A Comparative Analysis of Hydroponic and Conventional Blueberry Cultivation

Robby Dostart

I. Introduction

Problem Statement: This project was used to determine the benefits of growing blueberries (*Vaccinium* sect. *Cyanococcus*) hydroponically in a controlled environment compared with traditional outdoor growth. This research noted differences in overall growth, yield, fruit quality, and time to maturity to determine the benefits from either system.

Objectives:

1. Evaluate the level of success of growing blueberries in a hydroponic system within a greenhouse.
2. Compare the time to maturity, overall yield, and quality of the fruit growing indoors in a hydroponic system and traditional outdoor production.

II. Cultivar Selection

The selection of appropriate cultivars was achieved by determining the average chill hours central Kentucky receives annually, noted plant resistances, and desirable fruit characteristics. Chill hours are defined as the accumulated hours between 45°F and 32°F. Blueberry bush cultivars require a varied number of chill hours to produce a good fruit set. If the crop doesn't receive enough chill hours, flower development will be stunted leading to lower yields (ANR, 2017). Over a 5-year period between 2009-2013, the mean chilling hours of Madison County were measured at 1,606 hours (Xue, 2015). Cultivars requiring the most chill hours require a minimum of 800 hours, therefore, this was not a limiting factor in the decision.

Many cultivars noted a susceptibility to root rot which seemed less suitable for hydroponic growth and such cultivars were removed from the selection pool. There are 5 general types of blueberries grown in the United States: Northern Highbush, Southern Highbush, Rabbiteye, Lowbush, and Half-high. For this study, Rabbiteye cultivars were selected for a few reasons. This type has a growth habit from 6'-10' tall, was developed in regions with hot, humid summers, and has fruit with a longer shelf life than other types (Strik et al., 2014). Rabbiteye blueberries are not self-fertile and require crosspollination, therefore, two different Rabbiteye cultivars were selected. 'Premier' was the first cultivar selected and has the benefit of blooming later than others which protects the flowers from late frost. This characteristic was of particular importance as many regions of Kentucky are prone to late frost. 'Colombus' was the second cultivar selected. It was developed by North Carolina State in 2005 and is resistant to cracking of the fruit in wet weather. 'Colombus' is mid-season to late flowering which reduces the risk of damage from late frost.

'Premier' – Minimum chill hours 550

'Colombus' - Minimum chill hours 600

III. Hydroponic System

The hydroponic system was assembled and installed within EKU's Quonset #3 greenhouse. The system selected was Current Culture's Under Current system. This is a Recirculating Deep-Water Culture (RDWC) system where the plant's root system is suspended in nutrient solution that is in constant motion via a recirculation pump. Each

growth module has a dedicated air stone fed by a bank of 2 air compressors to provide oxygen to the root system. There are 24 individual 8-gallon growth modules spaced at 24" intervals and outfitted with 5" net pots. The net pots originally utilized expanded clay pebbles for the blueberry's growth media. The system is replenished by a gravity fed 275-gallon IBC tote used as a reservoir of nutrient solution. The nutrient solution consists of Current Cultures 2-part A (5-0-0.3) and B (1.3-2-5.9) Vegetative nutrients, a Calcium/Magnesium (2-0-0) supplement, and UC Roots (mineral de-scaler). Food grade hydrogen peroxide at 12% concentration was added to help maintain root health by reducing root rot. The pH was balanced on both the system and the reservoir to between 4.5-5.5 pH using food grade phosphoric acid. A 1/10th HP chiller was installed at the main control module to circulate and cool the nutrient solution to maintain a healthy temperature range. 24 slips of paper: 12 P's and 12 C's were drawn from a bowl to determine the randomized placement of the blueberry slips.

