Experiential Learning on Precision Agriculture Phenotyping Tool in in Muscadine Vineyards and Data Analytics

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Introduction

- Precision agriculture aims to improve crop yields and assisting management decisions using high-technology sensors and analysis tools. It is a field that entails the utilization of data acquisition, data processing, and data analysis expertise of crops to determine associate crop solutions and outcomes. Data such as phenotyping, leaf pigments, crop pigments, plant stress, soil water content, etc. can be utilized to perform such analysis.
- FAMU Center for Viticulture and Small Fruit Research is recognized internationally for excellence in warm climate grape research and facilitator of outstanding academic programs for experiential learning and student training. The Center is the only specialized research program among the 1890 colleges and universities dedicated to grape and wine, and it is a national leader in muscadine grape research.
- Dr. Chen's research team has developed a website platform that calculates muscadine grape canopy cover and berry percentage automatically using digital RGB image recognition from digital cameras or smartphones (https://phrec-irrigation.com/#/). This provides students and the general public a testing platform for experiential learning on precision agriculture phenotyping tool, image acquisition, storage, sharing, processing, and analysis.
- Understanding leaf area index (LAI) is important because the collected data provides further details in canopy function and the atmospheric energy exchanges on the leaf surface. LAI indicates the amount of present foliage, the photosynthetic active area, and the area subjected to transpiration.

Objectives

- To use the precision agriculture phenotyping tool (Muscadine grape canopy calculation automation website platform) to practice grape growth stage image acquisition, analysis, and extension education.
- To measure and collect the yields and LAI data of two red varieties of muscadine grape ("Floriana" and "Noble") from FAMU Center for Viticulture and Small Fruit Research.
- To analyze the linear correlation between LAI and green leaves and between grape yield and grapes pixel percentage.

Methodology

Part I Students' Experiential Learning in the Vineyard and Precision Agriculture Phenotyping Tool Application

Materials:

- Two muscadine red varieties: Floriana (6) and Noble (5)
- Muscadine grape canopy and berry calculation automation website platform
- ACCUPAR LP-80 PAR/LAI Ceptometer
- Refractometer (Soluble Solids), pH meter
- Eppendorf™ Centrifuge 5804 R
- iPhone/Android RGB Camera, 3 ft tripod
- 10 ft by 10 ft blue fabric backdrop
- Measuring tape, ladder, pruner
- Harvesting baskets, scale

Methods:

(1) Field Visits

- **Physiological parameters to monitor the best time for harvesting**: PH, Soluble Solids, and titratable Acidity
- **LAI measurements:** each vine
- **RGB Image acquisition**: blue backdrop to cancel the "noises" (weeds, clouds, and other grapevines not pictured): berries and leaves; exposed berries; and fully harvested
- **Yield measurements**: each vine

(2) Data Processing and Analysis

- **Image Analysis** using the website platform that aids in calculating grapevine canopy and berries percentage
- **Data Analysis** to find the linear relationship between LAI and grapevine canopy percentage and berries percentage

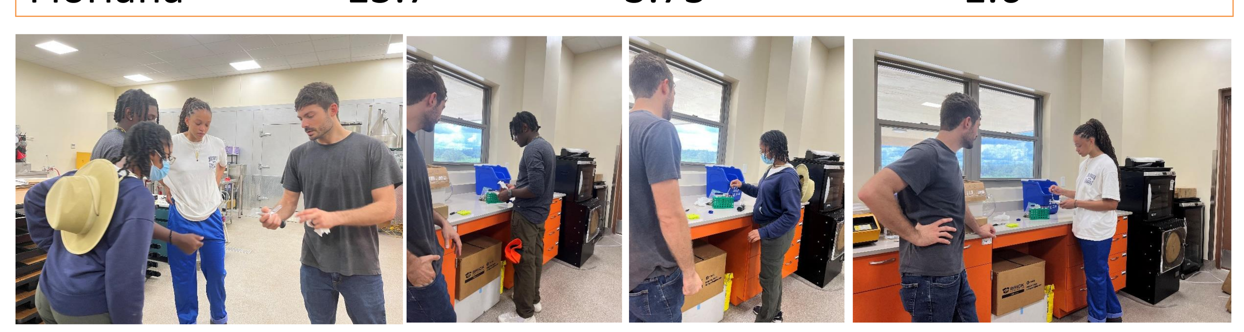
Part II Students' Experiential Learning on Extension and Outreach Using the Grapevine and Grape Detection Phenotyping Tool

Results

Physiological parameters: The pH will increase, titratable acidity decrease, and soluble solids increase approaching harvest.

Table 1 Physiological parameters in late August 2022

Variety	Soluble Solids (%)	pH	Titratable Acidity (g/L)
Noble	15.1	3.32	2.7
Floriana	15.7	3.75	1.6



Linear correlation between LAI and green leaves and between grape yield and grapes pixel percentage:

