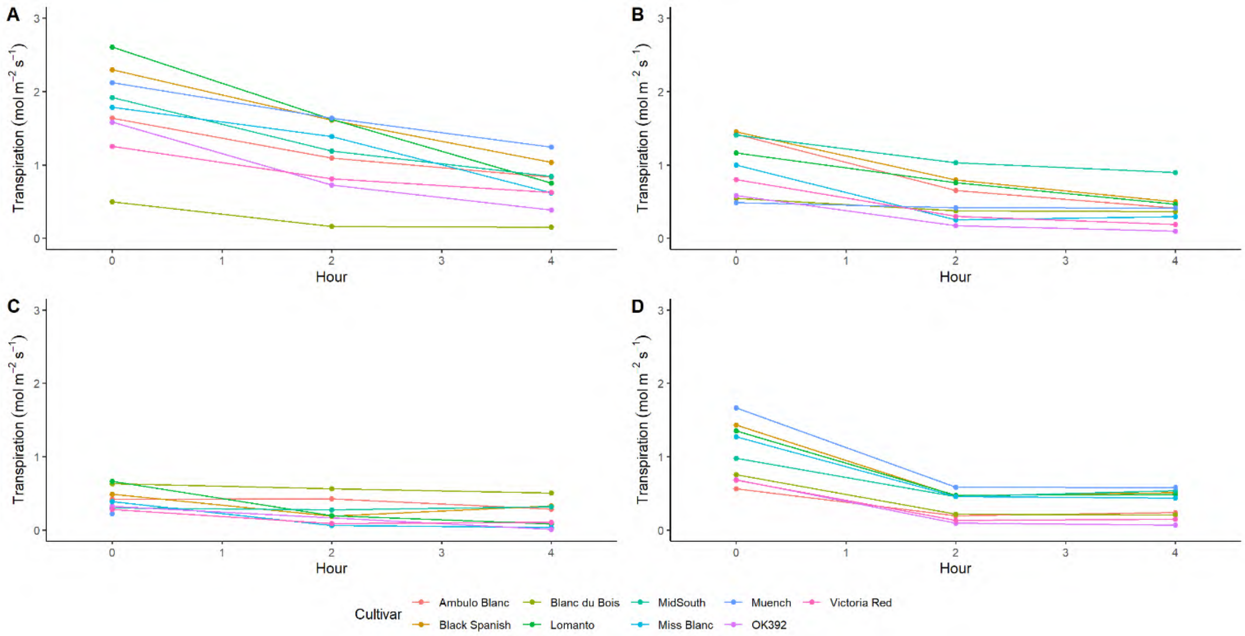

Figure 5. Transpiration during each round of drought simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 1 on May 31. (B) represents round 2 on July 4. (C) represents round 3 on August 9. (D) represents round 4 on September 9 (2023).

