

Exploring Feasibility of Softwood Compost as an Alternative to Peat Moss for Propogating Blueberries

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**Community Based Research Project #6045 - Exploring Feasibility of Softwood Compost as
an Alternative to Peat Moss for Propagating Blueberries
Final Report**

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ERST 3160H: Community Based Research Management

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Introduction

Belonging to the family *Vaccinium*, blueberries are a calcifugal perennial plant that are known for their antioxidant properties as well as being a popular snack on a summer day

(Worthey, 2015). Blueberries have a wide variety of consumer uses; they're certainly good on their own, but they also keep well compared to other berries, and can be frozen for use in pies, jellies and jams (Bratsch, 2009). Blueberries are a popular choice for smaller scale farms, including Wilson's Fresh Blueberries. Like many other blueberry farmers, Wilson's has been using peat moss for initial propagation of the plant. Peat moss is a popular medium for this, as it's naturally high acidity and porous texture complement blueberry growth well (Worthey, 2015). Peat moss has been a topic of discussion recently, as peat bogs are known as a carbon sink, and the harvesting practices associated with agricultural peat release a lot of this carbon back into the atmosphere (Schilstra, 2001). For this reason, in addition to the rising cost of peat moss, there is a movement in the blueberry industry to try and shift away from peat as a propagation medium, and thus the search for a worthy alternative begins. Softwood compost jumps out as an early obvious choice. Softwood trees share blueberry's acid loving nature, and so are often a common alternative to peat moss (Worthey, 2015). Wilson's Fresh Blueberries is among the farmers making the switch, so this study aims to gain a better understanding of the care for blueberries using softwood compost as a propagation medium. Challenges include; achieving appropriate pH in the soil, achieving a sufficient volume of compost within a reasonable time span to consistently meet demand, and determining nutrient deficiencies that need to be addressed in the new medium.

Peat Moss and its Impacts

Peat moss is said to be a regenerative resource, as seeds are sometimes planted after harvest and extraction. However, some layers of the peat bog that are extracted can be over 8000 years old, making that peat extremely rich in nutrients (Schilstra, 2001). Although efforts to initiate regeneration of the material may be practised, it can be assumed that this practice is not

exactly reasonable to claim as renewable energy if it would take many generations for that material to regenerate back to the state it was harvested in. Peat bogs are known to be net carbon sinks, meaning that they effectively store large amounts of carbon. Research shows that depending on the thickness and layers of peat, up to 20 years of “pulse” CO₂ can be released from a peat bog when the peat material is harvested (Schilstra, 2001). The operation of mining for peat from bogs in remote areas is exceptionally costly on the environment. The loss of a great carbon sink combined with using this non-local resource can have devastating impacts on the climate. The act of transporting goods to and from remote places not only increases carbon outputs, but can also impact local ecosystems, like the devastation of a peat bog. By comparison, Poplar, a soft wood, takes 40 years to regenerate to the state in which it was harvested, making it more sustainable than peat (Schilstra, 2001). Softwood is an alternative that is more likely to be locally available, and it is even possible for it to be obtained as a waste by-product from local operations. Utilising waste products is essential in reducing the need for extracting more resources directly from the Earth. In addition, while peat moss can be regenerated, the peat mining process contributes to biodiversity loss and ecosystem devastation (Schilstra, 2001). With softwood, there is potential to get even more use out of the already harvested local product, and with peat, there is potential to devastate an entire complex wetland ecosystem.

