Soil Fertility Recommendations for Christmas Trees

Fact Sheet FS1187



Cooperative Extension

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Christmas trees are grown on about 6,300 acres in New Jersey. When plantations are established on fertile soil and properly managed, Christmas tree production can be a profitable business.

Christmas trees can be successfully grown on a variety of soil types, but well-drained, loamy soils are best for Christmas tree production. Careful management of soil fertility can improve tree quality and appearance, as well as shorten the number of years needed to grow a Christmas tree to market size.

Depending on species, site and management practices, it takes six to twelve years to produce a marketable Christmas tree. Crops with a long rotation like Christmas trees should never be grown without first knowing the initial soil fertility levels and correcting any apparent nutrient deficiencies prior to planting, as measured by a recent (within 6 months before planting) soil test. After trees are planted, it becomes exceedingly difficult to apply soil amendments and effectively incorporate them with tillage. Recommendations provided by this fact sheet are intended to encourage Christmas tree growers to apply most soil fertility inputs, with the exception of nitrogen (N), before planting. These recommendations are a synthesis of soil fertility research in New Jersey, and surrounding states, as well as from practical experience of commercial Christmas tree growers.

Although N is a critical nutrient for Christmas tree production, N recommendations are not based on soil testing. Plant tissue analysis, however, may be a useful tool to guide N applications (refer to The Plant Analysis Handbook listed in references). In the year of planting, N fertilizer is not recommended. Therefore, this fact sheet first discusses nutrient recommendations and soil pH management that are based on soil testing.

Recommendations for phosphorus (P) and potassium (K) vary depending on the initial soil fertility test level. Soil fertility levels are based on the Mehlich-3 soil test method and are defined for general crop production in Rutgers Cooperative Extension Fact Sheet 719, "Soil Fertility Test Interpretation", in terms of the following as soil test levels: below optimum (low, medium) optimum (high) or above optimum (very high). The soil fertility levels described as optimum in this fact sheet have been adapted to New Jersey soil conditions for general production of many Christmas tree species.

Soil pH and liming recommendations, however, are more species specific. The most commonly grown species for New Jersey may be grouped into two general soil pH preference categories. A target soil pH of 6.0 is recommended at time of planting for Norway spruce, Fraser fir, Canaan fir, Scotch pine, and white pine. For Douglas fir, blue spruce, and concolor fir the target soil pH is 6.5. Although these species may prefer, or can tolerate, somewhat lower soil pH levels, these target soil

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pH levels are recommended as starting points at initial planting time, since soil pH naturally decreases during the rotation. Application of fertilizer materials also slowly drives down the soil pH. Once trees have been planted nutritional amendments can only be applied to the foliage or soil surface; there is no opportunity to work amendments into the soil until the end of the rotation.

Liming Practice: Soil pH, Calcium (Ca) and Magnesium (Mg)

A regular liming program to maintain soil pH also supplies calcium (Ca) and magnesium (Mg). Using the relative soil test levels for Ca and Mg, select the appropriate liming material based on its Ca and Mg concentrations. The goal of the liming program is to maintain the soil fertility levels for Ca and Mg near the optimum range (as a percentage of the cation exchange capacity: about 60-70% Ca and 10-20% Mg) and to establish the desired soil pH level before planting a specific tree species.

The most commonly used liming material is limestone. Depending on purity, or the concentrations of Ca and Mg in the mineral, a particular limestone is commonly referred to as calcite (calcium carbonate) or dolomite (calcium magnesium carbonate).

Soil test-based recommended rates of liming materials are prescribed in pounds of calcium carbonate equivalent (CCE) per acre. The CCE provides a way of standardizing liming materials with different levels of purity. By definition, pure calcium carbonate has a CCE of 100%.

It is possible for a soil tests to reveal fields having a satisfactory soil pH level for a given tree species, but the soil test Ca or Mg saturation levels are less than optimum. Applying liming materials containing Ca and Mg is not an option, since this may raise the soil pH level even higher.

To raise the Ca soil test level without raising soil pH, apply 500 lbs/acre of gypsum for sandy loam soils or 1000 lbs/acre for silt loam soils. This is a calcium sulfate mineral that supplies plant available Ca and sulfur without raising soil pH. Gypsum is also a valuable amendment for improving soil drainage.

