Soil Organic Matter and Carbon Potential of Christmas Tree Lots

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INTRODUCTION

Nova Scotia is known for its reputation growing quality Balsam fir (*Abies balsamea*) trees, and our very own Lunenburg County is home to the Balsam fir Capital of the world. Christmas trees are an important factor to agriculture in Nova Scotia. This industry provides local jobs and drives rural economies. Nova Scotian growers harvest over 1 million trees annually. In 2017, over 300,000 valued at over 7 million dollars, were exported to countries such as Aruba, Panama, Thailand and many more (Statistics Canada, 2017).

Balsam fir is a prolific tree that is native to Nova Scotia. Its distribution spans the maritime provinces to Alberta, as well as into the United States from New York to Minnesota (Frank, 1990). Fir is a resilient species and is known to grow in a variety of conditions from harsh to fertile environments. It is important to manage stands for proper conditions to achieve quality trees within a shorter period of time.

Both trees and the soil they grow in hold the capacity to sequester carbon. Although trees themselves can hold carbon, if managed properly, soil has potential to be a large carbon sink. Soil can contain up to four times the amount of carbon that plant biomass can store, making Christmas tree lots an ideal focus for soil carbon management. Agriculture in Nova Scotia is being faced with the challenge of climate change and how to mitigate its effects on various industries. A large area of our province is occupied by Christmas tree lots and maximizing soil carbon within these areas could help offset rising atmospheric carbon (Chapman, 2008). Farmers can mitigate carbon emissions on their farms by employing sustainable management techniques that both produce quality trees and increase soil carbon storage potential. Management strategies that maximize plant growth and minimize carbon loss and emissions will result in greater carbon storage potential of soils. This paper will focus on management practices intended to maintain and increase soil carbon potential within Christmas tree lots.

MANAGEMENT

Management of Christmas trees differs greatly from other crops grown in the province. *Abies balsamea* are a woody perennial species, that require many years of attention before they become a marketable tree. Balsam fir has a cropping cycle of 5-7 years depending on the desirable tree size (Christmas Tree Growers Manual, 2021). Proper

management techniques can greatly shorten the trees growing period. Management includes maintaining appropriate soil pH and fertility, management of pests, shearing, maintaining density of trees and numerous other factors. Christmas trees can be considered a no-till crop since site disruption rarely occurs after lots are established. Natural lots are derived from forest cut overs and plantations are established in retired fields. In Nova Scotia, the majority of Christmas tree lots are derived from natural stands and therefor management strategies will target such growing conditions.

Growth of Abies spp. is optimized when soil conditions, climactic factors and other site characteristics are favorable. Factors of soil include texture, moisture and drainage, pH, and nutrients. Influences of climate include annual temperature, frost hazard and coastal exposure. Important site characteristics include direction and degree of slope, landform configuration, surface and subsurface stones as well as pests (Christmas Tree Growers Manual, 2021). Podzolic soils span across the province and differ greatly in texture and drainage. Nova Scotia soils are known to be naturally acidic with relatively low organic matter (Sangster, 2018). From experience, the soil texture in Christmas tree lots is predominately clay to sandy loam. Balsam fir prefer well drained soils, and do not like what is referred within the industry as 'wet feet.'

Among the most important management strategies include maintaining soil organic matter, pH, and fertility management. These factors can greatly influence the length of the cropping cycle as well as the quality of the tree and ability of the soil to store carbon. Organic matter within the litter, fermenting and humus layer, as well as within the mineral soil helps maintain soil moisture and hold nutrients. A soil organic matter content of above 4% is optimal for Christmas tree lots and seedling establishment (Woodworth, 2021). Balsam fir grows best on soils with an acidity of 5.5 – 6.5 but can still grow moderately outside of this range. Maintaining the right pH level will optimize nutrient update of balsam fir trees. Both pH and magnesium can be maintained by application of dolomitic lime (Woodworth, 2021).

The main nutrients focused on for balsam fir include phosphorus, potassium, nitrogen, as well as calcium. Phosphorus is important to seed germination in lots that regenerate naturally and root development for both naturally established and planted trees. Optimal phosphorus within lots is 56 kg per hectare. Potassium supports growth of trees as well as disease resistance. It is recommended to maintain potassium at 225 kg per hectare for favorable results. Nitrogen improves growth rate, as well as maintains the sought after dark green color of a quality Christmas tree. Optimal soil nitrogen based on soil testing is 2% nitrogen (CTCNS, 2021).
Calcium facilitates the absorption of nutrients and increases the trees resilience to environmental stress and disease. Appropriate levels of calcium for balsam fir is at least 3 kg per hectare. Magnesium supports chlorophyll production and maintains color of trees. The optimal range of magnesium is 115-200 kg per ha within stands. Soil derived from parent rock such as shales and slates often have high fertility and have the ability to produce a 12-foot tree within seven years (Christmas Tree Growers Manual, 2021).

