2022 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.

Project Summary/Abstract.

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 *container-based* 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. *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 to make better decisions to effectively utilize this alternative system for blueberry production.*

Justification and Description:

There is a growing interest to investigate 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.

<u>Container-based production</u>

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 *<u>understanding the relationship between environmental factors and growth development is critical to determine how plants also can adapt to a variable climate.</u>*

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

We conducted an *<u>evaluation of the performance of blueberry production grown in containers</u>* 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. A selection two of southern highbush blueberry cultivars including Jewel and Meadowlark were 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 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).

Figure 1. Container system, established at the Plant Science Research Center in Auburn University, AL.

The chemical analysis of the potting mix showed that the soil characteristics are within the recommended range for blueberry growth with pH at 4.79, electric conductance of 0.65, and soluble salts at 413 p.p.m. The irrigation method is a low-pressure dripping system with a single emitter per pot. Two fertilizations of Peter's Peat-lite 20-10-20 at 250 ppm were made in August 2022, spaced intervals of one week. Data loggers have been used to monitor environmental conditions, including temperature readings (soil and ambient), water content, and relative humidity (Fig 2A, Fig 2B).

Figure 2A. Water content (m3/m3) and Soil temperature (°C) were monitored from Nov 2021 to Nov 2022

Late Spring Chill

The late Spring frost occurred between March 12 to 13 of 2022. The lowest temperature recorded was 4.9°C at 4:30 am.

Chilling accumulation

Chilling accumulation was calculated using three methods i) the number of hours below 7.22°C (45°F) from November 05 of 2021 to February 28 of 2022.; ii) using the Utah model calculated according to Byrne & Bacon's explanation and iii) the dynamic model estimated using 0.56°C - 12.78°C (35-55°F) as proposed for southern highbush blueberries by the University of Florida. The values obtained were 785 Chill hours for the first method, 542.3 chill units using the Utah approach, and 47.6 Chilling portions using the Dynamic Model.

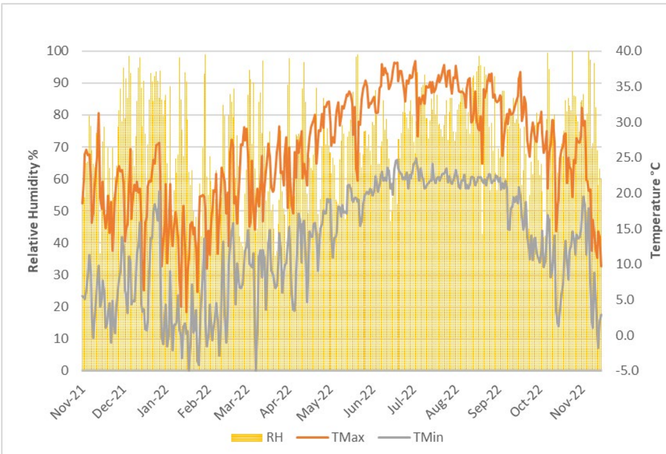

Figure 2B. Relative humidity (%) and temperature (°C) were monitored from Nov 2021 to Nov 2022

Growth: Destructive measurements have taken place periodically over time. The plants have been divided into leaves, stems, roots, and reproductive organs to be weighed individually for determination of fresh and dry weight (g). Leaf Area has been also measured (LA, cm2). In addition, a series of physiological measurements have periodically used the gas exchange portable system, LICOR LI6800. The factors being measured are: photosynthetic gas exchange as a response to the conditions of the potted plant's rate (A), stomatal conductance (GSW, mol m^{-2} s^{-1}), intercellular Carbon (Ci, µmol m^{-2} s^{-1}), transpiration (E, mol m^{-2} s^{-1}), and quantum efficiency (PhiPS2).

Results or Outcome:

We successfully implemented the proposed study planting and established the blueberry crop using containers, and we started with data collection during the 2022 season.

Destructive measurements

Height: Meadowlark presented the highest values for plant size, with an average of 41.2 cm and a maximum of 66.3 cm, compared to Jewel with an average of 40.3 cm and a maximum of 61.2 cm. Jewel showed a significant increase in leaf area at the end of the measurements. The Meadowlark cultivar has the lowest leaf area compared to Jewel.

