Crop Profile for Christmas Trees in Oregon and Washington

Prepared: October, 1998
Revised: January, 1999

General Production Information

1997 Facts At A Glance¹

Acres of Trees

- Oregon - 57,000 farm; 3,400 natural stands
- Washington - 23,000 farm; 29,000 natural stands
- Nationally - 1 million

1997 Harvest

1. Oregon - 8.0 million trees
2. North Carolina - 4.5 million
3. Michigan - 4.5 million
4. Washington - 3.8 million
5. Wisconsin - 3.0 million
6. Ohio - 1.0 million

1997 Harvest Nationally

- 34 - 36 million trees

The Crop Profile/PMSP database, including this document, is supported by USDA NIFA.
Crop Value
*(based on conservative $12 average wholesale price of a tree)*

- Oregon - $96 million
- Washington - $45 million
- Nationally - $360 million

Production of Trees in the Pacific Northwest

- Douglas-fir - 50 percent
- Noble fir - 40 percent
- Grand fir - 7 percent
- Pine - 1 percent
- All others - 2 percent (Fraser fir, Nordmann fir, Concolor fir, Shasta fir, Silver fir, Balsam fir, Turkish fir, Colorado blue and Norway spruce)

Average Years to Produce a 6-foot Tree in the Pacific Northwest

- Douglas-fir - 7 years
- Pine and Grand fir - 8 years
- Noble fir - 9 years
- Concolor fir - 12 years

Number of Growers in the Pacific Northwest

- Oregon - 950
- Washington - 425

Counties with Greatest Production in the Pacific Northwest

- Oregon - Benton, Clackamas, Marion, Polk, Yamhill
- Washington - Kitsap, Lewis, Mason, Thurston
Export of Pacific Northwest Trees

- Some 90 percent of all Pacific Northwest Christmas trees are exported out the region.
- California is the Pacific Northwest's largest market.
- Overseas and foreign markets include: Japan, China, Hong Kong, Phillipines, Hawaii, Alaska, Mexico, Guam, Puerto Rico, Samoa.

1 Source: Pacific Northwest Christmas Tree Association

Introduction(1)

Christmas tree plantations developed early this century out of the conservation movement. Cutting Christmas trees was looked upon as one of the major contributing factors to the degradation of the national forests. Out of this situation, the idea of growing Christmas trees as a farm crop was born. In the 1940s, growers in Washington and Oregon began to prune Douglas-fir. This improved the salability of the trees and was the beginning of shaping trees. Automated tree handling at the source point began in the 1950s with the introduction of conveyor belts and balers. Pruning, fertilizing, and apply pesticides raised the quality of the Douglas-fir tree. Flocking, introduced in 1958, was especially successful with Scotch pine, which in 1964 was the best selling Christmas tree nationally. Douglas-fir was second.

I. Production (3)

Counties with Christmas tree Plantations in Washington State.
Of the half billion trees growing in 43 states, 35 million trees are harvested each year in the United States. About 7,500 year-round workers plus 100,000 part-timers are needed to plant and tend these trees. It takes constant and skilled care for 7-12 years to produce a salable, high-quality Christmas tree. Christmas tree production is a multi-million dollar industry that requires year-round management efforts. These trees represent the annual harvest of an estimated 20,000 individual growers who annually plant, trim, protect and otherwise manage trees on roughly 500,000 acres of plantations. More than 15 different conifer species are grown for Christmas trees. Christmas tree production is a significant industry in the Lake States, the Pacific Northwest, North Carolina and areas in the Northeast. Traditionally, growers in these regions supply about 90% of all trees offered for sale at retail outlets. In 1997, the Pacific Northwest growers harvested over 12 million trees, while those in the Lake States of Michigan, Wisconsin and Minnesota harvested 8 million. About 4.5 million were harvested in North Carolina and 1 million in Ohio. Over all, Oregon produced the greatest quantity of trees valued at nearly $100 million and Washington produced $45 million. Nationally, growers produced trees valued at $360 million. (2)

**Acres of Oregon Christmas Tree**

Olive green: >10,000
Kelly green: 1,000 to 10,000
Aqua green: 100 to 1,000

Christmas trees are produced by two principal types of
operations; "wholesale" or "choose-and-cut" plantations. Most trees offered for sale at retail outlets such as garden centers, nursery stores, high volume discount stores and lots operated by service clubs, were produced by wholesale growers. These are individuals or companies that operate and manage large plantations of trees. They may sell trees either directly to retail outlets or to "brokers" who in turn market trees to retailers. Some large operations may sell 100,000 trees or more each year.

Choose-and-cut operations are usually smaller plantations that manage and produce trees for direct sale to consumers. These operations invite customers out to their fields and will either cut the trees for the purchaser or allow the customer to cut his/her own trees. Many choose-and-cut operations enhance the experience of getting a christmas tree by providing a variety of recreational activities for customers. Choose-and-cut farms are found in every state and are often concentrated near large population centers. These operations vary considerably with regard to the species and quality of trees produced, and the services offered.

Christmas tree production is a long-term process. The average 7 to 8 foot tree generally requires 7 to 8 years of growth after planting. Some species require even longer production times. Likewise, larger-sized trees which are becoming increasingly popular, require more years to produce. A major challenge for Christmas tree producers is to determine which tree species will be popular with consumers several years in the future. Although several species are utilized as Christmas trees, the majority of trees sold at retail markets today are Douglas-fir, Fraser fir, noble fir and Scotch pine. Species such as white spruce, Austrian pine and red pine are no longer as popular as they were in the past. Producers who are not sensitive to shifts in consumer preference will have difficulty marketing even high-quality trees of less preferred species.
Cultural Practices

Each component of Christmas tree production must be addressed from the standpoint of maximizing both productivity and quality. Failure to appreciate or deal appropriately with any aspect can result in management difficulties, pest problems, or production of low-quality trees which are difficult to sell in competitive markets.

Not all species used for commercial Christmas tree production grow equally well on all sites. Factors such as soil texture and fertility, water availability and air drainage will affect growth rates and tree quality. In general, true firs and Douglas-fir require better quality sites than pines and spruces. Species that are planted "off-site" will frequently experience stressful conditions. These trees are more likely to be attacked by insect or disease pests, and will be less likely to tolerate or recover from pest damage, than healthier trees.

