TECHNICAL NOTES

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Oregon Fertilizer Guide for Douglas-fir Christmas Trees

This Technical Note transmits the Oregon State University Extension Service Fertilizer Guide for Douglas-fir Christmas trees. When planning Nutrient Management 580 with growers of Douglas-fir Christmas trees reference this guide in the Nutrient Management specifications. A copy of this guide should be provided to the land user with the specification.

Recommended soil sampling procedures should be followed in order to estimate fertilizer needs. The extension agent in each county can provide soil sampling instructions and information sheets.

Fertilizer Guide

FG 73
Revised March 1994

DOUGLAS-FIR CHRISTMAS TREES
in Oregon and Washington

Fertilization is a standard practice providing nutrients for enhanced Christmas tree growth and color. If adequate nutrition is present, fertilizing is an unnecessary expense and is potentially detrimental to the environment. Fertilizer need for individual fields should be determined through soil and foliar analyses. Fertilization will not compensate for other growth-limiting problems such as soil compaction, poor drainage, pest infestations or weather-caused stress.

Soil analyses measure the amount of a nutrient available to plants. Soil testing and fertilization before plantation establishment are important steps in developing a suitable growing environment. Sample and analyze soil before site preparation and plantation establishment. Test soil before final cultivation of new fields so needed fertilizers or amendments can be incorporated before planting.

For established plantations, foliar analysis, which measures nutrient concentrations in the needles, is the preferred method of monitoring nutrient sufficiency. Foliar testing during the rotation normally is adequate to assess and correct nutritional status. However, soil testing can aid in diagnosing poor growth in established plantations. If foliar analyses are low after fertilization, or if growth or color do not improve after fertilization, a soil test in addition to foliar analyses may be helpful to identify the problem.

Routine monitoring is recommended so that declining or low nutrient levels can be detected before visual nutrient deficiency symptoms appear. Early detection of declining foliar nutrient levels allows corrective measures to be taken before nutrient deficiencies become severe and result in impaired tree growth or quality.

Monitoring nutrient levels is an important step in plantation management. Interpreting foliar analyses should be made with consideration of site conditions. For example, shallow sites limit root growth and may benefit more from fertilization compared to sites with deep soils. Record fertilization, tree growth, and weather conditions as well as disease, insect, or weed presence. Monitor changes in tree performance and soil and foliar nutrient status through time. Experience gained from these records will help interpreting analyses.

Apply only nutrients needed as determined by soil or foliar analyses and experience. Many different fertilizers are available to provide needed nutrients. Important features to consider are nutrient concentration, price, blendability, and availability. Nutrient form—urea versus ammonium, for example—is of less importance. Consult a fertilizer dealer for fertilizer cost and handling information so you can obtain needed nutrients in an easily handled formulation at the lowest cost.

Table 1 provides foliar and soil sampling guidelines for Douglas-fir Christmas trees.

Table 1. Suggested soil and foliar sampling guidelines.

What to sample	When	Season	Recommended Analysis
Soil	before site preparation	optional	P, K, Ca, Mg, pH (1,2)
Foliar	annually; begin in year three	September/ October	N, P, K, Ca, Mg, B, S (3)

(1) Organic matter is important and can be measured. Making changes in organic matter is difficult considering normal cultural practices.

(2) Corrective measures are most effective when incorporated during site preparation. Soil can be analyzed for other nutrients but their application as fertilizers during site preparation is not critical.

(3) Analyses for other nutrients is possible, however, these rarely limit Douglas-fir Christmas tree growth or color.

Finally, **tree performance is the key**! These tests are a guideline and tree quality should be the basis for fertilization corroborated with soil and foliar analyses.

Soil Sampling

Take at least 20 to 30 cores or small shovel samples from each uniform area or field. Samples should come from the surface 6 to 8 inches of soil. When sampling existing tree fields, sample with the estimated tree rooting zone, including under tree crowns. Mix the sample material to insure that it is uniform. Send a sub-sample of 1 to 2 cups for laboratory analysis. Table 2 summarizes fertilizer recommendations based on soil analyses.

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How To Take A Soil Sample And Why, EC 628, and *Analytical Laboratories Serving Oregon*, FG 74, provide information about sampling soils and list commercial laboratories performing soil and foliage analytical services. See the "For More Information" section for ordering instructions.

Table 2. Fertilizer recommendations based on pre-site preparation soil sample.

