12-1985

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University of Tennessee Agricultural Experiment Station

Eyvind Thor

lletin 641 December 1985

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The University of Tennessee
Agricultural Experiment Station
D. M. Gossett, Dean
Knoxville, Tennessee

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Eyvind Thor

Professor Emeritus
Department of Forestry, Wildlife, and Fisheries
The University of Tennessee
Agricultural Experiment Station
Knoxville, Tennessee

FOREWORD

The author is indebted to many persons who gave of their time and patience in the review of the manuscript. Special thanks go to Drs. Glen Smalley, U.S. Forest Service; Scott Schlarbaum, The University of Tennessee, Knoxville; and Eric Winters, The University of Tennessee, Knoxville, retired. The author is also thankful to the members of the Mid-South Christmas Tree Association for their support during the last 5 years.

A 5-year preparation time is, of course, not warranted for a publication of this nature. However, most of this time was lost due to the sickness and retirement of the author.

A publication on Christmas trees in Tennessee must address some fairly complex problems and come up with relatively simple solutions. This publication is primarily written to help new growers, those who are thinking about growing trees, and the amateur growers. "Experienced growers" (defined by the author as persons who have profitably cultivated and sold at least one crop of trees) may also find a few items that will help in their business.

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CHAPTER ONE

INTRODUCTION

The First Tennessee Tree Farms

The first Christmas tree producers in Tennessee began operations in the mid 1950's. A. E. Miller, Sr., a dentist from Elizabethton, and Frank Gentry, an Erwin businessman, each started plantations after seeing Christmas tree farms in the North Carolina mountains.

When Dr. Miller died, his son, Dr. A. E. Miller, Jr., assumed management of the plantations on Ripshin Mountain. In addition to usual Christmas tree operations of planting and harvesting, he collects substantial amounts of improved seed from a Fraser fir seed production area established by his father. The foresight to establish an orchard paid off; most natural stands of Fraser fir have been devastated by the balsam woolly aphid, and seed is now very difficult to obtain. The Miller and Gentry operations are examples of the long-term commitment required for successful Christmas tree production.

Research and Development

Shortly after establishment of these first plantations, the Tennessee Agricultural Experiment Station began Christmas tree research within the Forestry Department at The University of Tennessee. Dr. Eyvind Thor led the research program from the mid 1950's until his retirement in 1982, and it has been continued under the guidance of Dr. Scott Schlarbaum. Research has played a major role in the development of the Christmas tree industry in Tennessee. Information developed on species adaptation and proper seed sources helps growers avoid many costly mistakes.

The Tennessee Christmas Tree Growers Association (TCTGA) was formed in 1971 by a small group of growers. Membership grew from 16 in 1972 to more than 100 in 1984. The Tennessee group is associated with the National Christmas Tree Association (NCTA). Van Michael of Vale Forest Tree Farms, Sweetwater, served as national director from Tennessee from 1972 through 1979. Eyvind Thor of Valhalla Tree Farm, Knoxville, represented the state in 1980-82. Ron Emery, a retailer from Knoxville, succeeded Thor as director.

In May 1983 the members dissolved TCTGA and formed a new association for growers, wholesalers, retailers, and suppliers from Kentucky and Tennessee. The Mid-South Christmas Tree Association (MSCTA) is a member of NCTA. Some growers in the Upper East Tennessee Valley have joined a group that is primarily interested in Fraser fir.

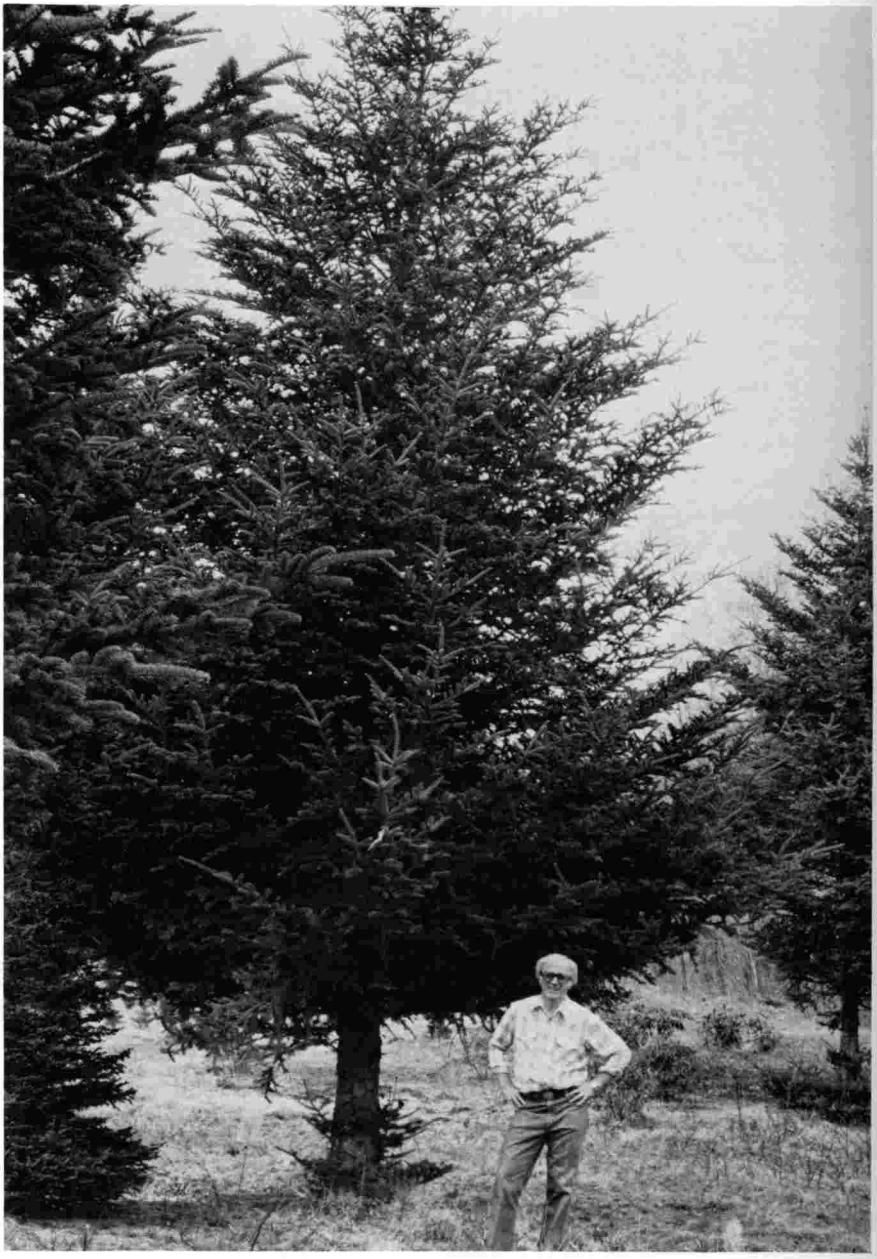


Figure 1: Dr. A. E. Miller, Jr. in his Fraser fir seed production area on Ripshin Mountain.

Both MSCTA and NCTA help growers produce and market their trees. State or regional associations conduct meetings, workshops, and visits to Christmas tree farms. The national association is primarily concerned with marketing, public relations, and tax issues. A quarterly magazine, the *American Christmas Tree Journal,* is published by NCTA. Membership in both MSCTA and NCTA is recommended to individuals planning to become Christmas tree growers. Dues are a small investment in consideration of the information made available to help growers avoid costly mistakes.

The Tennessee Division of Forestry (TDF) provides technical assistance for private landowners. Holdings up to 100 acres are examined at no cost, and $1/acre is charged for land in excess of 100 acres. At cost, TDF will provide assistance with tree planting, timber stand improvement, timber marketing, and controlled burning. Growers may contact any of the following TDF offices:

District 1. Greeneville, P.O. Box 731; 638-7841
District 2. Knoxville, P.O. Box 2666; 673-6432
District 3. Hixson, P.O. Box 160; 755-3091
District 4. Cookeville, 312 East First St.; 526-9502
District 5. Manchester, P.O. Box 616; 728-7059
District 6. Burns, P.O. Box 100; 797-3117
District 7. Columbia, West End Shopping Center; 388-0240
District 8. Lexington, P.O. Box 438; 968-6676
District 9. Brownsville, P.O. Box 202; 772-4592

Factors Affecting Success or Failure

When Christmas tree research was begun by the Tennessee Agricultural Experiment Station, it was anticipated that Christmas tree production would provide an extra cash crop for farmers. Most Tennessee growers, however, are not farmers but professional and business people. Farmers utilize their land for row crops or pasture and generally produce annual crops rather than long-term crops like trees. Incentives for Christmas tree production may be greater for professional or business people because of their higher average income. They may benefit more from the capital gains treatment of income derived from Christmas trees and are generally more inclined to invest substantial amounts of money in a long-term enterprise.

Regardless of background, growers must be dedicated as it takes 5 to 12 years, depending on species and site, to produce trees of marketable size. Cultural activities must be carried out every year. Ignoring these activities for a single growing season usually results in reduced tree quality or loss of an entire plantation. Many growers fail to perform the needed cultural practices and may never harvest many trees.

All sizes of Christmas tree operations are found in Tennessee — small (fewer than 10 acres), medium (10 to 100 acres), and large (more than 100 acres). Any size operation can be profitable if properly managed, but small operations have some advantages. Most labor on small operations is usually provided by the farm family. Equipment costs are low, and many trees can be sold directly to consumers, particularly if the plantation is near a population center. Large operations, on the other hand, require considerable investment in equipment. Due to the greater use of machines, however, labor input per tree is small, and production may be sufficient to maintain a wholesale operation. Medium-sized operations do not have the advantages of small or large Christmas tree farms. Small growers wanting to expand may experience some "growing pains."

CHAPTER TWO

SPECIES TO PLANT

Selection of species is a most important decision and the beginner cannot afford to experiment with a number of exotic (non-native) species. Comparisons of different species and varieties for adaptation to different parts of the state have been made by the Tennessee Agricultural Experiment Station and individual growers.

Adaptability to Site

The term *site* embodies the different ecological factors (biotic, climatic, and soil) that determine survival and growth of a tree. Most farms have several soil types, exposures, and drainage situations. Areas to avoid are poorly drained soils, very dry sites, and locations shaded by adjacent woodland. Some species, such as white pine, grow well on a wide range of sites. Norway spruce does well in partly shaded and damp locations, while Scotch pine requires full sunlight and grows well on dry hillsides with southern exposures.

Scotch pine and white pine can be grown from the Mississippi River to the Great Smoky Mountains. Other species have more restricted ranges; Norway spruce plantations are usually not successful in the western part of Tennessee, and Colorado blue spruce is best adapted to higher elevations on the Cumberland Plateau and in the Smoky Mountains. Fraser fir is limited to sites with elevation of more than 2000 feet in the mountains of East Tennessee.

Survival and growth rate are the most important characteristics in determining suitability of a species to a particular site. Vigorous growth is essential to obtain good bud set and dense foliage. Unwanted growth, such as forks, may be removed by pruning. Excessive leader and lateral branch development can be controlled by shearing. Thus, a vigorously growing tree can be shaped to a dense, high quality Christmas tree. Slow-growing trees, while needing little shaping, have poor bud set and sparse foliage. Experiments with Norway spruce and white pine have shown that with rapid growth rate and proper shearing, 64 to 85 percent of the spruce and 65 to 87 percent of the white pine were graded as U.S. Premium (see Appendix Two for explanation of USDA Christmas tree grades). Conversely, on an eroded site where growth was slow, only 33 percent of the Norway spruce and 59 percent of the white pine were premium trees.

Susceptibility to diseases and insects varies greatly among species, physiographic regions, and sites. In general, Fraser fir has the most disease and insect problems while Norway spruce has the fewest; white and

Scotch pines are intermediate. Most growers encounter some pest problems, but proper selection of species for site conditions will minimize disease and insect problems.