In the past, Christmas tree plantations were sometimes established with little or no site preparation other than removal of competing woody vegetation. Survival and success of these plantations were mixed. Where site preparation was minimal, pines were easier to produce than spruces or firs. Modern Christmas tree operations often spend much effort in site preparation activities including tillage, use of cover crops and soil fertility enhancement. These efforts pay off in higher seedling survival, fewer pest problems on young trees, more rapid initial growth and an overall increase in tree quality.

Most conifers planted for Christmas tree production require 7 to 10 years to reach maturity, depending on the species, the size of trees produced, and the intensity of management. Pines generally can be produced faster than spruce or fir trees, although size of planting stock, soil fertility and water availability can significantly affect rotation length. Damage from insect or disease pests that affect tree appearance, form or growth rate, can increase rotation length and production costs. Even after a pest population is controlled, trees may require 1 to 3 years to outgrow or recover from the damage.

Most Christmas tree plantations are established using planting machines. Christmas trees are planted in the late winter and early spring. Most growers do not have a grass cover crop, although a few of the smaller ones do keep a mulch grass or living sod. Seedlings may be planted by hand on adverse sites or to fill in plantations where mortality occurred in previous years. Nearly all growers plant 2 to 4-year-old seedlings or 3 to 5-year-old transplants in early to mid-spring. A few growers may produce their own planting stock, but the majority of producers purchase stock from private seedling-transplant nurseries. Pests, particularly diseases, may be transported on infested nursery stock. Purchasing stock from reputable dealers or buying inspected and certified stock can help prevent establishment of new pest problems. Tree-growing operations use fertilizers to increase growth, and to improve the trees' vigor, color and needle density. If any of these factors is not adequate, or if trees are spindly and off-green, fertilization is needed.

Christmas trees are typically sheared or shaped each year, beginning 2 to 3 years after planting, and
continuing on through harvest. Shearing accomplishes two goals. First, shearing develops the characteristic tapered shape associated with high-quality Christmas trees. Second, shearing controls the amount of annual growth and in some species, increases bud set. This results in greater density and uniformity of the foliage. Timing of shearing depends on the species of conifer. Pines are usually sheared during June and July; shearing of other species usually begins in August and continues until finished in the fall. Shearing can affect pest infestation or damage. For example, tight shearing can result in very dense crowns with little air circulation. This situation can lead to problems with needlecasts or other foliage diseases. Effectiveness of insecticide or fungicide applications may be poor if sprays do not penetrate the dense outer canopy. On the other hand, shearing can remove much of the damage caused by shoot-boring insects, Pales weevil (Hylobius pales) and other pests. A good understanding of potential pest problems as well as consumer preferences, should help growers develop suitable shearing practices.

In late summer, trees with that will be harvested that year are identified and marked with tags or flagging. Many growers spray trees with a water-soluble green latex pigment in August or September. The green paint is applied to mask the characteristic yellowing of foliage which commonly occurs in some varieties of Scotch pine, eastern white pine and Douglas-fir. Needles begin to turn yellow in fall, in response to shorter photoperiod and cooler temperatures. In the 1980s, large growers began to use helicopters to harvest their trees, because wet soils in the winter prevented road vehicles from entering the fields.

Actual harvesting begins in late October and will continue on through mid-December. After cutting, trees are shaken to remove dead foliage and debris, then baled with string or net. Trees are then transported from the plantation to a storage or loading yard where they will be stored until shipment. Shipment to retail centers and stores is usually well underway by November 18 to 20.

**Insect Pests**

Damage from insect and disease pests can lead to dead branches or terminal leaders, and some pests will kill trees. Loss of needles or shoots due to disease or defoliating insects will reduce tree growth, resulting in longer rotation times and economic loss. Aesthetic injury is probably the most common damage caused by pests. Christmas tree value is based largely on the appearance of the tree and its attractiveness to potential customers. Missing or dead foliage, a crooked stem or tiny white scales on the foliage will reduce the value of the tree or even make the tree unsalable. Needlecast diseases or defoliating insects such as sawflies cause needle loss. This injury can lead to reduced growth rates and thin, unattractive canopies. Loss of current-year needles, where nutrients are concentrated, usually has greater effects on tree health and appearance than loss of older foliage. In IPM, the Economic Injury Level (EIL) and Action (or Economic) Threshold (AT) are used to determine if and when pest control measures are needed. Unfortunately, few thresholds have been developed for Christmas tree pests. The difficulty of establishing an EIL or AT for any given pest arises from several factors. These factors include the difficulty of 1) quantifying aesthetic injury, 2) determining the economic costs of that injury...
and 3) relating pest density to levels of aesthetic injury. However, the concept of an Action Threshold remains valid and is incorporated into pest management recommendations wherever possible. One factor that affects pest management decision-making is the type of damage caused by the pest. Another important factor is how soon the trees will be harvested. A third factor affecting an AT is how long it will take the tree to recover from pest damage.

Ideally, pest management should be incorporated into all aspects of Christmas tree production, from site preparation to harvest. It is especially important to select a tree species that is well-suited for the site conditions in the field. Trees growing under stressful conditions are usually more susceptible to insect and disease pests and recover more slowly from damage. Irrigation and fertilization may effectively reduce stress and increase tree vigor. The importance of scouting, the practice of inspecting trees for evidence of pest infestation or damage, cannot be underestimated. Frequent and regular scouting will enable growers to detect signs or symptoms of pests before economic damage occurs. Signs include the physical evidence of pest presence such as insect frass or cast-off skins, pitch flows, or the fruiting structures of disease organisms. Symptoms refer to evidence that the tree has been affected by insect or disease attack.

Natural enemies often play an important role in reducing potentially damaging insect populations in Christmas tree fields. Fields managed on 6 to 12 year rotations are more likely to provide stable habitat for beneficial arthropods than agricultural systems where fields are harvested annually. Further, trees are more structurally complex than most agricultural plants. Trees can provide beneficial arthropods with resting or oviposition sites, and protection from adverse weather. Hedgerows along field edges that include flowering plants may enhance the fecundity or survival of parasitoids.