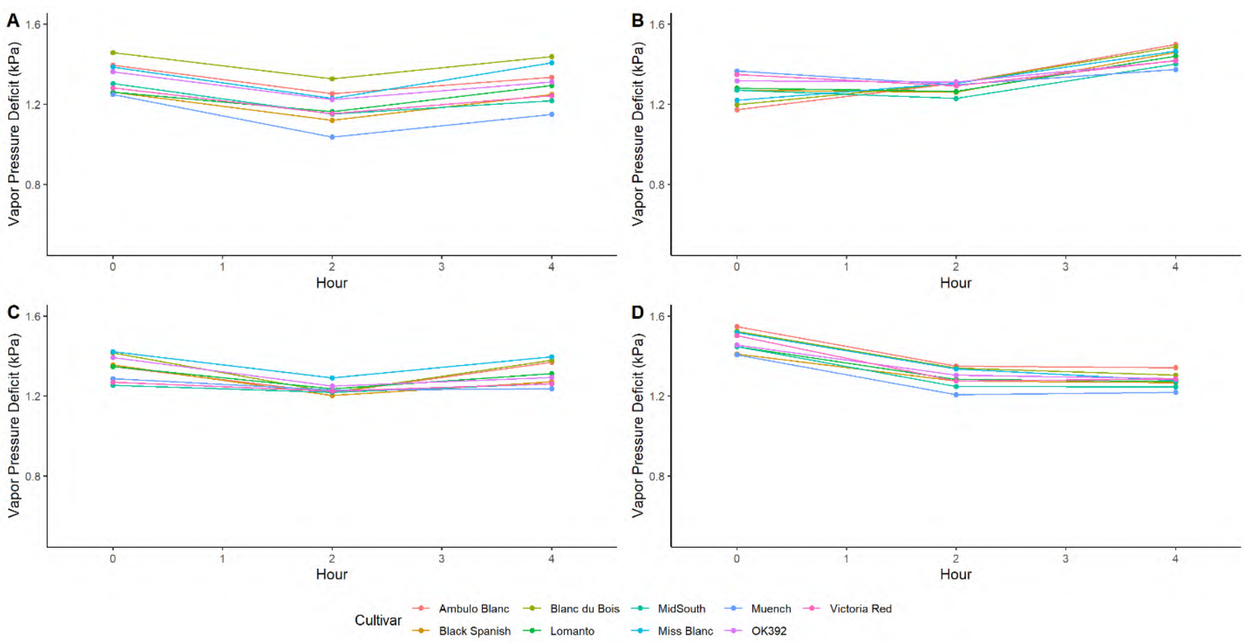

Figure 6. Vapor pressure deficit during each round of drought simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 1 on May 31. (B) represents round 2 on July 4. (C) represents round 3 on August 9. (D) represents round 4 on September 9 (2023).

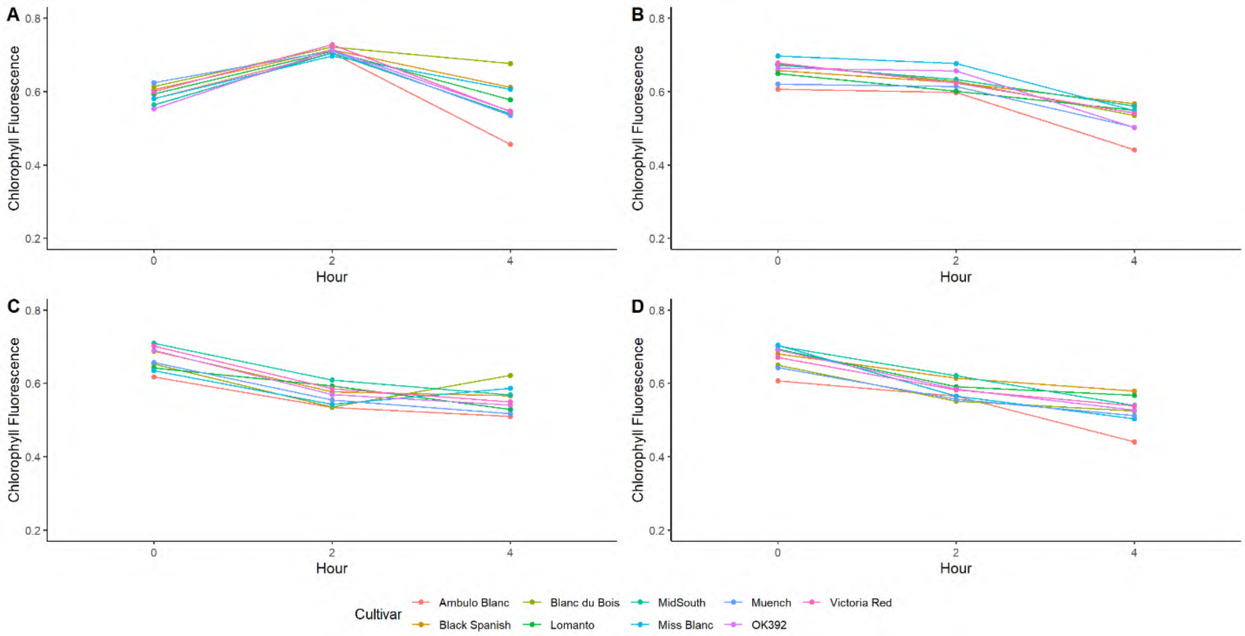

Figure 7. Chlorophyll fluorescence during each round of drought simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 1 on May 31. (B) represents round 2 on July 4. (C) represents round 3 on August 9. (D) represents round 4 on September 9 (2023).