On farms with a great variety of sites, it may be necessary to make a detailed map of soil and topography. The U.S. Soil Conservation Service (SCS) can provide the latest aerial photographs. Planting of a particular species may be limited to a very small portion of the total area. Careful planning will significantly reduce future losses, particularly to diseases such as *Phytophthora* root rot and needle cast. Fraser fir is especially susceptible to root rot. White pine also may be killed by this fungus, which is associated with soils having poor internal drainage. If growers avoid heavy clay soils or light soils underlain by a layer of impervious clay or rock, this disease problem will be of less importance. Needle cast of pines can be caused by several fungi, but *Lophodermium* is most common. High humidity favors the spread of needle cast diseases, which are more prevalent on shaded north slopes than on exposed south slopes. Plant spruce and fir, which are resistant to *Lophodermium*, on north slopes and the light-demanding pines on south slopes.

Availability of Seedlings

White pine and Virginia pine seedlings are produced for sale by the Tennessee Division of Forestry (TDF) nursery near Pinson in West Tennessee. Since their seedlings are sold at a low price, the demand is high, particularly for white pine. Customers of the state nursery are treated on a first-come, first-served basis. Therefore, it is important to place seedling orders by July 1 or shortly after for planting the following spring. Seedling application forms can be obtained from offices of TDF, SCS, and county extension leaders.

White pine seedlings from TDF cost more than Virginia pine because white pines must be grown for 2 years in the nursery bed while Virginia pines reach outplanting size in only 1 growing season. Seedlings or transplants of other Christmas tree species, such as Scotch pine, Norway spruce, Colorado blue spruce, and Fraser fir, are grown in a few small nurseries in the southern Appalachian Mountains. Some large commercial nurseries in northern states also specialize in the production of these species. The quality of their seedlings is usually good, but northern nursery beds are often frozen during the best planting season in Tennessee, delaying delivery of seedlings until late spring. When seedlings are planted late, they are more susceptible to mortality from spring droughts. However, orders placed for late winter delivery can often be filled with trees placed in cold storage by nurseries the preceding fall.

Seedling quality is largely determined by the environment within the nursery bed (seedbed density, fertilizer applications, irrigation, and length of growing season) and the genetic make-up (genotype) of the seed. The

outward appearance (phenotype) of a seedling is the product of its environment and genotype. An important aspect of the genotype is the provenance. Provenance refers to the original geographic source of the seed. Exotic species such as Norway spruce and Scotch pine will always be of a European provenance.

Seedling phenotypes may change greatly from how they appear in the seedling bed to appearance at time of delivery. Improper lifting, packing, storage, and transportation may damage or destroy seedlings. The evidence of improper handling is torn roots, inadequate packing materials, and dried-out roots and needles.

A North Carolina state nursery produces Fraser fir seedlings, but sale is limited to North Carolina landowners. Demand for these seedlings is so great that orders are only partially filled. However, seedlings and transplants are produced by a number of small private nurseries in the southern Appalachian region as well as by larger commercial nurseries farther north.

When planting stock of a particular species and provenance is unavailable, a grower may consider collecting wildlings. These natural seedlings are not as desirable as nursery-grown seedlings. Collection may be expensive, and usually wildlings lack the extensive root system of nursery-grown stock. Only shade tolerant species will have sufficient vigor, and this limits collection to Fraser fir. To obtain the well-developed root system needed for field planting, it is usually necessary to transplant wildlings in beds or containers for at least one year. Permission from the landowner should be obtained before wildlings are collected.

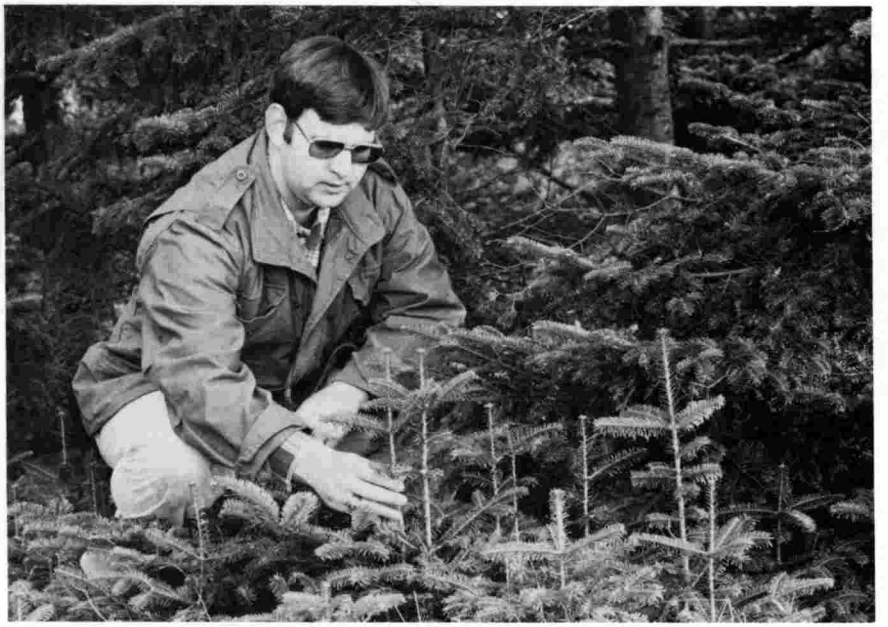


Figure 2: Fraser fir wildlings from a natural stand on Roan Mountain.

Saleability

In 1962 a survey was conducted to determine consumer preferences and buying habits for Christmas trees in the Knoxville area. Forty-two percent of the people shown a display of 6 species (Fraser fir, Norway spruce, white pine, red-cedar, Scotch pine, and Arizona cypress) preferred the Fraser fir. Preferences for the other species were 25, 16, 10, 7, and 0 percent, respectively. Tradition is an important aspect of preference, and Knoxville consumers were accustomed to Canadian balsam fir, which they could not distinguish from Fraser fir. Prior to 1962, long-needled trees such as white pine had not been sold in Knoxville. In succeeding years, however, large numbers of pines have been marketed. A current consumer preference survey would undoubtedly find that a greater proportion of buyers would prefer white and Scotch pines.

Some consumers prefer a given species and will ask for it, but most buyers cannot tell the difference among species of pines or, for that matter, the difference among spruce, pine, and fir. Most buyers are interested in size, appearance, needle-holding ability, and freshness rather than species. This customer attitude does not mean that the species is not important because appearance and needle-holding are related to species. However, cultural practices, such as shearing, will modify density and shape, and color can be improved by application of colorants.

A grower may receive almost twice as much money for a Fraser fir as compared to a white pine, assuming that they are of the same size and quality. Fraser fir has very desirable Christmas tree characteristics that are appreciated by many consumers. On the other hand, Fraser fir production costs are much higher than those for pines.

Potential customers shown the 6 species of trees in 1962 were asked, by 50-cent increments, which species they would choose if their first choice cost more than the others. Even though a few customers would not switch regardless of price, a difference of $1 ($6 at 1985 prices) made many Fraser fir customers switch to another species. Acceptable substitutes for Fraser fir were Norway spruce (75 percent), white pine (56 percent), and Scotch pine (45 percent). As the price differential increased, a greater number of customers abandoned their first choice and settled for a less expensive species. The message to Christmas tree growers is that when production costs of a given species become much greater than that of other species, the number of trees that can be sold at a profit will rapidly decrease.

Shipping Quality

Shipping quality means how well trees pack in a load and resist breakage and needle loss. Until recently, only a small number of Christmas trees were harvested in Tennessee; most of these trees were sold locally, and

there was little concern about shipping quality. With increased production and longer distances to markets, this characteristic has increased in importance.

If Christmas trees are tightly baled with twine or plastic netting prior to shipment and care is exercised in loading and unloading, breakage will be minimal. If trees are frozen, leaders and branches will be brittle, and extreme care must be taken to avoid breakage. The number of trees that can be loaded on a truck varies by size and type of truck, skill of the loaders, and size and fullness of the trees. Usually more Fraser fir or white pine can be loaded than Scotch pine, Norway spruce, Virginia pine, or Colorado blue spruce. With rising trucking costs, this is a factor that should be considered by growers developing wholesale markets.

Fraser fir, white pine, and Scotch pine have excellent needle-holding ability and can be shipped long distances with minimal damage as long as the load is protected from heat. Blue spruce and Norway spruce shed their needles after prolonged storage or transportation. These two species should be cut at the end of the harvest season (about the first week of December) and shipped immediately. Even with these precautions some spruce will start shedding needles before Christmas. It is best to market the spruces locally in a choose and cut operation or as live trees (balled and burlapped).

Recommended Species

Although more than a dozen species are commonly used for Christmas trees in the United States, only 6 are presently recommended for production in Tennessee. Tennessee growers have a reasonable expectation of a profitable operation if they select species and provenances recommended for their physiographic region and follow accepted cultivation and management procedures. When species and provenances other than those recommended are used, the probability of financial success decreases, regardless of other management practices employed. Restrictions on use of plant materials are not intended to discourage individual growers from experimenting with other species. Growers are encouraged to establish small plantings of different species. Information obtained from such plantings will be of great value to the industry and may result in additions to the list of recommended species. Recommendations will change over time as experience is gained and new plant materials are developed.

White Pine

Eastern white pine is native to East Tennessee and the Cumberland Mountains, but good quality Christmas trees have also been produced on the Highland Rim. In West Tennessee, survival is often poor, although the growth rate of established trees is acceptable. White pine grows best

on well-drained, sandy loam to clay loam soils.

Even though white pine is more shade tolerant than Scotch pine, it requires direct sunlight most of the day to develop vigor. Weeds must be controlled, or they will shade out the lower limbs. White pine weevil and blister rust are important pests in northern states but are not common in Tennessee. Aphids and bagworms can be serious pests.

Trees grown from recommended provenances, such as Morgan or Anderson counties, should reach commercial size (6 to 7 feet) in 7 years. The Tennessee Division of Forestry now collects white pine seed from these designated areas. However, if a grower is tardy in applying for seedlings, the order may not be accepted by the nursery, and seedlings may have to be bought from an out-of-state nursery. If the out-of-state nursery can guarantee that the seed was collected from approved areas in Tennessee or northern Georgia, the genotypes may be as good as those from the TDF nursery. Trees of many North Carolina provenances do not grow well in Tennessee; this may be due to lack of resistance to sulfur dioxide damage. Northern seed sources are unacceptable due to poor survival and slow growth. If seedlings of proper provenances are not available, Tennessee growers will be better off postponing planting or using another recommended species.

Scotch Pine

A species native to Europe, Scotch pine is the most popular Christmas tree in the United States. It will grow on a variety of sites in all parts of Tennessee but has not been widely planted. Results from seed source tests and commercial plantations are extremely variable, reflecting a large amount of genetic variation. Unfortunately, this variation results in a large proportion of cull trees. Even though some provenances on an average produce significantly better trees than others, all will have runts and giants, premium trees and culls, yellow needles and dark green needles, straight stems and corkscrews. The fastest growing trees tend to be from central Europe while trees from northern and southern Europe grow slower. In Tennessee, trees of French seed sources have exhibited a combination of good needle characteristics (fairly short and blue-green) and moderate growth rate.

Six to 7 foot trees can be grown in 7 years with little or no use of fertilizers. Pruning to remove forks and cankers of eastern gall rust is required. Scotch pine is extremely shade intolerant and susceptible to damage from a number of insects and diseases.

Norway Spruce

Uncultured Norway spruce is the traditional Christmas tree for most north Europeans. Norway spruce develops into a symmetrical, reasonably dense tree without shaping. Poor needle retention is not a problem in northern Europe; cold weather and the tradition of bringing the tree inside

Figure 3: White Pine — A good choice throughout most of Tennessee.

Figure 4: Scotch pine of proper seed source is a good species to plant on dry sites.