Common and important natural enemies in Christmas tree fields include spiders, flower fly larvae, lacewings and predatory mites. Ladybird beetle larvae and adults are especially important predators of aphid and scale insects. In addition, many insect pests are attacked by specialized parasitoids. Obviously, it is important to minimize insecticide use and drift to help conserve these natural enemies. Biocontrol in Christmas tree production probably holds more potential than is currently being realized. There is a scarcity of information on effectiveness of biocontrol agents, and the proper timing and density for agents that will be released in fields. To-date, there are few specialized biocontrol agents for Christmas tree pests available commercially.

Use of insecticides, fungicides, herbicides and rodenticides is common in Christmas tree production.
Application technology varies widely among growers, depending on the size of the operation. Many growers use air blast sprayers, but backpack sprayers, boom sprayers and airplane or helicopter application are not uncommon. Minimizing pesticide applications makes sense for both economic and environmental reasons, and makes it easier to integrate pesticides with other management strategies. Timing of pesticide application can have major effects on efficacy. Growers are encouraged to use scouting to determine when the vulnerable stage of the pest is present. Using degree days, rather than calendar days, can also improve the timing of pesticide applications. Degree days accumulate rapidly during warm weather and more slowly when temperatures are cool. Achieving adequate coverage is another concern when spraying conifer trees. Dense foliage, particularly on sheared trees, often makes it difficult to get good coverage.

When exotic (non-native) pests are discovered, federal and state quarantines may be enacted to limit the spread of the pest. Quarantines are intended to provide a legal means of reducing the risk that exotic pests will be carried along when Christmas trees (or other plants) are shipped to areas not yet infested. However, quarantines often represent a major challenge to IPM. Most quarantines restrict out-of-state shipment of trees if even a single pest is present.

**Integrated Pest Management in Christmas Tree Production (3,4)**

**Swiss Needle Cast**

*Douglas fir*

Major Pests: Rhabdocline needlecast (*Rhabdocline pseudotsugae*), Swiss needlecast (*Phaeocryptopus gaumanni*), Cooley's spruce gall adelgid (*Adelges cooleyi*)

This species is native to western regions of the United States and Canada and is widely planted in the Lake States and northeast. Because Douglas-fir breaks bud early in the spring, it must be planted on sites with good air drainage to prevent injury from late spring frosts. Douglas fir does best on well-drained, loam to sandy loam soils and will grow rapidly once it is established. It will not tolerate heavy soils which are poorly drained. Needle retention is generally good, although trees that have not experienced freezing temperatures before harvest may loose some needles during the display period.

**Lophodermium Needle Cast**
True Firs

Major Pests: Balsam twig aphid (*Mindarus abietinus*), Spruce spider mites (*Oligonychus ununguis*), Balsam gall midge (*Paradiplosis tumifex*), Lirula needlecast (*Lirula sp.*)

- Fraser fir: Closely related to Balsam fir, Fraser fir is native to high elevations in the southern Appalachians, but has been widely planted in other production areas. Fraser fir requires ample soil moisture and fertility, and a soil pH of less than 6.5. It will not grow in very wet or dry locations. Fertilization and sometimes irrigation are frequently used in well-managed plantations. Because of its excellent needle retention, attractive aroma, straight stem and dark green-silvery blue needles, the popularity of this species among consumers has increased tremendously in recent years. It is now widely recognized as a premier Christmas tree species and is one of the most popular species among both growers and consumers.

Rhabdocline Needle Cast

- Balsam fir: Native to the northeastern United States and adjacent Canada, balsam fir has been long used as a Christmas tree. Like all firs, its soft, fragrant foliage is prized by consumers. For many years wild balsams were harvested from natural stands and marketed throughout the northeastern United States. Most trees are now harvested from plantations located in New England and much of Quebec and the Maritime provinces of Canada. Growth is best on loam soils which are well-drained. This species responds well to fertilization and intensively managed plantations regularly supply trees with nitrogen fertilizer to promote growth and enhance foliage quality. Balsam fir foliage is often used for wreaths, garland, and other Christmas greenery.

- Concolor fir: Native to states in the Rocky mountains and intermountain west, Concolor or white fir is an important timber species throughout much of its range. However, because of its attractive bluish-green needle color and soft foliage it has been planted as both an ornamental and a
Christmas tree. Concolor fir is adapted to a wide variety of sites and soils. It will tolerate fairly dry sites, especially after it is well-established, and also grows well under varying soil pH conditions.

- Noble fir: Noble fir has become a popular Christmas tree and is produced primarily in the Pacific Northwest. This species is known for its excellent needle retention and symmetrical branching habit. Within its native range, Noble fir grows at elevations ranging from 2000 to 5000 feet above sea level. Efforts to grow this species outside of its native range have met with limited success, especially in the Lake States and northeastern United States. Some efforts are underway to identify seed sources which might prove hardy outside the region. Because of its popularity among consumers, many trees of Pacific Northwest origin are sold throughout the central and eastern United States.

Spruces

Major Pests: White pine weevil (Pissodes strobi), Cooleys spruce gall adelgid, Pine needle scale (Chionaspis pinifoliae), Rhizosphaera needlecast (Rhizosphaera kalkhoffii), Cytospora canker (Cytospora kunzei)

- Colorado blue spruce: This species is planted extensively throughout much of the United States. Although native to the central Rocky Mountains, it is adaptable to a wide variety of sites and soils. Colorado blue spruce is more popular in choose-and-cut operations than in large wholesale plantations, largely because of lack of consumer demand at the retail level. While its foliage is attractive, the stiff, sharp needles make for difficulty in handling and display. Needle retention is generally better than other spruce species.
• White spruce: For many years white spruce was a favorite species of many eastern growers. It is adaptable to diverse planting sites throughout much of the Lake States and northeastern United States. Its tendency to grow into a tree with a "natural" Christmas tree shape contributed to its popularity because only a minimal amount of shearing and shaping was required to produce a quality tree. However, its popularity has declined in the last several years due primarily to its reputation for poor needle retention. The small, short needles have a tendency to dry rapidly when the tree is displayed in a heated room with low humidity. A variety known as Blackhills Spruce has better needle retention characteristics and continues to be planted by a few growers.