Element	If Soil Test Is . . .	Recommended Action
Phosphorus (P) (ppm) (1)	0 – 10	apply 180 lb P_2O_5/a
	11 – 15	apply 90 lb P_2O_5/a
	above 15	adequate; monitor foliar P
Potassium (K) (ppm)	below 75	apply 100-200 lb K_2O/a
	above 75	monitor foliar K
pH	below 4.5	apply 2 t lime/a (2)
	4.5 to 5.0	apply 1 t lime/a
	above 5.0	monitor foliar Ca & Mg

(1) P determined using Bray procedure.
(2) If soil Mg is below 0.4 meq/100g soil, use dolomitic lime.

Foliar Sampling

Sample Christmas tree foliage by pinching five to eight needles of new or current season growth from six to eight locations on the tree as shown in Figure 1. Be sure samples contain only needle material with no buds, bark, stem wood, or lammas growth. Never sample the tree leader. All other current season needles on the upper 1/3 of the tree crown can be sampled. Sample Christmas tree foliage in the late summer or early autumn, before the rainy season begins (normally between early September and early October). Consult Table 1 for analyses to request.

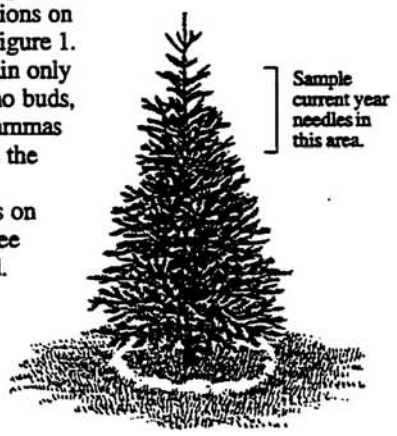


Figure 1. Foliar sampling instructions.

Consult a county OSU or WSU Cooperative Extension office with questions about soil or foliar sampling. Recommendations in this fertilizer guide apply to residual upland and alluvial valley floor soils. Plantations on other soils, such as those developed from glacial parent materials, may require different fertilization rates. Oregon and Washington field research (from 1987 to 1992), research from other areas, and grower observations are the bases for recommendations provided in this fertilizer guide.

Nitrogen (N)

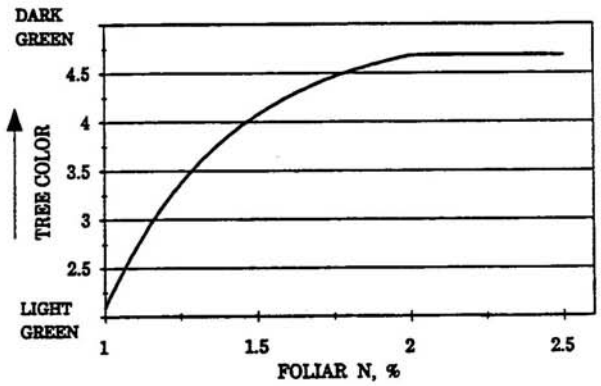
Nitrogen fertilizer has been recommended and used for decades to enhance color, growth, and value of Christmas trees. A recent nitrogen fertilizer trial on Douglas-fir Christmas trees in western Oregon and Washington established a quantitative relationship between color and nitrogen fertilizer applications. Number of buds, branch development, needle length, and tree quality were monitored, but showed no response to nitrogen fertilizer. However, foliar tests revealed that even before fertilization, foliar nitrogen was at or above optimum levels for growth, explaining any lack of response except for color enhancement.

In most situations, fertilization of newly planted Douglas-fir Christmas trees is not necessary. Seedlings from the nursery commonly have higher foliar nitrogen levels than can be sustained in non-irrigated conditions, therefore, trees draw upon reserves for the first 2 to 4 years after transplanting.

At sites where nitrogen is limiting, growers need to add N after 3 years of growth. Trees grown in deep soils usually do not need nitrogen fertilizer until the last 2 years of growth. Monitor foliar nitrogen as described in the previous section to determine if N fertilization is necessary.

Researchers in Canada and the Pacific Northwest found forest-grown Douglas-fir requires 1.4 to 1.7% foliar N for adequate growth and development. A Pacific Northwest Christmas tree fertilizer trial completed in 1992 found that needle color darkened with increasing foliar N to a level of 2%. Figure 2 illustrates the relationship between tree color and foliar N.

Figure 2. The relationship of Douglas-fir Christmas tree color and foliar N concentration.[1]



[1]Color was determined by comparing tree color to Munsell colors. Munsell is a standard color notation for hue, value, and chroma. Charts are available from MacBeth/Munsell, 405 Little Britain Road, New Windsor, NY 12533, telephone (914) 565-7660. Munsell equivalents for Figure 2 are 1 = 2.5 GY 5/6; 3 = 7.5 GY 4/6; 5 = 10 GY 3/4.