Aerial dry weight: This is the sum of leaf and stems weight. Overall biomass accumulation is the result of photosynthetic activity. Aerial dry weight values showed that Jewel accumulated the most amount of dry weight throughout the season. As previously presented the high leaf area value for Jewel, photosynthesis at the canopy level could have compensated for the low leaf level photosynthetic value since the aerial dry weight was similar to the meadowlark cultivar. The increase in photosynthesis can also increase biomass production. It must also be taken into consideration that there were two fertilizations done in august. This could also have influenced biomass production.

Leaf weight: Jewel showed the highest value for leaf area followed by Meadowlark (Table 2).

Jewel and Victoria show the highest values for stem weight. The low value for Jewel is similar to the height value as well since it was also the lowest value compared to the other cultivars.

Table 2. Growth variables measured Height (size of the plant in cm) WL, WS, TW, and LA corresponds to leaf, stem, and total weight respectively in g, LA leaf area in cm.

Cultivar									
	Jewel				**Meadowlark**				
Variable	**Mean**	**Std Dev**	**Min**	**Max**	**Mean**	**Std Dev**	**Min**	**Max**	**Variable**
Height	40.3	7.5	30.5	61.2	41.2	15.2	22.9	66.3	**Height**
WL	15.7	16.6	1.9	48.4	8.9	9.8	1.2	32.8	**WL**
WS	12.0	10.4	4.1	34.0	11.3	10.8	4.3	44.5	**WS**
TW	27.7	26.9	7.7	81.9	20.2	20.4	5.7	77.3	**TW**
LA	1545.8	1511.1	191.0	3818.0	820.6	714.9	147.6	2339.9	**LA**

Bloom Phenological stages: Phenology was monitored starting January 19th and every other day until the spring frost in March. Jewel saw the most amount of bud break and the most amount of petal fall which was the last stage recorded before the spring frost damage (Fig. 3).

Physiological data were collected and the maximum peak of the photosynthetic activity was registered at 8:00 am during the season for both cultivars, where the average Photosynthetic rate average was 5.78 µmol m2/s for Jewel and 7.763 µmol m2/s for Meadowlark (Fig. 4.). However, maximum photosynthetic values recorded on different days reached out to 15.05 µmol m^2/s for Jewel and 16.84 µmol m^2/s for Meadowlark.

Data shows that early in the season all cultivars were experiencing low photosynthetic rates, as the season progressed an increase in the photosynthetic rate was observed. We know that light is a major factor affecting photosynthesis, this behavior can be explained by the longer day lengths of the season. During June and July, daylight lengths were 14 hours long. There is a decrease in photosynthesis on day 260 in all cultivars, but Jewel showed to have the lowest value on this day. The decrease could be attributed to ambient stress. During the 225, 260, 289, and 322 days after transplanting (DAT), both cultivars showed the highest numerical values for midday measurements, no statistical differences were founded on this aspect, however, in the case of Meadowlark and Jewel, we can observe higher stomatal conductance up until the 10th hour of the day. Starting at the 12th hour stomata are reduced (Fig. 5.). We can assume that this is caused by the increase in temperatures to reduce transpiration. A higher stomatal conductance can increase carbon uptake. This could explain why these two cultivars show a higher photosynthetic rate during the first half of the diurnals. Temperature is the main drive of GSW, but when temperatures are too

The data presented and collected during the first season indicate that blueberry crops potentially can grow in a container more information is required for a couple of more seasons to cover the fruit production and evaluate the yield production. Management options include pruning, spacing, or the use of reflective covers to improve leaf light interception, a micro tunnel that could be beneficial to maximize daytime temperatures to increase photosynthesis, and the use of supplemental CO_2 as reported by Petridis et al., 2018 could be helpful.

