Interim Report:

Substrate Comparison in an Outdoor, Raised-bed Strawberry Production System

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Prepared on behalf of:
Horticulture Nova Scotia

In collaboration with:
Lore Strawberry Farms

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Project Overview

The Nova Scotia fresh strawberry industry consists of approximately eighty commercial growers producing more than six million quarts annually. In 2016, Statistics Canada reported (Statistics Canada. Table. 001-0009) Nova Scotia strawberry production on 246 fruiting hectares (600 acres). Most of these acres have been part of a tight strawberry rotation for over thirty years. A practice that is similar across Canada and has resulted in ever-increasing soil-borne disease pressure resulting in decreased yields and profitability. As a result, many berry operations going out of business or down-sizing.

Like many other farms, the incidence of soil-borne disease in Jackson Lore's strawberry cropped fields were increasing year-to-year, significantly impacting plant health and overall yield. Response to these soil diseases requires expensive soil treatment, and/or increasing crop rotation periods, rendering his land unsuitable for strawberry production for multiple years. Soil-based strawberry production also requires significant time weeding and/or applying herbicide to optimize crop growth. The berries produced in a soil-based system may be dirty as well, which is less appealing to the U-pick customers many farms depend on. Growing in soil can limit the market potential of many operations, and in 2020 Lore Strawberry Farm decided to convert one-third of their strawberry production land to a raised bed system with soilless substrate. The conversion to this system comes with many benefits including reduced root diseases, improved weed management, increased water and nutrient efficiency, and cleaner berries. The upfront investment is also significantly less compared to other soilless systems such as tabletops and greenhouse structures.

The raised bed soilless substrate system could be adopted by many commodity growers faced with similar production challenges. One of the challenges with this production system is the high cost of substrate (soilless media), as much of the substrate currently used is imported from across the world. In recent years, local businesses have begun producing substrate which provides growers with a locally sourced, cost-effective solution. Little has been done to evaluate the performance of these local products against industry standards. This project will evaluate the Nova Scotia sourced substrate against other commonly used substrate, ultimately assessing its impact on strawberry yield and quality.

Project Objective

The objective of this project is to identify the most successful substrate for strawberry production at Lore Strawberry Farms. This project is unique because it allows for the validation of locally sourced substrate performance in a real-world setting. This will be determined based on:

- Plant performance
- Strawberry yield
- Substrate cost

Materials and Methods

i. Trial Site

This trial took place on Lore Strawberry Farms, located outside of Shelbourne Nova Scotia.

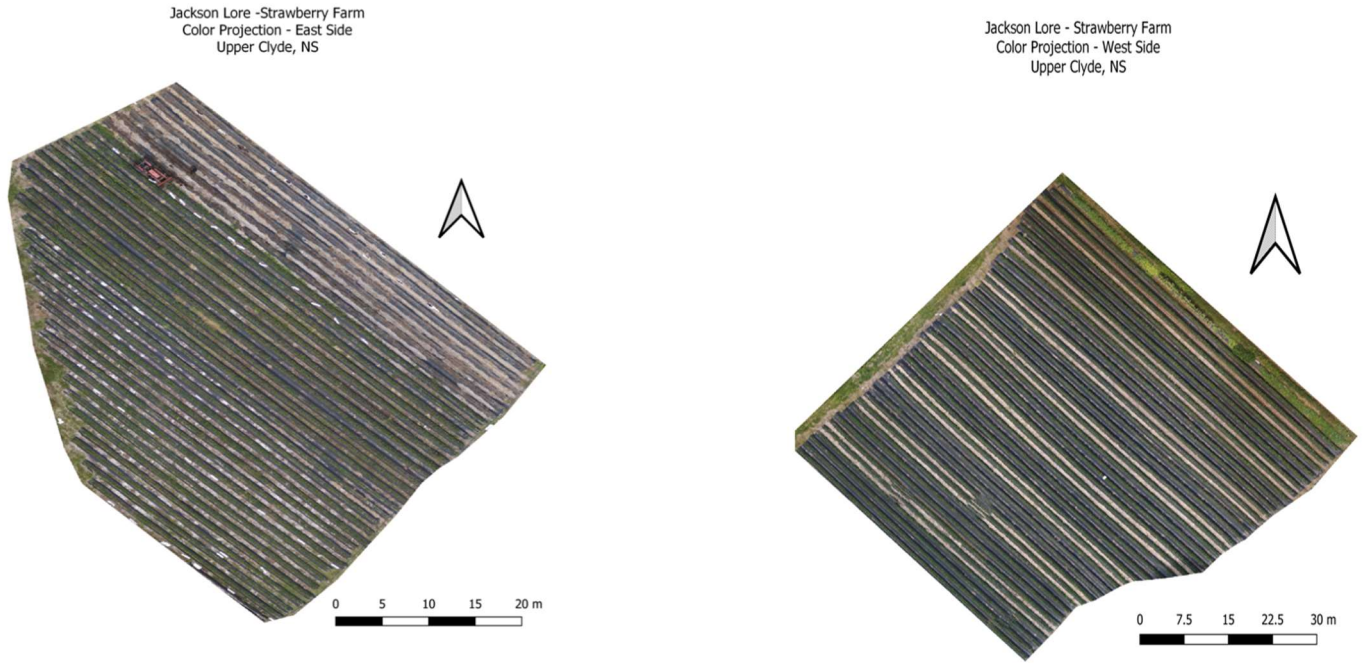

Figure 1. An aerial photo of the raised substrate beds at Lore Strawberry farms. The image on the left shows the East side of the farm, and the image on the right shows the West side. Scales and compass arrows are included for spatial reference.

