Soils 101

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The Great Lakes region is seeing a surge of new interest in Christmas tree production. Growing quality trees that establish within a reasonable time can be a challenge even for experienced growers. However, understanding the soil characteristics of your farm can make this goal more achievable. Selecting the proper site and soil type or making modifications to your soil prior to planting can prevent many problems later in the rotation. Consider the following steps prior to planting to improve the success of your Christmas tree farm.

Photo 2: *High seedling mortality due to poorly draining area of field. Bill Lindberg. MSU Extension.*

Photo 3: *Planting Christmas trees into a raised bed system. Jill O'Donnell*

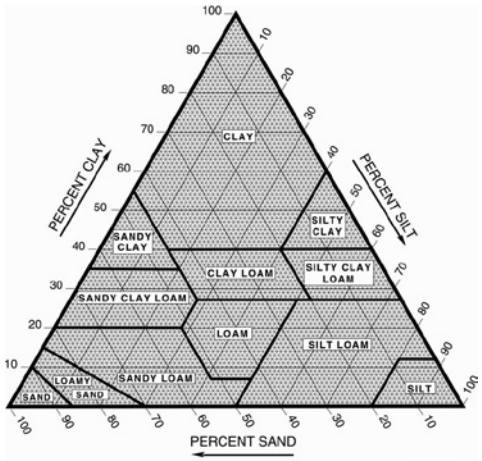

Photo 1: *Soil texture by soil aggregate distribution. International Society of Arboriculture , International Society of Arboriculture, Bugwood.org*

Location, Location, Location.

Some soils are ideally suited for Christmas tree production while others are not. In many areas of the Great Lakes region, soils are heterogenous and soil types can change dramatically within a short distance. Soils can be classified based on several properties. Soil texture, which describes the amount of different sized soil particles is useful to understand the suitability of a soil for tree production. Soil particles range from the smallest size, clays, to largest in size, sands. The distribution of these different sized particles determines your soil texture, which is classified as clay, loam, or sand (Photo 1). Many other soil properties will range dramatically based on soil texture. Clay soils have a high surface area to volume, and as a result can hold large amounts of water and nutrients. Sandy soils by contrast have a much lower surface area to volume and drain water and nutrients more readily. A well-drained loam soil is an ideal soil type for Christmas tree production. These soils have adequate nutrient and water holding capacity, but are also coarse textured enough to allow for sufficient gas exchange, root growth, and water drainage.

Poorly draining or heavy clay soils are often highly problematic for Christmas tree production. Trees in these soils exhibit poor growth, high mortality (Photo 2), and increased incidence of root rot diseases. Planting into these soil types should be avoided when possible.

If not possible, other management decisions could be implemented. Choosing a tree species that is more tolerant of these sites (pine or spruce versus a fir), adding surface or sub-surface drainage, or planting into a raised bed system (Photo 3) can help to alleviate some problems caused by heavy textured soils.

On the other end of the spectrum, light textured, sandy soils can also present challenges for quality Christmas tree production. These soils have very limited water holding capacity, making trees more susceptible to injury or death during drought conditions. Growers may consider supplemental irrigation to increase water availability in these areas. These soils also have limited nutrient holding capacity. Growers could consider split applications of fertilizer to reduce the leaching of nutrients through the soil. The addition of organic materials can also improve the suitability of sandy soils for production. Repeated incorporation of cover crops, mulch, manure, or wood chips can improve the organic matter content and increase the water and nutrient holding capacity of sandy soils (Photo 4).

To learn about soils at your farm, check the USDA web soil survey to identify your site's soil properties. From USDA web soil survey, highlight your area of interest, click the soil map tab, which will identify the different soil types present at your farm. To better understand each soil type, click on the map unit name. Two key parameters to look for in the soil series description are the soil drainage class and 'use and vegetation'. Sites that normally support uplands species (e.g., pines, oaks, sugar maple) are well-drained and better suited to most Christmas tree species than sites that are dominated by bottomland species, such as white-cedar. It is also valuable to make field observations prior to planting. Photos of an example field were taken after moderate rains and show difference in soil types between the somewhat excessively drained and somewhat poorly drained loamy sand soils (Photo 5).