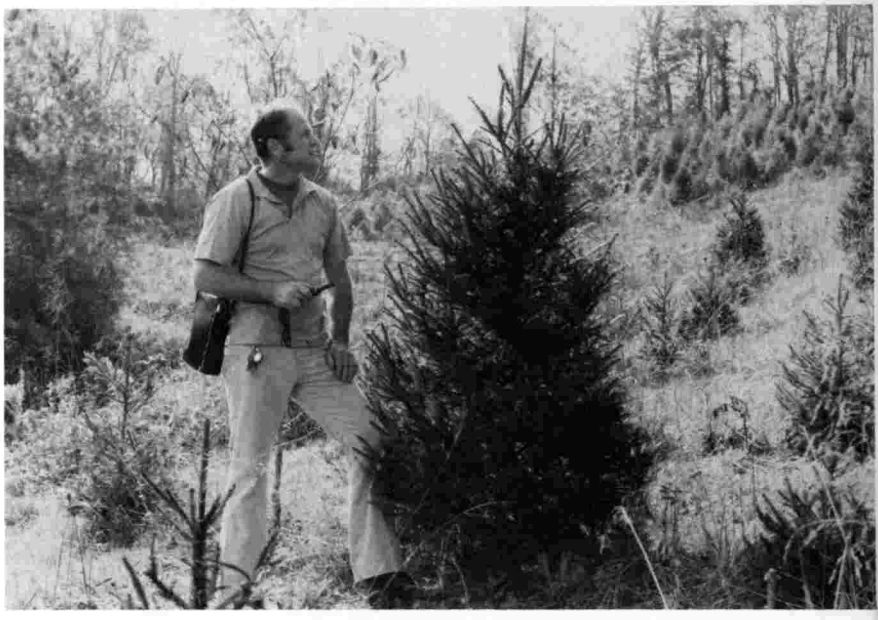


Figure 5: Norway spruce is well adapted to the growing conditions in East Tennessee.

shortly before Christmas Eve make it possible to keep the tree relatively fresh through the holiday season. In Tennessee, however, climate and Christmas traditions limit the use of Norway spruce to choose and cut operations and harvests designed to fill shortages occurring on local retail yards during the last week of sales.

Any seed source from central Europe may be used, and occasionally individual trees do exhibit good needle-holding ability. A selection breeding program is underway at The University of Tennessee to take advantage of this variation.

Norway spruce can be grown almost anywhere in East Tennessee, including the Cumberland Plateau and Mountains. It prefers a moist soil with relatively high fertility. Since it is adapted to a cool climate and is relatively shade tolerant, it does best on north slopes. Norway spruce can be planted along adjacent woodlands where pines do poorly because of low light intensities.

Rotation length for Norway spruce will be greatly influenced by quality of planting stock. Small seedlings with poorly developed root systems grow slowly for 3 to 4 years after planting. Large seedlings or transplants with well-developed roots will have acceptable growth rates after 1 year when planted on suitable sites. Using good planting stock and relatively light shearing, most trees will be 6 to 7 feet tall in 8 years.

Since Norway spruce is shade tolerant and not susceptible to many insects or diseases, it is possible to grow this species without heavy applications of pesticides. Top quality trees on 8-year rotations may require periodic applications of phosphate and nitrogen.

Blue Spruce

Colorado blue spruce is native to the middle and upper slopes of the central Rocky Mountains where the growing season is short. Although blue spruce is grown as an ornamental tree in the East Tennessee valley, its growth rate is too slow for commercial Christmas tree production. At higher elevations, 2000 feet and higher in the Cumberland and East Tennessee mountains, blue spruce may grow almost as fast as Norway spruce and produce an equivalent proportion of premium trees. The two species require about the same site conditions and cultural treatments.

Colorado blue spruce is sometimes preferred over Norway spruce because of the bluish needle color and somewhat better needle-holding ability. Genetic variation in foliage color is striking; individual trees vary from plain green to strong blue-green. Seed from the Kaibab region in northern Arizona will produce a high proportion of trees with blue foliage. However, trees from southern Arizona and New Mexico may grow faster.

Fraser Fir

Fir stands in the southern Appalachians are separated by relatively long distances. The variation pattern in Fraser fir indicates that during the last

glacial age a continuous fir forest extended south into Tennessee and North Carolina. Climatic changes have reduced this forest to a few relic stands in the southern Appalachian Mountains. Some scientists consider Fraser fir a southern variety of balsam fir. As a matter of fact, it is difficult to distinguish Fraser fir from balsam fir, especially when trees are too young for cone production. Fraser fir needles are usually shorter, wider, and more silvery. Fraser fir tends to grow a little faster than balsam fir and is now widely planted in some northern and northwestern states.

Fraser fir Christmas trees have traditionally been a product of the mountains of North Carolina. Due to heavy demand and limited supply, growers have prospered. This situation will probably change with increases in supply coming from new North Carolina growers and production in other states. Steep mountain land is not suitable for mechanization, and growers in the East Tennessee mountains should consider the potential impact of competition from northern growers operating on more level topography. Cost of producing quality Fraser fir Christmas trees will continue to be high even where mechanization is possible. One thousand transplants cost several hundred dollars, and trees must be fertilized annually. Spider mites and twig aphids are serious pests requiring control.

Figure 6: With proper cultivation and in favorable locations, Fraser fir grows well at elevations above 2000 feet.

Fraser fir can usually be grown commercially at elevations above 3000 feet in Tennessee; although good sites may permit production down to 2000 feet. For all practical purposes this limits production to the few counties bordering North Carolina, and the majority of this land is in public ownership. Much of the land in private ownership in this region is too steep or rocky for Christmas tree production, while other sites have undesirable soil properties. Fraser firs are very susceptible to root rot, so clay soils with poor internal drainage should be avoided. On suitable sites with proper fertilization and using sturdy transplants, a 7 foot Fraser fir can be grown in 8 or fewer years.

Virginia Pine

During the last decade a Christmas tree industry based on Virginia pine has developed in the southern United States. It is possible to produce a 7 foot tree in 5 years. Nearly all successful plantations have been established with seedlings grown from a single seed source—a grafted orchard propagated from selections made at the extreme southern edge of the species range in Alabama. This genetic material is apparently well suited for many conditions outside the natural range, but few plantations have been established in Tennessee. Research has been initiated to identify better provenances and evaluate selected phenotypes.

On an average, West Tennessee is a few degrees warmer than East Tennessee. This difference makes for poor survival of most Christmas tree species. Of the 6 species recommended for Tennessee, Virginia pine appears to have the best potential for the western portion of the state. Plantation establishment and cultural practices are quite different from those of the other 5 species:

1. Seedlings are cheap and planted when 1 year old.
2. Virginia pine is exceedingly shade intolerant; thus spacing must be wide, approximately 7 x 7 feet.
3. Due to shade intolerance, weed control must be very intensive during the whole rotation.
4. To obtain a dense tree, shaping is necessary 2 times during each of the last 3 growing seasons.
5. Repeated applications of insecticides are needed to control the Nantucket pine tip moth.
6. The normal yellow-green color of Virginia pine needles requires a heavy application of colorant.

Although Virginia pines may survive on the harshest, most eroded sites, growth is reduced under such conditions. Fast growth is necessary to obtain good density by shaping; therefore, stressful sites should be avoided. Most pastureland, including some dry sites, will give adequate growth. Slow growth and/or yellow needles may often be corrected by applications

of complete fertilizers such as 15-15-15.

Other Species

Douglas-fir and white spruce have only been tested to a limited extent in Tennessee. Although they show some promise, there are risks associated with their production. Growers are encouraged to experiment with these species, but the establishment of commercial plantations is not recommended at this time.

Douglas-fir is the most important timber species in the United States. Native to the Pacific Coast and Rocky Mountains, it exhibits wide genetic variation. One characteristic appears to be constant in Tennessee plantations; the trees are susceptible to damage from late spring frosts. Warm spring weather will encourage early bud burst, and a late frost will kill the tender shoots. Frost damage occurs most often at higher elevations and in "frost pockets" where cold air does not readily drain away. Successful plantations in East Tennessee were established on ridges with relatively deep soil and good air drainage. On such sites it is possible to grow high quality 7-foot trees on 8-year rotations when the best seed sources are used. Two such provenances have been identified: Lincoln National Forest, New Mexico (elevation 8500 feet), and Coconino National Forest, Arizona (elevation 7000 feet).

Figure 7: A seed source test in Anderson County demonstrates large differences in growth rate among geographic origins of Douglas-fir.

White spruce is native to the northern United States and Canada. It grows well on moist to moderately well-drained sites at higher elevations in East Tennessee. Above 2000 feet the species may grow faster than either Norway or blue spruce. Southern New England seed sources offer the greatest promise. Like other spruces, white spruce has pointed, sharp needles that tend to drop within a few weeks of cutting. Poor needle-holding will limit production, but growers at higher elevations are encouraged to grow a few trees of this species for local markets.

CHAPTER THREE

LAND SUITABILITY AND PLANTATION PLANNING

Use of land typically relegated to forestry may not be practical for Christmas tree growing. No farmer will invest an average of $300 per acre per year on land that cannot be traversed with a tractor. Since annual costs of Christmas tree production are higher than those for most agricultural crops, Christmas tree growers should consider agricultural land for planting sites.

Prospective growers may already own land and consider Christmas tree production as one alternative for getting a return. Some or all of this property may be suitable for production of Christmas trees. However, the owner should examine the property critically to determine that land characteristics do not adversely affect production cost and quality of the trees. If suitability is questionable, the owner should consider some other land use or sell the property and buy a more suitable property for Christmas tree production.

Favorable Locations

Success or failure depends on geographic and social factors as well as the more obvious physical factors. A Christmas tree farm is part of a community; theft and arson are problems just as real as honeysuckle and rocks, and a supply of dependable labor at reasonable cost is essential.

Roads that were adequate during summer may become impassable before Christmas. There may be no particular advantage in having plantations on a main highway, but a paved or gravel road to the property should be given high priority in site selection.

Prospective growers who anticipate harvesting by the choose-and-cut method must be close to a large population center. A few customers may drive a hundred miles to cut their own trees, but most will not travel more than 30 miles (one way). With increasing cost of transportation, it is likely that this distance will decrease. Growers producing less than 2000 trees per year can probably sell most of them on a choose-and-cut basis at close to retail prices. Higher prices tend to offset higher land values associated with proximity to urban areas.

If land is to be leased or purchased for Christmas tree production, the most desirable location is near home. In addition to having the trees close by for inspection of insects, diseases, and other pests and for control of theft, there are savings in transportation of equipment and workers.

Topography, Soil, Water, and Air Quality

Regardless of the physiographic region in which the land is located, any one of 4 factors (topography, soil, water, and air) may limit Christmas tree production. Sometimes 2 or 3 factors interact to make conditions poor for efficient production. Also, one factor may compensate for an otherwise limiting factor, making production feasible. For example, shallow soil on a north slope may have adequate moisture for tree growth while shallow soil on a south slope may be too dry.

Steeply sloping ground is not suitable for Christmas tree production because tractors can overturn, especially when rocks, stumps, or holes are present. Tractors operating on slopes must be equipped with roll bars, and operators should be required to use seat belts. Some growers in East Tennessee use backpack power equipment on very steep slopes, but their operating costs are high. Over the years these growers have found that level or slightly rolling terrain gives better net return on investments and have gradually phased out production on the steepest slopes.

Soil fertility and acidity may be corrected by applications of fertilizer or lime. However, extremes of soil texture may limit suitability of some sites for certain species. Problems are often associated with coarse textured (sandy) soils and sites with heavy clay soil. Sandy soils are excessively drained and tend to be droughty, while soils with a high clay content have poor internal drainage and, especially in low areas, may become waterlogged. Clay soils that have been cultivated tend to be compacted with plow pans at about 10 inches. Subsoiling may be needed prior to planting.