The raised substrate beds were planted in May of 2020 and 2021 with bare root or tray plants (depending on variety). Planting occurred on a site located off Upper Clyde Road outside of Shelbourne, NS (43.8515, -65.5132).

ii. Treatment List

Two June-bearing strawberry varieties were selected to assess the impact of substrate on production success (Table 1). Bareroot Evelyn plants installed in 2020 make up treatments #1 and #2. The second variety highlighted in this study is Jewel, which was planted as a tray plant in 2021. Due to inconsistencies in source plant (bareroot versus tray plant) and planting year, the different substrates were evaluated separately and not able to be compared.

Table 1. A list of the treatments to be included in the raised bed substrate trial at Lore Strawberry Farms

Treatment #	Planting Year	Variety	Plant Type	Substrate
1	2021	Evelyn	Bareroot	Peat + Coir Mix
2	2021	Evelyn	Bareroot	Peat + Coir + Perlite Mix
3	2020	Jewel	Tray plant	Peat + Coir + Perlite Mix
4	2020	Jewel	Tray plant	Pine bark + Peat Mix

iii. Data Collection

Three 10-foot experimental blocks were laid out within each treatment to assess plant performance. These blocks were harvested on three occasions through the peak of their production periods. While June-bearing strawberries are continuously harvest for three to four weeks, three strategically placed picking dates are sufficient to capture the differences that exist between the listed treatments and draw conclusions.

In addition to assessing yield, plant tissue and substrate samples were submitted for nutrient analysis (Appendix A). Substrates differ when it comes to their baseline nutrition, and it is important to consider the interactions that take place between fertilizer inputs and growing media when discussing plant performance. The relationship between poor performance and unsuitable nutrient levels in the substrate could account for differences observed through treatment analysis. The tissue samples submitted for nutrient analysis will give an indication of the plant health when grown in a particular substrate. Tissue samples will showcase what nutrients were actually taken up by the plant through the growing season.

One of the biggest differences across growing substrates is the composition of particle sizes within the media. Samples of each substrate were submitted to an analytical lab in Prince Edward Island (see Appendix B) to comment on the distribution of particle sizes within each media. This information will give feedback on the water holding capacity, as well as the drainage capacity, of each substrate, which directly impacts plant health and overall yield.

iv. Statistical Analysis

The trial was set up as a Replicated Block Design, where each treatment was replicated three times within each block of growing media. For this growing season, we will only be completing statistical analysis on the yield. At the conclusion of the project, substrate particle size distribution and nutrient results will also be analysed. Results collected from the trial were run through an Analysis of Variance (ANOVA) to determine significant differences between the treatments with a 95% confidence interval ($p<0.05$).

Results and Discussion

The first year of substate comparison illustrated the impact of different substrates on plant production in two different varieties. Given that the varieties tested were planted in different years, the two varieties were analyzed separately to remove any variability induced by plant age and plant type.

Based on the analysis of the replicated block design (Table 2), there was no significant difference in the performance of Evelyn bareroot plants across two different growing mediums: 1) peat + coir mix, and 2) peat + coir + perlite mix. When plant performance is similar across different base materials and various combinations, substrate source and cost per acre can play a larger role in the decision process of selecting the ideal growing media to be used on farm. Perlite is an expensive, inorganic additive used to increase the porosity in the substrate. It is not produced locally and can be difficult to deal with in the long run as it does not decompose over time. These results are promising to show that the addition of perlite has not resulted in better plant performance and could be excluded from future grow mixes. The exclusion of perlite translates to a more cost-effective substrate, and a lower carbon footprint when examining the distance of products travelled from the manufacturer.

Table 2. A comparison of the average yield harvested across strawberry plants planted in each soilless substrate. Statistical analysis was run within plant variety, where the two Evelyn treatments were compared to each other, and the two Jewel treatment

Treatment #	Variety	Substrate	Average Yield (kg)	Standard Deviation	Treatment Probability (p value)
1	Evelyn	Peat + Coir Mix	1.300 a	0.555	0.726
2	Evelyn	Peat + Coir + Perlite Mix	1.470 a		
3	Jewel	Peat + Coir + Perlite Mix	2.363 a	0.189	0.0037
4	Jewel	Pine bark + Peat Mix	1.420 b		

The second June-bearing variety included in the study is Jewel. These plants were installed into the system in 2021 into two different base materials: 3) peat + coir + perlite mix, and 4) pine bark +peat. As shown in Table 2, a significantly higher yield observed in treatment 3 (peat + coir + perlite) compared to treatment 4 (pine bark + peat), with a less than 1% probability of seeing these results by chance. These substrates originated from different suppliers and see a different makeup when looking at the base material. Unlike coir, pine bark is relatively available across Nova Scotia, and involves a less harmful extraction process compared to peat. The combination of pine bark and peat was an attempt to lower substrate and shipping costs, as well as reduce the impact on the environment.