Photo 4: *Addition of wood chips to Christmas tree planting. Bert Cregg*

Photo 5: *Difference in field conditions between excessively drained or poorly drained loamy sand soils. Bill Lindberg*

Soil testing: How to

In addition to the physical properties of the soil, consider submitting a soil test to manage the chemical properties of the soil. It is essential that the sample for a soil test is representative of the area as nutrient management decisions will be based on testing results. To collect a soil test, use a soil probe and a clean plastic bucket for collecting soil samples. Follow a zig zag pattern across your field, taking between 10 to 20 samples to a soil depth of 8 inches using the soil probe. Each sample should be taken directly perpendicular to the ground, not at an angle. Mix your probe samples together in the plastic bucket, then pour a uniform sample into a labeled, zip lock bag. Mail your sample and completed soil submittal form to a soil testing laboratory for analysis. Including as much detail as possible on the submittal form to help the laboratory make recommendations and for you to track changes to the soil sample results over time. Where possible, separate your submitted samples in areas with obvious differences in slope, soil type, or if there have been different past land uses such as pasture vs. grain crops vs. recently cleared woodlands.

Elemental sulfur rates based on CEC, target, and starting pH					
		Soil Cation Exchange Capacity (CEC)			
Target pH	Starting pH	1	5	10	15*
5.5	6.0	109	218	272	327
5.5	6.5	218	436	545	654
5.5	7.0	327	654	818	981
6.0	6.5	80	160	200	240
6.0	7.0	189	377	472	566
*Soils with CEC > 10 are resistant to change in soil pH and making an appreciable impact may be difficult					

Table 1: Elemental sulfur rates to reduce soil pH. Spectrum Analytic Inc.

Understanding your soil test

One of the most important aspects of your soil test results is the soil pH. Soil pH is a measure of soil acidity. At different soil pH levels, the availability of essential nutrients is altered. This impacts the ability of plants to absorb nutrients that are present in the soil. The optimal soil pH differs based on Christmas tree species, but in general should be near 6.0. If your soil is too high, application of elemental sulfur can reduce the soil pH. Elemental sulfur lowers the pH due to the activity of bacteria in the soil. This process may take 6 months to a year to take full effect, so planning with sufficient time for this process to occur is important. To determine the rate of application, look for the approximate starting and ending soil pH levels and the cation exchange capacity (CEC) of the soil (Table 1). The higher the CEC, the greater the buffering capacity of the soil and the more sulfur needed to lower the pH. Also, it is important to note that on heavy soil sites with a CEC of greater than 15, the amount of elemental sulfur needed may not be economically or realistically feasible to significantly lower the pH for Christmas tree production.

Conversely, some soils may be too acidic for tree production. In these situations, adding a liming material and incorporating into the soil is recommended prior to tree planting. There are many different liming products with differences based on purity, particle size, and nutrient

composition. Consider your starting soil pH, target soil pH, and soil buffer pH when deciding on rates of lime application (Table 2). Also note that different liming products are rated based on their effective neutralizing value (ENF).

If a soil test indicate that phosphorus or potassium are required, these elements are best applied prior to planting and incorporated. Phosphorus is a potential environmental contaminant as excessive applications can contribute to eutrophication of surface water. Therefore, applications should only be made if testing indicates the soil is deficient. To determine the rates of application, review the soil sample results and fertility recommendations. Check with your supply company on what phosphorus containing products they have available. Mono-ammonium phosphate (MAP) (11-52-0) is one of the most common products. To apply 25 pounds of P2O5, take desire rate of 25 and divide by 0.52, resulting in about 50 pounds of the MAP product per acre. Common granular fertilizer products containing potassium include muriated potash (0-0-60) and sulfated potash (0-0-50). Muriated potash has a relatively high salt index (high potential for fertilizer burn) and is often applied in the fall when rains are usually more frequent. For in-rotation or Spring application, sulfated potash is the desired choice.

Sample Lime Recommendations (tons/acre of 100%CaCO3)						
		Soil Buffer pH (BpH)				
Goal soil pH	Starting pH	5	5.5	6	6.5	7
5	4.5	6	4.7	3.3	1.5	0.5
5.5	4.5	8.4	6.4	4.5	2.6	0.7
6	4.5	10	7.8	5.5	3	0.9
6	5	8.4	6.4	4.5	2.6	0.7
6	5.5	-	4.6	3	2	0.5

Table 2: *Liming rates to raise soil pH based on original, goal, and buffer pH. Spectrum Analytic Inc.*