2023 SRSFC Research Report

Title: Blueberry performance evaluation in high tunnels as an alternative production system for frost protection.

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Budget: $5,000

Objective: Performance evaluation of three blueberry cultivars under high tunnels

Project Summary/Abstract.

Alabama has increased significantly the area planted in blueberries and there is a high interest in investigating the response of alternative systems for blueberry production Alternative production systems allow growers *to expand the production season while protecting the crop from challenges due to extreme weather events are a priority*.

Southern highbush blueberry cultivars are increasing in popularity and being preferred over the native Rabbiteye cultivars. The main challenge of growing Southern highbush cultivars in the region is *the risk of frost damage during the early spring frost*. Producers will lose most, if not all, of the season's berries to frost damage if a method of frost protection is not implemented. High tunnels have been beneficial to protect crops from severe weather conditions allowing for the cultivation of sensitive high-value crops. Some of the most notable benefits are being able to extend the harvest season, expediting fruit ripening, and decreasing loss from cold and frost damage. Three southern highbush blueberry cultivars have been planted under a high tunnel and in an open field, however, for this study, only the plants under a high tunnel will be considered. Evaluation of the characteristics for the establishment of the crop will be performed. Our goal is to evaluate the feasibility of producing blueberries in high tunnels.

The case of blueberry production in high tunnels has been studied in different countries including the U.S. and has confirmed that protected agriculture practices provide the opportunity for the producers to expand growing seasons, protect the crop from extreme weather, and thus increase productivity. In the U.S., high tunnel production has significant acreage in strawberry and raspberry crop production and several innovative blueberry producers have begun exploring using this unconventional system. According to the 2017 Census of Agriculture, a total of 536 farms across the state were reported to grow blueberries. *This project aims to evaluate the feasibility of the blueberry production grown in high tunnels as an alternative production system for frost protection, extended production season, yield, and quality fruit production to help Alabama producers make better decisions to effectively utilize this alternative system for blueberry production.*

Justification and Description:

One of the main research areas within the Consortium mission includes *applied cultural studies that investigate production and management issues with findings having a potential direct impact on crop production and grower success.* Alternative production systems that allow the growers to expand the production season while offering the protection of the crop from challenges due to extreme weather events are a priority. *The overall goal of this research is to understand blueberry production grown in high tunnels and evaluate its feasibility as an alternative production system for frost protection.*

This project will focus on whether high tunnel production of blueberries will lead to an alternative production system of cultivation as a desirable option for producers to protect their crops, particularly from freezes during flowering and early fruit development. Several strategies can be used by growers to reduce crop loss from freezes and to increase their profitability by extending the season of production. A spectrum of covered structures is used by growers, depending on the crop, the climatic region, and the anticipated benefit. We will address a large stakeholder need, as one of the biggest impacts on blueberry production currently in the southeast is early spring frost. Therefore, results from *this project will provide information to Alabama blueberry growers to assist in providing alternatives to protect and mitigate crop loss due to unpredictable weather events, and will also provide information necessary for the establishment of an alternative culture system in terms of cultivar development and breeding strategies.*

To date, this type of research is not popular in Alabama, therefore preliminary data to evaluate the benefit of this alternative production system for the producers in AL will be of value for small fruit producers.

High tunnel production

High tunnel (HT) production has become popular for small fruit cultivation for raspberry, strawberry, and blueberry producers recognizing it as a valuable tool to assist with season extension and crop protection (Demchak, 2009). The microclimate inside HTs advances bloom, accelerates fruit ripening, increases yield, and improves berry quality, as well as extends the harvest season and decreases fruit losses due to inclement weather (Banados, 2009; Santos et al., 2012). In contrast to greenhouses, HTs are not artificially heated or cooled and rely on passive ventilation, which, saves on both construction and maintenance costs. HTs have been used globally for decades worldwide, but commercial adoption and use of HTs in the United States have been slow.

Figure 1. High tunnel, located at the EV Smith Experimental and Research Center, Tallassee, AL.

Objective: Performance evaluation of three blueberry cultivars under high tunnels

We conducted an *evaluation of the performance of blueberry production grown in high tunnels* to characterize the growth and development of blueberries in this alternative system. Currently, there is limited information on the effects of a high tunnel used for blueberry production in Alabama climate conditions and this information is extremely important to support producers in decision-making while facing challenges generated by climatic conditions, especially frost damage.