Lindsay's Landscape

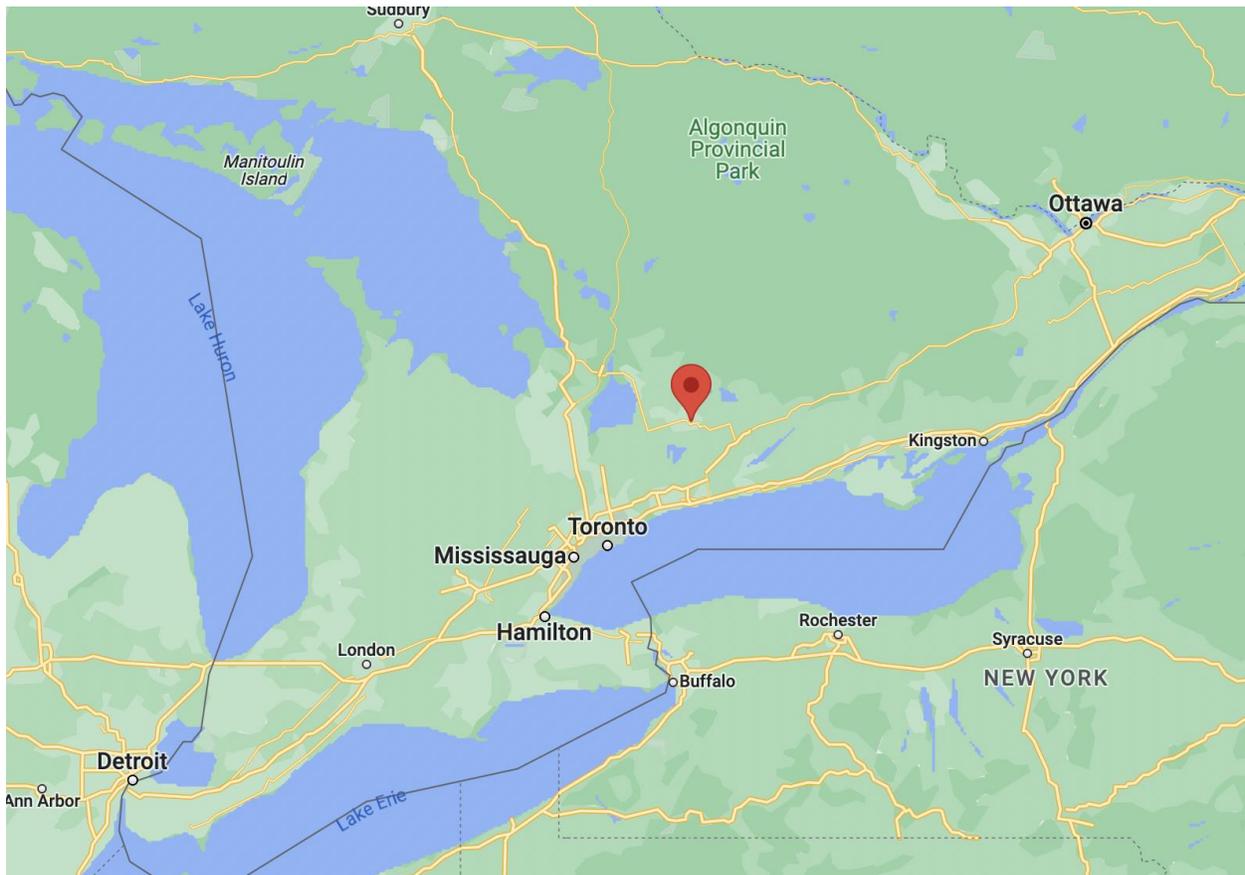


Figure 1: General Location of Lindsay, Ontario (Source: Google Maps).

Wilson's Fresh blueberry farm is located near Lindsay, Ontario. Lindsay is characterized by agricultural practices and the Scugog River that flows right through town, connecting the Trent Severn Waterway and Sturgeon Lake (Francis, 2015). The soil type located in Lindsay is clay loam. The specific materials this clay loam is composed of are calcareous lacustrine clay on top of stony till (Soil Survey of Victoria County, 2013; Gillespie & Richards, 1957). This particular type of soil is often prone to poor drainage. The topography of Lindsay is level with no major fluctuations in elevation. Surface soil reaction is alkaline and has few stones (Soil Survey of Victoria County, 2013). Lindsay belongs to the larger soil group of dark grey gleysolic soil, which is characterized by saturation as a result of poor drainage (Gleysolic, 2020).

Background on Composting

The principles of composting regard the breaking down of natural materials to enhance and create a completely new and unique type of soil rich in nutrients (Trautmann & Richard, 1996). Compost is used in agricultural settings to improve growing conditions and therefore increase the production of nutritious crops. It is used to make up for missing nutrients in the existing soil in a particular landscape. Unfortunately, compost is not always the most accessible or affordable option for farmers growing on large plots of land with many rows of crops. This is because compost takes a lot of time, energy, and resources to create. It can take months to cook, and much trial and error to get the batch to a precise heat without destroying essential nutrients (Trautmann & Richard, 1996). The resources available to create compost can be limited to farmers, and outsourcing the product from composting companies is not economically feasible for the amounts needed during a growing season.