In parts of Tennessee, rocks may be a serious problem. Exposed rocks are a hazard to equipment, but even rocks covered by soil may be undesirable. High rock content significantly reduces the water storage capacity of the soil.

About 30 years ago white pines in the Cumberland Mountains died because of sulphur dioxide emitted from coal-fired steam plants. Similar damage was observed in white pine Christmas tree plantations near steam plants in other parts of the United States. Although this problem has abated due to more stringent control of emissions, some damage, particularly needle tipburn, still occurs. In susceptible areas, white pine seedlings from selected resistant seed sources should be used or another species, such as Norway spruce, may be planted.

Existing Vegetation

Land may conveniently be divided into 4 use categories: cropland, pasture, old-field, and forest. Cropland has been cultivated in the last few years; land abandoned longer is classified as old-field. Similarly, pasture

years; land abandoned longer is classified as old-field. Similarly, pasture must be maintained by mowing, or it will revert to old-field status. If soil erosion, poor drainage, or steepness are not serious problems, the first 2 categories are easy to convert to Christmas tree plantations.

Before establishing plantations on old-fields, it is first necessary to control or remove woody vegetation, fill in gullies, disk, fertilize, and seed grasses or legumes. Some pines, particularly Scotch and Virginia, grow well on converted old-fields, but cost of establishment is higher than on pasture or cropland.

The Cumberland Plateau and the Highland Rim have the greatest potential for converting forests to Christmas tree plantations. In these regions poor quality hardwoods grow on gently rolling terrain. Most of this land will grow pine. Spruce can also be grown on sites with deep, well-drained soils in the Cumberland Mountains. Since much of this land is relatively level, erosion will be minimal, and plantations can often be established without a cover crop. Land clearing is expensive, but land on the Cumberland Plateau and the Highland Rim is inexpensive compared to land in East Tennessee.

Area Requirements

Size of Christmas tree operations relates to the number of trees a grower harvests per year and is a function of willingness to work hard and of financial ability. Tennessee plantations vary from 1 acre in a backyard to several hundred acres.

Spacing of trees is determined by the type and size of equipment available or expected to be acquired. If the tractor and bushhog are 5 feet wide, spacing between rows should be 7 feet. Smaller tractors and bushhogs are available, and it is possible to plant rows as close as 5 feet. Most growers do not crossmow, but use herbicides in the rows so spacing within the row can be variable. Small (4 to 5 feet) trees of a shade tolerant species can be grown as close as 4 feet while large (7 to 8 feet), intolerant pines require 7 feet between trees within rows. A 5 x 5 foot spacing is considered the minimum for producing quality pines. The number of trees per acre at various spacings is shown in the following tabulation:

Spacing (feet)	Number of Trees per Acre
5 x 5	1742
5 x 6	1452
6 x 6	1210
7 x 5	1244
7 x 7	889

To determine the total number of acres needed, multiply number of trees in the desired annual harvest by number of years in the rotation required

for the species and divide by number of trees per acre at the selected spacing. For example, to annually harvest 1000 white pines (rotation 8 years) planted on a 6 x 6 foot spacing requires an area of:

$$1000 \times 8/1210 = 6.6 \text{ acres.}$$

This figure assumes that all planted trees survive and all are saleable. Even when seedlings that die the first year are replaced the following year, survival at harvest time seldom exceeds 90 percent. With good management cull trees should not exceed 10 percent in white pine or Norway spruce plantations. Thus, to sell 1000 trees, about 1200 must be planted each year (replants not included), requiring a land area of about 8 acres. Land to be used for access roads, harvest lanes, storage sheds, parking, etc. must also be taken into consideration. Rather than 6.6 acres, a total of about 10 acres may be needed to meet production goals.

Intolerant species, such as Virginia pine, require wider spacing but may have shorter rotations. At 7 x 7 foot spacing and a 5-year rotation (assuming the same mortality and cull percentages as for white pine and Norway spruce), about 6.7 acres are needed. Adding land lost to roads, harvest lanes, etc., the total area is more than 8 acres. Selection of proper spacing may be a major factor in profitability, especially when property values are high.

It may not be advantageous to plant 1 acre every year for 8 years. A more efficient plan might be to plant 2 acres every other year, which will still provide an even flow of marketable trees.

Plantation Layout

When a public road is not available, it is necessary to construct an all-weather road to each plantation. An all-weather, graveled access road with ditches and culverts is a prerequisite of an efficient Christmas tree operation.

Plan the entire area, including roads, harvest lanes, and buildings, before planting. Small fields of a few acres will not require harvest lanes, but an access lane should be left along one or two sides of the fields. Since Christmas trees do not develop properly in the shade of bordering forests, access lanes should be placed along a forest's edge.

Larger plantations require additional harvest lanes through the fields. Lanes should be about 15 feet wide so that trucks and tractor wagons can pass without damaging border trees. Some growers space harvest lanes as close as 12 rows apart while others space them as far apart as 20 rows. Since these lanes will be used during wet weather, locate them so that they will drain well, preferably along ridges or on the contour of slopes.

Row direction is mainly determined by topography and the type of equipment that will be used for maintenance. On level to gently sloping

land, rows can be laid out in any direction, preferably parallel to the longest dimension. On steeper slopes, lay out rows up and down the side of the hill for mowing with a pull-behind bush-hog; rows should be laid out on the contour when using a self-propelled, walk-behind mower. Land with very steep slopes should not be used to grow Christmas trees as production costs are high and accidents are likely to occur.

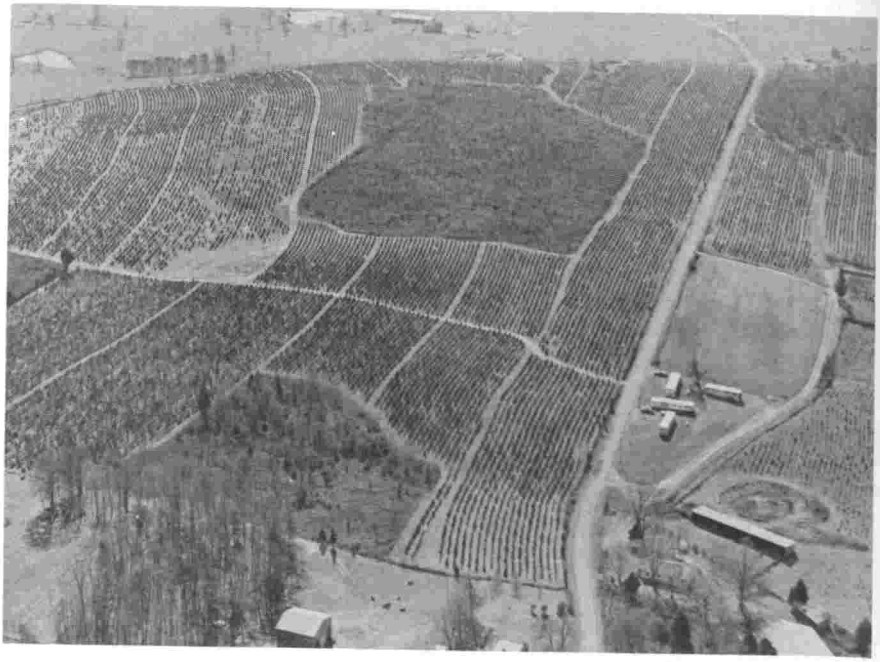


Figure 8: Christmas tree plantings should have good access and harvest lanes.

CHAPTER FOUR

SITE PREPARATION

Pasture and cropland are generally ready for planting without much site preparation. In most cases pre-emergence herbicides can be applied in rows before or after planting. On recently idled old-fields, a combination of bushhogging and chemical treatment of hardwood sprouts may be sufficient. Older abandoned fields and woodlands require bulldozing and disking to remove unwanted vegetation.

In addition to vegetation control, some sites need correction for imperfect drainage, unsuitable soil reaction (pH), low fertility, or soil compaction. It is always easier to make such corrections before the field is planted. Well-drained pasture and cropland require minimum preparation and should be planted first. Less desirable sites should be prepared according to a plan where sites with high conversion costs and/or poor productivity are assigned lowest priority.

Mechanical Site Preparation

The importance of proper site preparation cannot be overemphasized. Before planting old-fields or woodlands, it is imperative that they be free of all woody vegetation. Most hardwoods sprout from stumps and roots; therefore, stumps must be removed and roots chopped with a heavy disk. Mechanical site preparation is expensive, but less intensive preparation will result in crooked rows, uneven spacing, costly control of remaining woody vegetation, and possible damage or loss of trees from herbicides. Savings obtained by partial clearing will probably be lost by increased operating costs and poor quality trees.

The first step in converting woodland to a Christmas tree plantation is to harvest merchantable trees, if the value of the trees is large enough to attract a logger. If the area is near a city, there may be a market for firewood.

Prescriptions for establishing pine plantations for forestry purposes are not adequate for Christmas tree operations. Agricultural standards for row crops should be used. This type of site preparation includes removal of practically all organic material (roots, stumps, stems, and branches) and thorough disking. Organic materials are piled in windrows, dried, and burned.

Unfortunately, in mechanical site preparation much topsoil ends up in the windrows. This soil loss can be critical for survival and growth of white pine, spruce, and fir on poorer sites. On better sites the loss of some topsoil may not be too detrimental. However, any forested site that is cleared by mechanical methods will lose some fertility.

Soil Amendments

A soil test is needed to determine soil fertility. Landowners should contact the extension leader in their county for sampling instructions. Each analyzed sample will give information on soil acidity (pH), phosphorus, and potassium.

Most conifers grow best on acid soils (pH less than 7). But at a pH of 5 or lower, some nutrients become unavailable, or toxicities may develop. Some conifers grow naturally on soils with pH less than 4, but optimum survival and growth require a higher pH. Optimum pH-levels for individual species are not known, but most Christmas tree species grow well within a pH range of 5 to 6.5. At the lower end of this range, some nutrients, particularly phosphorus, may be tied up while at the upper end of this range, some disease problems can be expected.

Fortunately, most forest soils in Tennessee have a pH range from 5 to 6. Abandoned fields, particularly those invaded by Virginia pine, may have a pH lower than 5 after site preparation. In such cases agricultural grade limestone should be disked into the soil in the final step of site preparation. A good rule of thumb for clay soils is that it takes 3 tons of limestone per acre to increase the pH value 1 unit. If a soil analysis indicates an average pH of 4.5, apply 3 tons of lime per acre to raise pH to 5.5. However, the loamy soils of the Cumberland Plateau need only 2 tons per acre for the same effect.

Values of pH higher than 6.5 are unusual and sulphur can be used to make the soil more acid. As with lime, clay soils require heavier applications than sandy soils to make the same change in pH. Considering the high cost of sulphur, broadcast treatment may not be practical; sulfur may be applied to individual trees after they have been planted.

Phosphate fertilizer will be required if a soil analysis indicates that the phosphate level is less than 15 lbs. per acre. Disk 200 lbs. per acre of triple super phosphate (0-44-0) in the soil together with any limestone required.

While phosphate deficiency is common, particularly in East Tennessee, potash is usually adequate. Most agronomic crops require a potash level of at least 110 lbs. per acre, but there is evidence that trees require less. If a cover crop will be established following site preparation, it is necessary to provide grasses and legumes with the amount of potash recommended by a soil analysis. Do not apply nitrogen before planting if trees are planted without a cover crop.

Increasing site fertility will probably result in increased cost of weed control. An additional effect of fertilizers, especially those with nitrogen, is a lowering of soil pH. If the pH is 5 or lower prior to fertilization, lime should be added with the fertilizer.

Cover Crops

Bare land is subject to erosion and, depending on slope gradient, varying amounts of soil will be lost during the first year following site preparation. Estimates from agricultural crops indicate an annual loss of more than 20 tons per acre. First year soil losses from sloping land prepared for Christmas tree plantations may be larger than 20 tons per acre if a cover crop is not quickly established.