Materials and Methods

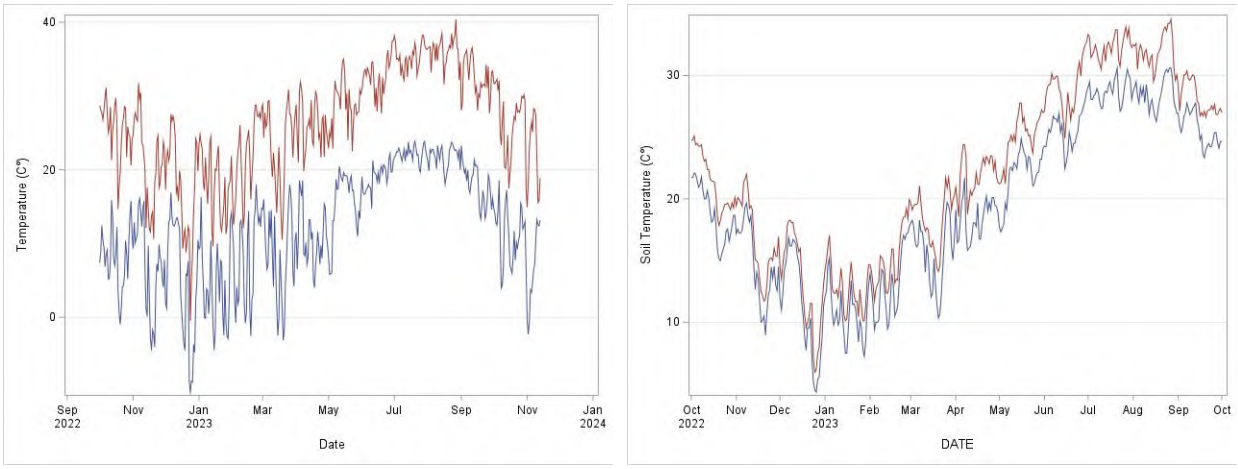
Plant cultivation and management. This study is currently established at the E.V. Smith Research Station, Plant Breeding Unit of Auburn University located in Tallassee, Alabama, (32.4419° N, 85.8975° W). The HT, in total measures 267.6 m², and it is covered with polyethylene film. Prior to HT establishment, soil preparation, and amendment were completed, including the incorporation of 15 cm of pine bark into the soil to promote soil acidification. Soil tests revealed a pH level between 4.8 to 5.2 after the amendments. Four raised beds, each 2.4 meters apart when measured from the center of the bed, were created using 5 cm of pine bark covered with weed fabric. Two beds were prepared nearby in open field conditions for comparison purposes. A selection three of southern highbush blueberry cultivars are currently established and growing in the HT including ‘Farthing’, ‘Indigo Crisp’, and ‘Legacy’. These cultivars were selected because of their growing popularity among researchers and producers. A total of 30 plants per cultivar has been planted in the HT at a 0.91 x 2.4m density using raised beds where incorporation of pine bark

has been made. This is a long-term planting trial, where we plan to evaluate more than one season. However, for this grant, we are collecting a series of physiological data including growth and development measurements that take place throughout the season, and harvest will be evaluated at the end of the production year. Data collected through the measurements will be analyzed and compared between cultivars and the effect of the high tunnel. We are not using a formal experimental design but rather utilizing a sampling approach. In case of extreme weather events, an evaluation of damage/survival will be performed. All management practices follow the extension recommendations for this crop

A series of physiological measurements have been periodically performed using the gas exchange portable system, LICOR LI6800. Diurnal measurements were conducted every month from sunrise to sunset to monitor photosynthetic rate (A, μmol m^{-2} s^{-1}) diurnal changes. Phenology and growth development were monitored throughout the complete season.

We are observing and in case of presenting we are planning to control any issue related to plant-parasitic nematodes, pests, diseases, or fungal diseases associated with this system that may occur, to assess nematode soil presence, we will collect random samples of soils if a problem of this nature arises.

Environmental conditions. Data loggers have been used to monitor environmental conditions, including temperature readings (soil and ambient), relative humidity, and rainfall (Fig 2).