One of the most important aspects of the composting process is having proper ratios of materials in order to ensure a sufficient yield of necessary nutrients. The Carbon to Nitrogen ratio in a compost pile is imperative to its effectiveness in growing crops. This ratio is crucial because nitrogen and carbon are required for the process of microbial decomposition (Compost Chemistry, 1996). Compost is made up of “greens” Nitrogen-rich organic material such as green waste - and “browns” - Carbon rich organic material such as wood (Trautmann & Richard, 1996). Carbon is responsible for providing energy and nitrogen for proteins, nucleic/amino acids and enzymes needed for growth and function of microbial cells (Compost Chemistry, 1996). Depending on how much of each element is available, these ratios might need to be adjusted in a composting mix (Richard, 1996). For instance, materials like wood typically have a high carbon content, and therefore the amount of softwood going into a compost mix would need to be

measured based on a proper carbon-to-nitrogen ratio (Richard, 1996). Additionally, when the physical particles of organic materials are small in size, they may degrade faster than those larger in size (Richard, 1996). The typical ratio is 30:1 parts carbon to nitrogen, so if materials added are high in carbon more nitrogen may need to be added (Compost Chemistry, 1996). Minerals essential to this microbial decomposition include phosphorus, potassium and trace minerals (Compost Chemistry, 1996). In the context of this research project, limestone bedrock in the region gives local soils a calcium and magnesium rich profile (Limestone Soils, 2020). It would be most ideal to source local supplies and organic materials and waste to decrease cost whilst keeping the production process local. One of the options available to Wilson's Fresh Blueberries is the use of softwood in compost in the form of woodchips.

Softwood Composting Process

With regard to the Carbon to Nitrogen ratio (C:N) in the soil, research suggests that complete decomposition of wood chips is not feasible within a reasonable amount of time (Klickitat County 2023). Instead, approximately $\frac{1}{3}$ of any individual wood chip can be expected to be composted within a 3 - 6 month period. This needs to be taken into account when calculating the C:N ratio, as only $\frac{1}{3}$ of the nitrogen expected will be available for uptake by the blueberries (Klickitat County, 2023).

When creating a compost pile, an integral aspect is understanding how much mass will be left over once the pile has finished the decomposition stage and is ready for agricultural usage. Oftentimes getting specific measurements of mass and volume of a compost pile is only achievable with specialized scientific equipment and knowledge (Breitenbeck & Schellinger, 2004). Studies for small scale commercial composting operations have been conducted to help address information gaps and aid small-scale farmers in understanding how much mass reduction

will occur in their compost pile. This study found that wood chips, when composted in windrows, see a 12.9% loss in mass and a 36.7% loss in volume (Breitenbeck & Schellinger, 2004). This study measured volume and mass loss over a span of 100 days, which is just over 3 months of decomposition. One aspect that aids in decreasing mass and volume loss within compost is the inclusion of non-volatile solids, or NVS. These solids are materials that do not get broken down during the decomposition process unlike organic matter. Examples of NVS include mineral materials, salt, sand, calcium and iron (Nonvolatile matter, n.d.). If more NVS are added to a compost pile, the decrease in mass and volume will be less significant since these materials do not biodegrade along with the volatile solids and organic matter.

While this experiment was conducted on windrow compost piles, it is expected that similar results will be shown by a static pile of compost (Brodie et al., 2000). Both windrow piles and static piles have their benefits and drawbacks, but this operation at Wilson's Fresh will see static piles as the most feasible option due to them being the least complex to create and do not require an excess of materials. Given that these values for percentage of mass lost are based on a 100-day period, we can extrapolate to conclude that the longer a compost pile is left to decompose, the more mass will be lost and therefore the lower yield retained.