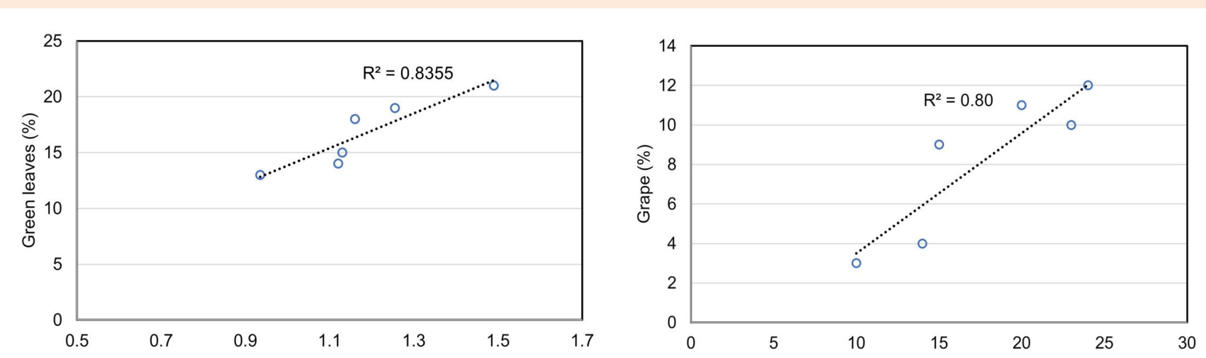
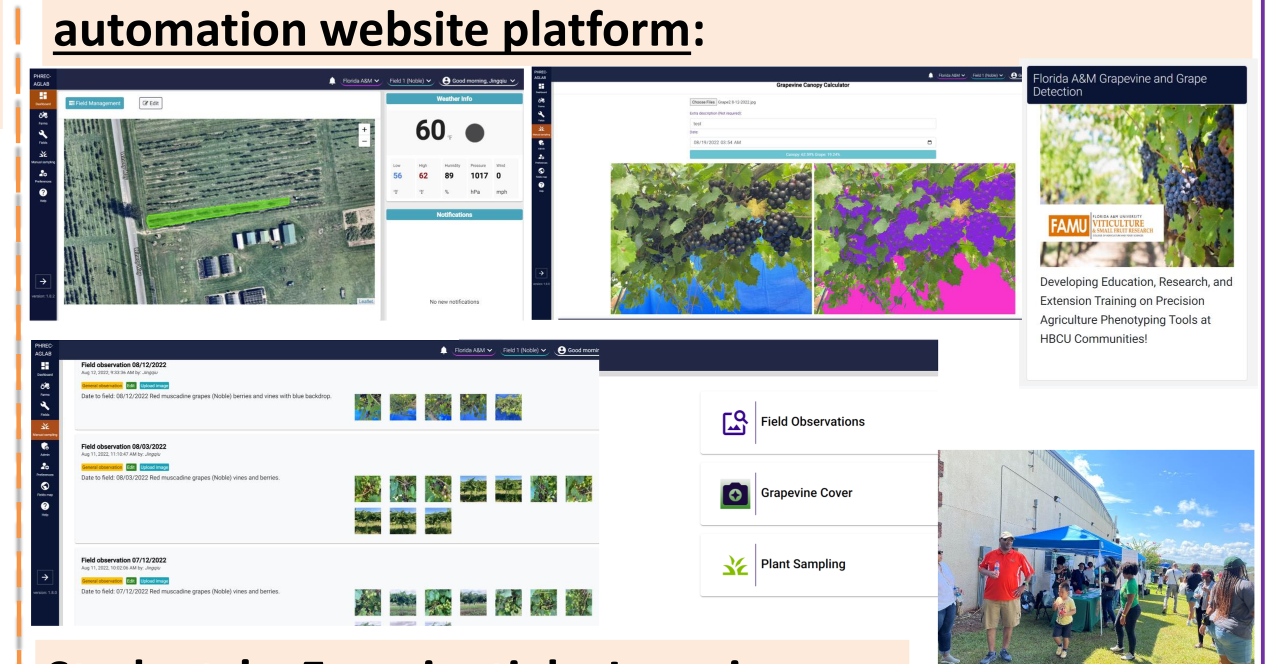


Figure 1: (left) Linear correlation between LAI and green leaves (%) and (right) Linear correlation between grape yield (lb) at camera extent and grapes (%)

Muscadine grape canopy and berry calculation automation website platform:



Students' Experiential Learning on Extension and Outreach Using the Grapevine and Grape Detection:

- August 20th, 2022: FAMU Grape Harvest Festival
- More than 500 event attendees viewed our website and about 50 participated in the "grape image collection competition" and tried our grape canopy and berry automatic detection function.
- More than 300 images were obtained from the field day uploading by the general public, and these images were used to refine the image processing algorithm.

Discussion

- Physiological parameters will differ based on cultivar, berry ripeness, crop load, and environment. Monitoring Physiological parameters can help determine the best time for harvesting. For example, the higher the sugar content the sweeter the juice, so in general we want a higher percent soluble solids of at least 14 or 15 to have a good flavor.
- Floriana's data showed there is a positive linear relationship between LAI and canopy percentage cover. However, more data on LAI, yield, and images need to be collected for Noble to have a better understanding on the Linear correlation between LAI and green leaves and between grape yield and grapes pixel percentage.
- The muscadine grape canopy and berry calculation automation website platform is user-friendly, which is attested by the FAMU Grape Harvest Festival activity, by which uninformed users can navigate the program, sign in as instructed, collect images, submit images, and generate canopy and grape percentages.
- It is important to note that the techniques developed are specifically used for muscadine grapes. As the online database is programmed to look for the shape and size grapes. But it can be altered or reprogrammed to apply to other crops and therefore expanding the application of precision agriculture.

Conclusion

In conclusion, by leveraging the current resources, students were trained to conduct firsthand fieldwork as well as to develop different types of data collection and data analysis skills. Students also had an increased experiential learning on a precision agriculture phenotyping tool and its application.

Acknowledgements

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