Pacific Northwest Growers Pesticide Use and Tree Damage Survey

In 1994, the PNWCTA and Oregon State University conducted a survey on the use of pesticides on Christmas trees in Oregon and Washington. The following data was extrapolated from the survey results of 20 percent of the acres planted. Additional information was appended to the survey from grower and pesticide fieldmen interviews given in 1997 and 1998. In general, 94% of the responding growers scouted tree plantations for insects, disease or weeds present; 88% consulted with an agricultural consultant or County Agent; 73% examined trees for spider mites; 71% alternated herbicides from year to year; 60% set out insect traps to monitor needle midge abundance; and 58% planted seedling trees from a superior seed stock.

Insect Pests Of Christmas Trees In The Pacific Northwest

Serious insect problems can be avoided by combining mechanical, biological and chemical controls. Native conifers planted at elevations lower than where they normally grow can suffer from too much or too little moisture, soil compaction, alkalinity, and exposure to sun and wind. Trees that become stressed or weakened by any of these conditions are attractive hosts for many insects. Watching for and correcting environmental stresses can prevent or reduce many insect problems listed below (1,3,4,5,11,12,13,15,16,17).

PACIFIC NORTHWEST

PACIFIC NORTHWEST SURVEY

Douglas-fir conifer aphids (Cinara spp.); True Firs: Balsam Twig Aphid Damage
The aphids that infest Douglas fir are large insects, up to 1/5" long. They may range in color from gray to brownish to dark. The aphids establish large colonies on the twigs, but are rarely found feeding on needles. Large amounts of honeydew (a sticky material) are secreted, often attracting ants. The honeydew may become covered with a dark growth of sooty mold. Aphid feeding on Douglas fir may cause distorted stems or stunted growth.

**Percentage Yield Loss without Control**

Aphids reduce the value of harvested trees by about $110,000 each year. The value of trees destroyed by aphids each year is over $39,000.

**Cultural Controls**

Provide proper culture for trees. Healthy plants are able to tolerate large aphid infestations with relatively little damage. Decrease amount of nitrogen available to discourage aphid reproduction. Use a slow-release or lower-nitrogen fertilizer formula. Wash aphids from trees with a strong stream of water. Encourage aphid-eating insects such as ladybird beetles and green lacewings. Avoid using broad-spectrum insecticides which kill these beneficial predators.

**Chemical Controls in Oregon**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorpyrifos</td>
<td>1.0 qt/acre</td>
<td>good</td>
<td>2,900</td>
<td>6%</td>
</tr>
<tr>
<td>malathion</td>
<td>1.0-3.0 pt/acre</td>
<td>fair</td>
<td>35</td>
<td>1%</td>
</tr>
<tr>
<td>oxydemeton-methyl</td>
<td>1.0-2.0 pt/acre</td>
<td>good</td>
<td>3,500</td>
<td>7%</td>
</tr>
<tr>
<td>endosulfan</td>
<td>1.0-2.0 lbs/acre</td>
<td>good</td>
<td>9,300</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Chemical Controls in Washington**

<table>
<thead>
<tr>
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<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>oxydemeton-methyl</td>
<td>1.0-2.0 pt/acre</td>
<td>good</td>
<td>2,190</td>
<td>11%</td>
</tr>
<tr>
<td>endosulfan</td>
<td>1.0-2.0 lbs/acre</td>
<td>good</td>
<td>820</td>
<td>4%</td>
</tr>
<tr>
<td>diazinon</td>
<td>1.0-2.0 lb/acre</td>
<td>good</td>
<td>100</td>
<td>&lt;1%</td>
</tr>
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**PACIFIC NORTWEST**

**Douglas-fir coneworms (Dioryctria spp.)**

**Damage**
Coneworms attack Douglas fir by boring into shoot tips or stems, especially around wounds, and feeding on the soft bark tissues. The portion of the branch beyond the injured point may die back. Coneworms may also bore into green cones, feed on the soft bark of young growth, or feed inside the bark on the trunk. The coneworms are small and cream-colored or light brown with a darker head. The adult coneworm is a mottled gray moth. Coneworms also attack pines, hemlocks, true firs, and spruces.

**Percentage Yield Loss without Control**
Unknown

**Cultural Controls**
Remove and destroy infested cones and twigs when possible. Plant non-susceptible conifers where coneworms are a serious pest.

**Chemical Controls**

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>none in survey</td>
<td></td>
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Applications must be made before eggs hatch and larvae tunnel into stem.

Experience has shown that wide-scale use of long-residual pyrethroids, like Pydrin and Asana are associated with subsequent spider mite outbreaks. You should therefore monitor fields closely following the use of these materials. Research has indicated poor performance of certain pyrethroids when applied by aerial application. Until further results are obtained, make pyrethroid applications by ground application. (PNW Handbook)

**PACIFIC NORTHWEST**

**Douglas-fir: Cooley spruce gall adelgid (spp.) ; Pines: Pine Bark Adelgid ; Fir: Balsam Woolly Adelgid**

**Damage**
This aphid-like insect feeds at the base of newly growing needles. Adelgids appear as woolly or cottony tufts on the needles, with heavily infested trees appearing "frosted" or flocked. Small purplish insects are found underneath the cottony tufts. Adelgid feeding can cause needles to become distorted or bent and yellowed. Infested needles sometimes drop prematurely. Once galls begin, their formation is irreversible. Light infestations can be hand pruned as galls form. This pest is a serious concern in Christmas tree plantations. Cooley spruce gall adelgids also infest spruces, but cause distinctive galls on spruce that are not seen on Douglas fir.

**Percentage Yield Loss without Control**
Unknown

**Cultural Controls**
Blue spruce and Douglas fir should not be planted together because the Cooley spruce gall adelgid needs both tree species to complete its life cycle.

### Chemical Controls in Oregon

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<tr>
<td>chlorpyrifos</td>
<td>1.0 qt/acre</td>
<td>good</td>
<td>2,900</td>
<td>6%</td>
</tr>
<tr>
<td>endosulfan</td>
<td>1.0-2.0 lb/acre</td>
<td>good</td>
<td>9,300</td>
<td>20%</td>
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### Chemical Controls in Washington

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<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorpyrifos</td>
<td>1.0 qt/acre</td>
<td>good</td>
<td>200</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>endosulfan</td>
<td>1.0-2.0 lb/acre</td>
<td>good</td>
<td>1,350</td>
<td>7%</td>
</tr>
</tbody>
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Apply to control crawler stage, usually when new growth is expanding in the spring.