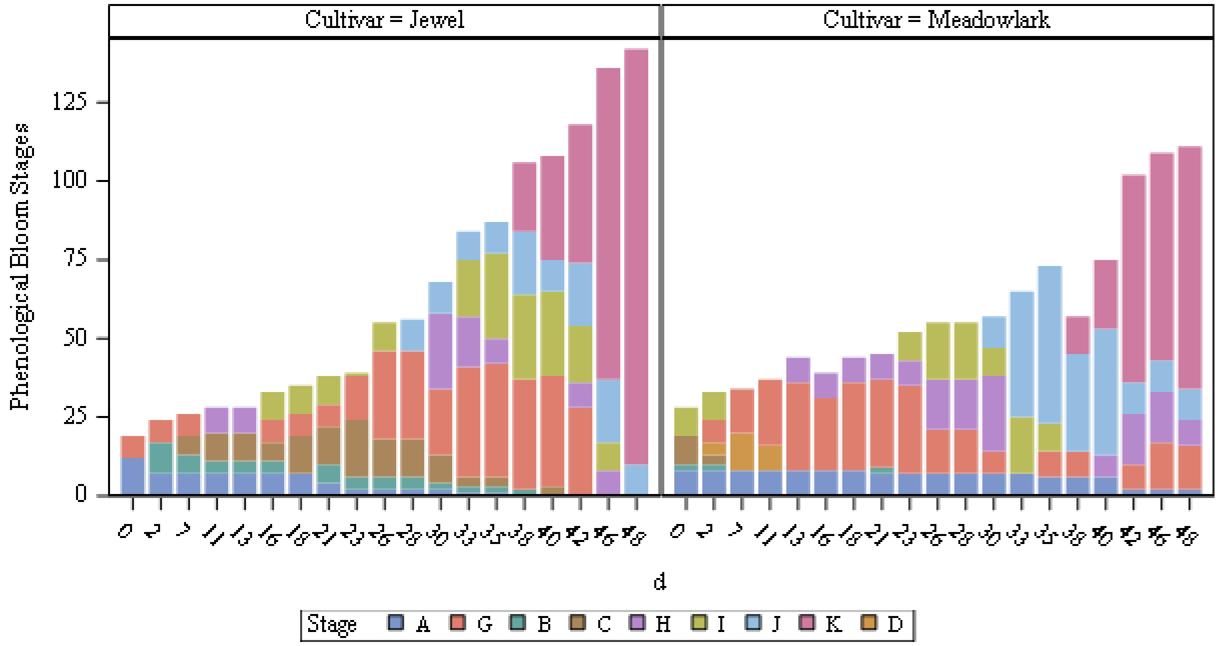

Figure 3. Phenological stages registered for Jewel and Meadowlark A=Dormant or tight bud, B=Bud swell, C=Early green tip, D=Bud break/Burst, G= Early pink bud, H= Late pink bud, I = Early bloom, J = Full bloom, K = Petal fall from January 19th to March 8th, 2022.