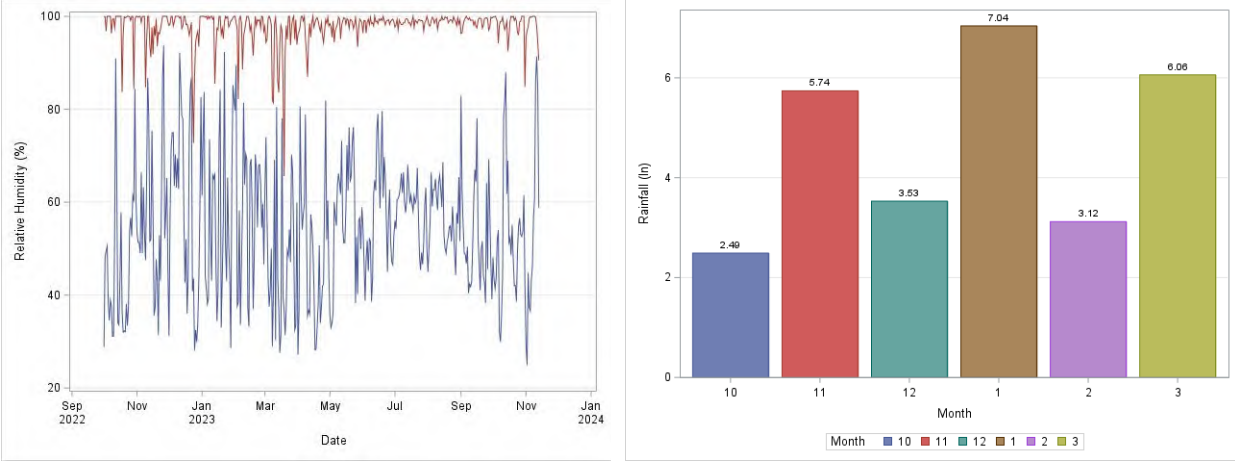


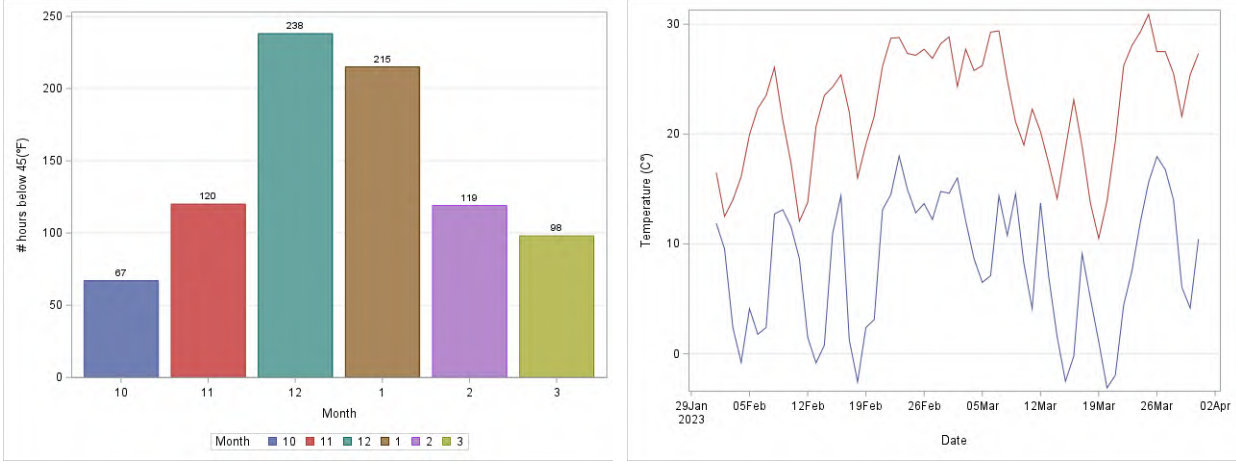
Figure 2. Climatic conditions registered at EV Smith (Tallasee, AL) during data collection (Nov 2022–Nov 2023). (A) Ambient Temperature (°C) minimum (blue) and maximum (red), (B) Soil Temperature (°C) minimum (blue) and maximum (red), (C) Relative humidity (%), and (D) Rainfall.

Results/Outcomes

We were able to successfully implement the proposed study planting and establish the blueberry crop using high tunnels (Fig 2). We started collecting partial data during the 2022 - 2023 season. Challenging environmental conditions were presented specifically we have an early spring frost.

Spring Chill

The total of hours recorded below 7.2°C (45°C) at EV Smith from October 1, 2022, through February 15, 2023, was 719 and the total until the end of March was 857, the monthly distribution of hours below 7.2°C (45°C) is presented (Fig 3A). The daily range of reported temperatures for Tallassee, AL where the trial is located, during February and March showed an increase in temperature in the middle of February and then a drop occurred on March 20th (Fig 3B). The lowest temperature recorded by our loggers in this location on March 20th was -2.6°C at 6:00 AM CDT. After the spring frost, the plants were put through a pruning session to fortify future growth. Another pruning took place in the fall on all the cultivars where 1/3 of the plant was cut back. We lowered the curtains of the tunnel and even though we experienced damage in the cultivars planted outside it was significative less damage presented at the high tunnels (Fig 3C, D).



