Developing High Quality True Fir Christmas Trees

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DEVELOPING HIGH QUALITY TRUE FIR CHRISTMAS TREES

A. INTRODUCTION

True firs are defined as all species of the genus *Abies*. About 50 true fir species are widely scattered throughout North America, Central America, Europe, Asia and North Africa. Six species of true firs are natives of the Northwest. As shown in Table I, the three most popular native species are noble fir (*Abies procera*), Shasta red fir (*Abies magnifica* var. *shastensis*), and grand fir (*Abies grandis*). Table II shows that the popularity of the true firs is increasing. They accounted for about 9% of Oregon and Washington Christmas tree production in 1969. Ten years later, true fir production has increased to nearly 22% and further increase is expected to continue into the 1980's though at a slower rate.

Table 1. True Fir Christmas Tree Production in Oregon and Washington — 1979*

Species	Number of Trees Harvested Oregon	Washington	Both States	Percent
Noble	435,000	250,000	685,000	68.5
Grand	80,000	70,000	150,000	15.0
Shasta red	50,000	60,000	110,000	11.0
Concolor	20,000**	3,000	23,000	2.3
Silver	2,000	15,000***	17,000	1.7
Fraser	1,000	6,000	7,000	0.7
Alpine	1,000	5,000	6,000	0.6
Others	1,000	1,000	2,000	0.2
Totals	590,000	410,000	1,000,000	100.0

* Composite of estimates by several leading PNW producers
** Principally harvested from Eastside natural stands
*** Harvested from Westside high elevation natural stands

Table 2. Christmas Tree Production in Oregon and Washington — 1969 and 1979 Comparisons

Species	Year	Number of Trees Harvested* Oregon	Washington	Total	Percent
Douglas-fir	1969	525,000	1,890,000	2,415,000	83
	1979	2,000,000	1,500,000	3,500,000	75
Noble, Shasta red, Silver, Alpine and Fraser	1969	85,000	55,000	140,000	5
	1979	490,000	337,000	827,000	17
Grand and Concolor	1969	95,000	35,000	130,000	4
	1979	100,000	73,000	173,000	5
Scotch pine	1969	45,000	120,000	165,000	6
	1979	40,000	70,000	110,000	2
All others	1969	40,000	30,000	70,000	2
	1979	40,000	20,000	60,000	1
Totals	1969	790,000	2,130,000	2,920,000	100
	1979	2,670,000	2,000,000	4,670,000	100

*1969 Estimates obtained from *Natural Products Harvesting Report for Oregon and Washington*, U S. Forest Service, Portland, Oregon.

1979 Composite — estimates by leading producer and wholesaler members of the Northwest Christmas Tree Association.

What are the reasons for this growing popularity of the true firs? Firstly, they are widely acclaimed as the most beautiful of all Christmas trees. Needles are dense, stiff, thick and dark green in color. The sturdy branches, symmetrically arranged in spaced whorls, are well adapted to support and display heavy pendulous ornaments. Secondly, an important asset of noble fir, and to a lesser degree for the Shasta red fir, is good needle and moisture retention during the shipment, storage and display. These characteristics have helped open new and expanding markets outside the Pacific Northwest, particularly in the southern tier of states from California to Florida.

Relatively high selling prices have boosted the number of true fir plantings. It is often said that noble firs (which generally are lumped with Shasta red firs in the trade) are the "Cadillac" of Christmas trees. This reputation is reflected in its selling price which averages about 50% more than Douglas-fir and pine and about 25% more than grand fir. New seed source information and better cultural practices have provided another stimulant to Northwest true fir plantings. This will be discussed later in more depth.

A few words of caution are directed to those who are thinking about establishing true fir plantations. True firs are the most difficult species to develop into salable quality trees due to characteristically slow growth and being very particular as to site. An estimated 60% of all true fir plantations fail to develop properly and turn a profit for their managers. Frequent problems include improper seed sources, poor matching of species to site, and unskilled cultural practices, especially shearing. A major objective of this publication is to help you avoid these pitfalls.

Less than 20% of the true firs harvested in Oregon and Washington in 1978 were grown in natural stands while the majority were plantation grown. Ten years earlier, these percentages were almost reversed, with only about 30% produced in plantations. A continued decline in production from natural stands appears inevitable due to growing consumer preference for the narrower, more dense, and symmetrically shaped plantation tree.

Growing high quality Christmas trees of any species requires a heavy investment of time, money and knowledge. This applies particularly to true fir species which are more difficult to develop than any other species. Relatively few growers have developed profitable true fir plantations. Most of the successful growers have paid strict attention to selecting good growing sites, planting seed from a suitable source, and using skilled cultural practices. This bulletin will describe conditions and practices that these successful growers have used or developed.

B. RECOMMENDED SPECIES AND STRAINS

The best prospects for Christmas tree plantations in Oregon and Washington are three of the native species: noble fir (*Abies procera*), Shasta red fir (*Abies magnifica* var. *shastensis*), and grand fir (*Abies grandis*).
Some concolor fir (*Abies concolor*), especially of Southern Rocky Mountain origin, have been developed into attractive Christmas trees in southern Oregon. However, in most areas they frequently suffer from terminal dieback, poor needle retention, frost damage, and slow juvenile growth. The use of silver fir (*Abies amabilis*) and alpine fir (*Abies lasiocarpa*) has shown little potential on lowland plantations and such use is not apt to play a significant role in future Christmas tree production.

1. **Noble and Shasta red firs.** These species have excellent needle retention and very attractive foliage.

These species are grouped here together because their appearance, cultural responses and site preferences are quite similar. They grow naturally at 2,500 to 5,500 feet elevations. Branch and needle structure is stiff and strong enough to withstand heavy snows in their natural habitat. They have characteristic well-branched whorls with rather short internodal brances and open internodal spaces between whorls. The greater assets of both noble and Shasta red firs are attractive, nonshedding needles and a stately appearance provided by a formal, uniform branching habit. They are easily decorated with hanging Christmas tree ornaments such as colored glass balls and tinsel. They are also adaptable to flocking with artificial snow.

Noble fir is a native of the high Cascades and Coast Ranges of Washington and Oregon. Its northern range limit is near Stevens Pass in the north-central Washington Cascades.Its southern range limit is the Umpqua-Willamette divide in southern Oregon where noble fir blends and hybridizes with Shasta red fir.

Shasta red fir is a native of the high Cascades and Siskiyou Mountains of southern Oregon and northern California. It forms a transition species between noble fir and California red fir and hybridizes with each where their ranges overlap.

Both noble and Shasta red fir species have produced beautiful, desirable plantation-grown Christmas trees when grown on suitable sites and properly cultured. Where one species grows well, the other is likely to succeed. Noble fir usually grows slightly faster than Shasta red fir, but Shasta red fir

is somewhat more tolerant of dry soil conditions. Needles of noble fir are generally considered more durable than those of Shasta red fir. They are darker green, stiffer and more densely arranged on the twig. On the other hand, Shasta red fir develops a narrower, more "self-shaping" crown than noble fir. Growers with suitable planting sites should, perhaps, try both species and give future preference to the one that responds the best.

A noble fir (left) is compared with a Shasta red fir (right) of the same age. Although these species are quite similar, the Shasta red fir is typically somewhat narrower, slower growing, more drought resistant, and about one week later in bud bursting.

Noble and Shasta red firs are very particular about their growing site. They prefer level to gentle northerly and easterly slopes where climatic conditions are coolor and soil is rich in humus, moist and well drained. They do not tolerate heavy compacted clay soil, high water tables, heavy grass sod or frost pockets. Cool moist conditions preferred by these species do not imply overhead shade. Like all other Christmas tree species, they develop best under open sunlight without root competition from larger trees, brush, grass and weeds.

A recently completed provenance test for noble fir and Shasta red fir provided much needed information about best seed sources for Christmas tree production.[1] The results follow:

a. The three best noble fir seed sources, in descending order for overall quality and vigor, were the Siletz River drainage in the north-central Oregon Coast Range; the Kalama River drainage near the southwestern slope of Mt. St. Helens in southwestern Washington, and Baw Faw Peak in the south-central Washington Coast Range.

b. The best Shasta red fir seed source was the Siskiyou Mountains west of Grants Pass, Oregon. No other Shasta red fir source rated even close to it for overall growth rate and quality.

c. The four top-rated seed sources listed above developed good trees over a wide range of climates, latitudes, elevations and soil types in the five western Washington and western Oregon test plots.

d. Ranking for the above top-rated strains did not change appreciably over the last four years that they were evaluated. This led us to believe that quality and growth rate characteristics first become evident when the trees are only 3 or 4 feet tall, and that they do not change much as the trees develop to heights of 6 to 8 feet.

e. Shasta red fir should be avoided on wet soil types. It was more susceptible to root rots than noble fir and also should not be planted near patches of bracken fern. Bracken fern is the alternate host of *Uredinopsis pterides*, a damaging true fir needle rust that infects Shasta red fir much more than noble fir.

f. California red fir is rated very low in the two test plots where it was located. Its greatest weaknesses included extremely slow growth and poor color. Growers are well advised to plant the Grants Pass strain of Shasta red fir instead.

g. Growers should make every effort to obtain noble fir and Shasta red fir seedlings from the general vicinity of the highest rated seed sources. The poorer seed sources would yield many fewer merchantable trees per acre. At the same time, they would increase growing costs because of longer rotations and extra pruning efforts to correct erratic growth. One of the test plot evaluators, an experienced and successful noble fir grower, summed up his observations with the following comment: "Regardless of how good my site or how much effort I put into culturing, I'd lose my shirt trying to develop Christmas trees from unsuitable seed sources."