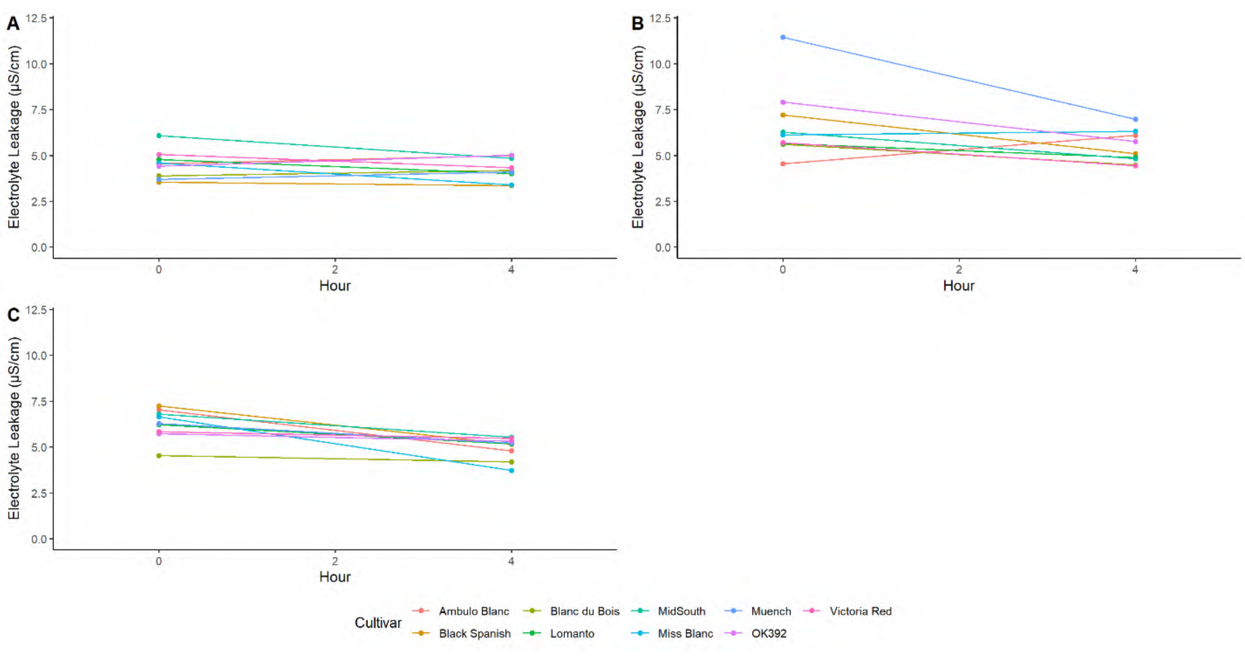

Figure 8. Electrolyte leakage during each round of heat simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 2 on July 4. (B) represents round 3 on August 9. (C) represents round 4 on September 9 (2023).

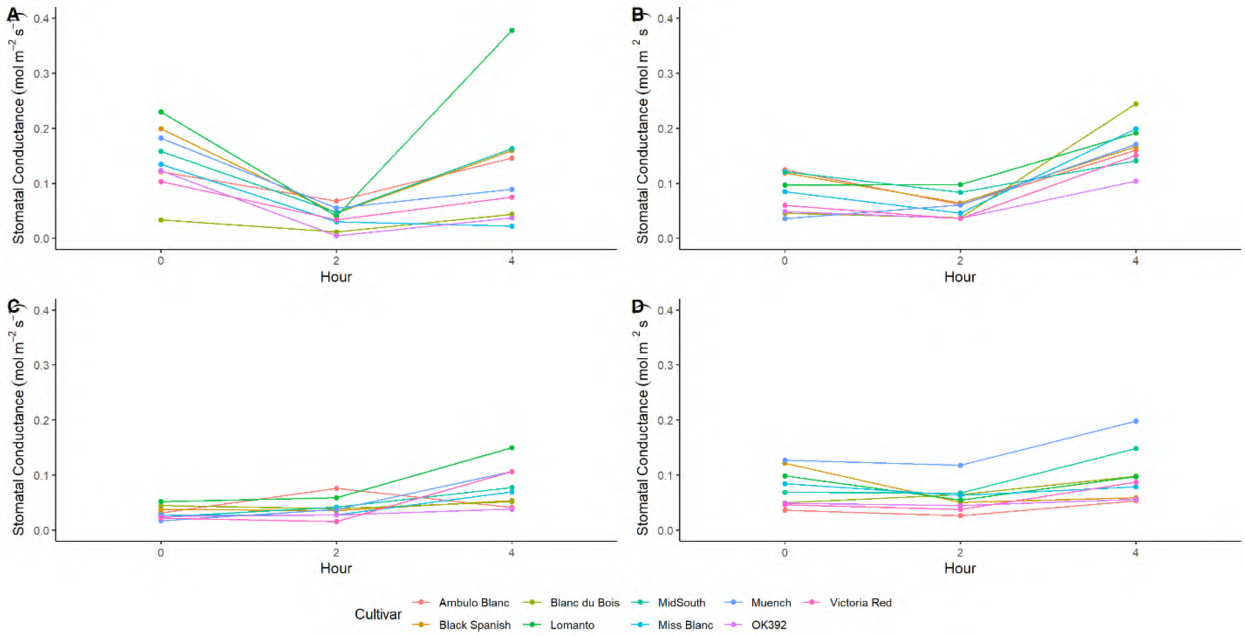

Figure 9. Stomatal conductance during each round of heat simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 1 on May 31. (B) represents round 2 on July 4. (C) represents round 3 on August 9. (D) represents round 4 on September 9 (2023).

