FERTILIZERguide
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Douglas-fir Christmas trees

Oregon and Washington

M.C. Bondi, R.A. Fletcher, J. Hart, D. Horneck, C. Landgren, and S. Webster

Fertilization provides nutrients for enhanced Christmas tree growth and color. However, if adequate nutrition is present, fertilizing is an unnecessary expense and is potentially detrimental to the environment. Apply only nutrients needed as determined by soil or foliar analyses and experience. Fertilization will not compensate for other growth-limiting problems such as soil compaction, poor drainage, pest infestations, or weather-caused stress.

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.

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.

Nutrient Testing

Soil testing and fertilization before plantation establishment are important steps in developing a suitable growing environment. Soil analyses measure the amount of a nutrient available to plants. 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 the reasons for 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 help identify the problem.

Monitoring nutrient levels is an important step in plantation management. 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.

Foliar analyses should be interpreted 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 you interpret analyses.

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

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

What to sample	When	Season	Recommended analysis
Soil	Before site preparation	Optional	P, K, Ca, Mg, pH[1,2]
Foliar	Annually; begin in year 3	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 only a guideline. Tree quality, corroborated with soil and foliar analyses, should be the basis for fertilization.

(In alphabetical order) Michael C. Bondi, Extension agent, Clackamas County, Oregon State University; Richard A. Fletcher, Extension agent, Linn and Benton counties, Oregon State University; John Hart, Extension soil scientist, Oregon State University; Don Horneck, faculty senior research assistant in soil science, Oregon State University; Chal Landgren, Extension agent, Columbia and Washington counties, Oregon State University; Steve Webster, area Extension agent, SW Washington, Washington State University.

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Soil Sampling

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

How To Take A Soil Sample...and Why, EC 628, and *Analytical Laboratories Serving Oregon*, EM 8677, provide information about sampling soils and commercial laboratories performing soil and foliage analytical services. See the "For More Information" section for ordering instructions.

Table 2.—Fertilizer recommendations for Douglas-fir Christmas trees 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
	over 15	Adequate; monitor foliar P
Potassium (K) (ppm)	under 75	Apply 100–200 lb K_2O/a
	over 75	Monitor foliar K
pH	under 4.5	Apply 2 t lime/a[2]
	4.5–5.0	Apply 1 t lime/a
	over 5.0	Monitor foliar Ca and Mg

[1]P determined using Bray procedure.

[2]If soil Mg is below 0.4 meq/100 g soil, use dolomitic lime.

Foliar Sampling

Sample Christmas tree foliage by pinching 5–8 needles of new or current-season growth from 15 locations on the tree as shown in Figure 1. Repeat this procedure on 20–30 trees in the plantation. Approximately 1 cup of needles is required for analysis. 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 half of the tree crown can be sampled. Sample Christmas tree foliage early, before the rainy season begins (normally between early September and early October). Consult Table 1 for analyses to request.

Consult a county OSU or WSU extension office with questions about soil or foliar sampling.

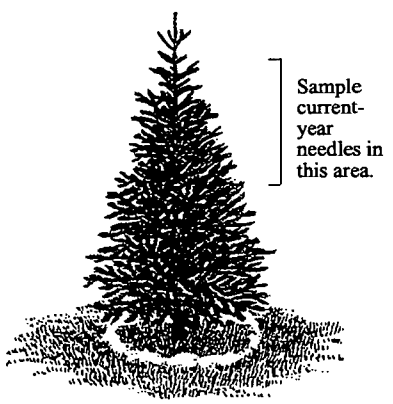

Figure 1.—Foliar sampling.

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.

Researchers in Canada and the Pacific Northwest found forest-grown Douglas-fir requires 1.4–1.7 percent 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 percent. Figure 2 illustrates the relationship between tree color and foliar N.

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 nonirrigated conditions; therefore, trees draw upon reserves for the first 2–4 years after transplanting.