2. **Grand fir.** Grand fir grows naturally in western and eastern Washington, and western and northeastern Oregon at many elevations. It is also found in southern British Columbia, northwestern Cali-

[1] Bernard S. Douglass and Frank A. TerBush, U.S. Forest Service, Portland, Oregon, *Final Report of Provenance Test for Plantation-grown Noble fir and Shasta red fir for Christmas Trees* (August 1977).

fornia, northern Idaho, and western Montana. Grand fir, like Douglas-fir, has many racial variations over its wide geographic range. These inherited differences include growth rate, disease resistance, needle retention, needle form, needle color, and other characteristics that are important to Christmas tree growers. One example is the needle arrangement differences of West Side and East Side strains of grand fir. The West Side strains usually have needles arranged in two single flat rows on the twig. many East Side strains have two double rows on each twig and the needles sometimes spread upwards somewhat like a noble fir.

Grand fir from suitable seed sources are beautiful Christmas trees. They are usually priced on the Christmas tree market between noble fir and sheared Douglas-fir.

Some West Side plantations of grand fir become heavily infested by *Uredinopsis pterides* (a needle rust) when the trees are planted near patches of bracken fern, the alternate host of this fungus. It causes shedding and discoloration of needles on grand, Shasta red and concolor fir. The problem is serious enough that some growers have completely eliminated their grand fir plantations and converted to noble or Douglas-fir. Others have solved the problem by the elimination of all bracken ferns within about 500 feet of their grand fir. This can be accomplished by spraying the ferns with the selective herbicide "Asulox" in July and August.

Another serious disease of grand fir is *Rhizosphaera pini*. It causes all or portions of the needles to turn red. Some trees are more susceptible than others.

A Christmas tree provenance test was established in 1968 to test and compare 24 grand fir strains from Oregon, Washington, California, Idaho and Montana.[2] Evaluations were made on five test plantings in western Oregon and Washington. They were based on vigor, Christmas tree form, needle attractiveness, insect and disease resistance, and lateness of flushing. The highest rated seed source in all test plots was that from east of Grangeville in the central panhandle of northern Idaho. Next best seed sources in descending order were near Pend Orielle, Idaho; Hamilton, Montana, and Pomeroy, Washington. An interesting observation was that strains from East of the Cascade summit produced better Christmas trees in West Side plantations than the native West Side strains. Needles on the better East Side strains were noticeably superior for density, upright arrangement and color.

[2] Bernard S. Douglass, U.S. Forest Service, Portland, Oregon, *Final Report of Grand fir Provenance Study to Rate Inherited Christmas Tree Characteristics of Various Seed Origins within the Natural Range of the Species* (January 1, 1974).

3. **Exotic species.** Too little is known about the exotic species to recommend planting them except on a limited trial basis. Red fir (*Abies magnifica*) from the Sierra Nevada mountains of California is similar in appearance to Shasta red fir, but much slower growing. Therefore, Northwest growers have little incentive to plant this species.

Fraser fir (*Abies fraseri*) from the southern Appalachian Mountains is a popular and attractive Christmas tree of the eastern United States. It grows quite well in Oregon and Washington, but develops even slower than noble fir and is very susceptible to damage by the balsam woolly aphid. Most promising of the overseas exotics are from the high mountains of Turkey or adjacent Asia minor countries and include Turkish fir (*Abies bornmuelleriana*), Nordmann fir (*Abies nordmanniana*), Cicilian fir (*Abies scilicica*), and Trojan fir (*Abies alba* var. *equi-trojani*).

C. MATCHING SPECIES TO SITE

The two high elevation true firs, noble and Shasta red fir, require more moisture and cooler growing conditions than do grand fir, Douglas-fir and pines. At the same time, noble and Shasta red fir require well drained soils to prevent root rot diseases. In low elevation Christmas tree plantations, best growth response can generally be expected on gentle slopes with northerly to easterly exposures which are not subject to severe summer heat and drought. However, their ability to survive on southerly and westerly exposures improves with higher elevations or where summer rainfall is heavy and summer temperatures are moderate. The probable reason is that the cooler, more moist sites come closer to the climatic conditions where the species grow naturally. Experience has shown that their chances for survival and growth response are likely to be better on a foothill field at 1,000 foot elevation than on a lowland field only a few miles away, assuming all other conditions are the same.

Grand fir requires greater summer moisture and coolness than Douglas-fir or pine. However, they are less demanding in this respect than noble fir or Shasta red fir. They appear to respond equally well on high or low elevation plantations, but prefer cooler, more moist sites. Level to gently sloping northerly and easterly exposures are usually most favorable for low elevation plantations.

Grand fir will tolerate wetter soil conditions than Douglas, noble or Shasta red fir. Some growers use grand fir to fill in excessively moist portions of their fields where these other species died from root rots. Grand fir also tolerates shady areas of a plantation, for example, along the fringe of adjacent stands of timber. This is not to say that grand fir prefers high water tables or shade. They merely

tolerate it better than most other species. Grand fir develops best quality in open sunlight and well drained soils.

Christmas tree growers sometimes have several site conditions on a single planting area. For example, a ridge running east and west through a field contains both north and south exposures. In this case, the north exposure is usually best for planting true fir Christmas trees, but not usually best for pines and Douglas-firs. A U.S. Geological Survey topographical quadrangle map is useful to determine direction and degree of slope for matching species to site.

Opportunities to establish true fir plantations East of the Cascades are limited by excessive heat and dryness. Planting moisture-loving species such as noble and Shasta red fir on east side sites is a waste of time and money! Even if the trees are watered frequently, low humidity and temperature extremes will cause poor growth and dieback. Native strains of grand fir may be a good prospect for east side growers providing it is not planted on drier sites. Its best chances for east side survival are northerly and easterly exposures at higher elevations where grand fir grows or once grew naturally.

D. PLANTING

True fir seedlings, like any other species, require sunlight and adequate moisture. They should always be planted on bare, freshly and cleanly cultivated ground. Fields infested with blackberries, quack grass, Canada thistle, or bracken fern should be avoided until these have been eliminated by chemicals or repeated cultivation. Rank growth or grass and weeds during the spring and summer months will shade and distort the newly planted seedlings and deplete moisture in the soil. Old fields with heavy sod or weed cover should be disked as often as necessary during the summer and then fall plowed to control grass and weeds; then disked and harrowed the following spring just before planting. This will cause sod and other heavy organic matter to break down and decay. It will also eliminate new growth from seeds and root sprouts.

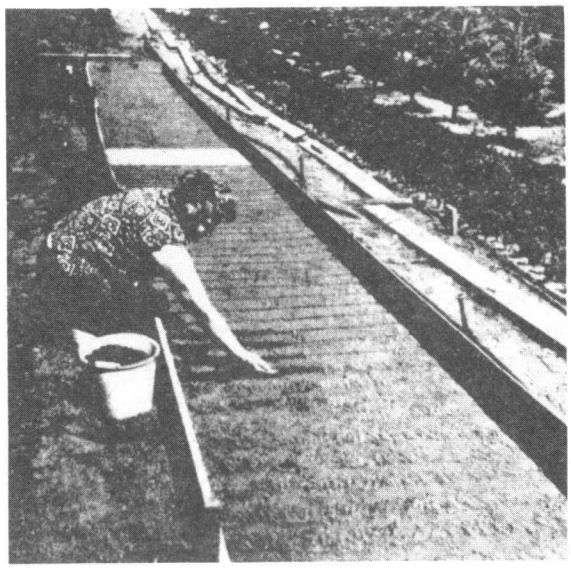
This spring-tooth cultivator is shredding old roots and loosening the soil in preparation for disking, harrowing, and tree planting. Several months previously, a heavy land clearing disk was used to uproot and pulverize stumps from a previous crop of Christmas trees.

Fields formerly planted to strawberries or other row crops sometimes become heavily infested with root-eating insects or larvae such as June beetle larvae and strawberry root weevils. Intense cultivation at least one year prior to tree planting will starve out most of these pests.

