**Title:** Long cane production of raspberries: monitoring of soil moisture and nutrient status.

**Name, Mailing, and Email Address of Principal Investigator(s):**

**Principal Investigator:**
Lisa Rayburn
Area Agent
NC Cooperative Extension, Onslow County
4024 Richlands Hwy
Jacksonville, NC 28540
lmraybur@ncsu.edu

Gina Fernandez
Professor/Extension Specialist
2721 Founders Drive
NCSU Dept. Horticultural Science
Raleigh NC 27695
gefernan@ncsu.edu

Brian Jackson
Professor/Director of Substrates Lab
2721 Founders Drive
NCSU Dept. Horticultural Science
Raleigh NC 27695
Brian_Jackson@ncsu.edu

John Havlin
Professor
Department of Crop and Soil Science
NCSU
Raleigh NC 27695
jhavlin@ncsu.edu

**Grower Cooperator:**
Cal Lewis
Lewis Farm
Rocky Point, NC

**Public Abstract:**
Raspberries, a high value crop, are not conventionally cultivated in the hot and humid conditions of the southeastern United States. The prevailing method involves annual substrate-grown long-cane production, where plants are cultivated in soilless media in pots or bags and grown in

tunnels during more temperate spring seasons. The typical substrate for this system has been coco coir. However, challenges in coconut processing and transportation have led to shortages and increased costs of coconut products. Research at NCSU has concentrated on exploring regionally sourced bark and wood products as alternative substrates for various crops, including raspberries. This study aimed to assess plant performance in both coco coir and locally produced pine bark substrate at Lewis Farms in Rocky Point, NC. 'Kwanzaa' long cane plants, produced in a Canadian nursery in the summer of 2022, were shipped to NC in the winter. In January 2023, these plants were planted in Hargrove high tunnels, with two tunnels using coco coir and two using pine bark substrate. Fertility and irrigation were managed through daily monitoring of fertigation input and output EC, as well as drainage percentage. Total yield (flats/row converted to flats/acre) was recorded at each harvest, while berry weight was measured by counting and weighing a clamshell of berries several times during the season. Plant tissue samples were collected bi-weekly to evaluate nutrient status. No significant differences were found in total yield or berry size between the two substrates. Substrate analysis showed that coco coir had higher water holding capacity, however more frequent watering of plants in pine bark substrate proved to supply adequate water to plants in that substrate. Plant tissue analysis showed no disparities in N, P, K, Ca, or S between the substrates, with only minor differences in micronutrients. Based on this two-year study, pine bark appears to be a promising substrate for long-cane raspberry production in the southeastern US.

**Introduction:**

The overall objective of this project is to determine the feasibility of long-cane raspberry production in a warm southern climate. This project has or is in the process of assessing cultivar suitability, timing of pull out (planting), economic inputs/outputs as well as alternatives to coconut coir as the substrate. Many of these objectives are still ongoing. However, for this proposal, the specific objective is to determine and optimize the fertility inputs and substrate moisture management of long-cane raspberries grown in coconut coir and pine bark substrates.

**Description of Outreach Activity:**

Cal Lewis of Lewis Nursery and Farms is providing NCSU with long cane raspberry plants (sourced from Pouliot Nursery, https://onesimepouliot.com/en/), substrate, pots, irrigation system and labor for a replicated study on his farm. Haygrove Tunnels has donated a 4-bay high tunnel to NCSU (constructed at Lewis Nursery and Farms). The field is in Rocky Point, NC.

Plot Layout (Figure 1)

- 4 30 X 170-200 ft tunnels (tunnel length changes per field dimensions)
- 1 pullout (“planting”) date January 24 and 25, 2023
- Cultivar Kwanzaa
- 2 media
    - Medicoir Classic cocopeat product
    - Pine bark TH Blue fine nursery mix with screenings buffered to pH 6.5

A team consisting of NCSU faculty (Fernandez and Jackson), NC Cooperative Extension agent/graduate student (Lisa Rayburn), TriEst Ag Group agronomist (Josh Mays) and personnel at Lewis Farm (Walt Webb) were the team working on this project. This research project will be

the basis of Ms. Lisa Rayburn, an NCSU Cooperative Extension Agent, Master of Science degree.