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**PACIFIC NORTHWEST**

**Douglas-fir: Douglas-fir needle midge (*Contarinia* spp.)**

**Damage**

The tiny white larvae of the Douglas fir needle midge mine the inside of needles, which become yellowed and distorted. Infested needles often have a sharp bend at the injury site. Three different midges infest Douglas fir: one species feeds near the needle base, one feeds near the tip of the needle, and the third feeds near the middle. Damaged needles often drop from the tree, and heavy midge infestations can cause severe defoliation. The midges pupate in the ground, with the adults emerging around bud-break in the spring. The adult Douglas fir needle midge is a small fly. This can be a serious pest in Christmas tree plantations. The Douglas-fir needle midge was first recognized as a Pacific Northwest Christmas tree pest in 1954, and by the 1960s, it was a serious cause of distorted needles. Thiodan has been the standard treatment for this fly.

**Percentage Yield Loss without Control**

Needle midges reduce the value of harvested trees by about $763,000 each year. The value of trees destroyed by midges each year is over $634,000.

**Cultural Controls**

Where practical, prune out heavily infested twigs. Use emergence traps on the ground to catch adults. This will help determine the need for control.

**Chemical Controls in Oregon**
Pesticide | Rate | Efficacy | Acres Treated | Percent Treated
--- | --- | --- | --- | ---
diazinon | 1.0-1.5 pt/acre | good | 100 | 1%
endosulfan | 1.0-2.0 lb/acre | good | 9,300 | 20%
oxymethon-methyl | 1.0-2.0 pt/acre | fair | 3,500 | 7%
chlorpyrifos | 2.0 pt/acre | good | 2,900 | 6%

**Chemical Controls in Washington**

| Pesticide | Rate | Efficacy | Acres Treated | Percent Treated
--- | --- | --- | --- | ---
endosulfan | 1.0-2.0 lb/acre | good | 500 | 3%
chlorpyrifos | 2.0 pt/acre | good | 200 | 1%

Base applications on adult needle midge trap catch and timed to coincide with adult emergence.

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**PACIFIC NORTHWEST**

**Douglas-fir: Douglas-fir Tussock Moth (spp.)**

**Damage**

Douglas fir tussock moth larvae start at branch tips at the top of the tree and work down, feeding mainly on the new foliage and causing severe defoliation. They may be found under webbing on the branches. Severe tussock moth outbreaks are very sporadic and last usually around three years before subsiding. The larvae feed on the needles of Douglas fir, spruce, pine, larch, and true firs. They feed mainly on forest trees and are infrequent pests in the landscape. The caterpillars are distinguished by three long tufts of black hairs on their body (two in front, one in back) and lighter tufts along their back. The hairs from tussock moth caterpillars break off easily and may cause skin or respiratory irritation.

**Percentage Yield Loss without Control**

Unknown

**Cultural Controls**

Parasites and other natural controls keep this pest in check most of the time. Prune and destroy (burn, if possible) heavily infested branches. Hand-pick caterpillars only with gloves.

**Chemical Controls**

| Pesticide | Rate | Efficacy | Acres Treated | Percent Treated
--- | --- | --- | --- | ---
no survey data
Apply to control young larvae when present and feeding

PACIFIC NORTHWEST
Douglas-fir: Spruce Spider Mite (*Oligonychus ununguis*); Eriophyid Needle Mites

**Damage**
The presence of spruce spider mites is indicated by yellow or bronzish stippling beginning near the needle bases. Infestations usually begin on older needles of the lower branches and spread upwards as the mite population increases. Damaged needles may turn brown or reddish-brown. Fine webbing may cover the needles and twigs. The actual spider mites are very small and vary in color from greenish to orange, dark green, or black, with orange legs. Spruce spider mites attack many species of conifers. They are easily spread by wind. These mites are often worst on dusty roadside trees.

**Percentage Yield Loss without Control**
Spider mites reduce the value of harvested trees by about $563,000 each year. The value of trees destroyed by spider mites each year is over $82,000.

**Cultural Controls**
Spider mites are probably controlled naturally by predatory mites and rain. Try to avoid broad-spectrum insecticides that will kill predatory mites and insects and allow a spider mite population explosion. Hose trees with strong stream of water to wash off spider mites (where practical).

**Chemical Controls in Oregon**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>fenbutatin oxide</td>
<td>2.0 pt/acre</td>
<td>good</td>
<td>250</td>
<td>1%</td>
</tr>
</tbody>
</table>

**Chemical Controls in Washington**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>fenbutatin oxide</td>
<td>2.0 pt/acre</td>
<td>good</td>
<td>120</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>oxydemeton-methyl</td>
<td></td>
<td>fair</td>
<td>90</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>endosulfan</td>
<td></td>
<td>fair</td>
<td>120</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Ground applications for the eriophyid mites should be made at high pressure to insure penetration of material under needle and bud scales. Use of spray oils may be beneficial.

PACIFIC NORTHWEST
Strawberry Root Weevil (*spp.*); White Pine Weevil
**Damage**

Strawberry root weevil larvae are crème-colored, "C" shaped grubs that feed on roots, sometimes girdling them. Adults feed on needles, resulting in characteristic notching. White pine weevils are a small brown weevil with the snout typical of other weevils. Wing covers are marked with irregular patches of brown and while scales. They are Important pests of spruce and pine and occasionally of Douglas-fir.

**Percentage Yield Loss without Control**

Unknown

**Cultural Controls**

none effective

**Chemical Controls**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>none in survey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For strawberry root weevil, controls should be directed at adult weevils. Time applications to coincide with adult feeding and oviposition. Adults are active at night. For while pine weevil, applications to the tops to control egg-laying weevils begin as weather warms in spring. Several applications spaced 3-4 weeks apart may be necessary.

**PACIFIC NORTHWEST**

**Spruce Budworm**

**Damage**

Budworms are green-brown larvae up to 1 inch long. They feed on foliage and buds of fir, spruce and Douglas-fir.

