2023 SRSFC Research Report

Title: Evaluation of blueberry production using Containers

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Budget: $5,000

Objective: Characterization of the growth and development of southern highbush blueberry cultivars grown in containers.

<u>Project Summary/Abstract.</u>

Worldwide production of highbush blueberry (*Vaccinium* sp.) has increased tremendously in recent years. The U.S. is leading the production, and this rapid growth is driven by strong consumer demand for the fruit, the development of new cultivars, and alternative production systems that have increased the availability of fresh blueberries in the market expanding the growing season. Blueberry farming has expanded into non-traditional growing areas in the U.S.

Alternatives to traditional open-field production include production systems in protected environments, greenhouses, high tunnels, high-density plantings, evergreen production, and *<u>container-based</u>* production. All these alternative systems have shown the potential to produce high yields of high-quality berries. According to the 2017 Census of Agriculture, a total of 536 farms across the state were reported to grow blueberries. Recently, container blueberry production using soilless substrate has had an increasing interest as a viable alternative to open-field blueberry planting.

Container production of blueberries offers the advantage of not being limited by suboptimal soil conditions in the open field and the ability to control substrate pH, drainage, and organic matter, enabling the growth of blueberries, in limited space that allows the moving of plants and adjusting high density in an expanded growing season. *<u>This project aims to evaluate the production of blueberries grown in containers 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.</u>*

Justification and Description:

There is a growing interest in investigating the response of alternative systems for blueberry production. Alabama has increased significantly the area planted in blueberries. Alternative production systems that allow the growers to expand the production season while protecting 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 containers in the southeast U.S.* This project will focus on whether container production of blueberries will lead to an alternative for blueberry production. This project addresses 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, 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 in container production for blueberries 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.

Container-based production

Container blueberry production is a relatively new approach (Li and Bi, 2019) with increasing interest in recent years (Fulcher et al., 2015; Voogt et al., 2014). Historically, blueberry has been propagated and grown in containers at nurseries, but only for a short time before planting. Blueberry is a long-term perennial that prefers soil pH in the range of 4.5-5.5, which are different requirements than most other small fruit crops grown in containers for fruit production (Retamales and Hancock, 2012). Container production of blueberries offers the advantage of not being limited by suboptimal soil conditions in the open field and the ability to control substrate pH, drainage, and organic matter (Kingston et al., 2017).

In limited space, container production enables the moving of plants and adjusting growing density based on plant growth (Whidden, 2008). The potential benefit of container production concerning cold protection is the ability to use much less water to achieve the same level of freeze protection However, concerns for blueberry container production include a potential constraint on root growth and the unknown feasibility of long-term production (Whidden, 2008). There are several unknowns for blueberry production using containers and for that reason *understanding the relationship between environmental factors and growth development is critical to determine how plants can adapt to a variable climate.*

Objective: Characterization of the growth and development of two southern highbush blueberry cultivars grown in containers.

We conducted an *evaluation of the performance of blueberry production grown in containers* to characterize the growth, and development, of blueberry in this alternative production system. Currently, there is limited information on the effects of containers used for blueberry production in Alabama climate conditions and this information is extremely important to support producers in decision-making. In addition, this research will inform the breeders about the potential of currently grown blueberry cultivars under containers as an alternative production system for frost protection, which is currently one of the most important limitations in blueberry production.

Materials and Methods

Plant cultivation and management.

For this year we included a selection three of southern highbush blueberry cultivars including, ‘Jewel’, ‘Meadowlark’, and ‘Victoria’ as well as a rabbiteye blueberry (*Vaccinium ashei*) ‘‘Baldwin’’ grown using containers. The trial was established at the Plant Science Research Center, at Auburn University (lat. 32.60_ N, long. -85.51_ W). The cultivars evaluated consist of 30 plants per cultivar that were transplanted in November 2021. On 28 January 2022, 40 ‘‘Baldwin’’ plants were planted in pots, and a second set of highbush where planted on 19 March 2022, a total of 120 plants (40 southern highbush per each of the cultivars ‘‘Jewel’’, ‘‘Victoria’ 20, and ‘‘Meadowlark’ 20) were planted into 15-gallon plastic containers with a potting mix composed of 50% ProMixBx 25% peat, and 25% pine bark. The pots are currently placed at a 3x2ft distance (Fig 1). We keep soil characteristics within the recommended range for blueberry and we test regularly electric conductance and soluble salts.