IV. Issues with Hydroponic System

After some time, it became apparent that some factors within the hydroponic system required changes or modifications. It was first discovered that the 275-gallon reservoir was growing algae due to light penetration. This was remedied by spray painting the reservoir black, covering it with a reflective tarp, and installing two air stones to constantly disrupt the nutrient solutions surface tension. It was then observed that the blueberry foliage appeared chlorotic, and the flowers were not forming correctly. It was determined that the expanded clay pebbles used for the growth media were not wicking enough moisture to the developing root systems and therefore the flowers were all lost. The decision was made to switch the growth media to perlite to try saving the crop for future production. The effects were noticeable almost immediately when color was restored to the foliage and healthy new root growth was seen penetrating the bottom of the net pots. The resulting new growth was strong but had issues supporting itself and required trellising. This was done by loosely tying twine around the cane and then tying it up to the greenhouse framework.

V. Row at EKU Red Barn Garden

At EKU's Red Barn Garden, a row was measured and marked with marking paint to one side of the existing rows of blueberries. A soil pH analysis was completed, and the soil was amended with 90% elemental sulfur to reduce the soil pH. A plastic covering was rolled and staked out over the row to reduce weeds and erosion. The covering was marked for 24 sites at equal distance. Using an improvised device made of a wooden handle and coffee can, holes were burnt into the covering by heating the coffee can with a propane torch and then applying pressure. 24 slips of paper: 12 P's and 12 C's were drawn from a bowl to determine the randomized placement of the blueberry slips.

VI. Issues with Conventional System

With the conventionally grown system, weather, planting date, and pests had a more critical effect on growth. The blueberry slips were not planted until November 16th, 2022, which significantly reduced the available time for growth before dormancy. This late season growth proved detrimental to the plants when they should have been readying themselves for dormancy. Strong winds during a weekend storm uprooted several of the recently planted

blueberry slips and partially desiccated them before they were replanted. The presence of deer tracks beside other damaged or removed slips was also noted at the time.

VII. Results

Unfortunately, neither of the systems produced fruit. The hydroponic system produced the best vegetative growth during the time span of this study. The hydroponic system was also more forgiving with fewer plants lost due to weather and user errors.

References

Agriculture and Natural Resources, University of California. (2017, February 13). *Cold enough for your blueberries?*. ANR Blogs. https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=23199

Polomski, O. A. F., Polomski, R. F., Reighard, G., & Williamson, J. (2023, March 28). *Blueberry*. Home & Garden Information Center | Clemson University, South Carolina. https://hgic.clemson.edu/factsheet/blueberry/

Strik, B. C., Finn, C. E., & Moore, P. P. (2014, February). *Blueberry Cultivars for the Pacific Northwest*. Oregon State University Extension Service. https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw656.pdf

Xue, Yao, "Accessing Chilling Conditions For Perennial Fruit Crop Production in Kentucky" (2015). Masters Theses & Specialist Projects. Paper 1486. http://digitalcommons.wku.edu/theses/1486

Table 3 (continued). Chilling hour means of 33 Kentucky Mesonet sites included in the study.

ID	County	Site	2009-10	2010-11	2011-12	2012-13	2013-14	Mean Sites
15	Grayson	BLRK	1252	1346	1248	1472	1425	1349
16	Hopkins	ERLN	1242	1413	1440	1731	1284	1422
17	Jackson	OLIN	1488	1510	1558	1851	1487	1579
18	Johnson	BTCK	1624	1560	1616	1958	1581	1668
19	Knox	BMBL	1550	1449	1446	1934	1593	1594
20	Lincoln	LGNT	1504	1484	1596	1862	1526	1594
21	Logan	RSVL	1225	1279	1184	1446	1341	1295
22	Madison	ELST	1559	1534	1586	1842	1509	1606
23	Marshall	DRFN	1286	1425	1448	1795	1328	1456
24	Mason	WSHT	1506	1499	1654	1919	1429	1601
25	McLean	PVRT	1369	1509	1571	1857	1419	1545
26	Mercer	HRDB	1448	1443	1544	1820	1374	1526
27	Morgan	WLBT	1469	1500	1602	1916	1449	1587
28	Ohio	HTFD	1200	1335	1243	1499	1314	1318