This is the second year of this on-farm trial. We repeated the experiment and sent solution, tissue, and soilless media samples to the NCDA&CS lab. We collected yield data, measured plant growth, assessed substrate content, monitored substrate moisture, temperatures and EC. Ultimately, our aim is to develop baseline recommendations for cultural and crop management practices for growing raspberries in pine bark substrates based on these on-farm trials. Funds from this grant paid for tissue, solution, and soilless media analysis and the WET-2 Sensor. Funds for travel for Ms. Rayburn to travel from her office in Jacksonville NC to Lewis Farm and national berry meetings.

Figure 1. Haygrove high tunnels with long cane raspberries. Lewis Farm and Nursery, Rocky Point NC.

**Results:**

*Yield parameters*

In the second year of this on farm trial yields were higher than in 2022 but comparable in both media (Figure 2). The average total yield in 2023 was 3918 flats/acre in coco coir and 3704 flats/acre in pine bark. Statistically there were no differences in yield between substrates in either year.

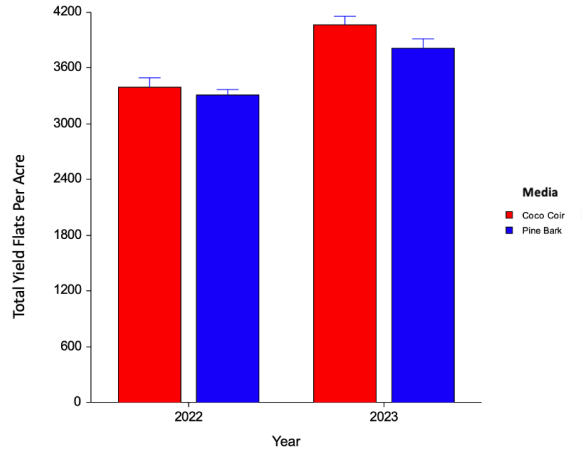


Figure 2. Total yield in flats/acre of Kwanzaa raspberry grown in coco coir and pine bark mulch. 1 flat = 5.1 lbs. actual fruit.

Similarly, there were no statistical differences in berry weight between the two substrates (Figure 3). Overall, the size was down from 2022. We think this was due to the sampling dates in 2023. All fruit samples were collected in the latter part of the season when fruit size decreased.

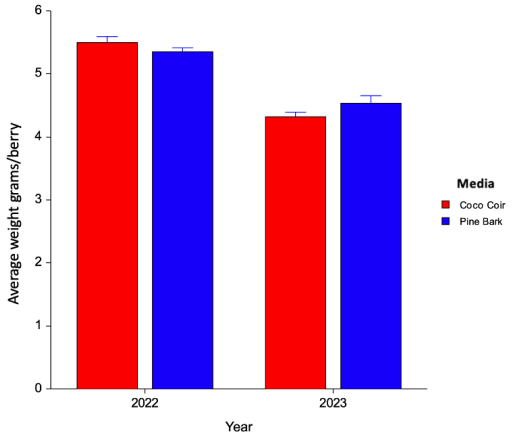


Figure 3. Berry weight (g/berry).

*Plant tissue, solution monitoring and substrate analysis*

Plant tissue samples were collected every two weeks to monitor plant tissue nutrients over the growing season. There were no differences between treatments for N, P, K, Ca, S, Mn, Cu and Na. Figure 4 illustrates the N in floricane leaf tissue collected from plants grown in coco coir and pine bark. Solution samples were also collected every two weeks from the irrigation source water as well as nutrient solution going into the pots and coming out of the pots. There were no differences in nutrients in these samples (data not shown).