When Mg needs to be supplied without raising soil pH, apply a Mg fertilizer such as magnesium sulfate or potassium magnesium sulfate. The latter is a good choice when potassium fertilizer is also needed.

On strongly acid soils, limestone should be broadcast well in advance of planting Christmas trees. Rutgers Cooperative Extension Fact Sheets FS903, FS904, and FS905 provide additional information about liming materials, soil pH, soil fertility management, and making adjustments for liming materials of different quality and purity.

Table 1. Pounds of calcium carbonate equivalent (CCE) recommended per acre for Norway spruce, Fraser fir, Canaan fir, Scotch and white pine with a target pH of 6.0.

	Soil Texture			
Initial Soil PH	Loamy Sand	Sandy Loam	Loam	Silt Loam
4.1-4.4	4000	4300	4700	5000
4.5-4.8	3000	3300	3700	4000
4.9-5.2	2000	2300	2700	3000
5.3-5.6	1000	1300	1700	2000
5.7-6.0	500	600	800	1000
Above 6.0	0	0	0	0

Table 2. Pounds of calcium carbonate equivalent (CCE) recommended per acre for Douglas fir, Colorado blue spruce, and concolor fir with a target pH of 6.5.

	Soil Texture			
Initial Soil PH	Loamy Sand	Sandy Loam	Loam	Silt Loam
4.1-4.4	4500	5400	9800	116000
4.5-4.8	3600	4500	8100	9800
4.9-5.2	2700	3600	6300	8100
5.3-5.6	1800	2700	4500	6300
5.7-6.0	900	1800	2700	4500
6.1-6.4	500	900	1800	3600
Above 6.5	0	0	0	0

Phosphorus (P) andPotassium (K)

Conifers have the ability to develop symbiotic relationships with mycorrhizal fungi which effectively extend the reach of the root system to facilitate phosphorus (P) uptake. This biology helps Christmas tree species grow well in soils relatively low in P availability.

Christmas trees are often grown on land previously used in the production of farm crops with a long history of P and potassium (K) fertilizer application. These nutrients are not very mobile in soil.

Phosphorus and K fertility can last many years in the soil. Crop harvest is the major factor that removes P and K from soils. For example, an average end-of-rotation harvest removing all the trees from a field of Christmas trees planted on a 5'x5' spacing removes approximately 46 lbs P/acre (106 P2O5) and 120 lbs K/acre (145 K2O).

Soils that test above 50 lbs P/acre on the Rutgers Soil Test Report have adequate P fertility and consequently zero P fertilizer is recommended. If the soil tests between 25 and 50 lbs P/acre, the recommended rate of 50 P2O5 per acre should be broadcast before transplanting. If the soil tests between 0 and 25 lbs P/acre, the recommended rate is 110 P2O5 per acre. (Note: Some soil test labs report Mehlich-3 results in ppm instead of lbs/acre. Use this formula to convert: ppm x 2 = lbs/acre).

Soils that test above 200 lbs K/acre on the Rutgers Soil Test Report have adequate K fertility and consequently zero K fertilizer is recommended. If the soil tests between 100 and 200 lbs K/acre, the recommended rate of 150 K2O per acre should be broadcast before transplanting. Or if the soil tests between 0 and 100 lbs K/acre, the recommended rate is 200 K2O per acre.

After broadcasting P and K fertilizer, tillage, such as plowing or harrowing is needed to mix the nutrients into the surface 6 inches of soil where they will be most effective. These operations should be performed well before planting.

Once the recommended amount of P and K have been applied, there is generally no need for annual applications of these nutrients during the typical eight-year rotation or production cycle. At the end of the rotation, another soil sampling and soil test should be performed in advance of planting the next rotation. Many choose-and-cut (C&C) growers continually replant as a field is harvested, never totally removing the crop. Because these growers will have to adjust P and K levels via soil surface application rather than by tilling, they should perform a soil test to determine P and K levels when approximately one-half of the originally planted trees have been harvested, then about every eight years there after.