Biochar

Biochar has become increasingly recognized as a potential additive or stand-alone compost material due to its chemical and nutrient properties. Biochar is obtained when organic material has gone through pyrolysis, which is when it's burned between 300 and 1000 degrees Celsius with little to no oxygen (Biochar, n.d.). The result is a charcoal-like substance that has a high carbon content. When used in composting, biochar can improve overall compost performance; enhance diversity and activity of microbes that break down compost; improve

nutrient retention; and immobilize toxic materials and PTM's (potentially toxic metals); and greenhouse gas reduction due to carbon sequestration (Antonangelo et al., 2021; What Is Biochar?, 2021). However, biochar can also negatively impact the composting process by causing soil degradation and compaction, which will affect the overall yield from crops (What Is Biochar?, 2021). If biochar is to be used in compost, it produces the best results when mixed with organic material that is high in nitrogen before being added to the rest of the compost pile (Practice Guideline, 2018). Although biochar can reap some helpful benefits, it adds to the overall complexity of making a compost pile due to its involute properties. It is recommended that the possibility of adding biochar to compost be noted for later consideration to avoid adding another layer of complexity to creating a viable compost pile at Wilson's Fresh.

Speeding up Decomposition

A multitude of actions can be taken to help speed up the decomposition process of softwood compost. There are several factors that come into play when breaking down compost, namely: heat, moisture, aerobics, pile size, and enclosure. Of those variables, heat is the most integral in the decomposition process.

Heat

Compost piles, when mixed well and composed of the right organic materials, will range between temperatures of 43 and 71 degrees Celsius (McLaurin & Wade, 2009). Creating a pile that reaches these temperatures at the core will greatly aid in speeding up decomposition. One way to heat a compost pile is by covering it in plastic, such as a tarp. The two main types of plastic used in heating compost are clear and black polyethylene. While both types help insulate soil and generate heat within a compost pile, they both reap different benefits. Black plastic is

particularly helpful with moisture retention and helps eliminate weeds and microorganisms (Pros and Cons of Using Plastic Mulch, 2018). Black plastic is also helpful in heating compost piles during the colder winter seasons. Clear plastic allows for more solarization to occur, since the rays of the sun will be directly hitting the organic material (Stapleton et al., 2019). Clear plastic is not as effective in preventing weed growth (Pros and Cons of Using Plastic Mulch, 2018). Thickness of the plastic tarp should also be taken into consideration. Thin plastic, around 1mm, provides greater heat but is also susceptible to tears from weather events and animals. 1.5 – 2mm plastic is better for areas that experience more wind and other weather events. Thick plastic, thicker than 4mm, is best used in cases where the pile of compost is relatively small (Stapleton et al., 2019). Since the compost on Wilson's Fresh is expected to be broken down during the cold off-season, black plastic around 1.5 – 2mm thick would likely be the most beneficial in terms of increasing the rate of decomposition, given heat will be a limiting factor.

Moisture

In addition to heat, moisture is also an integral aspect of breaking down mulch and compost. Low moisture levels not only slow down the decomposition process of softwood but can also lead to drastic temperature fluctuation that could result in spontaneous combustion and a ruined pile of compost (Cooperband, 2002). Keeping the pile of softwood compost moist will allow for the chips and mulch to break down faster since moisture allows for microbial activity to take place and begin the process of decomposition (Azim et al., 2018). The pile should just be damp, if it's too wet it will reduce oxygen flow and produce a foul odour (McLaurin & Wade, 2009). Optimal moisture content for a pile of compost lies between 45% and 60% in weight (Cooperband, 2002). Water should be added to the compost pile before it is covered by plastic and left to decompose. If the pile seems too dry, more water can be added by pouring it on top

before turning the pile once a month. It should be added in small increments to ensure the pile does not become too wet, which will ruin the compost. Moisture meters can be used to digitally measure moisture content within compost piles. If this is done, a meter with a long prong should be used to ensure accuracy due to the proposed compost pile being on the larger scale. Moisture content can also be measured manually with a sample of compost, a scale, and a container. The empty container should be weighed when empty before compost is added to it (Cooperband, 2002). This compost, which represents the wet weight, will then be dried in an oven over the span of 24 hours. The sample will then be weighed again to determine the dry weight. The equation for moisture content is as pictured, with \bar{n} meaning median of data:

$$\text{Moisture content} = 100 \times \left(\frac{\text{wet weight} - \bar{n} \text{ dry weight}}{\text{wet weight}} \right)$$

Figure 2: Formula for measuring moisture content in compost sample (Cooperband, 2002)

This process of measuring moisture content can be completed using the facilities on the Trent University campus in Peterborough. Additionally, it is possible to determine the amount of inorganic material present in our compost using an ash weight index, calculated by comparing the weight of the same sample used for determining moisture content before and after it has been dried in a furnace for a few hours at 550 degrees C (Whillans, Personal communication, 2023). Again, this process can also be completed in the laboratories located on Trent University's Peterborough campus.