Three-year-old bare root planting stock (2-1 or 3-0) is usually recommended. The extra cost compared to two-year-old seedlings is justified by more rapid development and decreased first year's mortality in the plantation. Seedlings with small diameter stems and weak tops or root systems should be sorted out before planting. These can be either discarded or developed for an additional year in a transplant bed which provides a handy source of seedlings to replace mortality in the field. Transplant beds may also be used to develop 2-0 seedlings to larger 2-1 stock for next year's planting. Although some growers develop their own transplant beds at home, most growers find it pays to contract his job to a commercial nurseryman who can often do a better job at less cost.

Bare root planting stock is usually packed in waterproof bags or cardboard boxes at the nursery for convenience during shipment. Wet moss or other absorbent material is placed around the roots to protect them from drying. Bags or boxes of trees should be stored temporarily outdoors in a cool, protected spot. Unless trees are planted within a week after delivery, they should be either (1) removed from the bag or box and heeled in where there is sufficient moisture, shade and protection from drying winds; or (2) stored in a 34° to 38° F. cold storage room until ready to plant. Opened, partially used bags or boxes require occasional sprinkling or high humidity cold storage conditions to prevent drying.

Container grown seedlings have become available in recent years. Growing seedlings in containers has, in some cases, reduced the time needed to grow the kind of large, vigorous noble and shasta red fir seedlings from 3 to 2 years. Before giving your seed to a greenhouse operator, be sure that



A home seed bed is one means of insuring availability of the best seed source. It also insures a fresh, adequate supply of planting stock. The bed on the left is being sown with noble fir seeds. The bed on the right contains one-year-old seedlings.

he/she can meet your particular specifications for size and vigor.

Planting, whether by hand or machine, requires special techniques for good survival. Spring planting is usually preferred to fall planting, especially on clay loam soils which are susceptible to frost heaving conditions.

A 5-foot by 5-foot spacing is commonly used for producing the popular 6- to 7-foot tree heights. Some growers prefer somewhat wider spacing up to 5½ by 5½ feet to permit easier operation of their equipment between the rows or to provide more open sunlight around the lower branches. A few growers have increased the yield in their true fir plantations by spacing the trees about 3 feet apart within each row. Every other tree is harvested for table top size when they start to crowd. The balance of the stand is developed into larger sized trees.

Perfect spacing of trees to form check rows in each direction has the advantage of permitting cultivation and mowing in two directions. However, many growers do not believe the additional cost of check row planting is justified. They prefer instead to space the trees randomly in straight rows and rely on chemicals or one-way cultivation and mowing to control grass weeds.

When check rowing is the preferred method, it can be accomplished by premarking the cultivated field in squares or hand planting along a wire marked at proper intervals. Machine planting is much faster and usually somewhat less costly than hand planting, but it makes check rowing more dificult.

Unless helicopter yarding is planned, roadways will be needed through the plantation to give adequate access. These can be provided by skipping the planting of two adjacent rows of trees at intervals of every 20 or 30 rows.

E. CONTROL OF COMPETING VEGETATION

True fir Christmas tree plantations should be kept free of grass and weeds for the entire rotation. Grass and weed competition harms trees in four ways:

1. It forms a canopy of shade that suppresses and deforms the lower branches. open sunlight is required for adequate growth and attractive needles;

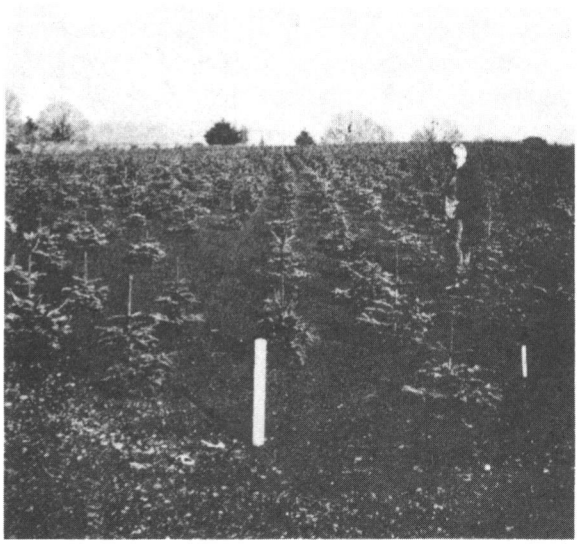
2. It depletes moisture and nutriments from the soil. Adequate summer moisture and nitrogen is required for good growth, color and survival;

3. It provides a habitat for meadow mice, gophers, rabbits and other destructive rodents, and

4. Accumulated dry grass and weeds create a fire hazard.

Frequent mowing or shallow cultivation between the rows was, until recent years, the most common practice for controlling grass and weeds. herbicides such as atrazine or Velpar are now either replacing or supplementing cultivation on most plantations. Chemical weeding usually proves less costly and more effective than just mowing or cultivation. Moreover, they permit controlling vegetation around the base of the trees that mowers and tillers cannot reach.

Atrazine has been the most widely used herbicide to control grass and weeds in Northwest Christmas tree plantations since the early 1960's. Atrazine is most economical when sprayed as a wettable powder. It is also available in liquid form, which requires no agitation in the spray tank. It is effective both as a pre-emergent spray (kills grass and seed sprouts as they germinate) and as a post-emergent spray (killing existing cover of grass and weeds). Atrazine should be applied uniformly over newly planted areas as soon as possible after planting, making sure the soil has been firmed adequately around the root systems. it usually should be reapplied annually in early March. Atrazine can be applied directly over dormant trees, even those that are newly planted, without causing damage. In fact, trees metabolize this chemical and often show improved color and growth after its applications.



Effective grass and weed control conserves soil moisture and prevents shading of lower branches. This practice shortens the rotation and at the same time improves color, vigor, and bud formation.

Subterranean clover was established between the tree rows to raise the nitrogen level of the soil, control erosion, and prevent muddy harvesting conditions. Note the circles of bare ground around the driplines where atrazine was sprayed to reduce competiton for sunlight and moisture.

Usual rate of application is about 4 pounds per acre (bag weight) on sandy or gravelly soils and about 5 pounds per acre on heavier clay-loam soils. However, rates of up to 10 pounds per acre on clay soils and 7 pounds per acre on sandy soils may be necessary to control moderately atrazine-resistant plants such as quack grass, perennial ryegrass, tarweed and Queen Anne's lace. Atrazine is usually applied as a wettable powder by helicopter, airplane, or tractor-drawn boom sprayer equipped with agitators. Some growers reduce erosion on slopes by planting on the contour and spraying in strips between the tree rows or 3-foot circles around individual trees; then mowing the intervening grass strips. However, broadcasting the entire area will usually save time and money in ordinary situations.

Sometimes atrazine-resistant vegetation such as Canada thistle, wild blackberry and orchard grass gradually invades a plantation after the third or fourth growing season. It can be held in check by mowing or shallow cultivating between the rows but a more permanent solution is completely eliminating the vegetation by means of a directed spray. Your county extension agent or chemical company field man can recommend the most effective herbicide for the particular species that has become a problem. If mechanical spray equipment is used, it must be sufficiently narrow to operate between the rows without causing mechanical injuries to the trees. The trees should be basal pruned in advance to avoid chemical contact.

A word of caution is in order where herbicides, such as atrazine, are applied year after year. Some growers are beginning to suspect that chemical buildup in the soils can be detrimental to tree growth. It is probably wise to use only as much chemical as absolutely necessary, and to rotate from one herbicide to another over time to prevent unexpected or possible adverse chemical buildup. Several new and promising broadcast spray herbicides have been developed to supplement atrazine in true fir plantations. Check with your local county extension agent or chemical company field man for brand names, methods of application and season to apply.

F. PROTECTION

1. **Insects.** Aphids are the most troublesome insects in true fir Christmas tree plantations. Grand fir and noble fir are both susceptible to large, long-legged black aphids (*Contarinia spp.*) that gather in clusters on the stems and leaders. The aphids feed on the sap and reduce tree vigor. They also secrete a honeydew on which an unattractive black mold grows on the twigs and needles. Another species imported from Europe, the balsam wooly aphid (*Adelges spp.*) is particularly partial to grand fir. This aphid causes swollen, stunted and deformed trees. Aphids may be controlled by spraying with malathion, thiodan or cygon. Aphid control is more effective, less costly and less damaging to the tree quality when it is carried out at the very first sign of an outbreak. Do not wait until a plantation is badly infected. Early infestation can usually be controlled by spot spraying individual trees, whereas heavy infestations may require aer-

ial or boom spray applications.

Grand fir usually requires spraying every year to control aphids that cause stunting and contorting of leaders and branch tips. The insect can be effectively controlled by spraying with cygon when the new growth is about half elongated. A back pack or tractor operated mist blower gives good foliage coverage with this systemic type aphicide.