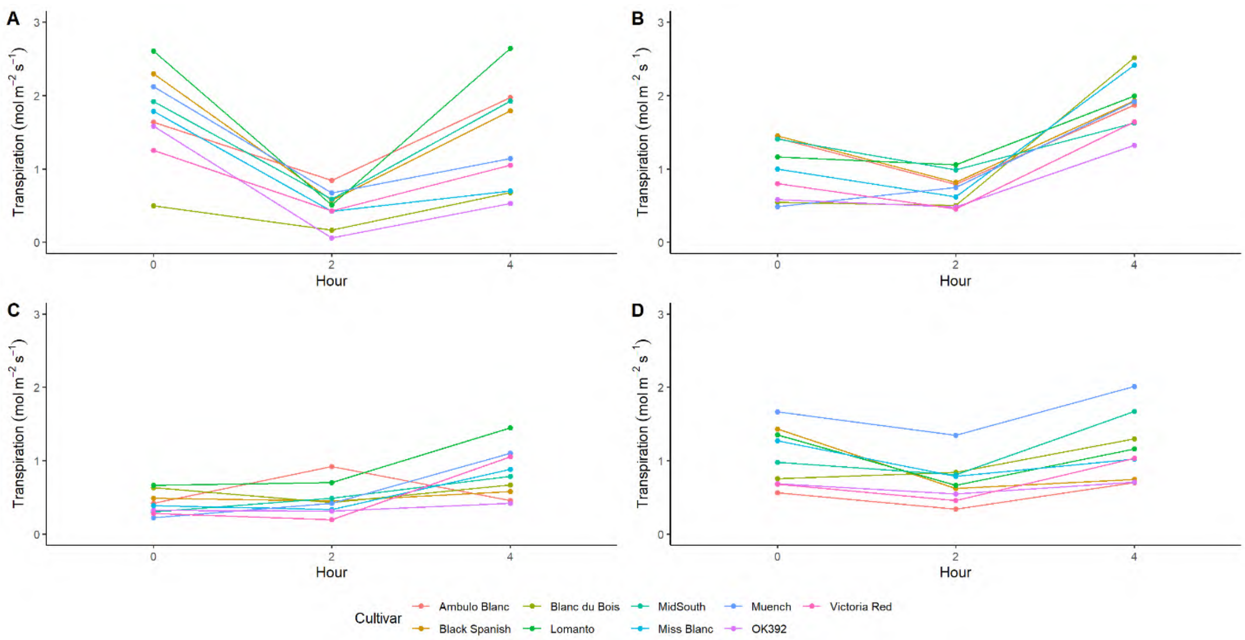

Figure 10. Transpiration during each round of heat simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 1 on May 31. (B) represents round 2 on July 4. (C) represents round 3 on August 9. (D) represents round 4 on September 9 (2023).