Aerobics

When layering compost, it's important to keep the aerobics of the pile in mind, seeing as aerobic compost piles are much more likely to break down faster than anaerobic piles. Aerobic

simply means there is an ample source of oxygen to the composting material that will allow for bacteria and microbes to aid in the decomposition process (Cooperband, 2002). Larger chunks of mulch and bark allow for more oxygen but take more time to break down due to their size. The best way to create an aerobic compost pile with smaller wood chips and mulch is to place a layer of sticks and branches underneath the compost pile (McLaurin & Wade, 2009). The larger pieces of wood will allow for more oxygen flow to the mulch and will in turn result in a faster decomposition rate. This base layer of coarse material should be watered before the second layer is added. A 20 - 25 cm layer of softwood chips will then be added and topped with a 2.5 - 5 cm layer of fertilizer and soil. Figure 3 provides a visual for how a pile should be constructed.

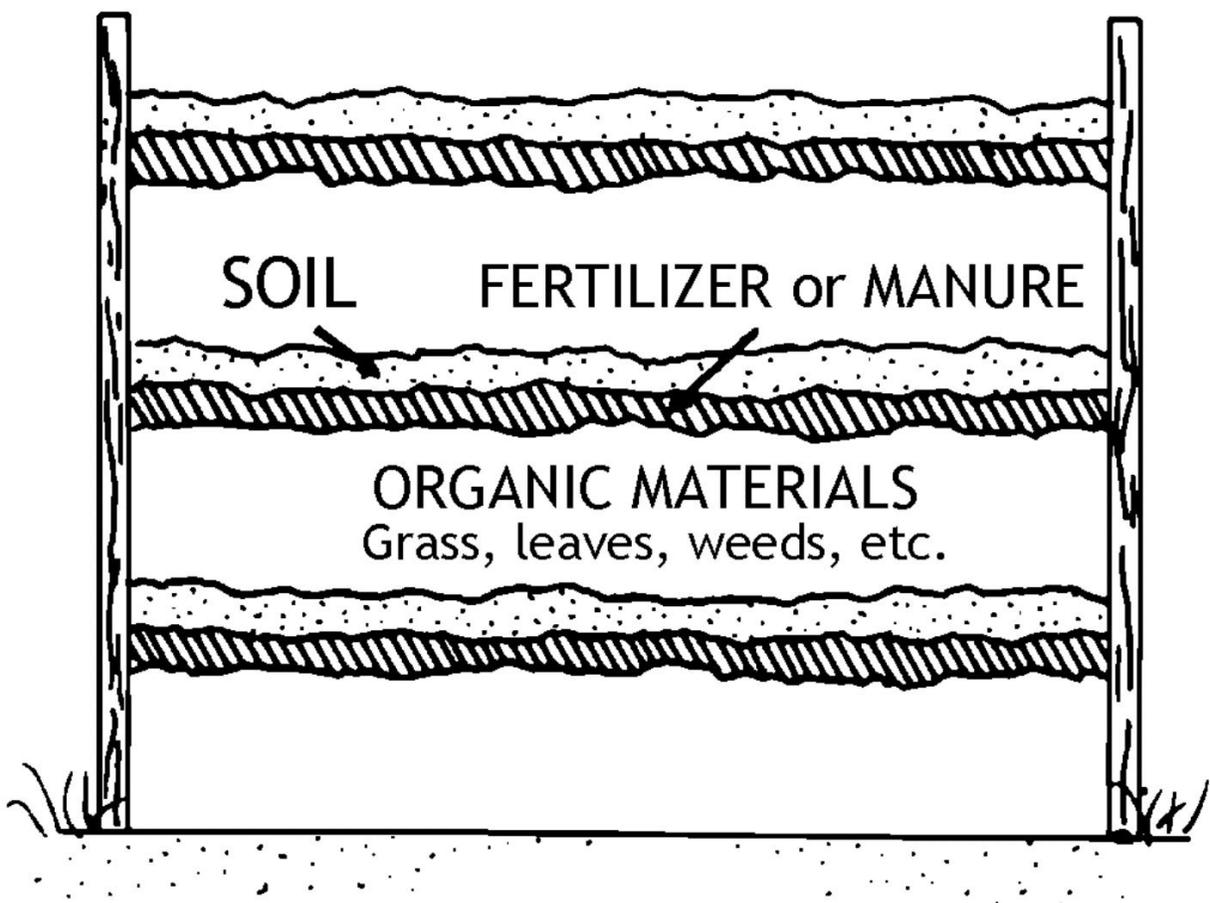


Figure 3: Optimal Layers of Compost Pile (McLaurin & Wade, 2009)

Size

Creating a sizable compost pile is what will allow for the decomposition process to continue through the off-season in the colder winter months. Smaller piles will not harbour enough heat to fully break down, so a pile of compost should range from 2.5 to 3.5 metres in height and 3 to 3.5 metres in width (Cooperband, 2002). Particle size is also important considering smaller softwood chips will break down faster. The mill located on site at Wilson's Fresh can be used to grind softwood down to the desired chip size, preferably between 2.5 to 5 centimetres (How to Compost, 2020).

Infrastructure

While not necessary, creating an enclosure for a compost pile can help with heat retention and decomposition speed. Simple enclosures can be constructed around a pile to aid in this process, however ensuring oxygen is still able to flow freely to the pile is integral. An enclosure can be constructed using chicken or hog wire wrapped around wooden stakes, which can be lined with plastic if smaller particles cannot be contained (Fact Sheet, 1977). Bricks can also be used, but they should be stacked with ample space left in between to ensure optimal air flow (Fact Sheet, 1977). Scrap lumber can also be used to construct an enclosure with spaces in between boards for air, but this type of enclosure is prone to decay (Fact Sheet, 1977). One side of the enclosure should remain open to allow for turning of the compost. A free-standing pile of compost covered with a plastic tarp will still decay, but an enclosure may help in speeding up the process if viable and done correctly.