2. **Diseases.** Various diseases infecting needles, stems and roots have been a serious problem in many true fir plantations. Some of the more troublesome diseases are decribed below:

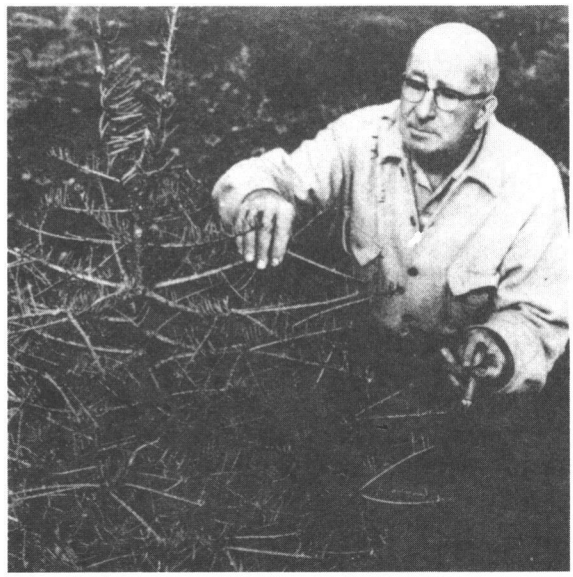
Needle rusts cause elongated white or yellow spore pustules on the undersides of the needles during early summer. By late summer or early fall, the infected needles usually develop brown spots and sometimes shed from the twig. Needle rusts are cyclic in the severity of occurrence. Heavy infestation years are believed to result from wind and moisture conditions that encourage spores to spread and cling to damp needles.

A particularly common and serious rust disease on concolor, Shasta red fir and grand fir is bracken fern rust (*Uredinopsis pterides*) which alternately infests bracken fern. This rust can be recognized by white pustules on the underside of the needles. Susceptibility to needle rust varies with species. While grand fir, concolor and Shasta red firs are very susceptible, noble fir is quite resistant. Unless a grower plans to eradicate all bracken fern within 500 feet from the trees, he should avoid planting the susceptible true fir species and switch to noble fir.

Another species of true fir rust (*Peridermium spp.*) forms yellow spore pustules on the underside of the needles. Huckleberry plants are the alternate hosts.

No practical chemical treatments are known for rusts. Planting rust resistant species is the simplest solution. The only other practical solution might be eradication of the alternate host plants for the particular species of rust that is infesting the trees.

Stem canker (*Phomopsis*) cause swellings or roughened areas of dead cambium that girdle the main stem. Shasta red firs, and to a lesser extent, noble firs are quite susceptible. This disease is commonly associated with poor site conditions such as very dry soils, water logged soils, or heavy grass competition. Planting trees on moist, but well drained, fertile soil with north and east exposures, and then maintaining good grass amd weed control are the most effective preventative measures. Once infection sets in, salvage as many trees as possible before they die. Replant problem areas with more resistant species such as grand fir, Scotch and shore pine.



Rust infection is followed by browning and shedding of needles during late summer and fall.

3. **Excessive Soil Moisture or Drought.** Noble and Shasta red fir have a narrow tolerance for moisture. Mortality unrelated to insects and diseases has been observed for both species when winter wet spots and summer drought occur. We are indebted to the State of Washington Department of Natural Resources for the following information on this subject.[3]

Noble fir and Shasta red fir, but particularly Shasta red fir, show poor growth and high mortality on excessively wet soils. First symptom of damage is slowing of growth followed by yellowing and eventually browning of the entire crown. The cause of dying may at first be puzzling to the grower because the stems, branches and needles show no outward damage other than a gradual drying.

However, examination of the roots shows dead cambium without evidence of a primary disease, although a noticeable root swelling sometimes occurs just below the ground line. The best solution is to refrain from planting these species in wet areas. If wet spots must be planted, consider Scotch or shore pine, which are relatively tolerant of wet soils.

Both species, but Shasta red fir to a much lesser degree than noble fir, are susceptible to damage from drought. Two types of drought — soil and atmosphere — may occur. Each will be described separately.

[3] Kenelm W. Russell, Forest Pathologist, Washington State Department of Natural Resources, reports of May 2 and May 16, 1972.

Soil drought symptoms are somewhat similar to those caused by root rots. Trees tend to droop and fade during extended periods of drought. The new growth sometimes takes on a "shepherd's crook" appearance. The crown dies rather evenly and eventually turns red. The roots are the last to die and sometimes appear outwardly healthy or at least not diseased, after the crown dies. The best solution is to keep the plantation free of grass and weed competition and to water at 2- to 4-week intervals during periods of extended summer drought. If watering is impractical, plant trees only on cooler, more moist sites. Good prospects are northerly and easterly exposures, higher elevations, and well-drained soils with good moisture retention.

Atmospheric drought occurs when needles lose water faster than it can be replaced by the roots. It most frequently occurs during periods of hot, dry summer winds or drying winter winds when the ground is frozen. Trees are particularly susceptible in early summer when the new growth is still succulent and can be dehydrated very easily. In this case, the tips of the tender needles or shoots die back, but the tree usually recovers. Symptoms of atmospheric drought are dying and browning of the needles from the tips back. The tree may look like it is seared, particularly on the top and exposed sides. Severe conditions may cause the entire tree to die from the top down, with the roots being the last portion of the tree to die. Atmospheric drought is associated with adverse weather conditions and is, therefore, difficult to predict or control. One solution is to plant pines instead of true firs on exposed ridge tops and southwest exposures where winds or temperature extremes are most likely to occur.

4. **Animals.** Cattle, horses and sheep are not compatible with Christmas tree growing on the same sites. The animals browse the succulent tips, trample seedlings, and damage the branches by rubbing. Fencing costs can be minor when compared with potential losses to such damage.

Deer and elk do similar damage, particularly where plantations are adjacent to wooded areas with overstocked game populations. Your State Game Department can offer advice on protecting your tree farm from wild game animals.

Small rodents are frequently more damaging than any other types of animals. Meadow mice may girdle smaller trees near the groundline and pocket gophers may eat and girdle the roots. The best solution in either case is to control grass and weeds which provide feed and cover. Heavily gopher-infested areas may also require an intensive baiting or trapping program. People from the State Game Department, U.S. Fish and Wildlife Service, and State Universities can provide advice and assistance.

5. **Fires.** Fire damage is not a serious problem on plantations where flammable grass and weeds are effectively controlled by herbicides or cultivation. Where a fire hazard condition exists, vegetation-free firebreaks should be cultivated or bulldozed around the perimeter and through the fields to dissect them into smaller fire control units. Fire lanes should be maintained to expose mineral soil until the existing vegetation finally decays and future growth of grasses and weeds is checked.

6. **Trespass.** Theft is less likely to occur when trees are growing on your home property and can be watched. The best solution for absentee owners is to establish their plantations on a private road with controllable access. Where this is not possible, signs, fences, and locked gates should be planned. Problem areas may require patrolling during the Christmas tree cutting season. Cooperative neighbors and local law enforcement officers can be a deterent to seasonal trespass.

G. SHAPING THE TREES

1. **Overall Objectives.** Two very important ingredients on which a profitable Christmas tree operation depends are time and tree quality.

Time, or rotation, is the number of growing seasons required to grow a crop of Christmas trees. Assume that grand fir seedlings were field planted in 1981 and then harvested over the three year period of 1987, 1988 and 1989. The rotation would be nine years or the number of growing seasons from spring of 1981, when the trees were planted, to December of 1989 when the last trees in the field were harvested.

All things being equal, the shorter rotation usually produces greater profits because a larger number of trees per acre per year can be grown under a continuous cropping program. The sticker in this theory, of course, is that all things are not always equal. With very short rotations, low quality often results from excessively long leaders and light density.

A modified overall objective might be stated as follows:

Strive for the shortest possible rotation that produces a high proportion of U.S. No. 1 and

better grade Christmas trees with desired size, density and taper. (Taper is defined as the width of the tree expressed as a percentage of the height.)

The following describes various cultural practices used to produce high quality true fir Christmas trees. They are particularly applicable to western Oregon, western Washington and southwestern British Columbia. To a lesser degree, such practices should also be suitable to other regions as well. An interesting observation has been noted during the authors' travels to principal Christmas tree producing areas throughout the United States. It is that many time-proven cultural practices are equally effective in the North and South as well as the East and West.

2. **Correcting Multiple Leaders.** An important objective of skillful Christmas tree culture is to maintain only a single leader throughout the development period of the tree. When more than one leader forms, all except the best one should be cut flush with the main stem. Considerations for selecting the best leader are length, vigor, erectness, central position and completeness of terminal bud set. If a multiple leader has five terminal lateral buds and another has only four, save the five-budded leader to insure a balanced, five branched top whorl next year.