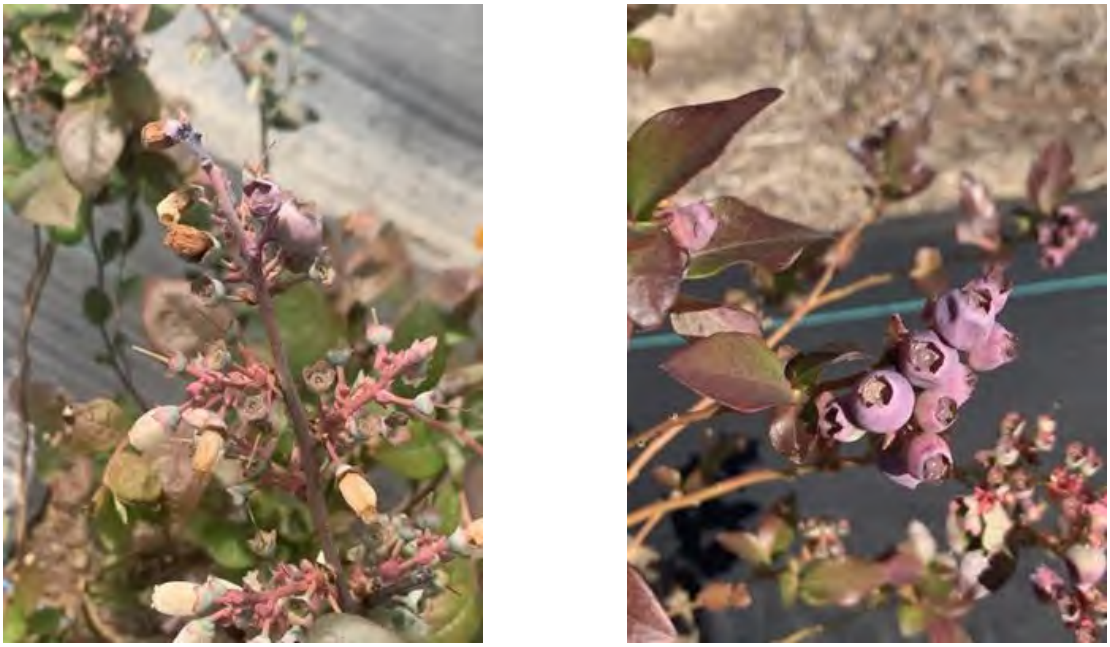


Figure 3. Number of hours below 7.2°C recorded at EV Smith Research Center (A) is on the left top, and the variability in temperature during the critical months of February and March 2023 (B) is on the right top. Damage presented in berries outside of the high tunnel (C) bottom left, damage presented in berries inside the high tunnel (D) during the freeze event in March 2023

Physiological measurements-Photosynthesis Preliminary

Physiological data was collected, and we analyzed the photosynthesis, by hour throughout the season, we estimated the maximum rate per hour and along we considered the location. In refers to ‘inside the high tunnel’ and Out refers to the location at the open field (Figure 4).

Figure 4. Establishment of the blueberry trial inside the high tunnel (In) and in an open field (Out) at EV Smith Research Center. Auburn University, Tallassee, AL.

The data indicated that early in the season, all cultivars were experiencing low photosynthetic rates. As the season progressed, an increase in the photosynthetic rate was observed (Fig 5A). We know that light is a major factor affecting photosynthesis, this behavior can be explained by the longer day lengths of the season.

We found that the maximum peak of the photosynthetic activity for hourly measurements varied according to the cultivar, 'Farthing' recorded the highest values of photosynthetic activity with peaks at 10:00 15,64 µmol $m^{-2}s^{-1}$and at 12:00 15,52 µmol $m^{-2}s^{-1}$ Inside de high tunnel followed by 'Indigo Crisp; at 8:00 am 15,50 µmol $m^{-2}s^{-1.}$ A different behavior was presented outside where Legacy registered the highest value at 10:00 am during the day of 15,60 µmol $m^{-2}s^{-1.}$, followed by Farthing with 14,76 µmol $m^{-2}s^{-1.}$ (Fig 5B), other cultivars activity is also presented (Table 1).