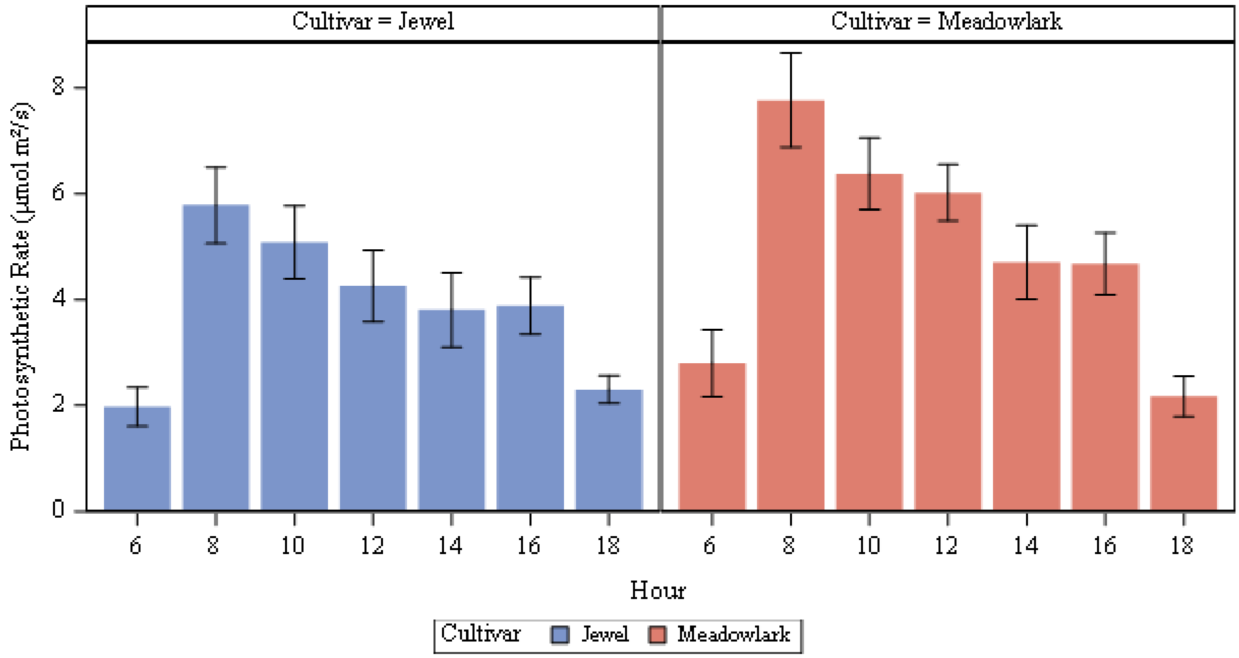

Figure 4. Average of the photosynthetic rate in µmol m^2/s for Jewel and Meadowlark cultivars on a daily curve during the growing season of 2022.

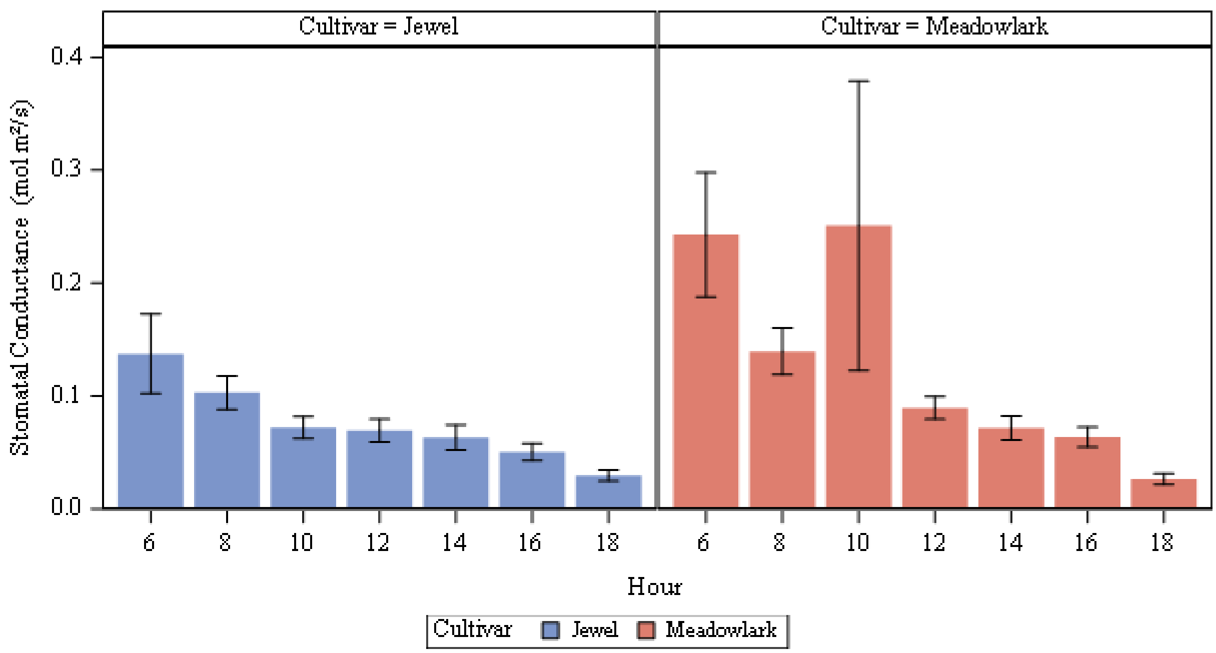

Figure 5. Stomatal Conductance in µmol m2/s for Jewel and Meadowlark cultivars on a daily curve during the growing season of 2022.