Multiple leader removal should be done whenever they occur. This is usually the only type of pruning required during the first 2 or 3 years after a plantation is established. Multiple leader culture is not very time consuming in young stands because only a minority of the trees normally form multiple leaders. However, they should be cut out every year. Postponing this job may cause crowding and suppression of lateral branches arising from the multiple stems. It also results in crooked stems because multiple stems tend to lean away from each other.

Multiple leaders may also form towards the end of the rotation after excessively long leaders have been pruned back. These multiple leaders can often be prevented on pruned leaders by cutting the leader above a *single* internodal bud which is situated an inch or more above an internodal bud cluster. The single becomes a terminal and the cluster grows into a false whorl. Cutting the leader just above the bud cluster itself frequently causes multiple leader problems because no single bud in the cluster is in a dominant position to form a new leader.

If multiple leaders form from a cut leader despite these precautions, it is best to retain the lowest one on the stem. This avoids unattractive, upright stubs below the leader that is retained.

Suckers are similar in appearance to multiple leaders except that they rise vertically from an upturned lateral branch or sprout below the top whorl. (One might quote the late P.T. Barnum who advised: Never give a sucker an even break!) Complete removal of a sucker is almost always the preferred solution. Removing only the top portion seldom arrests its abnormally vigorous and haphazard growth characteristics which detract from the appearance of a tree. One exception to the toal removal of a sucker is the retention of a single outpointing branch near its base to fill an opening in the crown.

3. **Basal Pruning.** This is the removal of unwanted branches between the bottom whorl of the Christmas tree and the ground. The pruned stem provides a reasonably straight handle of at least 1 inch per foot of tree height for insertion into the tree stand. The stem should be pruned sufficiently high to avoid serious defects, such as incomplete bottom whorls and crooked stems. Most growers strive for a minimum distance of about 10" between the bottom whorl and the ground. This allows sufficient leeway in handle length to help prevent cutting into the ground and dulling the chain saw when the trees are felled. The branches should be cut flush with the stem to avoid both stubs and heavy scars. Hand pruners, and sometimes short machetes or heavy knives, are used for basal pruning.

The selected bottom whorl should preferably contain five or more uniform, well-distributed branches in a main whorl. Sometimes, however, the only available prospects for forming a bottom whorl contain only three or four branches instead of five. In such cases, the deficient whorl must be "backed up" by several strong internodal branches just below or above the main whorl to complete the whorl pattern and help fill in the gaps. Distance between the ground and the selected bottom whorl should be more than the usual 10" if heavy competing vegetation is not controlled.

Basal pruning provides several other important benefits besides forming a handle. It defines the usable portion of the crown, exposes the bottom whorl to sunlight, and it facilitates mowing, cultivating, spraying, fertilizing and harvesting.

Last, but not least, basal pruning provides an effective means of shock treatment to help control future excessive leader growth. Basal pruning alone frequently provides sufficient shock to prevent excessively long leaders until the tree is ready to

Basal pruning improves quality by forming an adequate handle above a strong, symmetric bottom whorl. Unwanted lower branches should be cut flush with the stem below the selected bottom whorl.

harvest. If excessive leader length develops despite basal pruning, most growers follow up with leader pruning to attain proper length, together with light side shearing to prevent overly-wide crowns.

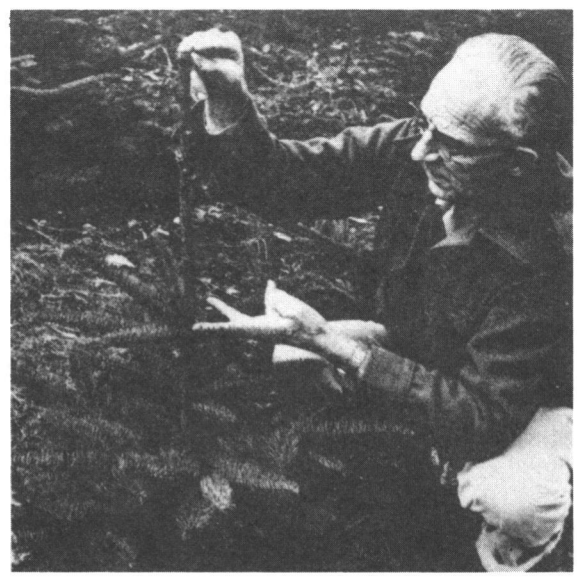
Some growers use additional shock treatments such as root pruning, leader scarring and basal scarring to slow future growth. These treatments are not generally recommended because they reduce the normal vigor of the tree and it is difficult to predict the amount of growth response. A better method is to redirect the excessive growth energy to the over-all crown area of the tree by shearing or leader pruning.

It is important to know when to start basal pruning. If done when the tree is too small, it may over-shock the tree and appreciably stunt the leader growth for another year or two. When postponed too long, excessively long leaders may result, as well as increased costs due to the difficulty in cutting the heavy bottom branches.

One good rule of thumb for the proper time to basal prune a true fir is to wait until a leader first develops a length between 12 and 16 inches. This stage of development frequently occurs after three or four growing seasons in the plantation. Basal pruning may be done at any time of year, but extra care must be taken to avoid breaking tender shoots during the succulent stage of new growth.

If complete basal pruning would be so severe as to cause overshock, it could be done in two stages. The first stage should establish the bottom whorl of the Christmas tree and progress downward from this point until the desired number of branches were removed. Defer pruning the remaining lower branches until the tree has made another season's growth.

This noble fir is not ready for basal pruning. Annual growth is less than 12" per year. Premature basal pruning would shock the tree and unnecessarily prolong the number of years required to attain a marketable height.



This noble fir is ready for basal pruning as indicated by the 14" leader. If the tree is not shocked at this time, next year's leader is likely to grow excessively long.

Basal pruning during the previous year effectively controlled growth of this noble fir. Had the tree not been shocked, indications are that the leader would have been about 18" long instead of 13".

A height-growth control study for noble fir[4] shows growth retardation of 21% during the first growing season after removing 50% of the live branches by basal pruning. Retardation was even more, 25%, during the second growing season, and continued to a much lesser degree into the third growing season after treatment.

4. **Replacing Lost Leaders.** Abortion of the center bud on the tip of the leader is a frequent and very troublesome problem on true firs. This is usually caused either by freezing or by bud boring larva. During the succulent stage, existing leaders may also be broken off by birds, animals or equipment. Whenever a leader is broken off near its base or fails to develop, serious conformity problems result unless remedial action is promptly taken. One major problem is that the lateral branches absorb the growth energy that would normally go into the leader. This causes the crown to become abnormally wide. Tight side shearing is required to maintain a narrow taper until a new top develops. Another problem is that several branches in the top whorl turn up and try to form a new leader. This spoils the conformity and balance of the top whorl. Several solutions are offered below. Although they usually give "less than" desirable results than a natural leader, they often make a saleable tree from one that otherwise would become a cull.

a. Cut off the entire top whorl above a strong lone internodal branch. The best time to do it, if you have a choice, is during the late succulent stage. Leave a base 2" stub above the internodal branch. Bind the internodal branch tightly against the stub in a vertical position with a couple of wraps of plastic flagging. Stretch the flagging before wrapping to insure against slipping or additional stretching. Remove the stub and flagging several months later when the new leader has "set" in a vertical position.

b. Select two branches in the top whorl that are exactly opposite each other. Draw them together in a vertical position. Bind them tightly together near their bases and near their tops with a couple of wraps of stretched, plastic flagging. After several months when they have set in a vertical positon, remove the flagging. Then, select the best leader and cut out the other one.

Note that a leader formed by an upturned branch tends to produce a three-sided, branch-like whorl the following year. This three-sided appearance can be de-emphasized by removing the terminal bud cluster from the upturned branch and relying on the lone internodal bud *facing the leader scar* to produce next year's leader.

This last remedy is especially effective if small buds or sprouts are beginning to show where the top leader bud aborted or was broken off. Cut the top whorl back severely, but leave two or more buds on each branch stub to keep it alive and well balanced. This will stimulate growth of several new leader sprouts, which will form multiple leaders. Retain the best multiple leader. Cut back the others

This Shasta red fir grades below U.S. No. 2 because of excessive whorl spacing. Timely shearing to improve density could have resulted in a U.S. Premium or U.S. No. 1.

[4] Study made in Clackamas County, Oregon by Bernard Douglass, Alvin Parker, Clayton Wills, and Harry Rounsefell, 1961-1963.

severely or remove them completely, depending upon the best overall balance and appearance.

5. **Leader Pruning and Side Shearing Techniques.**

a. **Definition.** Leader pruning consists of cutting back excessively long leaders to adequate length. As part of the same operation, unwanted multiple leaders are removed or shortened. Hand pruners are effective tools for this job. They permit close control in making the cuts in proper relation to the position of the internodal buds.