Grasses and legumes are good cover crops and easy to establish. Use a mixture of 30 lbs. of rye or wheat, 20 lbs. of Kentucky 31 fescue, and 2 lbs. of Ladino clover seed per acre. One hundred pounds of ammonium nitrate or 200 lbs. of 10-10-10 per acre should be applied at seeding time. The latter formulation is best if a soil analysis indicates marginal levels for phosphate and potash. Fertilizers and seed should be lightly disked in during . ugust or September.

Cover crops should be well established before planting trees in late winter or early spring. To reduce competition with the cover crop, it is necessary to kill the cover in 2-foot wide strips (tree rows). If the rows are 6 feet apart, about one-third of the area will be treated.

Chemical Site Preparation

Fescue turfs should be broken up into strips with treatments such as a Paraquat-Atrazine mix (spring), Roundup (summer), or Kerb(winter). If a substantial amount of woody vegetation is present, it will be necessary to spray with a phenoxy herbicide such as 2,4-D twice before planting – first in May and again in August.

Weed control is usually easier to accomplish prior to tree planting. When there are no crop trees, most types of herbicides can be used, and no shielding is necessary. Another advantage is that rows premarked with dead weeds save time during the busy planting season. Chapter 9 has been devoted to the use of herbicides with an emphasis on weed control in established plantations.

Drainage

Poorly drained land is not suitable for most Christmas tree species, although spruce will grow on relatively wet sites. The cheapest way to drain land is by digging open ditches with a backhoe. However, ditches restrict the movement of equipment and must be maintained. A more expensive solution, which does not have any of the problems associated with open ditches, involves the installation of underground drainage

systems. Both these methods work if there is a good place to drain the water. When suitable drainage is not available, it may be possible to dig a pond.

It is difficult to give specific recommendations for draining. Contact the Soil Conservation Service before planting any trees since design and location of the drainage system may affect plantation layout.

Figure 9: Availability of effective herbicides makes chemical site preparation easy on former pastureland.

CHAPTER FIVE

PLANTING

Success depends on many factors of which only a few, such as site preparation, weed control, care of seedlings, and planting techniques, can be controlled by the grower. Other factors like time of planting and quality of seedlings can be partially controlled by the grower. Weather is uncontrollable, and many first-year plantations are destroyed by droughts.

Bare-Rooted Nursery Stock

Age and condition of tree seedlings are designated by a 2-digit code, e.g., 1-0, 2-1. The first digit indicates number of years the plant was grown in a seedling bed. The second figure is the number of years it was grown as a transplant. Total age of the tree from seed is the sum of the two digits. Transplants usually have larger stem diameters and better developed root systems than seedlings of the same age. Hence, transplants will usually survive better and initially grow faster. Recommended size and age for bare-rooted seedlings and transplants are shown below:

Species	Height, inches	Age and Type
Scotch pine	8 to 12	2-0
Virginia pine	8 to 12	1-0
White pine	8 to 16	2-0
Norway spruce	8 to 16	3-0 or 2-1
Blue spruce	8 to 16	3-0 or 2-1
White spruce	8 to 16	3-0 or 2-1
Fraser fir	8 to 16	2-1 or 2-2
Douglas fir	8 to 16	2-1

A large top compared to size of root system indicates poorer chance of survival. Top/root ratios can be improved by pruning the lowest lateral branches and removing forks. Such pruning will have to be done sooner or later, and it is much easier to do it before planting than after.

Transplants cost about twice as much as seedlings of the same size. Many growers of spruce and fir purchase 2-0 seedlings and set them out in a transplant bed or pots for 1 or 2 years prior to planting. This practice saves the grower money, insures a supply of large, vigorous transplants, and permits the grower to plant at a convenient time.

A transplant bed requires reasonably fertile, well-drained soil, and a source of water. Lime and fertilize in accordance with a soil test, disk the area thoroughly with a rototiller, and shape the beds to a 4 to 6 foot width.

In early spring insert seedlings in notches of a transplant board so the roots hang down against the vertical wall of a cross-bed trench; then pack loose soil against the roots and remove board.

A spacing of 6 inches between trenches and 4 inches between seedlings in the rows gives a bed density of 6 trees per square foot, which is ample room for 2 years growth. Keep transplant beds free of weeds by using herbicides such as Goal or Poast. Top-dress with ammonium nitrate at a rate of 0.5 lb. per 100 sq. ft. twice during the growing season. Before winter, mulch beds with a 1-inch layer of old sawdust to build up organic matter in the soil and prevent frost heaving.

Container Grown Nursery Stock

Millions of containerized seedlings are grown each year in large greenhouses. Relatively slow-growing species like Douglas-fir and Norway spruce can be grown to plantable size in 1 year instead of the 3 years required for conventional bare-rooted stock. High costs of materials and greenhouse operations make the production cost of 3-0 bare-rooted seedlings less than the cost of 1-0 containerized seedlings. Also, shipping costs are higher due to the bulk of the soil mix.

Containerized seedlings provide Christmas tree growers with 2 advantages. Planting season can be extended and "planting shock" reduced due to minimum disturbance of the root system. In Tennessee, however, containerized greenhouse seedlings have not shown survival or early growth advantages over standard field grown, bare-rooted seedlings.

Production of potted transplants may be of interest to some Christmas tree growers. Seedlings with normal needle length and color, but too small for outplanting, are planted in 1-gallon plastic pots using a mix of bark, sand, peat moss, lime, and fertilizers. It is difficult to thoroughly mix these materials, and some growers buy prepared potting mixes from nursery supply houses. Roots will permeate most of the medium in 1 growing season, and transplants should be outplanted after 1 year. If pines are held over for 2 years, they will be potbound and have poor field survival. Cutting a few slits in the rootmass may improve lateral root development and survival.

Keep pots free of weeds by hand weeding or applying a herbicide shortly after potting and as often thereafter as recommended by the manufacturer. Fertilize with a slow release urea and top-dress with ammonium nitrate or place slow release fertilizer tablets in the pot. Amounts and frequency of watering depend on rainfall and potting medium; a greater proportion of peat moss in the mix will cut down on watering. Heavy watering may result in root rot, especially if the medium does not drain well. Frequent inspections of roots and medium is necessary. During winter, push pots closely together and cover with sawdust to prevent damage from freezing and thawing.

Figure 10: Containerized seedling ready for planting.

Potted plants offer several advantages, especially for small growers. Due to the large mass of soil, trees can be outplanted anytime except during drought conditions. Mortality from previous years' plantings can be replaced with trees the same size as that of the survivors, making it possible to complete harvesting without having many undersized trees left.

Care of Nursery Stock

Commercial and state nurseries ship seedlings packed in boxes or bags of moisture-proof material or wrapped in bundles with wet moss. Growers should check to see that the trees have not dried out and that the correct number, species, size, and quality have been received. If there is reason to reject the shipment, the nursery should be notified immediately, preferably by telephone and then by letter. The grower is required to take good care of the trees until the complaint is settled.

Trees can be kept in moist moss or other suitable packing material for several weeks or months when properly refrigerated. Seedlings grown in southern nurseries should not be allowed to freeze. Most species store best at 34°F to 37°F. At higher temperatures molding may occur and cause poor survival. If refrigeration is not available, packages may be kept in a cool (35°F to 50°F) location for a couple of weeks. Check every few days to be sure that the roots stay moist. Bags or bundles should be stacked on pallets or slats. If suitable storage is not available, trees should be taken out of the bundles or bags and heeled in when they arrive.

"Heeling in" refers to storing planting stock in a trench dug in a shaded area. The soil should be well drained and moist, and the trench should have a vertical side as deep as the roots are long. Trees should be placed in the trench in a relatively thin layer and covered with soil above the root collar. Fill remainder of trench with soil and pack tightly. If properly heeled in, the plants will remain in good condition for several weeks.

Grading of Nursery Stock

Seedlings from the TDF nursery have not been graded and must be sorted according to top length and root system development. Keep seedlings moist while sorting into 3 groups:

1. Tops longer than 8 inches and several lateral roots, each having a network of fine hairlike roots.
2. Tops shorter than 8 inches or larger seedlings with few lateral roots lacking a network of fine roots.
3. Seedlings of any size without fine roots and/or having yellow, short needles.

Prune lateral branches and remove forks from trees in group 1. Such

pruning facilitates machine planting and improves first year survival. Root pruning should be avoided; only roots longer than 8 inches should be cut back to facilitate planting. Seedlings in group 2 should be placed in transplant beds or pots. Seedlings in group 3 are culls and should be discarded. Planting such trees results in high mortality, slow initial growth, and many poor quality trees.

When ordering seedlings from the state nursery, it is important to consider the result of sorting on number of trees needed for field planting. Presently, less than half the white pine seedlings are suitable for outplanting. This situation will probably improve if a TDF nursery is established in East Tennessee.

The number of plantable trees will depend upon species, genetic quality, and nursery practices. Private nurseries will sort their seedlings and transplants according to height and age. Small trees cost less than larger ones of the same age. Since there usually is a relationship between growth rate in the nursery and growth in the field, planting larger trees (of the same age) is recommended.

When to Plant

Growers can plant 6 weeks before Christmas if they are not busy harvesting and selling Christmas trees. At that time the topsoil is moist, and the ground is seldom frozen. However, fall planting is not recommended on poorly drained sites with clay soil or high elevation sites subject to frost heaving.

Most tree planting in Tennessee is done in late winter and early spring. The best month for planting barerooted stock is usually March; at higher elevations planting can continue into April. During January and the first half of February the ground is often frozen, and there is usually no snow cover to protect seedlings from desiccation.

General Recommendations

Tree roots must be protected from drying out during the planting process. Bundles of seedlings should be dipped in a slurry of clay or commercial water absorbent materials. Keep trees shaded and in moist packing materials during transport to the planting site. Upon arrival find a cool location for temporary storage. Planting bags of waterproof canvas should be large enough to provide room for trees and some moist packing material. When using planting machines, cover trees in storage trays with moist packing material.

Planting holes must be wide and deep enough to accommodate the roots in a natural position. Cramming roots into a small hole does not permit trees to exploit moisture and nutrients. There are 2 advantages to planting trees 1 or 2 inches deeper than they grew in the nursery. First, soil

moisture increases with soil depth during droughts. Second, herbicides applied during the first growing season are less likely to reach and damage roots.

Roots must be in close contact with soil to take up water. Well-planted trees should have soil so firmly compacted around the roots that they will resist an effort to pull them out. Do not plant in freshly cultivated fields with dry soil.

Straight rows are an absolute requirement in Christmas tree plantations. Planting trees in a straight line should not be a problem if you have an experienced tractor driver for the planting machine. For hand planting, mark rows in advance by herbicide applications or use a string as a guide when planting. Marking of rows with string will slow planting somewhat, but it is only necessary to move the string every third or fourth row if planters use measuring sticks to locate correct planting positions. Some growers align trees both between and within rows, which will further slow down planting but is necessary if cross mowing is used for weed control.

Hand Planting

Trees can be planted with a dibble or planting bar, a spade, a planting hoe, or an auger. Pines are usually planted with a dibble as they have long but relatively poorly developed root systems. Transplants of fir and spruce usually have more roots and are generally planted with a spade or hoe. Regardless of planting tool used, all workers carrying and planting their own seedlings is most efficient.

Transplants and seedlings with large root systems should be planted in holes. Dig a hole 6 to 8 inches deep with a spade or hoe and make a cone-shaped mound in the bottom of the hole. Spread roots over the surface of the mound and cover with topsoil, using hands to compact the soil around roots. Finish filling the hole with soil and tamp firmly with feet.

Hand planting of 1000 seedlings per day with a dibble is often quoted in forestry literature, but this rate is not realistic for Christmas tree plantations. The necessity of planting in straight rows reduces output. Also, most planting will be done with temporary laborers or students who work slower than experienced planters. On the average, a reasonable expectation is 500 trees per person per day with dibble bars and half that many for hole planting.