**Percentage Yield Loss without Control**

Unknown

**Cultural Controls**

**Chemical Controls in Oregon**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorpyrifos</td>
<td>1.0 qt/acre</td>
<td>good</td>
<td>2,900</td>
<td>6%</td>
</tr>
</tbody>
</table>

Apply controls from May to June or when bud flush is at 90 to 95% and new growth is ¾ to 1 inch long. Pay particular attention to areas adjacent to infested forest land. Two applications may be necessary.
PACIFIC NORTHWEST

Europen Pine Shootmoth

Damage
Larvae will stunt and deform stems, especially terminals.

Percentage Yield Loss without Control
Unknown

Cultural Controls

Chemical Controls in Oregon

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>dimethoate</td>
<td>2.0 pt/acre</td>
<td>good</td>
<td>1,200</td>
<td>3%</td>
</tr>
</tbody>
</table>

Cover the branch terminal ends at the time of egg laying and egg hatching.


PACIFIC NORTHWEST

Black Pineleaf Scale (Nuculaspis californica); PineNeedle Scale (Chionaspis pinifoliae)

Damage
Scale suck plant juices. Trees lose needles and the general appearance can make them unsaleable

Percentage Yield Loss without Control
Unknown

Cultural Controls

Chemical Controls

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>none in survey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Overwintering, immature scales can be killed by spraying trees with dormant or superior oil before buds break. Dormant oils should not be used after buds begin expanding, and improper use of oils can cause injury to foliage. Dormant oils may remove the waxy bloom on blue spruce, causing discolored foliage. Insecticide sprays are most effective against the crawler stage of scale insects. Repeated applications, usually at 7- to 10-day intervals, will give coverage through an egg-hatch cycle.

Diseases
Christmas trees occupy a unique niche, incorporating aspects of both agricultural production and forestry. Insect and disease pests can have major effects on tree growth, appearance and value. Managing these pests, along with weeds and even rodents, is a critical component of tree production. But the most critical threat is usually disease. Diseases affecting trees in their natural settings may be relatively harmless, but in intensively managed nurseries and plantations, they can have a devastating impact. Disease can reduce growth, produce unsightly foliage, increase susceptibility to insects and other diseases, and even kill trees (8). Outlined below are the major disease management control methods used in the Pacific Northwest (1,9,10,14).

**PACIFIC NORTHWEST**

**Swiss Needle Cast (Phaeocytopus gaumannii)**

**Damage**

Swiss needle cast is the most common disease of Douglas-fir Christmas trees produced in the Pacific Northwest. The presence of infected needles on healthy appearing infected trees also caused them to dry out twice as fast as healthy trees once they were cut. Thus controlling this disease not only increases the marketability of trees at harvest, it also improves the post harvest quality of cut trees which is very important in today's competitive market. If fungicides were not available to control this disease, there is no reason to believe that within a few years losses would not approach the levels seen in the early 1980s (18).

The browning and early needle loss caused by this fungus result in thin-foliaged trees that are unfit for sale. The 2- and 3-year-old needles, especially on the lower branches, brown up during July and August and fall off in late August. Rows of fuzzy, black, fruiting bodies in tiny, pore-like openings (stomata) can be seen on the undersides of both green and discolored needles during most months. Swiss needle cast is favored by high humidity. Severe infected trees will have only current year's needles.

**Percentage Yield Loss without Control**

Total needle cast damage reduces the value of harvested trees by about $518,000 each year. The value of trees destroyed by all needle cast diseases each year is over $245,000. Extensive surveys in the early 1980s before fungicides were being used to control this disease, showed that this disease was causing an estimated $3.4 million dollar annual loss because of premature needle loss prior to harvest. (18)

**Cultural Controls**

Avoid planting in low-lying areas with poor air drainage. Space plants for good air circulation. Control weeds around the bases of trees.

**Chemical Controls - Oregon**
<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorothalonil</td>
<td>2.25-4.5 lbs/a</td>
<td>good</td>
<td>10,000</td>
<td>21%</td>
</tr>
<tr>
<td>triadimefon</td>
<td>4.0 lb/acre</td>
<td>good</td>
<td>315</td>
<td>1%</td>
</tr>
</tbody>
</table>

**Chemical Controls - Washington**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorothalonil</td>
<td>2.25-4.5 lbs/a</td>
<td>good</td>
<td>3,000</td>
<td>15%</td>
</tr>
</tbody>
</table>

Swiss needle cast damage cannot be predicted, trees must be sprayed with a protectant. Fungicides are not needed the first few years a Christmas tree is in the ground. Begin spraying 3 years prior to harvest. When needed, make a single application when new growth in the spring is 1 to 2 inches in length.

Chlorothalonil is the primary fungicide used to control this disease. The alternatives, Mancozeb and benomyl, are effective when applied from the ground under low to moderate disease pressure. According to WSU research, only chlorothalonil at the maximum rate (5.5 pts./A) controls Swiss Needle Cast under high disease pressure, or from the air (18).

**PACIFIC NORTHWEST**

**Rhabdocline Needle Cast**

**Damage**

The greatest losses are the results of the unsightliness of diseased trees which renders them unsaleable. Severe losses also occur from the less conspicuously affected trees whose needles discolor and drop during transit and marketing.

**Percentage Yield Loss without Control**

Total needle cast damage reduces the value of harvested trees by about $518,000 each year. The value of trees destroyed by all needle cast diseases each year is over $245,000.

**Cultural Controls**

Good air circulation is important in disease prevention. Do not plant in areas with poor drainage and space plantings to provide good air circulation. Remove weeds around trees, thin canopy, and prune lower branches to reduce humidity around tree. Seedlings from east of the Cascade Range are more susceptible than those from the western side.

**Chemical Controls - Oregon**
Pesticide controls for Lophodermium Needle Cast in Christmas tree plantations.

### Chemical Controls - Washington

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorothalonil</td>
<td>2.75-5.5 pt/a</td>
<td>good</td>
<td>10,000</td>
<td>21%</td>
</tr>
<tr>
<td>triadimefon</td>
<td>4.0 lbs/acre</td>
<td>good</td>
<td>315</td>
<td>1%</td>
</tr>
</tbody>
</table>

**Chemical Controls - Oregon**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorothalonil</td>
<td>2.25-4.5 lbs/a</td>
<td>good</td>
<td>3,000</td>
<td>15%</td>
</tr>
</tbody>
</table>

Make first applications when new growth is 1 to 2 inches long and an additional application 3 weeks later.