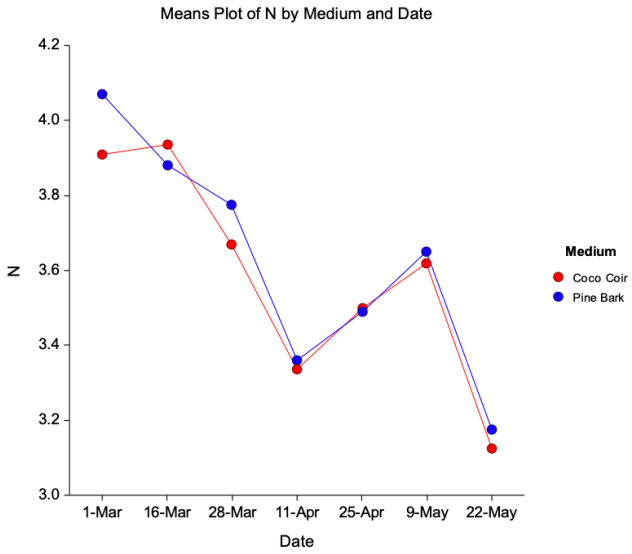


Figure 4. Floricane tissue N level in leaves of plants grown in coco coir and pine bark substrates.

Substrate Moisture

The WET-2 sensor was purchased for monitoring of soil moisture and EC in real time. We thought that we would be able to assess substrate in multiple containers in a short period of time and multiple times a day if necessary. We thought that the WET-2 sensor would allow us to refine our irrigation program from both a substrate moisture and nutrient management perspective. However, we learned that frequent use of this sensor was cumbersome in this system. For this reason, we used our existing fertigation monitoring station for daily assessment.

There was a lot of variability in readings when taken in the top of the pot. Emitter placement resulted in dry and wet areas in the top of the root zone affecting moisture and EC measurements. Accurate readings were collected from the bottom third of the pot. To access the bottom of the root zone, we had to remove plants from their pots and insert the sensor. In the process of removing plants from their pots, it was easy for the root ball to fall apart and this reduced the accuracy of the reading. This problem was more pronounced in the pine bark substrate. Care had to be taken to not damage fruiting laterals when removing plants from their pots. This process was time consuming and labor intensive to complete accurately. For these reasons, we determined that this sensor was not the most efficient way to monitor moisture and EC on a daily basis in this system. However, this sensor was a useful tool for periodic checks and in diagnostic scenarios.

Monitoring substrate moisture and EC using the WET-2 sensor.

In the second year of this trial in order to better determine the physical properties of the pine bark substrate, samples of pine bark and coco coir were analyzed in the Substrate Processing and Research Center (SPARC) at NCSU (Table 1). In general coco coir has more total porosity, higher water holding capacity and lower bulk density than pine bark. However, we learned that with appropriate irrigation management including more frequent, shorter duration irrigation intervals, the pine bark proved to be an acceptable substrate.

Table 1. Physical Properties of pine bark and coconut coir substrates.

| Substrate | Total Porosity % Volume | Container Capacity % Volume | Air Space % Volume | Bulk Density g/cc | Initial Moisture % weight | Testing Moisture % weight |
|---|---|---|---|---|---|---|
| Pine Bark (pre) | 75.6 | 46.4 | 29.2 | 0.19 | 54.0 | 53.97 |
| Pine Bark (post 2) | 85.2 | 49.9 | 35.3 | 0.17 | 64.8 | 64.81 |
| Pine Bark (post 4) | 85.6 | 52.2 | 33.4 | 0.17 | 68.0 | 68.02 |
| Coco Coir (pre) | 91.1 | 54.2 | 36.9 | 0.06 | 83.1 | 83.11 |
| Coco Coir (post 1) | 96.2 | 68.4 | 27.8 | 0.06 | 85.1 | 85.08 |
| Coco Coir (post 3) | 96.1 | 67.2 | 29.0 | 0.06 | 85.2 | 85.19 |

Conclusions:

- Yield and fruit size in the two substrates are comparable, therefore pine bark is a viable alternative to coco coir.
- There were no negative impacts on plant growth or nutrient status.
- Less expensive with the cost of pine bark substrate currently being about 25% that of coco coir.

- Pine bark is locally produced increasing sustainability and decreasing risk related to supply chain issues.
- Irrigation management is critical and needs to be monitored closely.