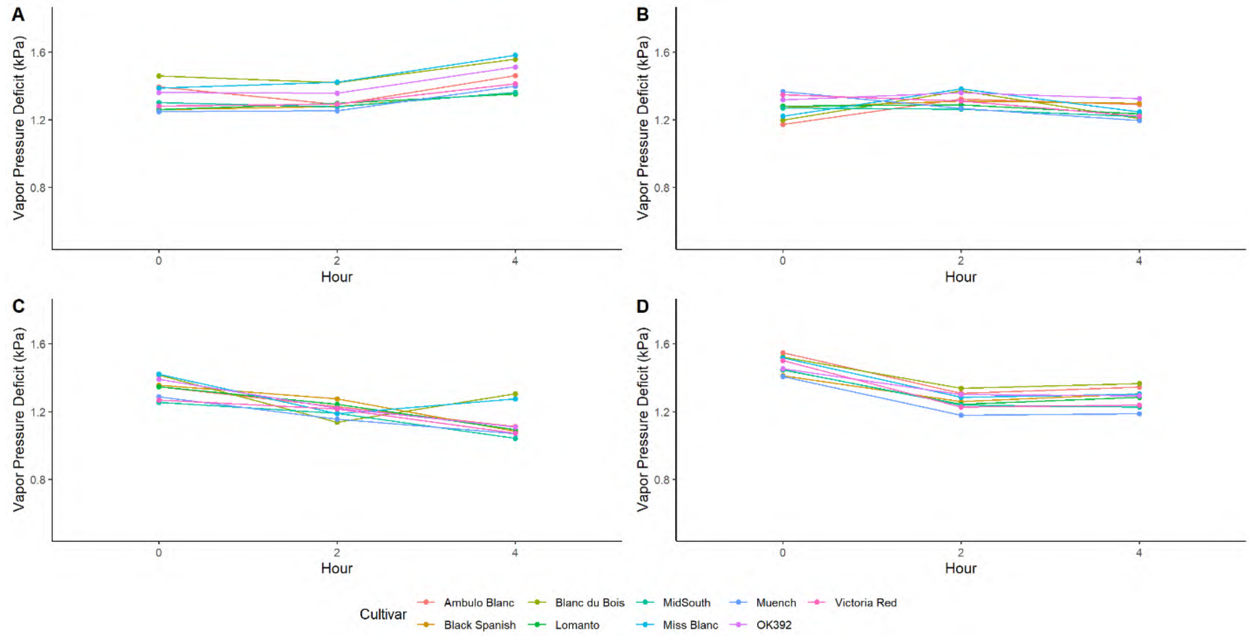

Figure 11. Vapor pressure deficit during each round of heat simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 1 on May 31. (B) represents round 2 on July 4. (C) represents round 3 on August 9. (D) represents round 4 on September 9 (2023).

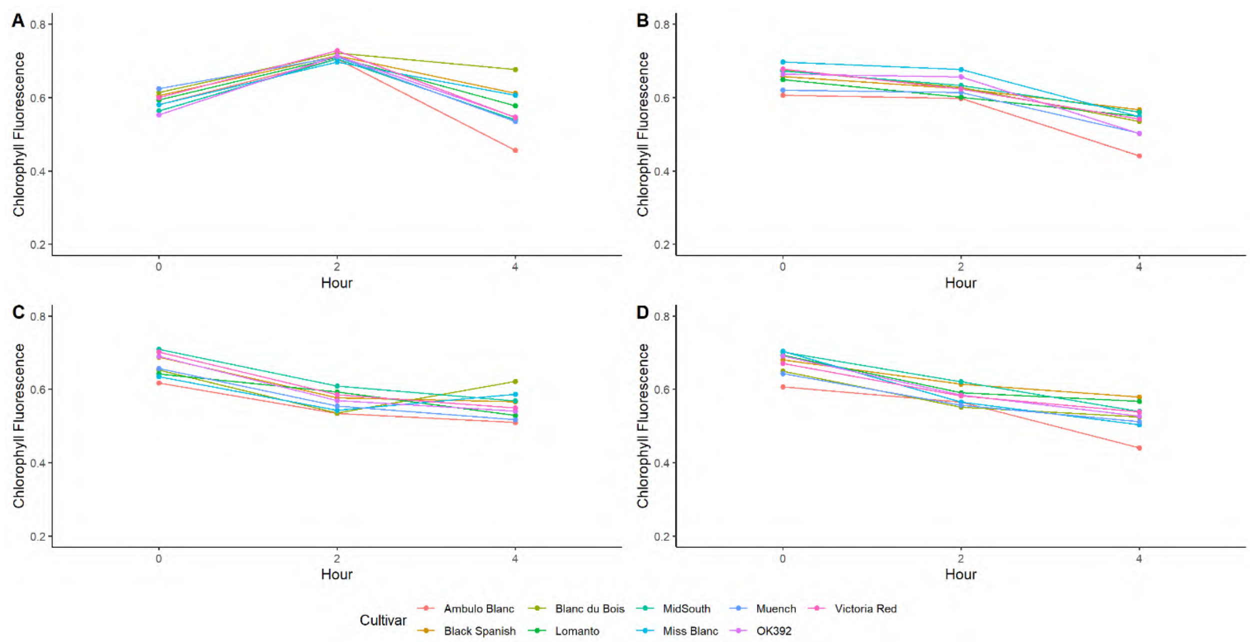

Figure 12. Chlorophyll fluorescence during each round of heat simulation of nine interspecific hybrid bunch grape cultivars. (A) represents round 1 on May 31. (B) represents round 2 on July 4. (C) represents round 3 on August 9. (D) represents round 4 on September 9 (2023).