Chlorothalonil is the main control for Rhabdocline Needle Cast. Mancozeb and benomyl provide partial control. Two applications of the highest label rate are necessary under high disease pressure (18).

### PACIFIC NORTHWEST

**Pine: Lophodermium Needle Cast**

**Damage**

Lophodermium needle cast became a serious problem in Scotch pine Christmas tree plantations in the early 1970's. It was disseminated around the country primarily on infected nursery stock. This infected nursery stock infected nearby susceptible trees with wind borne spores. The first symptoms show up as spots on otherwise green needles. Infected needles turn brown early in the growing season and by summer most of the infected foliage has fallen off, leaving only the green, current-year growth. Black fruiting bodies develop on the brown needles from August through October. Spore dissemination and infection processes are similar for most needle cast diseases.

**Percentage Yield Loss without Control**

Total needle cast damage reduces the value of harvested trees by about $518,000 each year. The value of trees destroyed by all needle cast diseases each year is over $245,000.

**Cultural Controls**

Provide good air circulation; do not crowd plants. Control weeds.

**Chemical Controls - Oregon**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorothalonil</td>
<td>2.25-4.5 lb/acre</td>
<td>good</td>
<td>10,000</td>
<td>21%</td>
</tr>
<tr>
<td>Triadimefon</td>
<td>4.0 lbs/acre</td>
<td></td>
<td>315</td>
<td>1%</td>
</tr>
</tbody>
</table>
**Chemical Controls - Washington**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorothalonil</td>
<td>2.25-4.5 lbs/a</td>
<td>good</td>
<td>3,000</td>
<td>15%</td>
</tr>
</tbody>
</table>

A minimum of 3 applications between late July and September to control the disease in British Columbia.

Clorothalonil is necessary at the higher label rate for high pressure of Lophodermium Needle Cast (18).

**PACIFIC NORTHWEST**

**Fir: Gray Mold**

**Damage**
New shoots are curled, twisted, withered, brown or dead. The gray mold grows in the moist areas.

**Percentage Yield Loss without Control**
Negligible

**Cultural Controls**
Avoid high density for good air circulation. In the greenhouse, keep humidity below 90%.

**Chemical Controls**
none in survey

**PACIFIC NORTHWEST**

**Fir: Rust**

**Damage**
New growth shows reddish-brown sunken cankers. These can girdle the stems causing die back.

**Percentage Yield Loss without Control**
Total losses from rust total about $33,000 annually

**Cultural Controls**
Remove all poplar or cottonwood trees from the area within 1,000 ft. of the Christmas trees (18).

**Chemical Controls - Oregon**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Rate</th>
<th>Efficacy</th>
<th>Acres Treated</th>
<th>Percent Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorothalonil</td>
<td>2.24-4.5 lbs/acre</td>
<td></td>
<td>10,000</td>
<td>21%</td>
</tr>
</tbody>
</table>
Apply once when shoots are 1" to 1.5" long.

Triadimefon is the primary fungicide for needle rusts, and us used at 2 to 16 oz/A. Chlorothalonis is not very effective (18).

PACIFIC NORTHWEST
True Fir: Interior Needle Blight

Damage
Lower interior needles turn brown in late summer and early fall, and fall off by the following spring.

Percentage Yield Loss without Control
Total losses from rust total about $3,000 annually.

Lewis County, WA, where true fir accounts for about 70% of the Christmas tree crop, which in turn is about 25% of Washington's crop, is one of the hardest hit areas. Growers there indicate their losses to be hundreds of thousands of dollars (18).

Cultural Controls
Increase air circulation.

Cultural controls are not effective (18).

Chemical Controls
none in survey

Apply when new shoots are expanding.

Chlorothalonil at 5.5pts/A (18).

PACIFIC NORTHWEST
True Fir: Rusts

Damage
White tubelike fruiting bodies (aecia) grow on the lower needle surface, usually in the spring. Severe infection may cause the needles to drop.

Percentage Yield Loss without Control
Total losses from rust total about $3,000 annually

Cultural Controls
Remove and destroy bracken fern, which is the alternate host to a distance of at least 1,000 feet.

**Chemical Controls**

none in survey

---

**Weeds**

Mowing and Cultivation Practices to control all other vegetation

In the beginning of the Christmas tree plantation industry weeds were controlled using cultural techniques such as mowing or grubbing. The main problem with weeds, especially grasses, was that they

1. compete for water during the dry summer months

2. provide cover for rodents that girdle the trees

3. provide a breeding ground for destructive insects.

Mowing controlled most weeds and, with proper tree spacing, did not mechanically damage the trees. However, mowing to improve moisture conservation was only about 25 percent as effective as complete weed eradication. Cultivation was more expensive than mowing and seriously damaged feeder roots. This tillage practice also resulted in a significant moisture loss. It was common practice to cut a furrow with a double moldboard plow and plant the trees in the furrow. Although many trees could be planted, it was a poor cultural practice and was generally abandoned as herbicides became available. Proper chemical control offered the most economical weed control without tree injury or moisture loss.

Chemical weed control in Christmas trees was limited at first to ammate and sodium arsenite, but these were supplanted by 2,4-D and 2,4,5-T. Sodium arsenite was poisonous and ammate was both corrosive and expensive. They were applied to control brush and hardwood trees. By 1960, five new herbicides were in common use in Christmas trees. Aminotriazole was applied to the foliage and helped contain poison oak. Fenuron, a soil active chemical, was applied as a pellet to control deep rooted perennials. Dalapon, applied occasionally, controlled grasses. Simazine and atrazine were the most commonly applied herbicides and controlled grasses.

A weed-free planting strip was made by using simazine, dalapon, or Amitrol-T. Atrazine replaced simazine because of the highly organic soils and high precipitation. Herbicide applications kill the grass that is growing in the areas where the trees will be planted. Trees are then planted in the dead grass, a
type of mulch that serves as a moisture conservation aid by shading the ground from the direct heat of the sun. This mulch serves to make the trees more tolerant to drought, the biggest cause of tree mortality. Heavy grass rott cover occupies the soil equally at the 3-foot depth. Such a living mulch will withdraw water to that depth, but when the grass is dead, adequate moisture will remain throughout the summer. Young trees, clipped off by rodents and deer, recover and grow in farms where the weeds are controlled.