Turning

Since the softwood pile will be decomposing in colder temperatures, it should only be turned once a month to ensure heat loss is kept to a minimum. Turning compost piles helps with air flow to the pile and ensures that particles located on the outside of the pile make their way to the centre in order for microbial processing to take place (Cooperband, 2002). A pile can be turned by using a shovel or pitchfork to turn the material inwards (McLaurin & Wade, 2009). There should be no odour arising from the pile when it is turned.

Timeframe

The timeframe from when a compost pile is started to when it's ready for use can vary depending on the characteristics of the pile. The aforementioned methods will greatly help in speeding up the decomposition as much as possible. It can be expected that it would take several months for the compost to become usable (How Long, 2020). A compost pile can be considered ready for agricultural use when it consists of smaller, crumbly wood chips that are damp to the touch and have a subtle wood-like scent (Composting, n.d.).

Case Studies

A review of blueberry propagation in softwood compost attempts yielded fruitful results. From a study of custom compost designed for Highbush Blueberry (*Vaccinium corymbosum L.*) we found that blueberries are known as calcifuges, meaning they grow best in acidic conditions (Sullivan et al., 2014). This makes the recommendation of softwood compost a common one, as softwood trees are known to be calcifuges as well. In fact, in a survey of blueberry growers in Georgia, 98% of farms surveyed used softwood compost as their primary propagation medium (Worthey, 2015). Of these farms, many also stated that they preferred not to wait for complete

composting of the softwood to occur because of the time and volume reduction associated with complete composting, stating they still see adequate growth, which is supported by literature (Krewer and Cline 2003). Alternatively, these farms purchase their material from a company that manufactures it. The purchase of manufactured compost reduces waiting periods and ensures consistent nutrient levels across all batches. In a study conducted on blueberry propagation in compost amended media, the researcher found that softwood compost is not as effective a growth medium for blueberries when compared to the control: peat moss. This study measured the pH of the soil which revealed all samples to have pH levels from 6.29 - 7.79, with peat moss being the most acidic (Worthey, 2015). These values are all well above the ideal growing conditions of blueberries, usually from 4 - 5.5 (Sullivan et al., 2014).