Side shearing consists of cutting back the tips of lateral branches to complete the cone shape to a desired taper. It is an effective means of correcting excessive crown width, lopsidedness and inadequate density when the trees do not naturally shape up well. Although many consumers still prefer the completely natural look of the unsheared tree, increasing numbers desire the more bushy, compact sheared type. In response to this changing market demand, most true fir growers now shear all or a portion of their true firs. Several types of shearing tools are used and include hand shears, shearing knives, hedge shears and electric and gasoline motor operated power clippers. Choice of tool largely depends upon the preference of the user. Knives are the most commonly used shearing tool at this time.

Some growers prune the tops of their trees as a separate operation before starting to shear the sides. Others combine both jobs as part of the same operation. In either case, the techniques are the same. Leader pruning should precede side shearing to establish the top of the cone and provide a guide for shearing the lower portion of the cone.

b. **Noble and Shasta Red Fir Techniques.** Ideal annual leader growth is 12 to 16 inches. However, it is usually better to retain natural leaders up to 17 or 18 inches in length rather than cut them back. Reason: the base of the new leader arising from an internodal bud or the top bud of a sheared leader sometimes forms an unsightly crook or offset called a "dogleg." The first year's terminal bud set of this new leader also may contain only three or four buds which produce an unsymmetrical top whorl. These leader shearing problems are more pronounced on noble and Shasta red fir than on other species. They can be minimized by shearing during the summer succulent stage when new growth is still brittle during its final stage of elongation, rather than later in the season. Succulent shearing allows the terminal bud to become more erect on the stem. It also frequently causes internal changes to occur in the bud structure which result in a normal five-bud terminal bud cluster the following year.

Pointed out is a top internodal bud on a Shasta red fir leader several months after it was succulently pruned to correct excessive length. Note that the bud has enlarged somewhat and has assumed a more erect position on the stem.

Detailed instructions for pruning excessively long leaders of noble fir and Shasta red fir follow. Locate a cluster of internodal buds on the leader, preferably about 12 to 16 inches above its base. Then try to locate a single internodal bud 2 to 4 inches above the cluster which can form the new leader. If more than one bud occurs at the desired level on the leader, pick all but one of them off. If such a bud cannot be located above the cluster, select the top bud of the cluster.

A new leader formed from the top bud one year after succulent shearing. No top shearing is required at this time because the new leader is only about 14" long, reasonably upright and contains a terminal bud surrounded by a rosette of five lateral buds.

When the leaders are pruned during the recommended late succulent stage, the cut may be made only a fraction of an inch above the top bud.

If leader pruning was neglected during the succulent growth period, then it is better to do it during the late summer or dormant season than not at all. In dormant pruning, leave a 2" leader stub above the selected top bud. This will form a post for tying the new leader erect. In case it does not grow straight and vertical, tie the leader against the stub with stretched plastic flagging. If leader pruning results in multiple leaders, then remove all except the best one. An exception would be where complete removal of the competing leaders would leave an obvious gap in the branch structure. In this case, cut the unwanted leaders back severely just above an "out-pointing" bud.

Growers are frequently tempted to shear the tips of the top whorl to correct a flared shape near the top of the crown. However, a better practice in most cases is to defer shearing the top whorl for one year. This will permit time for the lateral branches to form nodal forks during their second growing season. Shearing above these forks will noticeably improve the symmetry and naturalness of the sheared branch structure.

Some growers, are apprehensive that the uncut branches in the top whorl will turn up and form multiple leaders if the leader is shortened. However, true firs react differently than Douglas-firs in this respect. The branches in the top whorl tend to remain in their original horizontal position following leader pruning.

After the leader has been sheared, it is almost always necessary to shear the sides of the tree for maintenance of good proportion and prevention of excessive width. Shearing also increases the crown density by diverting growth energy from the main branch tips to the internodal branches and inside buds.

Three methods of side shearing will be separately described — random shearing, fork shearing, and disbudding. More than one method may be practiced on a single tree to bring out its best response. For example, branches that need drastic shortening may be fork sheared; those that need only slight shortening may be random sheared; and those that need lengthening may be left unsheared in order to catch up with the others.

(1) **Random shearing** consists of narrowing and shaping the crown to a uniform cone by cutting all 1 year old branch tips that project beyond the general desired cone shape. Care should be taken to avoid cutting secondary branches along with the tips. This would spoil the balance of the branch structure which is very important to many noble and Shasta red fir buyers. However, no attempt is made to make the cuts in relation to the position of individual buds on the sheared branch tips. A thin, sharp shearing knife is the most commonly used tool, but a hedge shear or power clipper may also be used. Random shearing is the more frequently used method of shaping the sides of a tree. It is also the least costly method to perform and easiest to teach shearing crews.

Cutting back the tips of the branches in the top whorl is a good practice for perfecting crown shape during the year of harvest. However, it is not recommended prior to the year of harvest unless the branches are abnormally long. Tip cutting virtually halts branch elongation for a year or two.

(2) **Fork shearing** uses a hand pruner to remove tips of individual lateral branches. These branches are located just above a fork formed by a nodal branch cluster or oppositely arranged secondary branches. Sufficient branch tip should be removed to attain desired crown width and uniform cone shape. Heavy fork shearing may actually cut into 2 or 3 year old wood where extreme narrowing of the crown is needed. Appearance and resistance to splitting is improved when the cut is made just above a branchlet arising from the bottom of the main branch. This is true for oppositely arranged branchlets on the side of the main branch. A disadvantage of fork shearing over random shearing is the tendency of the forked branch to split out during handling and shipping, or during silver thaws.

(3) **Disbudding** consists of removing one or

Fork shearing removes individual lateral branch tips to improve shape and prevent excessively wide trees. New growth from secondary branches tends to form a fork.

more buds from the bud cluster at the tip of a main lateral branch. As a minimum, it picks off the terminal bud plus any bud arising from the top side of the bud cluster. Time can be saved by cutting or pinching off the entire terminal bud cluster. A few growers develop sufficient skill with a shearing knife to flick off the terminal bud cluster with extreme accuracy, but most growers depend upon using their fingers or hand pruners. Disbudding the tips of the largest main laterals enables a grower to improve the shape of the tree and stimulate internodal branch growth in such a subtle manner that the tree will appear to be unsheared. Disbudded trees have a wider taper than those that are random sheared.

c. **Conclusions from a Noble Fir Shearing Study.** A cooperative study of noble fir culture was made by the U.S. Forest Service, State of Washington Cooperative Extension Service, J. Hofert Company and member growers of the Northwest Christmas Tree Association. The study was to determine most effective and economical techniques for developing plantation-grown noble fir Christmas trees in western Washington.[5] All known methods of leader pruning and side shearing were compared during both the dormant and succulent seasons and with and without applying nitrogen fertilizer. The conclusions follow:

(1) **Shear or not to shear?** Nonsheared trees that shape up well are very attractive. then, why shear a plantation at all?

The biggest reason to shear is that only a small percentage of trees are naturally self-shaping. The others developed various problems such as lopsidedness, excessive flares, and excessive spans between whorls. With proper shearing and leader shortening, most trees that would otherwise become culls could be developed into highly salable U.S. No. 1 and Better grades.

A second advantage of shearing was narrowing the tapers for easier handling, more economical shipping, and a wider range of consumer acceptance.

A third advantage was increasing the crown density. Current market demand is toward bushier crowns.

(2) **Best Shearing Techniques.** The best overall shearing practice was random shearing with a knife. Both light and medium intensities of knife shearing gave excellent and approximately equal grade recoveries. The main difference was a narrower taper for medium shearing (69% taper vs. 82% for light shearing).

Advantages of random knife shearing over clipping individual branches with a hand pruner were less cost, greater speed, more perfect cone shape, and more positive control of percent taper.

(3) **Proper Leader Pruning Techniques are a Must for Quality Control.** Side shearing alone was not enough. When leaders exceeded about 16", they needed to be cut back to about that length to prevent excessive internodal spans. Ideally, a leader should be cut just above a single internodal bud located one to four inches above an internodal bud cluster.

An additional advantage of leader pruning was diversion of growth energy to internodal branches, which increased crown density.

(4) **Fertilizing with Nitrogen Increased Tree Quality.** Nitrogen fertilized trees were visibly better quality than unfertilized control trees. Nitrogen more than doubled the grade recovery of U.S. No. 1 and Better trees. In addition, the fertilized trees grew almost a foot taller than unfertilized trees in eight growing seasons. The visible benefits from fertilizing were darker green, longer and heavier needles. Fertilizing also increased the number of internodal buds and increased the caliper of stems and branches.

(5) **Dormant vs. Succulent Shearing.** Results of shearing the sides of trees were acceptable and about the same for both the dormant and succulent stages. However, shearing was somewhat easier and faster during the succulent season

[5] Bernard S. Douglass, forester retired, U.S. Forest Service, Portland, Oregon, *Final Report of a Shearing and Fertilizing Study for Plantation-grown Christmas trees* (January 1977).

when new growth was still tender.