Based on the first year of testing, a general observation was made that in both varietal plantings, higher yields were achieved in the peat + coir + perlite treatment.

Next Steps

The 2022 trial will provide a second year of data to strengthen the results that were found during the first year. To increase the number of treatments and improve the statistical design, Perennia will assist Lore Strawberry Farm with field design in the 2022 newly planted treatments. Year two will continue to assess the overall yield harvested, substrate nutrition, and plant health to assist in the selection of the most suitable growing media for raised bed soilless substrate system in Nova Scotia. Conclusions will be presented in the final report following the second year (2022) of the trial.

Appendix A. Substrate nutrient analysis for the three substrates tested.

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Sample Number	Lab Number	pH	Lime Index	Total Organic Matter %	Phosphorus Bicarb ppm	Phosphorus P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Aluminum Al ppm
COIR/PEAT	**23113**	**5.1**	**5.7**	**72.5**	**18**	**33**	**172**	**435**	**835**	**52**

Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Sodium Na ppm	Nitrate-N NO3-N ppm	Soluble Salt ms/cm	Moisture %
8	**2.6**	**6**	**95**	**0.4**	**0.3**	**48**			

INTERPRETATION

CEC	Percent Base Saturation					Proportional Equivalents (meq)				Cation Ratio	
meq/100g	% BS	% K	% Mg	% Ca	% Na	K	Mg	Ca	Na	Mg/K	Ca/Mg
12.0	**70.0**	**3.67**	**29.81**	**34.79**	**1.74**	**0.44**	**3.58**	**4.18**	**0.21**	**8:1**	**1:1**
Optimum Range:		3 - 5	8 - 20	60 - 80		0.5 - 1.3				7:1	5:1

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Figure 2. The nutrient analysis results reported by A&L labs on the coco + peat substrate.

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Sample Number	Lab Number	pH	Lime Index	Total Organic Matter %	Phosphorus Bicarb ppm	Phosphorus P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Aluminum Al ppm
COIR/PART/ PERLITE	**23111**	**5.4**	**6.3**	**51.5**	**4**	**8**	**67**	**476**	**1192**	**49**

Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Sodium Na ppm	Nitrate-N NO3-N ppm	Soluble Salt ms/cm	Moisture %
4	**0.8**	**4**	**64**	**0.4**	**0.2**	**27**			

INTERPRETATION

CEC	Percent Base Saturation					Proportional Equivalents (meq)				Cation Ratio	
meq/100g	% BS	% K	% Mg	% Ca	% Na	K	Mg	Ca	Na	Mg/K	Ca/Mg
11.4	**89.4**	**1.51**	**34.45**	**52.45**	**1.03**	**0.17**	**3.91**	**5.96**	**0.12**	**23:1**	**2:1**
Optimum Range:		3 - 5	8 - 20	60 - 80		0.5 - 1.3				7:1	5:1

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Figure 3. The nutrient analysis results reported by A&L labs on the coco + peat + perlite substrate.

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Sample Number	Lab Number	pH	Lime Index	Total Organic Matter %	Phosphorus Bicarb ppm	Phosphorus P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Aluminum Al ppm
BANK/PANT	**23109**	**4.6**	**5.2**	**78.1**	**40**	**104**	**164**	**798**	**1546**	**72**

Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Sodium Na ppm	Nitrate-N NO3-N ppm	Soluble Salt ms/cm	Moisture %
13	**5.6**	**97**	**116**	**0.2**	**0.3**	**38**			

INTERPRETATION

CEC	Percent Base Saturation					Proportional Equivalents (meq)				Cation Ratio	
meq/100g	% BS	% K	% Mg	% Ca	% Na	K	Mg	Ca	Na	Mg/K	Ca/Mg
20.5	**72.7**	**2.05**	**32.05**	**37.75**	**0.81**	**0.42**	**6.56**	**7.73**	**0.17**	**16:1**	**1:1**
Optimum Range:		3 - 5	8 - 20	60 - 80		0.5 - 1.3				7:1	5:1

S8*

Figure 4. The nutrient analysis results reported by A&L labs on the pine bark + peat substrate.

Appendix B. Substrate particle size distribution analysis for the three substrates tested.

Table 3. Substrates were submitted to a lab in PEI for particle distribution analysis (e.g., >4mm, represents the proportion of the media that did not pass through the 4mm sieve; 2-4 mm represents the proportion of the substrate that has a particle size

	Peat + Coir	Peat + Coir + Perlite	Pine bark + Peat
Sieve Size (mm)	**Particle Size Distribution**		
> 4	15.2	8.0	10.4
2-4	23.2	21.4	23.6
1-2	29.0	28.5	27.2
0.5-1	17.2	21.4	16.9
<0.5	15.4	20.7	21.9