Common fertilizers for P include superphosphate (20% P2O5) and triple superphosphate (46% P2O5). Rock phosphate, which is approved for use in organic farming, may contain approximately 30% P2O5 but this P is only very slowly available to the trees over time. On strongly acid soils with a pH level below 5.5, rock phosphate can be used as an effective alternative source of P because the higher soil acidity makes P more readily available. Legume cover crops also help to make P available from rock phosphate.

Potassium chloride, or muriate of potash (60% K2O), is the most commonly used source of K fertilizer. When there is a need for sulfur, potassium sulfate (50% K2O) may be used instead. Sulfate of potash magnesia (22% K2O, 11% Mg, and 23% S) may be used when there is a need for magnesium.

Sulfur (S)

Sulfur-deficient plants have yellow leaves. Sulfur fertilization is generally not based on soil testing. Soil tests for available sulfur (S) are helpful but the required sampling of the subsoil to a depth of 24 inches discourages widespread testing for this nutrient. The need for S fertilization is usually based on soil type, field history, and plant tissue analysis.

Sandy, highly leached, low organic matter content soils are the soils most likely to need S fertilization. Soils high in organic matter content or fields that have a recent history of manure application generally supply adequate amounts of S. An average Christmas tree harvest (from a field planted on a 5'x5' spacing), at the end of a rotation (all of the trees harvested from the planting), removes approximately 20 lbs S/acre.

A sulfur-deficient soil can be corrected by selecting and applying a S containing fertilizer that is already recommended as a source of other nutrients. For example, if an N fertilizer is applied to Christmas trees as ammonium sulfate, the crop will be well supplied with S, since ammonium sulfate contains 24% S. Other sulfur fertilizers that supply S as sulfate (magnesium sulfate, 14%S; potassium sulfate, 18%S; potassium magnesium sulfate, 23%S; calcium sulfate, 24%S, or gypsum, 19%S), are effective whether incorporated into the soil or applied to the soil surface. Select the most appropriate S fertilizer by consulting the soil test fertility levels for K, Mg, and Ca.

Micronutrients: Manganese (Mn), Iron (Fe), Boron (B), Chlorine (Cl), Copper (Cu), Nickel (Ni), Molybdenum (Mo), and Zinc (Zn)

Manganese (Mn) is often deficient in coarse-textured soils of southern New Jersey, but is seldom found deficient in fine-textured soils of northern New Jersey. Sandy soils are very susceptible to Mn deficiency if too much limestone is applied. As soil pH increases, plant availability of soil Mn decreases. Symptoms of Mn deficiency in Christmas trees are yellowing needles. Manganese deficiency is often a persistent and reoccurring problem in certain fields.

Manganese deficiency has been observed in a Christmas tree plantation in Burlington County. Field trials demonstrated that spring foliar applications of Mn fertilizer improved needle color. On fields with a history of Mn deficiency, apply Mn fertilizer as a foliar spray as soon as one inch of new growth occurs in the spring. In severe cases of Mn deficiency, it may be necessary to reapply the Mn sprays more than once. To be effectively absorbed, the Mn fertilizer must be applied while the needles are still soft and before they have developed a waxy coating. Apply the Mn at the rate of 0.5 to 1.0 lbs of Mn per acre for each foliar treatment. Manganese sulfate or chelated forms of Mn are equally effective as foliar fertilizers.

Manganese fertilizer may also be applied to the soil, but there is very little long term benefit from soil applied Mn fertilizer. If Mn is soil applied, a typical recommendation is 10 lbs Mn/acre broadcast. Chelated forms of Mn are not recommended for soil application. Refer to Rutgers Cooperative Extension Fact Sheet 973 "Manganese Needs of Soil and Crops in New Jersey" for additional information about Mn nutrition, soil test interpretation, and correction of this deficiency.

Iron (Fe) deficiency is uncommon in Christmas trees grown on New Jersey soils. A deficiency may occur, however, on soils that have received too much limestone. The use of acidifying N fertilizers such as ammonium sulfate can help to improve the availability of soil pH sensitive micronutrients such as iron or manganese. Refer to Rutgers Cooperative Extension Fact Sheet 971, "Iron Needs of Soils and Crops in New Jersey", for further information on iron.