Cutting leaders during the succulent stage produced better results than during the dormant stage. The top bud on a succulently cut leader tended to become more erect and dominant during the course of the summer growing season, and thus was able to produce a relatively straight, even-whorled leader next growing season. Those on a leader cut during the dormant season usually formed a noticeable offset, commonly called a "dogleg".

(6) **Summary.**

(a) Shearing and fertilizing greatly increased the percentage of U.S. No. 1 and Better grade recovery. About half of the unsheared trees became U.S. No. 2 and culls, compared with only about ten percent of those that were sheared and fertilized.

(b) The most effective shearing technique was also the easiest and cheapest to perform. It consisted of light to medium side shearing to a cone shape with a knife and cutting the leaders back with a hand pruner to form a false whorl when their length exceeded about 16 inches.

(c) Side shearing was equally effective during the succulent and dormant stages of growth. However, leaders pruned during the succulent stage produced straighter future leaders from the top bud and more uniform whorls than those pruned during the dormant season.

d. **Grand Fir Techniques.** Three types of grand fir are produced in Northwest plantations: unsheared, light sheared, and heavy sheared. The unsheared and light sheared types are produced largely on slower growth sites. Acceptably short leaders may be attained on some trees by the shocking effect of basal pruning alone. Other trees do not respond sufficiently to basal pruning and require light cutting of the leaders and longer branch tips. Trees developed in this manner retain visible internodal spaces between whorls, a rather wide taper and a more or less natural look. Techniques for this light shearing of grand fir are about the same for those previously described for noble fir and Shasta red fir.

Heavy sheared grand firs are usually grown on faster growth sites where few trees develop adequate density without an intensive shearing program. These true firs can also be developed on low sites which are fertilized to stimulate growth rates. Heavy sheared trees are in growing demand by consumers who prefer trees with dense crowns and narrow to moderate tapers. The method of shearing is quite similar to that used to develop sheared plantation-grown Douglas-firs. The main difference is that grand firs are not usually sheared as tight as Douglas-firs.

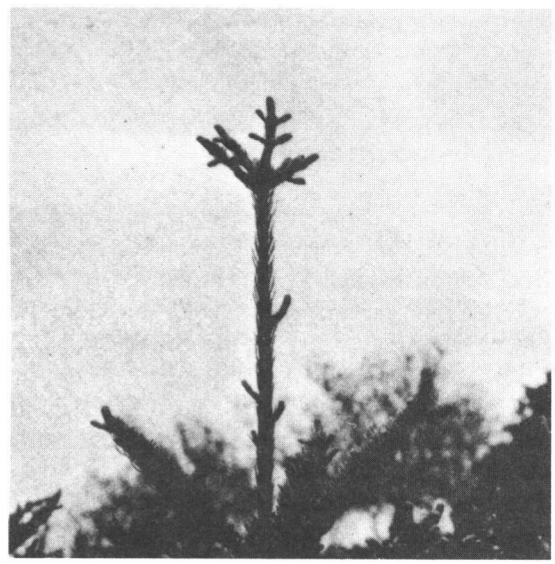
Instructions follow for developing the six- to eight-foot tall size:

(1) Shear the tips of the lower whorl only when the tree has developed two whorls above the handle. Do not cut back the leader until the total height of the tree exceeds about 4½ feet.

(2) When the total height of a tree above the base of an 8" handle first exceeds about 4½ feet, reduce the height to approximately 4½ feet by cutting back the leader. Make the cut above the single internodal bud located above a cluster of internodal buds. Grand firs develop more prolific internodal buds than any other true fir species. Lightly shear the sides of the trees to form a cone with a taper of about 50%.

(3) During the following year, and each year thereafter, cut the leader to about 12" long and continue side shearing to form a cone with about a 50% taper.

(4) During the last year of shearing, cut the leader to whatever length gives the best proportion. This is commonly eight to ten inches. At the same time, side shear very lightly to form a



A late summer flush of regrowth is shown on a terminal bud cluster. It most frequently occurs after irrigating or heavy summer rains. Regrowth sometimes occur only on one or two lateral buds. Shearing to correct the resulting unsymmetrical appearance is most effective if deferred until the late succulent stage of the following growing season.

stub-free, natural appearing cone. Lighter side shearing will expand the taper of the cone from about 50% to about 60%.

(5) Recommended season of shearing is during the late succulent stage after the new growth has fully elongated. Shearing the leader at this time causes the top bud to grow more erect during the summer. Where it is necessary to shear during the dormant season, leave a 2" stub above the selected top bud on the leader. This stub will serve as a post to bind the new leader into an upright position if it tends to lean.

e. **Conclusions from a Grand Fir Shearing Study.** A Cooperative study on culturing grand fir Christmas trees was completed in 1977 by the U.S. Forest Service, Washington State Cooperative Extension Service and members of the Northwest Christmas Tree Growers Association. The purpose of the study was to determine the most effective and economic techniques for developing plantation-grown grand fir Christmas trees in Oregon and Washington.

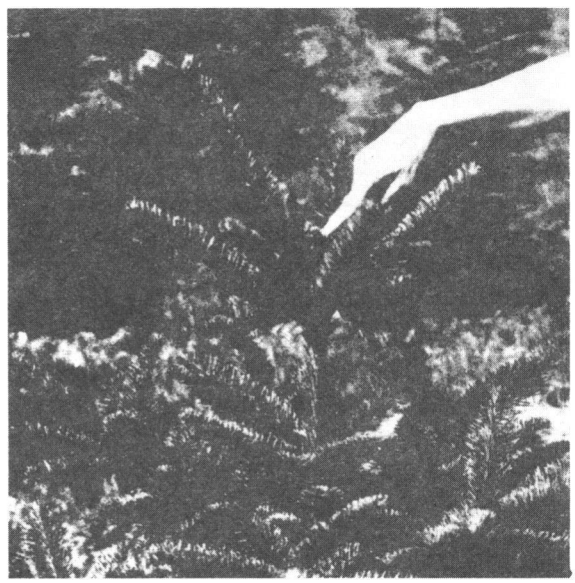
Two study plots were involved: one near Olympia, Washington, and the other near Hillsboro, Oregon. Various methods and seasons of leader pruning and side shearing were compared with and without fertilizing.[6] Results follow:

(1) From the standpoint of both grade recovery and shortness of rotation, the most effective shearing technique was light, random shearing with a knife to form a cone-shaped crown. Light shearing produced a 70% average taper and yielded 25% more premium grade six- to seven-foot trees than the tighter shearing to a 58% average taper.

(2) The most productive leader shearing techniques for developing the popular six- to seven-foot height was accomplished by cutting the leaders back to about 12" each year. This shearing was done once the pruned height of the tree exceeded about 4½ feet. Any trees less than 4½ feet tall were not leader pruned, but most of them were side sheared to narrow their taper. This leader pruning technique started producing six- to seven-foot, U.S. No. 1 and Better grade trees after seven growing seasons in the field. During this period, the trees received four consecutive shearings and three consecutive leader prunings. Two additional years of leader pruning and side shearing were required to attain merchantable size and quality for the slower developing trees.

(3) Succulent shearing, when the leaders were fully elongated but still tender, developed 36% more U.S. No. 1 and Better grades than dormant shearing. Succulent sheared trees developed straighter leaders.

(4) Fertilizing with nitrogen visibly improved vigor, color, and crown density. Thirty-seven percent more U.S. Premium grade trees were tallied on fertilized trees than on unfertilized trees.



Birds broke off the leader several months ago during its succulent stage. Note the tendency of the lateral branches of the top whorl to grow erect and form multiple leaders.

H. STUMP CULTURE

Stump culture is the practice of leaving a few limbs below the handle to keep the stump alive after the Christmas tree is harvested. Cutting back the tips of the limbs will stimulate growth of several vertical adventitious sprouts from the sides of stump. The most promising one is then selected to produce a new tree. The competing sprouts and branches are gradually removed to insure dominance of the selected sprout.

Stump culture is not recommended in plantations unless a special tree or seed source needs to be preserved. Too much time and labor is required to cut back the competing growth. It does have application in natural stands where new seedlings are lacking or difficult to establish. Using an established root system of a cut tree may actually reduce the time necessary to develop the next trees.

[6] Bernard S. Douglass and Frank A. TerBush, "Shearing and Fertilizing Study of Plantation-grown Grand Fir Trees," *Northwest Lookout*, September 1977.

Stump culturing is sometimes used to replace a cut tree without replanting. It consists of saving a few branches in the stump below the handle to keep the roots alive. Cutting back the branch tips will help force adventitious buds from the stump, which develop into a new tree much more readily than an upturned branch.