Monitor foliar nitrogen as described in the previous section to determine whether N fertilization is necessary. At

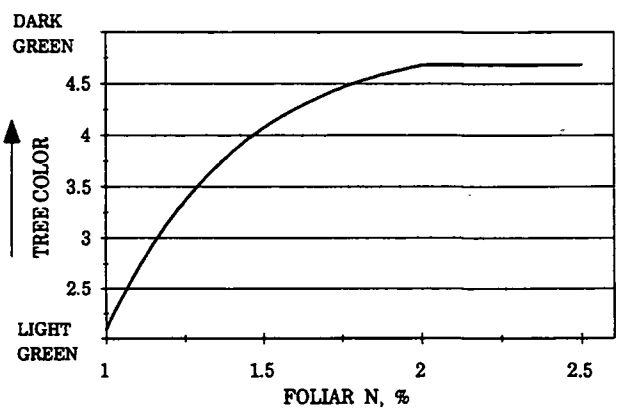

Figure 2.—The relationship of Douglas-fir Christmas tree color and foliar N concentration.[1]

[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;

sites where nitrogen is limiting, add N after 3 years of growth. Trees grown in deep soils usually do not need nitrogen fertilizer until the final 2 years of growth.

Apply fertilizer during February or early March. Fertilize just before spring root growth to minimize fertilizer loss to groundwater. 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 for Douglas-fir Christmas trees based on foliar tests.

Foliar N (%)	Average tree height for plantation[1] (ft)	Amount of N to apply[2] (oz/tree)	Expected results
under 1.6	under 3	0.7[3]	Improved growth and color
	over 3	2.0	
1.6–2.0[4]	under 3	0.7	Improved color
	over 3	2.0	
over 2	Any height	0	

[1]In experimental plots, increased growth resulted from annual N fertilization throughout the rotation even when foliar N exceeded 1.6 percent 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 percent 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.

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.

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 commonly is 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 in 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 percent. This contrasts with research done on forest trees that suggests a foliar level of 0.11 percent as a minimum for Northwest soils. Fertilization rates for foliar S levels below 0.08 percent 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 percent. Ammonium sulfate contains 24 percent S. Sul-po-mag has 22 percent sulfur, 22 percent potassium, and 11 percent magnesium. Elemental sulfur (100 percent) can be used when only sulfur and no other nutrients is 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 unless 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: 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.

Magnesium is a component of chlorophyll. Deficiencies are expressed as a chlorosis or yellowing of needles. 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 percent. Magnesium rates based on soil and foliar tests are provided in Table 4.

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

Table 4.—Fertilizer recommendations for Douglas-fir Christmas trees based on foliar analyses.

Element	Foliar analysis	Fertilizer	Comments
P, %	under 0.08	180 lb P_2O_5/a	Surface band rather than broadcast*
	0.08–0.15	90 lb P_2O_5/a	
	over 0.15	0	
K, %	under 0.4	100 lb K_2O/a	—
	0.4–0.8	50 lb K_2O/a	
	over 0.8	0	
S, %	under 0.08	20–30 lb S/a	Before treating large acreages, try on small area
	0.08–0.12	trial application	
	over 0.12	0	
Mg, %	under 0.07	20–40 lb $MgSO_4$/a	If pH below 5.0, Use 1 t dolomitic lime/a instead
	0.07–0.12	Trial application	
	over 0.12	0	
Ca, %	under 0.25	100 lb gypsum/a or 1 t lime/a	If pH below 5.0, use 1 t lime/a instead
B, ppm	under 6	2–3 lb B/a	Broadcast only
	6–10	Trial application	
	over 10	0	

*Apply fertilizer in a narrow band rather than spread over the entire soil surface.

Micronutrients

Christmas tree fertilization with micronutrients [boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and 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

OSU Extension Service publications

How to Take a Soil Sample ... and Why, EC 628, by E.H. Gardner (revised 1997). No charge.

A List of Analytical Laboratories Serving Oregon, EM 8677, by J. Hart (revised 1997). No charge.

To order copies of the above publications, send the complete title and series number, along with a check or money order for the amount listed (payable to Oregon State University), to:

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World Wide Web

Fertilizer and Lime Materials, FG 52, by J. Hart (reprinted 1997). No charge.

You can access the above publications, as well as FG 73, *Douglas-fir Christmas Trees: Western Oregon and Washington,* our Publications and Videos catalog, and many other publications via our Web site at **eesc.orst.edu**

Other publications

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

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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).

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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