On land where brambles were a problem, 2,4,5-T and 2,4-D were applied. After the trees were established, the spaces between the rows were mowed frequently. However, by the end of the 1960s, more growers relied on chemical control of weeds during the year following planting.

By 1980, it was well recognized that weed control in Christmas tree plantation was necessary if high quality trees were to be produced with a minimum of cost. Weed control measures do the following:

- improve survival and growth of trees
- result in better formed trees
- provide better working conditions
- reduce insect and disease potential
- reduce the potential for animal damage
- reduce fire hazard in summer and fall
- produce more attractive trees

Studies have shown that extensive weed control measures can reduce significantly the time required to grow and average tree.

By 1980, the most commonly applied soil herbicides were atrazine, Kerb, and Velpar. Simazine was used to a lesser extent. These were the backbone of vegetation management program and were applied in the tree row. There were several foliar applied herbicides. Amitrol-T was most commonly used, but paraquat and 2,4-D were also applied. Use of 2,4,5-T was suspended in 1978. Roundup was used on Christmas tree plantations since 1976 and was the most useful herbicide since atrazine. Tree growers applied Surflan in addition to atrazine to control more resistant grasses. In the mid 1980s, growers began using a mixture of 2,4-D and Velpar. During that time, growers used Asulox to control braken fern and horsetail rush.

Roundup is used for site preparation in February. Established plantations are fertilized at this time, and weed control begins in March. One of four treatments is applied, depending upon weeds present: atrazine and Velpar, atrazine and Roundup, atrazine alone, or 2,4-D. In May, Goal or Velpar are
sometimes applied. Poast or Roundup are applied as spot treatments. Pre and postemergence herbicides are applied to perennial grasses. It is still difficult to control the following weeds: wild carrot, rattle fescue, false dandelion, groundsel, and triazine resistant plants.

Asulox is applied in midsummer to control ferns. Berry vines are treated in the late summer with Roundup. Kerb is used on grass in November and December (1).

A weed is any plant that competes with a crop under management. Annual and perennial grasses, broadleaved herbs, and woody shrubs, some of which are cultivated as ornamental plants in landscapes, can be weeds if growing in unwanted sites. Threats to plant health from excessive weed growth are numerous because weeds not only compete with desired plants for water, nutrients, light, and space, but may harbor unwanted insects, diseases, and rodents. Also, stress by interference with physiological processes makes young trees less winter hardy. Seedlings which have been outplanted less than two years seem to be most susceptible to competition from weeds because of their small size and poorly established root systems; however, weeds also reduce the growth and quality of established trees.

Christmas tree growers approach the problem of weed control with various levels of energy and enthusiasm. Some do nothing about weeds, and they are destined to wait a long time before they see any return on their investment.

Others mow, apply herbicides, and/or plant cover crops depending on their particular situation.

If mowing is the only weed management strategy employed, it will do little to improve overall tree health. Our research shows that mowing does not reduce grass or weed competition with trees. Additionally, although the risk of injury from herbicides will obviously be non-existent, trees may be inadvertently hit by mowers and vining weeds growing close to the tree will grow unchecked.

The most effective approach to weed management is to combine the careful use of herbicides within rows with growth of a controlled cover crop between the rows. Herbicides are used to maintain a weed-free strip 24-30' wide under the trees and the cover crop between rows is managed by mowing once it is established. A cover crop of perennial rye, hard fescue, or a mixture thereof will usually crowd out noxious weeds and keep the need for mowing to a minimum (6).

Weed control in the Pacific Northwest using chemical and non-chemical controls are outlined below (1,7).

<table>
<thead>
<tr>
<th>PACIFIC NORTHWEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Preparation - Late winter and early spring</td>
</tr>
<tr>
<td>Pesticide</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>2,4-D</td>
</tr>
<tr>
<td>atrazine</td>
</tr>
<tr>
<td>glyphosate</td>
</tr>
<tr>
<td>hexazinone</td>
</tr>
</tbody>
</table>

**PACIFIC NORTHWEST**

Established Plantings

<table>
<thead>
<tr>
<th>Rate</th>
<th>Oregon acres treated</th>
<th>Oregon percent acres treated</th>
<th>Washington acres treated</th>
<th>Washington % acres treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D</td>
<td>0.5 pt/acre</td>
<td>2,480</td>
<td>6%</td>
<td>3,000</td>
</tr>
<tr>
<td>atrazine</td>
<td>2.0-4.0 lb/acre</td>
<td>4,100</td>
<td>9%</td>
<td>6,000</td>
</tr>
<tr>
<td>glyphosate</td>
<td>1.0 qt/acre</td>
<td>7,980</td>
<td>18%</td>
<td>3,100</td>
</tr>
<tr>
<td>clopyralid</td>
<td>0.25-0.67 pt/a</td>
<td>680</td>
<td>2%</td>
<td>200</td>
</tr>
<tr>
<td>oxyfluorfen</td>
<td>5-10 pt/acre</td>
<td>15,000</td>
<td>32%</td>
<td>100</td>
</tr>
</tbody>
</table>

mustards, tansy ragwort, false dandelion, berry briars, poison oak

dandelion, grasses, broadleaf plants

Canada thistle, quackgrass, wild carrot, groundsel, field bindweed, poison oak, false dandelion

glyphosate

canada thistle, groundsel

clopyralid

blackberries, Canada thistle, groundsel, pigweed

oxyfluorfen

wild carrot, fescue, dandelion, groundsel
On-Line Resources

Pacific Northwest Christmas Tree Association
(http://www.nwtrees.com/lookout.htm)

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Phone (253) 445-4528
Fax (253) 445-4569
Internet: chastag@wsu.edu
References

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4. Deborah G. McCullough, Assistant Professor. Dept. of Entomology and Dept. of Forestry. Michigan State University.
6. Dr. Joseph Neal, Associate Professor, Department of Floriculture and Ornamental Horticulture, Cornell University, Ithaca, NY.
11. New Mexico State University. NMSU and the U.S. Department of Agriculture cooperating.
   Winter 1995. pp20-23
   1987. pp22,23
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