Given that pH has been cited as the most important factor in blueberry growth it should come as no surprise that the blueberries grown in the medium with the lowest pH will do the best (Sullivan et al., 2014; Worthey, 2015; Jiang et al., 2019). Worthey (2015) noted that elemental sulfur can be added to the growth medium to lower the pH while also increasing magnesium uptake, availability of essential nutrients, and electrical conductivity. Nitrogen deficiency was encountered as an issue under acidic conditions, however Sullivan et al (2014) found that addition of nitrogen up to a total of 20g/kg is enough to provide the blueberries with essential nutrients without raising the pH beyond ideal levels. Best practices for blueberry propagation include well drained soil, with plenty of pore space (Krewer and Cline, 2003). A material called perlite is often used in agriculture to increase pore space in soils. Perlite is a volcanic rock that is known to expand to up to 20 times its original size when exposed to high heat. This “popping” process makes perlite popular in agricultural soils to improve pore space and water retention, without decreasing thermal conductivity (Maxim et al., 2014). For these reasons, perlite is

commonly used as a component of blueberry propagation media, often seen alongside peat moss and softwood compost. (Worthey, 2015;Jiang et al., 2019;Krewer & Cline, 2003;Saha, 2016).

Discussion and Conclusions

Research suggests that although peat moss is a viable propagation medium for blueberries, peat alone is not enough to reach ideal conditions for blueberries. It often sees the addition of perlite, sulphur, and nitrogen to achieve the desired pore space, acidity, and nutrient levels respectively. With this in mind, the shift to softwood compost appears viable, with demonstrated success in some regions. Although softwood compost is not as effective as peat moss on its own, it has comparable success. With some amendments, softwood compost has the capacity to be an effective propagation medium for blueberries. These amendments will not differ much from those already practised with peat moss propagation techniques, save for slightly more of each ingredient being needed.

Although it is possible to propagate blueberries in softwood compost from a biological perspective, that is to say softwood compost has all the necessary characteristics,, the same cannot necessarily be said from a business perspective. Before it can become ‘compost’ the organic material first needs to decompose, which takes time. The amount of time to achieve suitable compost varies depending on a number of factors including but not limited to; temperature, moisture level, and air flow (McLaurin & Wade, 2009). The time factor is possibly the biggest that distinguishes peat from softwood compost, as purchased peat can be used immediately while compost created on-site must be prepared in advance in sufficient quantities.. With this in mind, efficient blueberry growth models need to include time for composting, ideally in the off season, when things aren’t growing. In order to provide an adequate environment for composting during the winter, when natural conditions are far from ideal,

infrastructure will be needed in the form of an insulated compost pile that can continue the composting process year-round, to ensure a consistent supply, with a reliable reserve.

Alternatively, a consistent supply of compost could be obtained from a third party, negating any cost-savings benefits of switching to on-site composting.

	Peat Moss	Softwood Chips
Cost	\$12.00 per 62297.1 cu. cm (Home Hardware)	\$10.00 per 79287.2 cu. cm (Home Hardware)
Availability	Old-growth ecosystem, regeneration can take hundreds of years	Local commercial operations; mills, arborists, - Softwood compost readily available
Upkeep/Maintenance	Readily available in mass quantities at stores, can be used right away	Gathered and processed locally, several month process time
Environmental Impact	Carbon sink, complex wetland ecosystem - Losing this can result in biodiversity loss and carbon sequestration loss.	As a waste by-product, it is not causing additional harm to the environment - makes use of the natural materials that have already been gathered, rather than being discarded.

Figure 4: Comparative Table for Peat Moss and Softwood

Future Research

Using softwood compost as an alternative to peat moss for blueberry propagation is certainly feasible as we've outlined above. That being said, more research should be done in the form of application of these methods, especially in the region this study is focused on. This research will not only provide Wilson's Fresh blueberries with concrete information straight from their own property, but also serve to add to existing studies on the topics of composting and berry propagation techniques in the area. This research should take the form of seeing these

methods in action and monitoring the plants' response to different types of compost amended media under a variety of conditions including but not limited to; temperature, moisture, pH, and nutrient availability.

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