FERTILIZING NATURAL STAND DOUGLAS-FIR CHRISTMAS TREES
Eight out of ten consumers prefer dark, blue-green Christmas trees. A small amount of fertilizer will give this desired color. Satisfied customers will want to continue to buy natural trees rather than switching to artificial ones.

Fertilizer can also be used to stimulate growth. Growth rates of only 4 or 5 inches per year can be doubled or tripled. As a result, trees can be produced in a shorter period of time and with more efficient use of capital.

Trees that need both growth increase and darker color should be fertilized in the period from mid-March through April. This treatment to increase growth should be made three or four years ahead of harvest.

Trees that need only darker green color should be fertilized during May. The fertilizer should be applied only to trees that will be harvested during the coming fall.

Small amounts of nitrogen fertilizer have produced good results. The cost of the fertilizer is about 1 to 3 cents per tree.

For best results, fertilizer should be applied to trees that have been previously thinned and pruned. It should not be wasted on unmanaged stands.
FERTILIZING NATURAL STAND DOUGLAS-FIR CHRISTMAS TREES

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Every Christmas tree grower who wants to remain competitive should consider the possible use of fertilizer on his trees. Growers who have used it find the "pay off" is substantial in higher prices received for trees.

Growers who use fertilizer are likely to have the highest quality trees and be in the most favorable competitive position when there is a larger supply of trees than the market demands.

DOUGLAS-FIR TREES AND FERTILITY

Douglas-fir tree color is directly related to the supply of nitrogen. When the nitrogen supply is low, the trees are yellow. When soil nitrogen is adequate, the trees are green.

Soil moisture is also important. During dry years, when soil moisture is limited, bacterial breakdown of organic matter is reduced. This, in turn, reduces the supply of soil nitrogen and sulfur available to the trees. Thus Douglas-fir trees tend to be more yellow in years that are drier than normal. Better color is observed during years when soil moisture is adequate throughout the growing season.

Tree color and needle retention are related to needle nitrogen content

The color of Douglas-fir trees corresponds to the total nitrogen content of the needle foliage. When total needle nitrogen values are in the vicinity of 1.0 per cent, tree color is yellow and needle loss occurs. Trees with dark green foliage have total needle nitrogen values in the vicinity of 1.7 to 1.8 per cent.

Consumer acceptance is greatest for trees with dark color. These are the trees with high needle nitrogen content. The buying public does not care for light colored, yellowish green trees. Thus many trees that are otherwise acceptable are discarded or never harvested because
Nitrogen-deficient Christmas trees. Such trees have no sales appeal.

of inadequate color. With fertilizer treatment, most cases of color deficiency can be overcome.

Trees with low needle nitrogen content lose their needles quickly at room temperature. The dark green trees with high needle nitrogen content hold their needles well at room temperature. Needle retention is important to the housewife who dislikes the litter of fallen needles around the Christmas tree.

Many trees produced in the Northwest are marketed in the Southwest. Fertilized trees hold up better during shipment into warm areas than non-fertilized trees.

Tree growth is also related to the supply of available nitrogen

Douglas-fir Christmas trees can grow from 12 to 14 inches per year without becoming too sparse and losing the desired shape. In many
areas, however, the trees fail to grow a foot a year. In some areas, growth is only 3 to 6 inches a year.

The time needed to produce a crop of trees can be greatly reduced by keeping the trees growing as near the allowable maximum of 12 to 14 inches a year as possible. In many cases, this would double the production presently obtained per acre.

For example, if the normal growth rate is 6 inches per year, it will take 12 years to grow 6 feet of tree. With the use of fertilizers, a tree of the same height could be ready for market in seven years.

SOIL TYPES AND PRODUCTION PROBLEMS

Both growth and color may be a problem in the Puget Sound area

Most of Washington's natural stand Douglas-fir Christmas trees are grown on gravelly, droughty, and infertile soils—such as the Everett and similar soil series—in Kitsap, Pierce, and Mason counties.

Christmas trees which are grown on these dry, gravelly soils grow slowly. They develop a desirable dense, bushy appearance without being sheared. However, in some areas, the trees grow too slowly. The laterals grow faster than the leaders and the trees lose the desired conical shape and become flat topped.

In addition, trees grown on these soils are often chlorotic and tend to look more yellow than green. In severe situations, the interior of the trees will defoliate.

Color is the main problem in other areas

The growth rate is not usually a problem in natural stands in such southwest Washington counties as Lewis, Cowlitz, Clark, and Skamania, or in western Oregon. In these areas, leader growth may be from 10 to 20 inches a year and shearing is often needed to keep the trees from becoming too spindly and sparse.