Fertilize Douglas-fir Christmas trees with N according to Table 3. Monitor foliar N to determine need for N fertilization. Refer to foliar sampling section for sampling instructions. One type of nitrogen fertilizer generally is not superior to another. In western Oregon and Washington, urea and ammonium sulfate, along with blends of the two, have been used with similar results. Ammonium nitrate,

although used less commonly, should be equally effective. Apply fertilizer during February or early March. Fertilize just before spring root growth to minimize fertilizer loss to ground water. Some growers tout May or September – October fertilization as beneficial, but these timings have not been verified by research. Fertilize with N according to Table 3.

Table 3. Fertilizer N recommendations based on foliar tests.

Foliar N %	Average Tree Height for Plantation (1)	Amount of N to apply (2)	Expected Results
less than 1.6	less than 3 feet more than 3 feet	0.7 oz/tree (3) 2.0 oz/tree	improved growth and color
1.6 – 2.0 (4)	less than 3 feet more than 3 feet	0.7 oz/tree 2.0 oz/tree	improved color
more than 2	any height	none	

(1) In experimental plots, increased growth resulted from annual N fertilization throughout the rotation even when foliar N exceeded 1.6% at sites with soil less than 3 feet deep.

(2) These rates are amounts of actual N per acre or per tree, not fertilizer material. If a fertilizer material is 33% N, the rates shown above need to be multiplied by three to determine the amount of fertilizer material to apply.

(3) For broadcast applications, multiply number of trees per acre times 2 oz/tree to arrive at a per-acre rate.

(4) Apply only for 2 years before harvest for darkening foliage.

Fertilizer can be broadcast or applied to individual trees. The objective is to apply fertilizer evenly to the tree's root system. For small trees (i.e., less than 3 feet tall), fertilizer is commonly spread around the drip line or tossed in two bands on opposite sides of the tree. While this probably is a good way of conserving fertilizer when treating young trees, older plantations have roots spread throughout the site and may be fertilized using a broadcast method. Foliar burn occurs from concentrated nitrogen fertilizers on needles. Be careful to ensure that fertilizer material does not remain on the needles after application.

Phosphorus (P)

Phosphorus deficiencies of Christmas trees in western Oregon and Washington are rare. In fact, very low soil test P levels (i.e., below 5 ppm) commonly are measured in plantation soil with trees having adequate color and growth. However, growers should measure soil and foliar P status. Correcting P deficiencies after plantation establishment is difficult due to P immobility.

Surface application of P is less effective in supplying P to tree roots than subsurface applications. Consequently, applying and incorporating P before planting is recommended. See Table 2 for fertilizer recommendations based on soil analyses.

In addition to soil test P, measuring P foliage concentrations is recommended. If low foliar P levels are found, corrective action for the current crop may be warranted. See Table 4 for the recommended P fertilizer rates based on foliar analyses.

Potassium (K)

Potassium-containing minerals are present in the parent material of most Pacific Northwest soils. In general, this native supply of K is adequate to meet Christmas tree needs, making K fertilization unnecessary. However, growers are advised to check soil and foliar levels periodically to determine whether K supplies remain adequate. Apply K as recommended in Tables 2 and 4.

Sulfur (S)

Although growers commonly apply sulfur fertilizer, its benefits have not been proven. This situation remains unchanged. Current research indicates Douglas-fir Christmas trees have adequate color with foliar S levels as low as 0.08%. This contrasts with research done on forest trees that suggests a foliar level of 0.11% as a minimum for northwest soils. Fertilization rates for foliar S levels below 0.08% are given in Table 4. Soil tests for S are not recommended.

Several sulfur fertilizer sources are available. The S content of ureasul, a physical blend of urea and ammonium sulfate, depends upon the portion of ammonium sulfate in the blend. A common S content for ureasul is 12%. Ammonium sulfate contains 24% S. Sul-po-mag has 22% sulfur, 22% potassium and 11% magnesium. Elemental sulfur (100%) can be used, too, when only sulfur and no other nutrients are desired.

Lime, Calcium (Ca), and Magnesium (Mg)

Soil in western Oregon and Washington is naturally acidic, having a pH between 5.0 and 6.5. Douglas-fir trees are well suited to these moderately acidic soils. Therefore, liming soil for Douglas-fir Christmas tree production is not recommended until soil pH is below 5.0. Conversely, research in the Pacific Northwest shows that Douglas-fir Christmas trees grown on soils with a pH above 6.0 may need higher rates of N fertilization to attain marketable color.