The key to good production and a quality job is the foreman. Hand planting crews generally consist of 3 or 4 persons including a foreman. The foreman should set the pace and check the work of each crew member several times each day to insure quality planting. Some mistakes to avoid are:

1. Making holes too shallow, resulting in root deformation or drying.

Figure 11: The Old Standard (OST) planting bar has a wedge-shaped blade that tapers to a straight edge at the bottom. The gasoline-powered portable auger is best for planting large transplants or potted trees. Both tools operate best in light-textured soils.

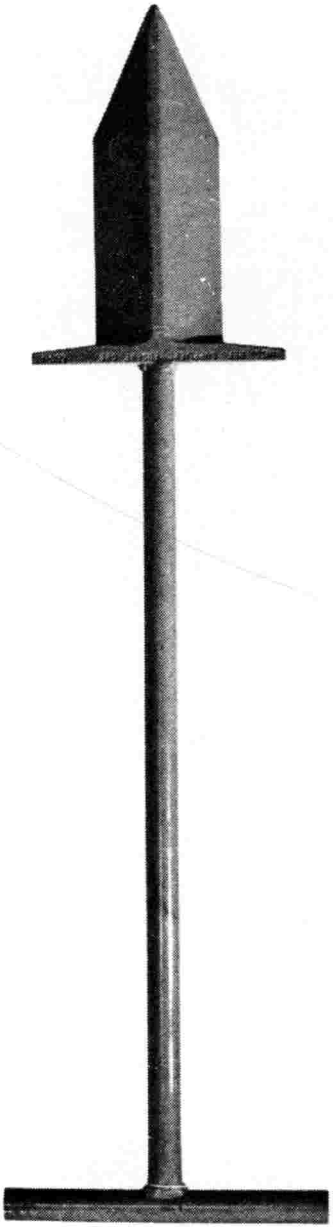


Figure 12: The KBC planting bar features a blade with a wide, triangular cross section that tapers to a point in the last 4 inches. The KBC bar creates a tapered hole that can accommodate large, bare-root seedlings. It is well adapted to hard, rocky soils.

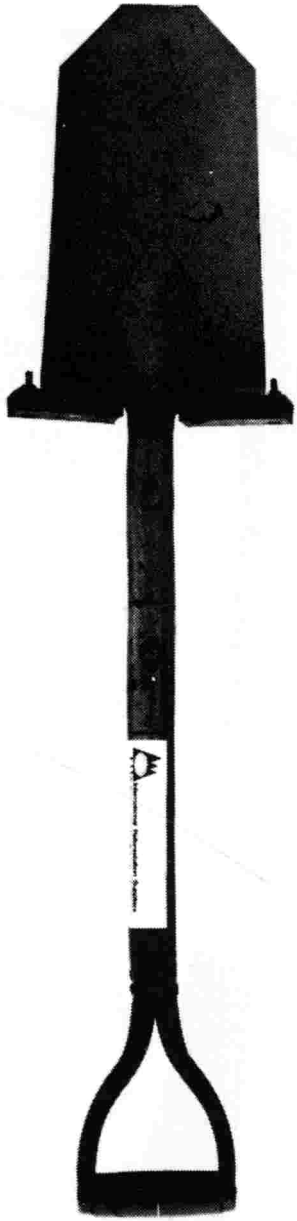


Figure 13: Nursery spades are suitable for planting large transplants. Most nursery spades have thin, flat blades with square or slightly pointed edges designed for easy digging in loose soils.

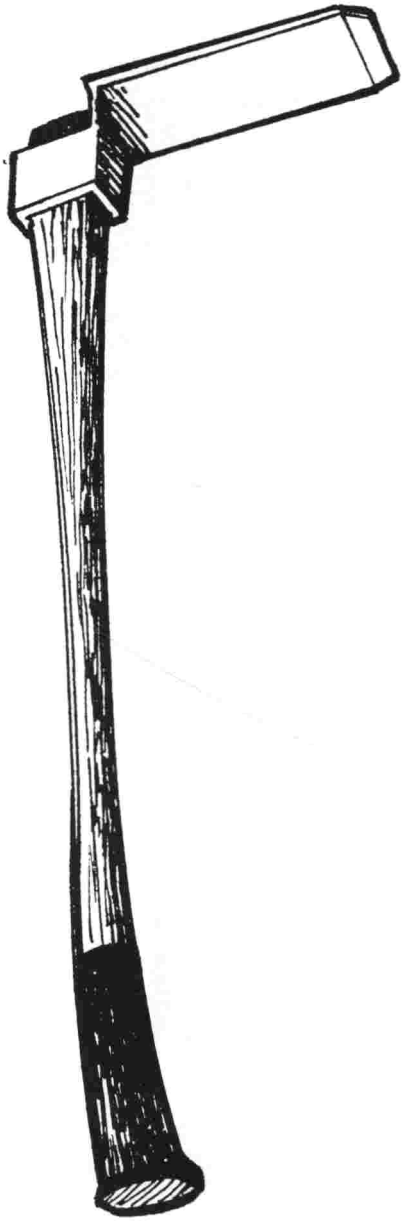
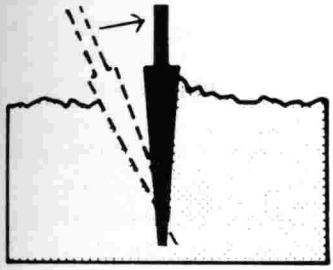
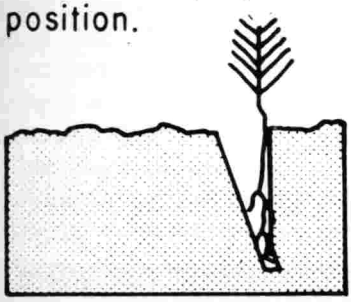


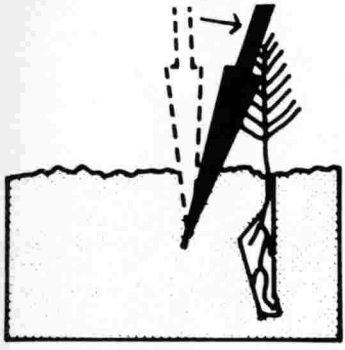
Figure 14: This sturdy planting hoe has a narrow, rectangular blade with a straight, beveled working edge. Most tree planting hoes have a large one-piece blade with a tapered eye that fits onto a handle at a 90 degree angle.



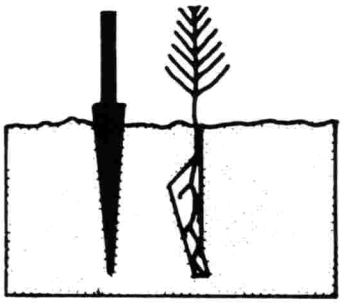
1. Insert dibble at angle shown and push forward to upright position.



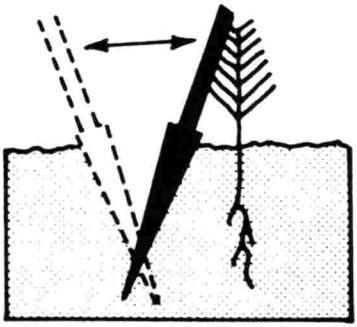
2. Remove dibble and place seedling at *correct* depth.



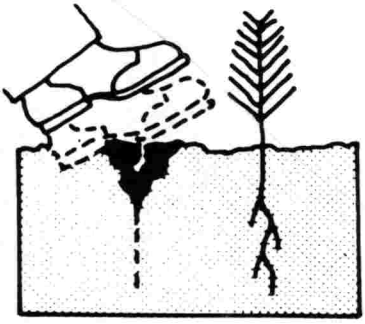
3. Insert dibble part way, push and twist forward closing top of planting slit.



4. Push dibble straight down to depth of blade.



5. Rock dibble back and forth to pack soil firmly against root.



6. Fill in last hole by stamping with heel.

Figure 15: How to plant with a dibble.

2. Failure to push the tree to the bottom of the hole and then pull it up to the proper position.
3. Failure to close the hole tightly. This can easily be determined by pulling hard on the top of planted seedlings; they should not come out of the ground.
4. No moss in planting bags or carrying trees in hand while planting. Roots will dry out very quickly.
5. Failure to plant trees in a vertical position, resulting in stem crook.

Machine Planting

Many kinds of tree planters are available. Lightweight machines are adequate on sandy or loamy soils free of rocks and roots. Heavy-duty planters pulled by 65 to 85 hp tractors are required on clay soils. A machine with a dual control hydraulic system is desirable so the machine can be raised and lowered and wheels leveled when planting on slopes.

The Tennessee Division of Forestry has a number of lightweight planting machines that are available free of charge. They are equipped with a 3-point hitch and can be pulled by a small farm tractor. In addition, TDF has several Whitfield planting machines, requiring a much larger tractor.

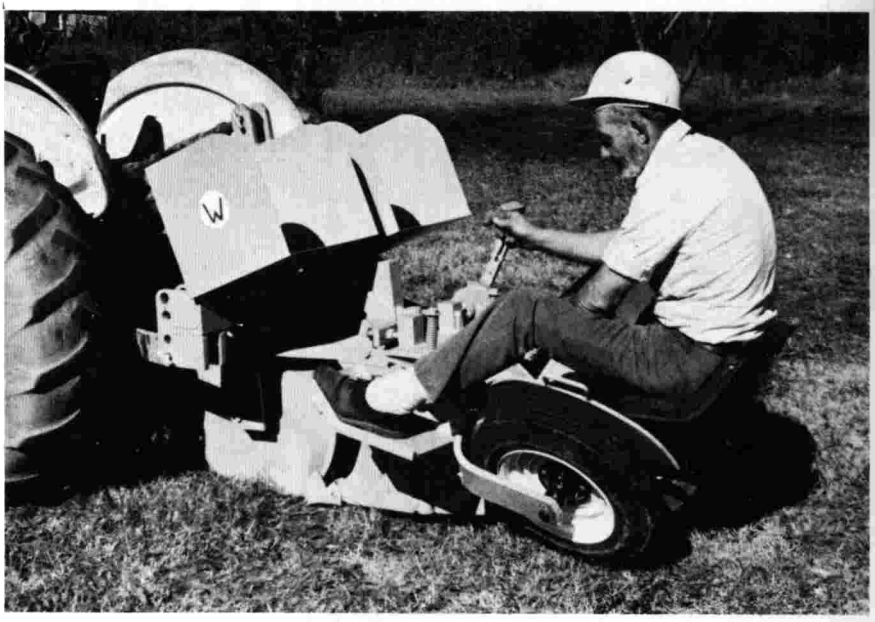


Figure 16: Transplanter for use in contour terrain planting. The packing wheels can be turned up the hillside to keep the tires from running over planted seedlings. Rear packing section is spring loaded to keep the packing wheels on the ground for packing pressure at all times. Photo credit: R. A. Whitfield Mfg.

Growers can apply at the nearest district TDF office. The Whitfield machine with a 2-person crew plants an average of 6000 to 7000 trees per day.

Several times each day, the machine operator should check that seedlings are planted properly. Key points include proper depth of trench, correct tracking of packing wheels, and proper closure of the trench by packing wheels. Root placement can be checked by exposing one side of the planting trench with a spade. Seedlings planted too shallow (roots will appear L or U shaped) may have poor survival, especially when they are poorly packed. The crew may be responsible for a poor planting job by not placing seedlings in the trench at the proper depth and not releasing them at the proper time. However, the transplanting machine and soil conditions more likely will determine the success of the operation. Do not attempt to plant when the soil is dry and hard or loose due to recent cultivation.

Replanting

While 70 to 80 percent survival is adequate for reforestation purposes, less than 90 percent survival requires replanting in Christmas tree plantations. Replacements must be hand planted. This will significantly increase planting costs for large operations normally using machine planting. With low survival (less than 50 percent), it may be more economical to start over and replant the whole field by machine the following year.