However, the trees may exhibit varying degrees of yellowness over all their foliage or over part of it. As a result, they often have low sales appeal.
Lack of nitrogen can cause needle loss, as shown on the two-year-old segment of this twig. Also note the larger needle size on the current year's growth, the result of fertilizer treatment.

**RATES AND TIMING OF APPLICATIONS**

Nitrogen can greatly improve needle retention and alter color. It will also greatly increase tree growth. Before beginning a fertilizer program, a grower must be certain of his objectives. He must decide whether his problem is one of poor growth, one of inadequate color, or a combination of the two.

**Nitrogen applied three or four years before harvest improves tree growth**

Increased growth in Douglas-fir is easy to achieve by treating the trees with nitrogen. The effect of the treatments will last about four or five years. The exact period of increased growth will depend upon the amount of nitrogen applied and upon growing conditions in the years that follow.

For best results, the fertilizer should be applied between the middle of March and the end of April. Treatments later than May 1 do not
increase growth during the current year. They stimulate the trees to
grow more the following year, with the growth stimulus tapering off
in succeeding years.

Growers who wish to stimulate growth should start their fertilizer
program three or four years before they plan to harvest the trees. This
will allow adequate time for the nitrogen to increase the growth rate
and be completely utilized before harvest.

Nitrogen applications to stimulate growth must be kept small. Large
amounts will overstimulate the trees, even though they are growing on
very infertile and droughty sites. This is true because lack of nitrogen
limits growth more on such sites than lack of water.

The accompanying chart shows the effect of nitrogen treatments on
leader growth and on lateral growth. As nitrogen rates increased, the
leaders were stimulated to grow more than the laterals.
Leader growth at three levels of fertilization. Left—1/2 pound of nitrogen gave too much leader growth, 26 inches. Center—1/8 pound of nitrogen gave 10 inches of leader growth, just the right amount. Right—no fertilizer resulted in too little leader growth, only 4 inches.

The higher rates of nitrogen made the trees open up. They produced long leaders the second season following treatment. The result was a tree with very little consumer appeal. The trees were not desirable from the consumer's viewpoint before treatment either. Before treatment, the laterals were growing more than the leaders. This gave the trees a flat-topped look instead of the desired conical shape. They also had poor color and were losing needles.

The spread between the rate of leader growth and the rate of lateral growth increased as the amount of nitrogen per tree increased. At the highest rate of nitrogen (1 pound per tree), leader growth was 97 percent more than lateral growth. These trees were worthless as Christmas trees. At the lowest rate of nitrogen (1/8 pound per tree), the leaders grew only one-third more than the laterals. This corresponds to the more normal situation and the trees had an acceptable shape.

When fertilized at the rate of 1/8 pound of nitrogen per tree, Douglas-fir can be expected to have an increased growth rate of about
75 per cent. If trees were growing at the rate of 6 inches per year, this would increase their annual growth rate to about 10½ inches, well within acceptable limits.

The amount of nitrogen to be applied to individual trees at various growth rates is as follows:

- **Average annual leader growth without fertilizer**
  - Above 9 inches: none
  - 7 to 9 inches: 1/16 pound
  - 5 to 7 inches: 1/8 pound
  - Less than 5 inches: 3/16 pound

If aerial applications are made on a per acre basis, the rate should be from 50 pounds per acre on the better sites to not more than 75 pounds per acre on the poorer sites.

Fertilizing with nitrogen improves color and increases needle size, as shown on this twig segment with two different years of shoot growth.
Nitrogen applied during May of the year of harvest improves tree color

Often the growth rate is adequate, but color is not. Nitrogen applications made during May allow time for the nitrogen to be taken into the tree during the current season, but do not allow the nitrogen to influence growth during that season. This makes it possible to achieve a marked color change in the trees by harvest time in November without changing the growth rate.

The effect of nitrogen treatments on color is shown in the accompanying chart. Trees rated 1 and 2 on the color scale are worthless as Christmas trees. Such trees are too yellow and the interiors are usually badly defoliated. Color ratings 3, 4, and 5 cover the normal range of Douglas-firs harvested as Christmas trees. Ratings 4, 5, and 6—the green and blue-green trees—are preferred by the public. Trees rated as 3, which tends toward yellow-green, are considered less desirable.
The blue-green rating, number 6, usually occurs only on fertilized trees. Not all Douglas-fir trees in a natural stand are the same color. Some are light, others dark. To some extent, this is due to the fertility and moisture in the root zone of the individual tree. Inherited genetic characteristics also influence tree color. Thus a certain tree may be light in color, while a tree a few feet away with a different parenthood may be naturally much darker. Because of heredity, not all trees will give the same degree of color change from applied nitrogen. Most trees, however, may be expected to change from one to two units on the color rating scale. The larger the amount of applied nitrogen, the greater the degree of color change.