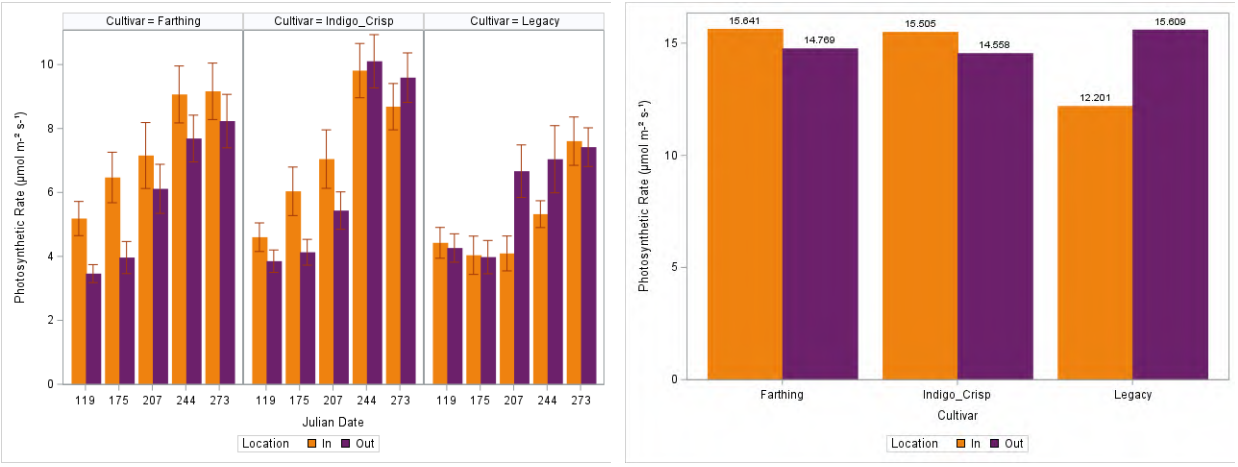


Figure 5. Average of the A in µmol $m^{-2}s^{-1}$ for all cultivars evaluated on a daily curve during the growing season of 2023(A) on the left and Maximum A in µmol $m^{-2}s^{-1}$ recorded for all of the cultivars(B) on the right.

Table 1. Photosynthetic activity per hour in both locations inside and outside the high tunnel values per hour in µmol $m^{-2}s^{-1}$.

Location	Hour	Cultivar	Amin	Amax	Amean	Location	Hour	Cultivar	Amin	Amax	Amean
In	6	Farthing Indigo	1.11	7.08	3.13	**Out**	6	Farthing Indigo	1.58	4.80	3.07
		Crisp	0.56	6.35	2.93			Crisp	1.02	4.93	2.80
		Legacy	0.62	5.73	2.87			Legacy	0.95	7.19	3.65
	8	Farthing Indigo	2.11	13.48	9.01		8	Farthing Indigo	2.06	12.35	8.39
		Crisp	3.19	15.51	8.94			Crisp	2.92	13.49	7.88
		Legacy	1.08	11.21	7.35			Legacy	4.52	15.61	9.37
	10	Farthing Indigo	4.39	15.64	10.45		10	Farthing Indigo	4.10	14.77	7.89
		Crisp	5.61	12.92	10.07			Crisp	2.67	14.07	8.46
		Legacy	2.63	12.20	6.99			Legacy	2.94	12.89	7.75
	12	Farthing Indigo	3.16	15.53	8.83		12	Farthing Indigo	3.26	11.97	6.85
		Crisp	4.31	13.65	8.41			Crisp	2.51	14.19	7.78
		Legacy	1.91	9.16	5.51			Legacy	1.44	11.62	6.00
	14	Farthing Indigo	3.89	13.12	8.31		14	Farthing Indigo	2.82	7.78	5.22
		Crisp	3.26	14.64	7.77			Crisp	2.44	14.02	6.94
		Legacy	0.57	10.85	4.73			Legacy	1.84	11.28	5.38
	16	Farthing Indigo	1.59	12.44	6.61		16	Farthing Indigo	1.18	10.78	4.60
		Crisp	3.85	11.96	6.93			Crisp	2.08	14.56	5.99
		Legacy	1.86	8.42	4.54			Legacy	0.65	8.48	3.98
	18	Farthing Indigo	0.60	5.99	1.80		18	Farthing Indigo	0.40	4.72	1.85
		Crisp	0.20	5.32	1.57			Crisp	0.06	6.52	2.56
		Legacy	0.07	6.27	1.67			Legacy	0.02	7.15	2.66

Bloom Phenological stages.

Phenology was monitored starting in the middle of January and every other day until the spring frost in March. No data is presented at this time, analysis is in progress and we will continue to collect data the following season.

The data presented and collected during the 2023 season preliminarily indicate that blueberry crops have the potential to grow in high tunnels. However, more information is required for a couple of more seasons to cover the fruit production and evaluate the yield production.

We are grateful for the support provided that allowed us to collect preliminary data to continue with the project.