Four ounces of urea were spread under each noble fir to increase its vigor and bud production. Although the larger trees were improved, a number of smaller ones died from nitrogen shock. Mortality could have been prevented by adjusting the amount of fertilizer for each tree according to its size.

I. FERTILIZING

Some cleared lands, formerly under cultivation, contain sufficient nutriments for good Christmas tree vigor and color without fertilizing. However, chlorotic (yellowish) needles, sparse buds and excessively slow growth rates can occur in many true fir plantations even with good grass and weed control. This is a fairly reliable indication of a nutritional deficiency.

Fertilizers must be used with caution. Overdoses may injure the roots, cause excessive growth or stimulate rank growth of grass and weeds. Experimental applications of 1/16 to 1/4 pound (actual nitrogen) per six foot tree should be made to determine the least amount per tree needed to obtain desirable color and vigor. Heavier applications of fertilizers will probably be more necessary on clay soils than on sandy soils. Large scale applications should not be made until sufficient small trials have proven their effectiveness under local conditions.

Straight nitrogen fertilizers have in most cases proven equally effective and less costly than balanced fertilizers. Commonly used nitrogen fertilizers are urea, ammonium nitrate and ammonium sulphate.

Fertilizer should be scattered under the drip line of the tree in late winter or early spring before the buds have burst. Proper amounts of nitrogen will cause deficient trees to develop heavier, darker green needles and a noticeable increase of internodal buds after one growing season.

Increased leader growth will only be slight during the first growing season, but frequently doubles during the second. Therefore, the safest time to apply nitrogen on unsheared or lightly sheared trees is in March or April of the same year that the tree will be harvested. Another advantage of deferring fertilizing until the year of harvest is obtaining maximum color response which always occurs during the same year that the nitrogen is applied.

Another use of nitrogen is for stimulating vigor and growth of stunted or unthrifty trees on poor sites. Two precautions should be observed in fertilizing younger plantations.

a. Do not fertilize the same year that trees are planted. Roots at this time are easily damaged by even small applications of nitrogen.

b. Use nitrogen very sparingly on small trees. Overdoses will burn the roots. Trial applications should be made around the drip lines of a few trees to determine the correct amount to stimulate adequate growth without killing the roots. Perhaps try a tablespoon full for small trees after the first growing season in the field.

J. NUMBER OF YEARS REQUIRED TO GROW A MERCHANTABLE TREE

Rotations for growing true fir Christmas trees will vary with species, sites, and intensity of culture. Harvesting is usually spread over a period of three or more years because all trees do not develop uniformly.

The rotation ages shown below are considered average for intensively managed plantations on Site III lands. Estimated percentages of total cut for each year of an assumed three year harvesting period are also shown.

Percentages of Total Merchantable Trees Harvested at Various Plantation Ages

Species	Number of Growing Seasons					
	7	8	9	10	11	Total
	----- Percent of Total Harvest -----					
Grand fir	20	50	30			100
Noble fir		30	40	30		100
Shasta red fir			40	40	20	100

K. SEASONAL CULTURAL INSTRUCTIONS

1. **After First Growing Season.** Concentrate only on keeping trees alive, healthy and growing. The only pruning would be removing double leaders. The decision of which leader to save should be based on its vigor, erectness, number of internodal buds, and completeness of terminal buds. Weed and grass control is essential for good growth and survival. Herbicide application is the usual method.

The first summer's mortality should be replaced during the regular planting season with the same species originally planted. Replacement stock can be developed in a transplant bed where trees from the original planting stock are held. Sufficient trees should be ordered to meet this need.

2. **After Second Growing Season.** Same general instructions as for "After First Growing Season."

True firs develop slowly and are unlikely to require pruning at this time. When Atrazine is used to control grass and weeds, it should be applied between February 15 and March 30.

Mortality should be replaced with planting stock of the same species from a nursery or transplant bed. The planting stock should be large and thrifty to reduce the spread in tree sizes, and thus the cutting rotation. However, persistent mortality spots caused by shallow bedrock, sterile soil, or poor drainage should be either left unplanted or replanted to grand fir, Scotch pine, shore pine or some other more tolerant species. Replantings of true fir would likely die for the same reason that the original planting failed.

3. **After Third Growing Season.** Weed and grass control should continue. Most seedlings will not require pruning except for removing multiple leaders. A few exceptionally fast growers may have developed leaders longer than 12" to 16". These may be basal pruned to prevent excessive growth and to start a handle. However, in order to prevent overshock and stunting, not more than one half of the total live branches should normally be removed in any single year.

4. **After Fourth Growing Season and Thereafter Until Trees Are Harvested.** Weed and grass control should be continued. Basal prune only those trees that develop leaders longer than 12" to 16". Trees with leaders less than 12" long need their full crowns for adequate growth.

Annual leader growth of 12" to 16" is an acceptable length for true firs. Leader growth less than 12" will not detract from tree quality, but will unnecessarily lengthen the time required to develop merchantable size. Leaders longer than 16" or 17" will detract from tree quality and should be cut back during the late succulent stage to a single internodal bud. This bud is preferably one that is situated at least one inch above a cluster of internodal buds. At the same time, the lateral branches should be lightly sheared to form a uniform cone-shaped crown if the existing taper of the tree exceeds about 50%.

Shearing techniques for various true fir species are quite similar. However, grand fir may be sheared somewhat tighter than noble. Most growers strive for a grand fir shearing intensity about midway between that of Douglas-fir and noble fir. Shasta red fir are less apt to require shearing than noble fir. Their narrow self-shaping growth habit frequently makes shearing unnecessary.

L. CONCLUSIONS

True firs are in ever increasing demand for Christmas trees and bring top market prices. Attractive needles, heavy and symmetrical branches, and

durable foliage are selling advantages. At the same time, true firs are considered the most difficult species to produce.

Relatively few Northwest growers have produced plantations of high quality true firs. The most successful growers have very carefully selected planting sites that are natually well-suited for growing true firs. These growers have also been selective about their seed sources. They have also cultured the trees very skillfully and intensively to attain desirable shape, density and spacing of whorls.

Until recent years, all true firs were developed with natural, unsheared crowns. This was very often wasteful production because many trees developed poor shape or excessively large openings between the whorls. Shearing is becoming increasingly popular to correct these defects and to increase the percentage of marketable quality trees that can be harvested from a true fir plantation. Growing numbers of consumers are beginning to accept, and even prefer, the more symmetric, dense, narrow crowns that are found on sheared trees.

M. PROTECTION

The following are recommended references:

Growing Christmas Trees in the Pacific Northwest, PNW-6, Cooperative Extension Service, Washington State University, Revision - May 1976.

Insect Control Guide for Commercial Christmas Tree Growing (Revised) Washington State University Extension Service, November 1974.

Pests and Disease Control Guide for Christmas Trees, C.S. Davis, E.E Gilden, C.S. Koehler and A.H. McCain, Pub. 2994, University of California Cooperative Extension Service, Division of Agricultural Sciences, Revision - January 1965.

Why Is My Evergreen Brown? A.D. Partridge and J.A. Schenk, Idaho Agricultural Extension Service Bulletin 514, 1976.

Wildlife Feeding Injuries on Conifers in the Pacific Northwest, William Laurence, Nelson B. Kverno, and Harry D. Hartwell, distributed by Western Forestry and Conservation Association, Portland, Oregon, 1978. $3.00.

N. HARVESTING AND MARKETING

Refer to the following bulletin: Christmas Tree Harvesting and Marketing for Pacific Northwest Growers, Bernard S. Douglass, U.S. Forest Service, Region 6, Portland, Oregon, 1979.

O. SOURCES OF ASSISTANCE AND INFORMATION

Most growers in Oregon and Washington belong to the Northwest Christmas Tree Association. Meetings, field tours, culturing demonstrations and current literature are provided for members. The name and address of the current secretary may be obtained by contacting any of the above mentioned sources of information.

Both the Oregon State and Washington State University Extension Services provide biennial two day, short courses for Christmas tree growers. Your local Extension Forestry Agent can provide information on time, place, and agenda of these training sessions.

Further information may be obtained from the Association Secretary.

The pesticides reported on and recommended here was registered for the use described at the time this manuscript was prepared. Since the registration of pesticides is under constant review by State and Federal authorities, a responsible State agency should be consulted as to the current status of this pesticide.

Pesticides used improperly can be injurious to man, animals and plants. Follow the directions and heed all precautions on the labels.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

Pacific Northwest cooperative Extension bulletins are joint publications of the three Pacific Northwest states — Oregon, Washington, and Idaho. Similar crops, climate, and topography create a natural geographic unit that crosses state lines. Since 1949, the PNW program has published over 200 titles. Joint writing, editing, and production has prevented duplication of effort, broadened the availability of faculty specialists, and substantially reduced costs for the participating states.

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