Nitrogen applications to improve color can range from $\frac{1}{8}$ to $\frac{1}{2}$ pound of nitrogen per tree. The amount will depend upon the extent of color change desired. However, any tree receiving more than about $\frac{1}{8}$ pound of nitrogen will be lost as a Christmas tree if it is not har-
vested in the fall following treatment. The nitrogen will force too much leader growth for the tree to have value as a Christmas tree in succeeding years unless the grower is willing to follow up with a shearing program. In general, about 1/8 pound of nitrogen per tree has been enough to improve the color of most trees in average stands.

If the fertilizer is applied by air, a rate of about 100 pounds of nitrogen per acre can be used on trees that will be harvested in the fall.
MATERIALS AND METHODS OF APPLICATION

Granular fertilizer is commonly used and is readily available. Various sources of nitrogen can be used. Ammonium sulfate is especially effective during years of low spring and summer temperatures when organic matter breakdown is slower, inducing both nitrogen and sulfur deficiencies.

The amount of different materials needed to apply various rates of nitrogen and the approximate costs are shown in Tables 1 and 2.

The fertilizer can be applied to the trees as individuals or it can be applied on an area basis.

Fertilizing trees as individuals allows selective application

At the present time, most fertilizer is applied to Christmas trees individually. This allows a grower to be selective as he fertilizes. Only trees with good potential need be treated. And, when fertilizing to improve color, only trees to be harvested during the current year are treated.

Fertilizer can be applied by hand or with a cyclone-type portable spreader. The average application takes about 10 seconds per tree. The fertilizer should be applied evenly over the soil from the base of the tree out to the drip line. In other words, if the branches of the tree spread 4 feet from edge to edge, the fertilizer should be spread in a circular area 4 feet in diameter underneath the tree. If the roots overlap, don’t use the full rate on both trees. Using the full rate on both will give too much nitrogen and overstimulate the trees.

Fertilizing the trees as individuals is advantageous because it requires a low total volume of fertilizer material and allows the material to be used only on trees with good sales appeal.
Fertilizing by area may overstimulate some trees

Trees can also be fertilized on an area basis. This may offer possibilities to large growers interested in aerial application.

Fertilizing by area to improve color requires that a large percentage of the trees be the same size and ready to market the same year. If this is not the case, overstimulation of trees not ready for market may cause considerable loss. Fertilizing by area to correct color will probably be limited to specific situations unless growers change from their present management practices to a rotation pattern based on clear-cutting.

Fertilizers will also stimulate brush growth. This is a greater problem in area fertilization than in fertilizing selected trees.

Table 1—APPROXIMATE AMOUNTS OF FERTILIZER NEEDED TO APPLY VARIOUS RATES OF NITROGEN

<table>
<thead>
<tr>
<th>Sources of Fertilizer Nitrogen</th>
<th>Pounds of Nitrogen (N) Desired Per Tree</th>
<th>Pounds of Nitrogen (N) Desired Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/16 1/8 3/16 1/4</td>
<td>50 75 100</td>
</tr>
<tr>
<td>Ammonium Sulfate (21% N)</td>
<td>5 10 15 20</td>
<td>240 360 480</td>
</tr>
<tr>
<td>Ammonium Nitrate (33% N)</td>
<td>3 1/2 7 101/2 14</td>
<td>150 225 300</td>
</tr>
<tr>
<td>Urea (46% N)</td>
<td>2 4 6 8</td>
<td>110 165 220</td>
</tr>
</tbody>
</table>

* A pint of dry fertilizer weighs approximately 16 ounces. Thus 8 ounces of urea would be 1 cup; 4 ounces, 1/2 cup; etc.

Table 2—APPROXIMATE COSTS OF FERTILIZER MATERIALS AT VARIOUS RATES OF NITROGEN*

<table>
<thead>
<tr>
<th>Sources of Fertilizer Nitrogen</th>
<th>Pounds of Nitrogen (N) Applied Per Tree</th>
<th>Pounds of Nitrogen (N) Applied Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/16 1/8 3/16 1/4</td>
<td>50 75 100</td>
</tr>
<tr>
<td>Ammonium Sulfate (21% N)</td>
<td>0.9 1.8 2.7 3.6</td>
<td>7.15 10.72 14.30</td>
</tr>
<tr>
<td>Ammonium Nitrate (33% N)</td>
<td>0.8 1.6 2.4 3.2</td>
<td>6.55 9.83 13.10</td>
</tr>
<tr>
<td>Urea (46% N)</td>
<td>0.7 1.4 2.1 2.8</td>
<td>5.65 8.48 11.30</td>
</tr>
</tbody>
</table>

* Based on fertilizer prices as of January, 1966.