Figure 1. Container system including ‘Baldwin’ and second planting set for southern highbush, established at the Plant Science Research Center in Auburn University, AL.

For the irrigation method, we continue using a low-pressure dripping system with a single emitter per pot. Fertilization of Peter’s Peat-lite 20-10-20 at 250 ppm has been made regularly and a schedule of fertilization according to the extension recommendations is followed.

Environmental conditions.

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

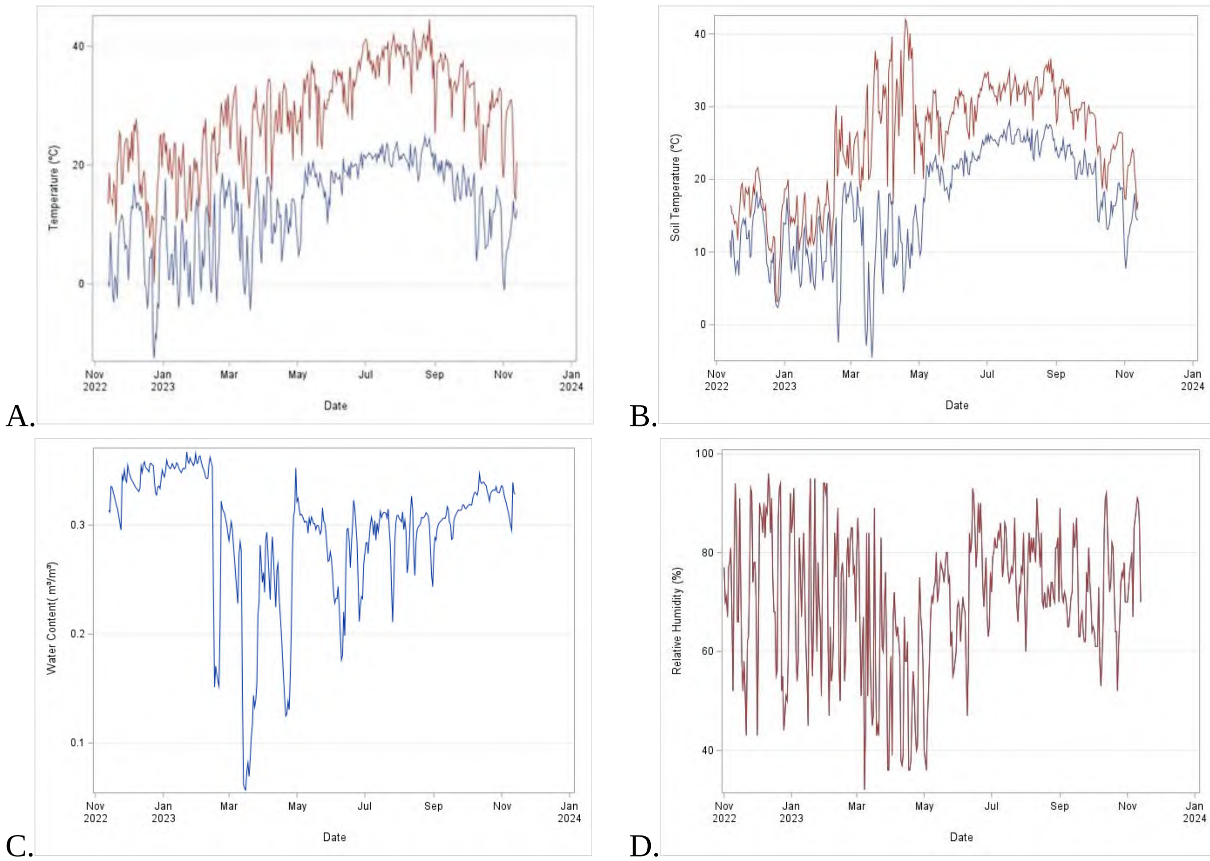


Figure 2. Climatic conditions registered at PSRC (Auburn, AL) during data collection (Nov 2022–Nov 2023). (A) Ambient Temperature (°C) minimum (blue) and maximum (red), (B) Soil Temperature (°C) minimum (blue) and maximum (red), (C) Water Content (m3/m3), and (D) Relative humidity (%).

