Accumulation of Carbon by Christmas Trees

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There is a growing market for agricultural and forest products that are produced using sustainable or environmentally friendly production practices. This includes products that are certified as "environmentally green" based on the use of scientifically-based best management practices to those that are produced using certified organic production methods. More and more, people are asking about how much carbon is removed from the air and fixed by Christmas trees during a rotation.

As plants grow, they sequester carbon from the air through a process known as photosynthesis. This biochemical process takes place within chloroplasts inside needles or leaves. Sunlight provides the energy needed to drive this process which combines water (taken up by roots) with carbon dioxide (CO_2) (absorbed from the air) to make complex sugars called carbohydrates, the building blocks for growth. A byproduct of this reaction is the production of oxygen (O_2), which is released by the plant back into the air. Plants use the carbohydrates produced during photosynthesis to grow through a process known as respiration, which occurs in the dark as well as light. Unlike photosynthesis, respiration uses oxygen in the air to break down the carbohydrates to produce energy needed to combine carbon with various nutrients to produce the tissues and cellular structures needed for the plant to grow. This process results in the release of some CO_2 and water by the plant.

Limited carbon biomass accumulation information is available specifically for Christmas trees. In the Pacific Northwest (PNW), some biomass data are available for Douglas-fir Christmas trees. In one study, the total dry weight of biomass of a 5-foot-tall Douglas-fir tree averaged 10 lbs for branches and needles, 4 lbs for the stem and 4 lbs for the stump and roots (Landgren, personal communication). Although the carbon content of the biomass in this study was not determined, other studies would suggest that about 50% of the dry biomass is carbon (Schlesinger 1991). Thus the above ground portion of a harvested 5-foot-tall Douglas-fir tree would contain about 7 lbs of carbon. This is equivalent to about 5.8 tons of carbon per acre of trees planted on a 5' X 5' spacing. In addition, a little more than one ton of carbon per acre would be tied up in the root system that is left in the field. Similar biomass accumulation data are also available from a study of Fraser fir trees in North Carolina (Hinesley 1989). Based on this research it appears that a reasonable estimate of the carbon in harvested 6 to 7-foot-tall Fraser fir trees on a 5' X 5' spacing is about 12 tons per acre.

To provide growers with better estimates of the annual increase in the amount of CO_2 that is sequestered by trees, last fall we initiated a multi-state cooperative project to obtain biomass data for the major species of Christmas trees grown in the PNW, North Carolina, Michigan and Pennsylvania. These four regions produce almost 90% of all the Christmas trees harvested in the U.S. each year. Because Fraser fir is grown in most regions, we are collecting data on Fraser fir in all four regions. We are also collecting data on five other regionally important species (Table 1).

Within each region, trees of each species were sampled at 3 to 6 farms. To obtain information on the increase in biomass accumulation throughout a rotation, we sampled three trees from each of four size classes (2-3, 4-5, 6-7, and 8-9 feet) at each farm. The height, width, stem diameter and planting spacing was recorded for each tree. The trees were harvested and the stump and root system was then dug up. The branches and needles were then removed from the stem of each tree.

To determine the total amount of dry biomass of each tree, the three components (branches, stem and roots) were chipped and dried in an oven at 100C. A subset of these samples is currently being tested to determine how much the carbon content varies by species, farm and component. Upon completion of this analysis, the biomass data will be analyzed to determine if it is possible to use stem diameter or tree height to predict the amount of carbon that has been accumulated by different sizes of trees. Determining carbon accumulation rates throughout the rotation will provide accurate baseline information that demonstrates the value of tree production systems on carbon fixation. This represents an important step in documenting the environmental benefits of real Christmas tree production and use.

Table 1. Species of Christmas trees sampled in various production regions.

Region	Species (No. of sites sampled)					
	Fraser fir	Douglas-fir	Noble fir	Grand fir	Nordmann fir	Leyland Cypress
PNW	+ (4)	+ (5)	+ (5)	+ (6)	+ (5)	-
North and South Carolina	+ (5)	-	-	-	-	+ (5)
Michigan	+ (3)	+ (3)	-	-	-	-
Pennsylvania	+ (3)	+ (3)	-	-	-	-

Selected References:

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