Potential organic carbon of soil depends on clay content, bulk density, soil depth and minerology. The attainable organic carbon depends on climatic inputs of rainfall, temperature, and solar radiation. Actual organic carbon of soil depends predominately on increasing plant productivity and soil management (Carson, 2021). With over 6 thousand hectares currently managed for Christmas tree production in Nova Scotia (CTV, 2019), there is a massive potential to increase carbon within soil. Soils in the southern Appalachian Mountains have been found to have a soil carbon biomass of 240 Mg per hectare (Chapman et al., 2012). The Christmas tree industry is a commodity we could address climate change with by slightly altering management techniques. There is currently little legislation that governs sustainable methods within the Christmas tree industry.

CARBON LOSS IN CHRISTMAS TREES

Tilling soil can lead to a significant release of carbon stored in the soil. In other cropping systems, 30-40% of carbon loss can be attributed to tilling (Murty et al., 2002). Since tillage may only be used in site preparation, it is not a management strategy used in established lots and can therefore be dismissed in this cropping system. Pesticides can heavily interrupt soil microorganisms, therefore resulting in significant carbon loss. Pesticides can also affect the efficiency of soil carbon sequestration (Gunstone, 2021). Insects, weeds, and fungi that are targeted by pesticide application, once dead and decomposing will release carbon back into the atmosphere (Bolin, 1970). Furthermore, even untargeted, and beneficial insects, plants and fungi can be killed by pesticide use, further exuberating carbon release.

The use of synthetic fertilizers may be the leading cause of greenhouse gas emissions in Christmas trees. Both the production and use of these fertilizers' releases carbon into the atmosphere. The production of these products uses an obscene amount of fossil fuels, but often do not aid much in soil health. Soil health is important because although vegetation sequesters carbon, the potential of soil carbon storage is far greater (Bolin, 1970).

The use of machinery on farms is also a large contributor to greenhouse gas emissions and are used at mostly every stage of a Christmas trees rotation. This includes land preparation, vegetation management, harvesting and transporting trees (Farmer, et al., 2020). Often, these machines rely on fossil fuels to run, emitting pollution while being operated. The last factor of carbon loss in Christmas trees is harvest. After a tree is cut, it loses its ability to absorb carbon from the atmosphere. Once decomposition begins, that carbon is released back into the atmosphere (Mohanty, 2011). Alternatives for disposing of and repurposing trees after the holidays include mulching and composting, as well as biochar production (Anonymous, 2021).

OPPORTUNITIES FOR INCREASED CARBON STORAGE IN CHRISTMAS TREES

Since Christmas trees in Nova Scotia are primarily grown in natural stands, there is often no use for tilling the soil. Unless land is being prepared for establishing a plantation, road construction or drainage work, ground disturbance in Christmas tree lots is minimal. It is known that no-till systems result in healthier and more fertile soil, therefore increasing carbon storage potential (Karsenty et al., 2003). Reducing ground disturbance can in turn, increase the health of the microbial system within the soil. Reducing or eliminating the use of pesticides can keep microorganisms intact. Implementing integrated pest management practices can reduce reliability on pesticide use as well as pesticide resistance (Wray, 2008; Chase, 1995).

Maintaining proper tree density at 2500 trees per hectare and ensuring there is ground vegetation between trees helps protect the soil (CTCNS, 2021). Soil cover is important as it decreases soil erosion and helps maintain soil moisture. Employing the use of a cover crop that is able to fix nitrogen can reduce application rates and costs (Wray, 2008). Proper fertilizer use can be beneficial in a variety of ways, but fertilizer use should be regulated without complete elimination. Ensuring farmers are encouraged to use the 4R's that include; right source, right rate, right time and right place (Christmas Tree Growers Manual, 2021). More often than not, nutrients are applied incorrectly, by either the wrong nutrient mix or applied in excess. Alternatives to chemical nutrients include biochar, potash, calcite or dolomite lime, manure, and compost. Employing proper use of fertilizers can enhance their efficiency as well as save on costs.

There are numerous opportunities for Christmas tree growers to increase soil carbon storage within

their lots. By reiterating the importance of soil health by maintaining organic matter, pH, fertility, drainage, ground cover and lot density, growers have the information they need to begin managing for soil carbon and combatting climate change. Ensure the retailer provides a fresh cut (butt) and place the tree in room temperature freshwater.

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