Chilling accumulation

The total of hours recorded below 7.2°C (45°C) at PSRC from October 1, 2022, through February 15, 2023, was 606 and the total until the end of March was 717. The monthly distribution of hours below 7.2°C (45°C) is presented (Fig 4A). The daily range of reported temperatures for Auburn in February and March shows the increase in temperature in the middle of February and the drop that occurred on March 20th (Fig 4B).

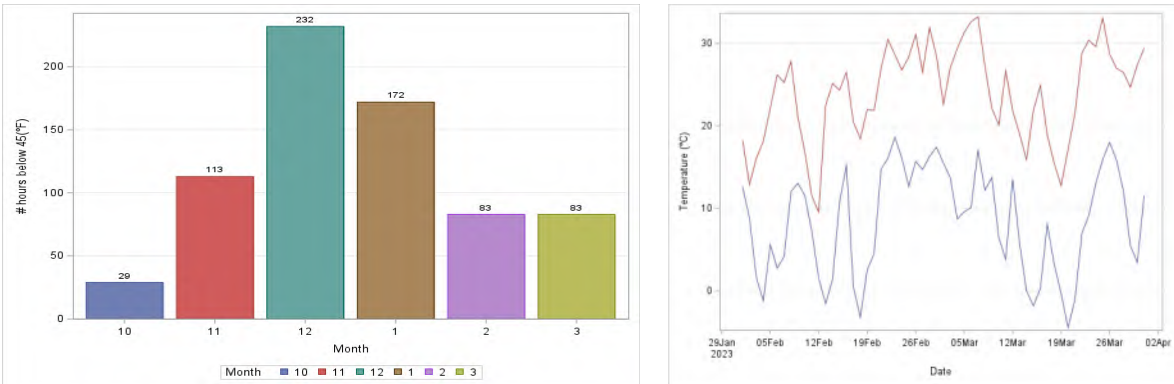


Figure 4. Number of hours below 7.2°C recorded at PSRC Auburn (A), and the variability in temperature during the critical months of February and March 2023.

A series of physiological measurements have been periodically performed using the gas exchange portable system, LICOR LI6800 including photosynthetic CO_2 assimilation rate (A), stomatal conductance (gs), leaf intercellular CO_2 concentration (Ci), and transpiration (E), for the cultivars evaluated. Diurnal measurements were conducted every month from sunrise to sunset. Phenology and growth development were monitored throughout the complete season.

Results/Outcomes

We were able to successfully implement the proposed study planting and establish the blueberry crop using containers. We started collecting data during the 2022 season, but the 2023 season was very challenging due to environmental conditions specifically an early spring frost.

Spring Chill

We had a tough year for blueberries. Warm temperatures appeared unexpectedly in February, causing many plants to bloom prematurely. Blueberry plants have overlapping phenological stages, and a freeze that occurred on March 20th damaged the buds, flowers, and fruit (Figure 3). We used plant blanket covers over a metal ring-dome structure to protect the containers from the freeze (as shown in Figure 3A), but the wind caused some of the staples to come loose (Figure 3B), leaving the berries exposed and causing damage (Figure 3C). To protect part of the new blueberry planting, we removed and relocated the internal containers to the greenhouse (Figure 3D, E, F). The lowest temperature recorded by our loggers in this location on March 20th was -2.5°C at 6:45 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 of the cultivars where 1/3 of the plant was cut back.