Some crops grown on New Jersey soils require boron (B) fertilization. Christmas trees, however, are not known to require or benefit from boron fertilization on New Jersey soils. Legume cover crops that may be sown in plantations may benefit from B fertilizer. Sandy coastal plain soils are the most susceptible to B deficiency. Soils with less than 0.5 ppm B (by hot water extract or by Mehlich-3 soil test) are considered B deficient. On B deficient soils, broadcast 0.25 to 0.50 lbs B/acre before planting. Because excessive B can cause harm to crops, be careful not to exceed the recommended rates. There are several B fertilizer formulations available for pre-plant broadcast application. Refer to Rutgers Cooperative Extension Fact Sheet 873, "Boron Needs of Soils and Crops in New Jersey", for additional information.

Chlorine (Cl) is a nutrient used by plants in the ionic form as chloride. A chloride deficiency is unlikely in Christmas trees grown in New Jersey.

Copper (Cu) deficiency in Christmas grown on New Jersey soils is unlikely. For further information on Cu refer to Rutgers Cooperative Extension Fact Sheet 720, "Copper Needs of Soils and Crops in New Jersey."

Nickel (Ni) deficiency is unlikely in Christmas trees grown in New Jersey.

Nitrogen fixing bacteria require molybdenum (Mo). New Jersey soils generally contain sufficient Mo, but its availability is strongly influenced by soil pH. Liming acid soils to the proper soil pH (6.0 to 6.5) for legume cover crops will greatly improve Mo availability. Molybdenum may be applied along with the seed inoculation treatment to legume seeds, such as white clover, which may be sown in plantations as a ground cover. Apply 2 ounces Mo per bushel of legume seed. For additional information on Mo refer to Rutgers Cooperative Extension Fact Sheet 972 "Molybdenum Needs of Soils and Crops in New Jersey."

Zinc (Zn) deficiency is not a common occurrence on Christmas trees grown on New Jersey soils. Zinc deficiency is most likely to occur on soils with pH values greater than 6.5, and on soils testing very high for P. For additional information on Zn refer to Rutgers Cooperative Extension Fact Sheet FS721, "Zinc Needs of Soils and Crops in New Jersey."

Nitrogen (N)

Nitrogen (N) fertilizer is not recommended during the first growing season that Christmas trees are planted. Newly planted trees contain sufficient reserves of nutrients in their living tissue to carry them through establishment. Soils also naturally release some N from decomposition of soil organic matter. Applying fertilizers with a high salt index to young trees makes them more vulnerable to drought stress. Wait at least

one year after establishment before applying any N fertilizer.

On good soils with a clover grass ground cover, satisfactory Christmas trees may be grown without any applied N fertilizer. Regular mowing and leaving the clipping residue recycles N into a biologically active soil that supplies N to the tress. If tree vigor, color, and bud density is not satisfactory, application of a commercial N fertilizer may be beneficial. A fertilizer trial on a small area of the plantation can determine whether or not the trees will benefit from applied N.

Following the year of establishment, a commercial N fertilizer may be applied each spring about three weeks before bud break. The fertilizer may be applied as a broadcast over the entire field or only around the drip line of individual trees. When the fertilizer is broadcast, grasses and other competing vegetation will uptake a significant amount of the applied N. Applications around the drip line are more efficient for tree uptake, but the concentrated fertilizer should never be applied closer than within 18 inches of the tree trunk. Growers also have the option to split their N application between spring and fall: one-half of the recommended rate in early spring three weeks before bud break to assist new growth and development, and the second half in late summer/early fall (mid-September to mid-October) to enhance foliage color.

In the second and third year after planting, recommended N rates range from 0.25 to 0.5 oz. N/tree applied around the drip line. Or if applied as a broadcast, recommended N rates range from 25 to 50 lbs N/acre.

In the fourth to final years of the rotation, recommended N rates range from 0.5 to 0.75 oz. N/tree applied around the drip line. Or if applied as a broadcast, recommended N rates range from 50 to 60 lbs N/acre.