Lime is applied to increase soil pH, supply Ca and/or Mg, decrease acidity, and reduce problems associated with soil acidity. Two primary types of lime are available for application: agricultural or calcitic lime and dolomitic lime. Agricultural lime contains only Ca carbonates whereas dolomitic lime consists of both Ca and Mg carbonates. Agricultural lime normally is the preferred product unless soils also are low in magnesium. For more information about liming and lime products, refer to the "For More Information" section.

Lime moves slowly in soil. Therefore, the best time to lime is before planting so it can be mixed with soil. Spreading lime on the soil surface in an established plantation will

have little effect on soil pH below 2 inches. Lime application rates based on soil pH are provided in Table 4.

Table 4. Fertilizer recommendations based on foliar analyses.

Element	Foliar Analysis	Fertilizer	Comments
P, %	below .08 .08 – .15 above .15	180 lb P_2O_5/a 90 lb P_2O_5/a 0	surface band rather than broadcast[1]
K, %	below .4 .4 – .8 above .8	100 lb K_2O/a 50 lb K_2O/a 0	
S, %	below .08 .08 – .12 above .12	20-30 lb S/a trial application 0	before treating large acreages, try on small area
Mg, %	below .07 .07 – .12 above .12	20-40 lb $MgSO_4$/a trial application 0	if pH below 5.0, use 1 t dolomitic lime/a instead
Ca, %	below .25	100 lb gypsum/a or 1 t lime/a	if pH below 5.0, use 1 t lime/a instead
B, ppm	below 6 6 – 10 above 10	2-3 lb B/a trial application 0	broadcast only

[1]Apply fertilizer in narrow band rather than spread over entire soil surface.

Magnesium is a component of chlorophyll with deficiencies expressed as a chlorosis or yellowing of needles when foliar levels are low. Deficiencies of Ca and Mg have not been demonstrated for Douglas-fir Christmas tree production in western Oregon and Washington. Current research shows no relationship between needle color and soil or needle Mg levels when foliar Mg is greater than 0.07%. Magnesium rates based on soil and foliar tests are provided in Table 4.

Calcium is important for cell structure with deficiencies observed as deformity in new growth. Foliar Ca has not improved tree color when above 0.25%. Calcium rates based on soil and foliar tests are provided in Table 4.

Micronutrients

Christmas tree fertilization with micronutrients [Boron (B), Chlorine (Cl), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Zinc (Zn)] in western Oregon and Washington has not yielded growth or color responses. The lack of Christmas tree responses to Zn, Cu, Mn, and Fe applications is not surprising because these "metallic" micronutrients are readily available in the region's acidic soils.

Boron is the micronutrient most likely to limit Christmas tree growth in the Pacific Northwest. OSU/WSU research showed tree color and grade to be independent of foliar B when foliar B was above 8–10 ppm. Research in British Columbia, where foliar B levels were below 10 ppm, showed increased height when a single application of 2–3 lb B/a was broadcast. Based on information from these studies, if foliar B levels in Christmas trees are below 10 ppm, a trial application of 2–3 lb B/a is suggested. A single B application should provide adequate B for the life of the stand. NEVER band boron fertilizers.

For More Information

To order FG 74, *Analytical Laboratories Serving Oregon*, EC 628, *How To Take A Soil Sample And Why*, or FG 52, *Fertilizer and Lime Materials*, write Publications Orders, Agricultural Communications, Oregon State University, Administrative Services A422, Corvallis, OR 97331–2119. There is no charge for these publications.

Ballard, T.M. 1986. *Evaluating Forest Stand Nutrient Status*. Land Management Report #2, British Columbia Ministry of Forests.

Bondi, M., C. Landgren, R. Fletcher, T. Sabin, J. Hart, and S. Webster. 1993. *What's Nitrogen Fertilizer Buying You?* Christmas Tree Lookout, 26(1)18–28.

Green, R.N. 1993. Boron and Magnesium Fertilization of a Coastal Douglas-fir Plantation. *Western Journal of Applied Forestry*, 8(2)48–53.

McEvoy, T.J. 1992. *Using Fertilizers in the Culture of Christmas Trees*. Paragon Books, Richmond, VT.

Turner, D.O. and J. Buhaly. 1966. *Fertilizing Natural Stand Douglas-fir Christmas Trees*. EB 585, Washington State University, Cooperative Extension Service.

Walker, R.B. and S.P. Gessel. 1991. *Mineral Deficiencies of Coastal Northwest Conifers*. Institute of Forest Resources Contribution 70, College of Forest Resources, University of Washington, Seattle.

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