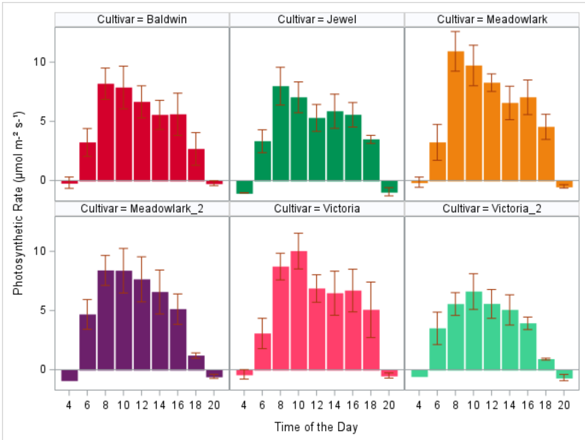
A. B. C.

D. E. F.

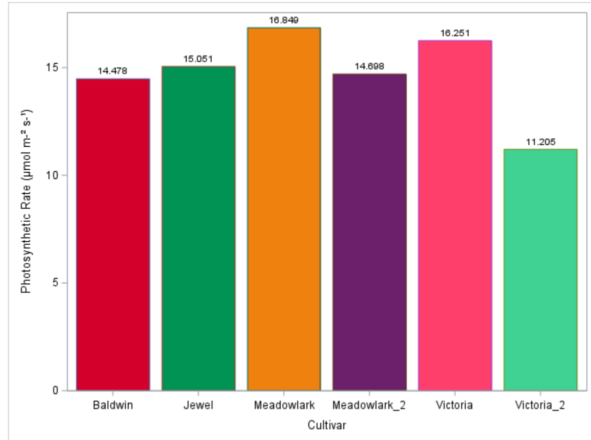
Figure 3. Cold protection during late winter – early spring of 2022. plant blanket covers for freeze protection (3A) damage caused by temperature and wind (B, C). Containers set up in the field (double) (D). Greenhouse display of 'Victoria' and 'Jewel' (E, F).

Physiological data was collected, and we found that the maximum peak of the photosynthetic activity occurred at 8:00 am during the season for 'Baldwin', 'Jewel', and 'Meadowlark'. On the other hand, 'Victoria' consistently presented the peak at 10:00 am. The average photosynthetic rate during the day was recorded for 'Baldwin' at 6.23 µmol $m^{-2}s^{-1}$, 'Jewel' at 6.59 µmol $m^{-2}s^{-1}$, 'Victoria' at 7.76 µmol $m^{-2}s^{-1}$, and 'Meadowlark' at 8.02 µmol $m^{-2}s^{-1}$.

For the second planting date, 'Victoria' recorded 4.18 µmol $m^{-2}s^{-1}$ and 'Meadowlark' 6.32 µmol m^2/s (Fig. 4A). The maximum photosynthetic values recorded on different days reached a maximum of 16.84 µmol m^2/s for 'Meadowlark', followed by 'Victoria' with 16.25 and 15.05 µmol $m^{-2}s^{-1}$ for 'Jewel' (Fig. 4B).



A.



B.

Figure 4. 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) Maximum A in µmol $m^{-2}s^{-1}$ recorded for all of the cultivars(B).

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 similar behavior was observed in the past season. We know that light is a major factor affecting photosynthesis, this behavior can be explained by the longer day lengths of the season.

Bloom Phenological stages.

Phenology was monitored starting middle of January and every other day until the spring frost in March. An example of the scale used is presented for 'Baldwin' (Figure 5).


A. Dormant


B. Bud swell


C. Early green tip


D. Tight cluster


E. Budbreak


F. Early pink bud


G. Late pink bud


H. Bloom

Figure 5. Phenological stages that were monitored for blueberries.

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

As a part of this effort, we have published an open-access paper titled " Photosynthetic Response of Blueberries Grown in Containers" in the Plants Journal. 2023 reference as follows:

Salazar-Gutiérrez MR, Lawrence K, Coneva ED, Chaves-Córdoba B. Photosynthetic Response of Blueberries Grown in Containers. Plants (Basel). 2023 Sep 15;12(18):3272. doi: 10.3390/plants12183272. PMID: 37765438; PMCID: PMC10537620.

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