The actual N rate to apply should be decided based on several factors such as species, vigor and appearance of the trees, soil texture, soil organic matter content, and grower experience. Plant tissue analysis may also be useful. Scotch pine and white pine have a lower demand for N fertilizer than Douglas fir, most species of true fir or spruce. Trees growing on sandy soils and soils with less than three percent (3%) organic matter content typically need more applied N fertilizer than trees grown on loamy soils.

Trees are naturally conservative with N. They are capable of carrying over some N in tissue from previous seasons. If the tree growth and color are already satisfactory, consider reducing the N application rate.

As trees are approaching market size, or in the final growing season of a rotation, Christmas tree color may be improved by applying 0.3 oz. N/tree around the drip line between mid-September and mid-October (and if the N application is not already being split between spring and fall, as previously mentioned above). Tree roots remain active until soil temperatures fall below 40-45 degrees Fahrenheit.

Commercial N fertilizers commonly used for Christmas trees include urea, ammonium sulfate, and calcium nitrate. Of these materials, urea (46% N) is generally the least expensive N source. Use of urea fertilizer gradually lowers soil pH. Ammonium sulfate, which contains 21% N and 24% S, is a strongly acidifying fertilizer that will contribute to soil pH reduction. Calcium nitrate contains 15% N and 19% Ca and will increase soil pH. For security reasons, ammonium nitrate is no longer available for sale in its pure form. However, blended substitutes of varying composition may be commercially available.

When using urea fertilizer, loss of applied N via ammonium volatilization is a concern. This is not a concern with other granular fertilizer sources. When urea is applied in the early spring about three weeks before bud break, weather conditions are often cool and moist which helps to limit this type of loss. However, urea applied during warm dry weather is more susceptible to ammonium volatilization. Applying urea before an expected rain helps to minimize this type of loss by moving the fertilizer material into the soil.

A common method of applying N fertilizers in smaller Christmas tree plantations is spreading the material by hand in the drip line. A tin can or plastic bottle can be cut to a size to hold just the amount of N fertilizer to apply around a tree. To use this method of application, a particular fertilizer recommendation given in weight must be converted to a volume measure. This is determined by weighting out the amount of fertilizer material recommended for a tree and cutting off the volume measure at the fill line.

When using urea, 1.09 oz. (or 31 grams) of this fertilizer material supplies 0.5 oz. of N. When using ammonium sulfate, 2.3 oz. (or 68 grams) of this material supplies 0.5 oz. of N. When using calcium nitrate, 3.3 oz. (or 95 grams) of this material supplies 0.5 oz. of N.

Because chemical fertilizer materials can burn green plant tissue, try to keep the granules off of the tree foliage, especially if the foliage is wet.



A plastic cup made by cutting a section of a bottle to desired size. It is designed to hold 1.09 oz. (31 grams) of urea fertilizer material which would supply 0.5 oz. of N when applied around the drip line of a Christmas tree.

Organic Soil Fertility Management

The soil fertility management for production of organic crops should be considered within the context of the overall organic crop rotation cycle or organic farm plan. When transitioning farmland to the organic system, inclusion of legumes in the crop rotation is important. In the case of organic Christmas trees, N fertility can be provided simply by encouraging white clover to grow as a ground cover within the plantation.

Compost or manures may also be used to augment the soil fertility program. Apply only properly made compost. Be careful with the importation of manures which may introduce undesirable weed seed into the plantation. If supplemental P or K is needed, only raw, mined, unprocessed fertilizer sources are approved for organic production. As a source of P, rock phosphate may be used. If K is needed, there are three commercial K fertilizers that may sometimes be used with certain restrictions in organic farming: langbeinite, potassium sulfate, and sylvinite.

When micronutrient deficiencies occur, they can be corrected as necessary for organic crop production using many of the same fertilizer materials and application practices as used in conventional agriculture. In organic farming, however, micronutrient fertilizer products cannot be routinely applied without prior soil or plant diagnostics to confirm the specific micronutrient deficiency.

Liming soils and soil pH management using carbonate limestone is essentially the same for organic production as for conventional production. Always check with the organic certifier to be sure a particular product is approved for use in organic farming.

References

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