Small growers should keep their fields close to 100 percent stocked. Trees planted the year following original establishment will average 1 foot shorter at harvest time. If 2 replantings are required, potted trees should be used for the second replacement; otherwise, the rotation will be too extended. An empty space is not without cost; land rent, taxes, weed control, etc. must be paid whether or not the space is occupied by a tree.

Planting for Second Rotation

In large Christmas tree plantations the second rotation is started after all merchantable trees are cut. Unharvested trees should be cut, piled, allowed to dry, and burned. It may be possible to sell some poor quality trees as balled and burlapped stock for landscape purposes. Sometimes branches can be lopped off cull trees and sold as boughs or used to make wreaths and roping (garlands).

The second rotation trees can be machine planted between the rows of stumps. To facilitate mowing, all stumps must be cut close to the ground. If the second rotation is hand planted, the trees are usually placed between stumps in the row, using old stumps as a guide for the planting crew.

By hand planting, the second rotation can be started before the first

rotation is completed. Since most Christmas tree species are shade tolerant as seedlings, it is possible to interplant near the end of the rotation. For example, if white pine is grown on an 8-year rotation, Norway spruce can be interplanted in the rows after the 6th or 7th growing season. Assuming that spruce is grown on a 10-year rotation, interplanting will reduce production time by 10 and 20 percent, respectively. It is a practice that should be considered where land cost is high.

There are some disadvantages associated with interplanting. Interplanted trees can be damaged in cultural practices or harvesting of the older trees. Trees of the first rotation may be infested with insects or carry diseases that can spread to interplanted seedlings. Also, many growers would like to conduct operations differently in the second rotation: better plantation layouts, different spacing, straighter rows, etc.

Second rotation plantings can be delayed 1 year after clear cutting to avoid problems with *Pales* weevils. This weevil feeds on stumps and roots of freshly cut trees. However, production losses associated with such a delay are unacceptable to most growers. A more realistic solution is to spray stumps with an insecticide.

Since herbicide usage is reduced during the last half of a rotation, there often is an invasion of hardwood sprouts and vines. Rather than fighting this problem the entire second rotation, a grower may consider using a year for eradication. Disking and use of herbicides, which often damage or kill Christmas trees, will prepare the site for the second rotation. The 1-year delay of planting may be acceptable when land values are low.

CHAPTER SIX

FERTILIZATION

Fertilization in Christmas tree plantations may promote vigorous tree growth and dense foliage with good color. Rapid growth, when controlled by proper shearing, results in improved bud set and greater foliage density. If other conditions are suitable, fertilizers help to grow trees in the shortest possible time.

Determining Need for Fertilization

Scotch pine and Virginia pine growing on well-drained sites with moderate fertility usually will not need to be fertilized. White pine requires more fertile soil, particularly a higher phosphate level. Phosphate deficiencies should be corrected before planting since phosphate applied to the surface moves very slowly into the soil. Spruces and Douglas-fir have intermediate fertility requirements. These species usually respond to moderate applications of nitrogen in addition to phosphate. Fraser fir is the most demanding species planted for Christmas tree production in Tennessee. In addition to a high level of phosphate, nitrogen applications are needed to produce high quality trees within a reasonable rotation.

Trees characterized by slow growth, poor needle color, short needles, or early shedding may be influenced by factors other than low fertility. Insects, diseases, air pollution, and misapplied herbicides often produce the same symptoms. In plantations where only an occasional tree appears to be in poor vigor, it is unlikely that the cause is low fertility. Applying fertilizers to such trees probably will not be beneficial. When whole or portions of fields have trees with reduced vigor, there is reason to suspect a fertility problem. However, fertilization of very dry sites or poorly drained areas usually will not result in improved growth. Planting of drought resistant species like Scotch pine on dry sites and draining low areas are better solutions.

The location of discolored needles on Christmas trees may be indicative of a particular nutrient shortage. When nitrogen, phosphate, or potassium are deficient, the lower, older needles are most apt to be discolored because these elements are readily translocated within a tree. During periods of stress, these nutrients are translocated to the actively growing terminals. In contrast, calcium and several of the micronutrients (manganese, iron, boron, zinc, and copper) are relatively immobile. Leaf discoloration due to deficiency of these elements occurs in younger needles in upper parts of the crown.

Low soil fertility is often indicated by lichens, sparse natural weed and

grass cover, and patches of bare soil. This situation is common on eroded fields. Growers need to have soil tests made for such areas.

The University of Tennessee Soil Testing Laboratory offers Christmas tree growers several chemical tests:

Test	1985 Cost/Sample
Basic	$2.00
Calcium	$1.00
Magnesium	$1.00
Zinc	$1.00
Iron	$1.00
Manganese	$1.00
Organic Matter	$3.00
Soluble Salts	$3.00

The basic test includes phosphorus, potassium, and pH. Soil sample boxes are available at county extension offices. Tests for micronutrients should be requested only where research or experience indicates a need. Sites with pH between 5 and 6 have most micronutrients available. In areas not exposed to sulphur dioxide emissions from coal-fired steam plants, there may be a shortage of soil sulphur.

Types of Fertilizers

Most fertilizers are in a granular form and contain one or more of the three major nutrients: nitrogen, phosphorus, and potassium. Generally, most Tennessee soils have sufficient potassium for adequate tree growth; nitrogen and phosphorus are more apt to be limiting. Addition of unneeded nutrients wastes materials and raises costs. Fertilizers also add to the salt concentration in the soil and increase chances of poor survival.

Fertilization of newly planted trees can cause mortality depending on type, amount, and placement of the fertilizer. Each fertilizer has a "salt index," which indicates the strength of the soil solution after a given amount is added. The salt index (per unit of plant nutrient) for ammonium nitrate (35-0-0) is 3.0, for potassium chloride (0-0-50) 2.2, and for triple superphosphate (0-44-0) only 0.2. It takes 10 to 15 times as much superphosphate to give the equivalent salt concentration as muriate of potash or ammonium nitrate. Consequently, phosphate fertilization seldom causes mortality when properly applied.

How to Apply

The large amounts of nitrogen fertilizers applied to grow high quality Fraser fir will result in a more acid soil. At a pH below 5.0, problems such

as unavailable phosphate may occur. Lime should be applied to bring the pH up to 5.5.

Both nitrogen and potassium fertilizers will cause mortality when placed in the planting hole, in the closing slit, or on the surface. Only phosphorus fertilization is recommended at planting time. When bar planting, superphosphate should be placed in the closing slit. With other planting methods it is important to place the fertilizer several inches below or to the side of seedling roots. The amount of superphosphate to apply depends upon species, existing fertility level, and spacing. A moderate level of soil phosphorus can be obtained by applying superphosphate at the rate of 100 lbs. per acre. This rate is equivalent to 1 oz. of superphosphate per tree at 5 x 5 spacing, 1.3 oz. at 6 x 6, or 1.8 oz. at 7 x 7.

Established trees can be fertilized by applying the required amount to the ground around each tree. No purpose is served by painstakingly applying fertilizer in a prescribed circle. Granulated fertilizers will scatter when they are thrown at the base of a tree, and with practice it is possible to get coverage of about 2 square feet. Broadcasting by hand or with mechanical spreaders during the first few years after planting results in loss of materials, especially nitrogen. Also, broadcasting fertilizers stimulates growth of weeds, resulting in increased competition and mowing costs. Broadcast application should wait until tree roots have extended into the middle of rows and can take advantage of added nutrients.

Use of high analysis fertilizers such as urea (46-0-0), superphosphate, or diammonium phosphate (18-46-0) is recommended. These fertilizers are cheaper to apply than low analysis fertilizers because a smaller amount is required per tree. Contrary to popular beliefs, high analysis fertilizers cause less "burn" per unit of plant nutrient than low analysis fertilizers. When the soil test indicates a need for a balanced fertilizer use 15-15-15 or 19-19-19.

Large and old plantations can be fertilized by broadcast applications from the air or the ground. Some fertilizer may be wasted, but the cost of lost material is recovered in reduced application expenses. Fertilization of individual trees normally stops after the third or fourth growing season; subsequent applications are made as broadcasts.

When using high analysis fertilizers on small trees, it is important that the amounts applied be fairly accurate. If 1 oz. per tree is recommended, 2 oz. is not twice as good; 2 oz. may kill the tree. It is impractical to weigh the fertilizer needed for each tree. To solve this problem, weigh out the desired quantity in a plastic cup or can and trim the container so that it will hold the exact amount when level full. With some experience it is possible to use a "handful" as measure but keep checking the "handful" against the standard cup.

When to Apply

If the soil analysis indicates a phosphate deficiency (less than 20 lbs. P_2O_5 per acre), apply superphosphate at the time of planting. No other fertilizer should be needed the first year. However, some Fraser fir growers apply diammonium phosphate or urea on the surface during May. In early spring of the following year, trees can be fertilized by surface application of diammonium phosphate (2 oz. per tree), urea (1 oz. per tree), or ammonium nitrate (1 oz. per tree).

Pines and spruces usually do not require annual applications of fertilizers. However, early spring applications of diammonium phosphate, urea, or ammonium nitrate should be made if trees have poor color, few or weak buds, or thin foliage. Nitrogen derived from ammonium nitrate is almost immediately available to the trees, but it is completely absorbed or leached within 3 months. Thus, many growers make split nitrogen fertilization on Fraser fir, usually in April and September. Each application consists of 300 pounds of ammonium nitrate per acre.

If foliage is thin and color unsatisfactory at the end of the rotation, a broadcast application of about 500 lbs. per acre of urea or ammonium nitrate in early spring for 2 years before harvest may make the trees more saleable. However, some foliage characteristics are under genetic control and cannot be changed by fertilizer applications.

CHAPTER SEVEN

SHAPING

Most species of Christmas trees grow slowly the first year after planting. This time is needed to overcome transplant shock and establish a good root system. After the second growing season trees should grow much faster and will develop long leaders and open crowns unless shaped. Shaping consists of shearing and pruning. Shearing controls the height and width (taper) of the tree, stimulates bud development, and will increase the number of branches and needle density. Pruning removes multiple leaders and corrects deformities in branching.

Shaping is essential to obtain a high proportion of trees that will grade as U.S. Premium. U.S. Premium trees have no less than medium density, normal taper, and all four faces (sides) free from any type of damage or deformity (see Appendix Two).

Tools

Only 3 hand tools are needed to shape Christmas trees: (1) hedge shears with 8 to 10 inch blades; (2) lightweight shearing knives with 14 to 16 inch blades; and (3) hand pruners. In the South, shearing machines have gained acceptance. Both backpack- and tractor-mounted machines are used to increase production per worker and reduce fatigue and accidents.

Some growers prefer knives while others prefer hedge shears. An adequate shearing job can be done with either tool. Most growers need both tools especially if pine as well as spruce or fir is produced. The first shearing consists of cutting back the leader and a few main lateral branches. This can be done easily and quickly with shears. Shearing 6 to 7 foot pines with knives takes about one-half the time needed when using hedge shears.

There is some debate among growers regarding merits of the more "natural," open-looking trees obtained by shearing with hedge shears as opposed to the dense, uniform appearance of trees sheared with knives. Studies indicate that many customers prefer a dense pine and a more open spruce or fir. Therefore, most pine producers use knives while many growers of spruce and fir (including Douglas-fir) use hedge shears.

Tools must be kept clean and sharp. Dull and dirty tools result in bruised tree limbs, and workers tire more quickly. It is good practice to take a break every hour and clean shearing tools with steel wool using kerosene or rubbing alcohol. Remove all pitch before sharpening. Sharpen knives first with a file or coarse stone to restore the proper V-shape of the edge,

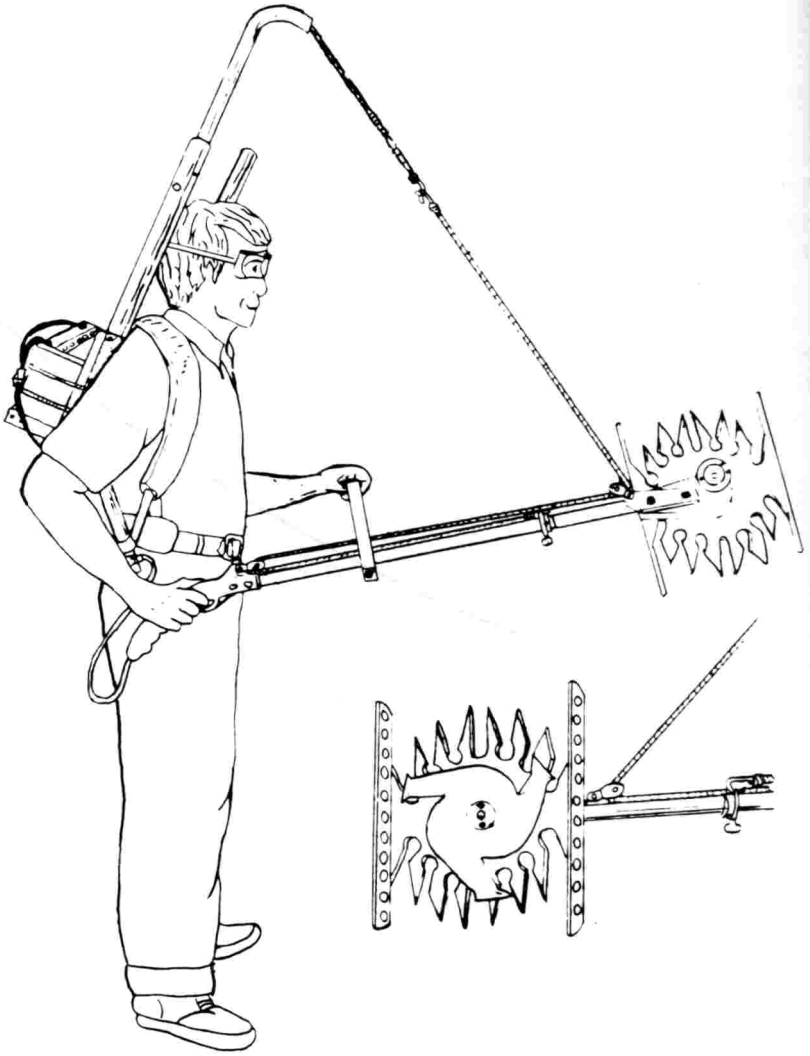


Figure 17: Light-weight, battery-operated machines are not limited to flat terrain and will take some of the hard work out of shearing. Illustration credit: Zum Zum Products, Inc.

and then use a fine stone to smooth the edge. Movement of the sharpening tools always should be against the blade. Probably more accidents, mainly cut fingers, occur when sharpening tools than while shearing trees. Use of leather gloves will lessen the frequency and severity of accidents.

At the end of each working day, tools should be cleaned, sharpened, and coated with a film of kerosene or oil to protect them from rust. Knives should be stored in sheaths.

Many accidents are associated with shearing knives; most could be prevented by use of common sense and protective equipment. Keep workers separated by at least one row of trees. Right-handed persons should wear a guard on the right leg and shear trees counterclockwise. Additional protection can be provided by wearing a guard on both legs. Right-handed persons should also wear a heavy-duty glove reinforced with staples on the left hand. Reverse the above directions for left-handed persons. Workers should be instructed to keep their free hand behind them when shearing and use the hand pruner rather than the knife to correct for multiple leaders and other deformities. More accidents occur in late afternoon when workers are hot, tired, and less attentive. To reduce accidents, it is a good rule to start work at dawn and take frequent breaks for rest and tool maintenance. On hot days limit work to 6 or 7 hours.

When to Start Shaping

If seedlings were properly pruned prior to planting (see Chapter 5), no further shaping should be necessary during the first and usually the second growing seasons. Vigorous white or Scotch pines will require some pruning the second growing season such as removing forks and pruning leaders longer than 12 inches. Since Scotch pine has a strong tendency to fork,

Figure 18: In the South, where topography is gentle and the summers are long and hot, shearing machines have been developed to shape Virginia pine. This species requires at least 2 shearings each summer. Photo credit: Murphy-Matic, Inc.

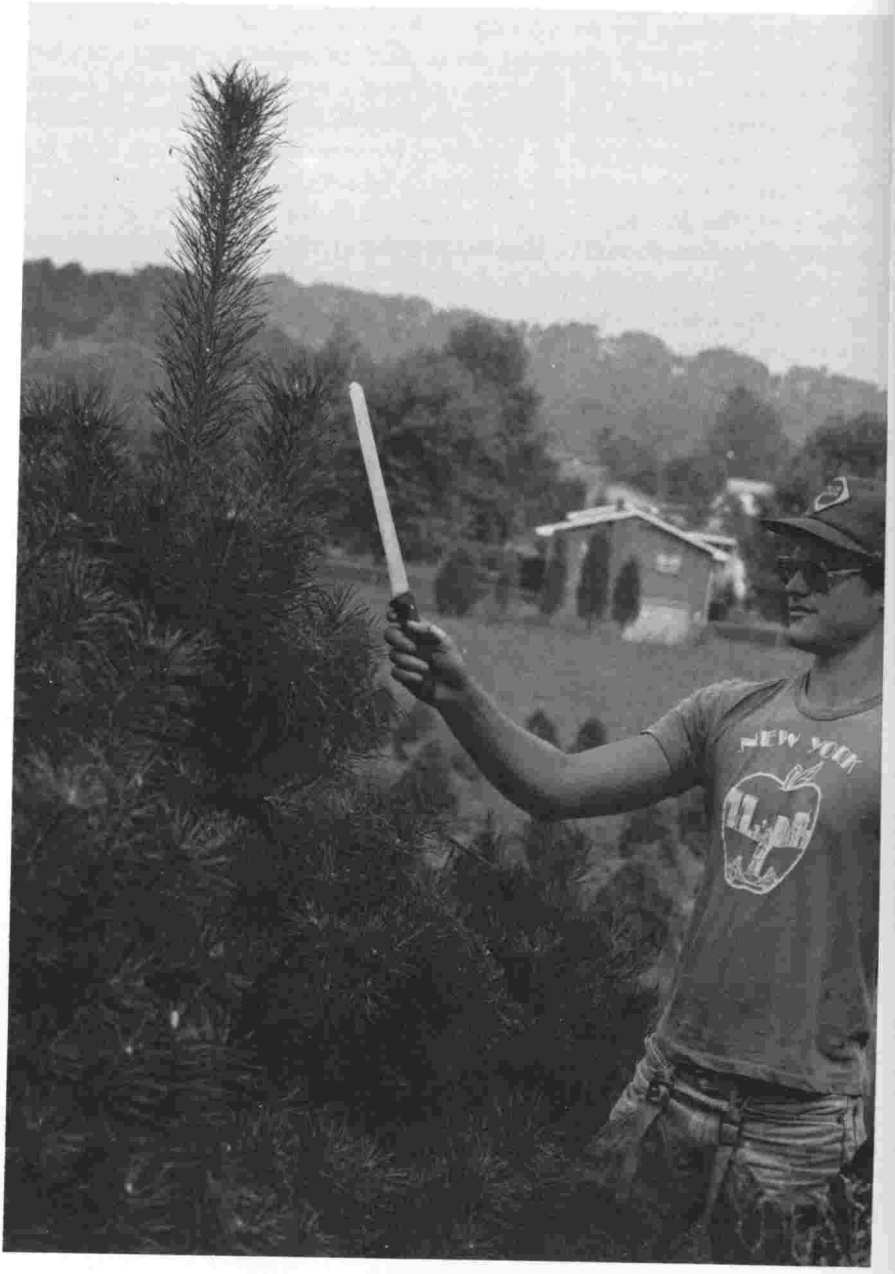


Figure 19: Scotch pine is sheared with a 14-inch-long knife. The worker has a glove on the left hand and guards on both legs.

it is necessary to cut back competing lateral branches in the top whorl. Shearing Virginia pine in the second growing season may be one reason why trees become top heavy with a tendency to fall over. Some growers have to stake a large proportion of their trees, a practice that probably could be avoided by delaying shearing for another year.

Spruces and firs normally do not require shaping until the fourth growing season or when they are 3 to 4 feet tall and long leaders have developed. Use a hand pruner to cut the main leader back to 12 inches and to remove multiple leaders, forks, and other deformities.

Time of Year to Shape

The optimum period for shearing white pine is about 1 month long, between the time the new leader completes its growth and before it hardens off. In Tennessee this period usually occurs from mid June to mid July. There is some annual variation, and at higher elevations the period is a little later. As a general guide, when length of the new needles is two-thirds of the length of old needles, it is time to shear.

Virginia pine must be sheared twice a year beginning when the trees are 3 to 4 feet tall. The first shearing should be in late April and the second in mid July. Don't be afraid to cut into older and thicker branches; up to a point, the stouter the branch, the more buds it will produce when cut.

Scotch pine is not as exacting as white pine when it comes to shearing season. Though the optimum season coincides with that of white pine, shearing of Scotch pine can be delayed until after white pine has been sheared.

If sheared too early, white, Scotch, and Virginia pines may set more buds than are desirable. If sheared too late, the result will be few and poorly developed buds. About a dozen well-developed buds on the terminal leader are desirable. Most growers shape their spruce and fir in late summer or early fall after they have completed shearing pines and while the weather is still agreeable.

How to Shape Pine

Each tree has its own characteristics produced by its genetic constitution and environment, including site quality, vegetation control, insect damage, and prior shapings. Trees of poor vigor cannot be made into premium trees just by shaping. Only healthy, vigorously growing trees have the capacity to produce an adequate number of large buds after shearing.

Terminal buds in pine produce small amounts of natural growth regulators called auxins, which inhibit bud formation further down the leader. When these terminal buds are sheared off, auxin control is temporarily lost, causing nearby bundles of needles to become buds. The bud nearest the cut end usually becomes the new leader; lower buds

become lateral branches.

Most pine growers cut leaders back to 10 to 14 inches. The longer length is chosen for vigorous trees because they form more buds further down the leader. These buds will develop into more branches, causing shorter gaps between branch clusters. Trees with poorly developed terminal bud clusters should be cut back to 10 inches or shorter. Remember that only needle bundles can become buds; always leave at least 10 needle bundles.

When trees do not have a central leader, select a strong lateral branch as a new leader. Force the new leader into an upright position by using the stem section of a large weed, such as goldenrod, to wedge it in place among other laterals. When a leader has died, tie a lateral branch to the dead leader using natural materials such as tough grasses that will rot away and not strangle the tree.

After the leader has been cut to proper length, shear lateral branches to give the tree a desirable shape. Give special attention to the new laterals at the base of the leader. These are often cut too short. Proper length is 3 to 5 inches shorter than the terminal. Do not shear trees too "tight"; this results in an unnatural ("tinroof") appearance. Excessive shearing removes so much foliage that tree growth is slowed, the rotation is prolonged, and production costs are increased.

Since old wood (previous year's growth) of white pine cannot produce buds, only the current year's growth should be sheared. Unwanted old wood should be removed with a hand pruner. Virginia and Scotch pine will regenerate buds in needle bundles on previous year's growth. With these 2 species, mistakes made in a previous season can usually be corrected.

Christmas trees should be shaped like a cone with a uniform taper. To obtain marketable pine Christmas trees with a taper of approximately 75 percent, it is not necessary or desirable to maintain this taper during the whole life of the tree. It is best to start shearing a tree to about 90 percent, and then gradually reduce the taper until the desired 75 percent has been obtained at maturity. The reason for developing a young tree with a wide crown is to produce more uniform growth over the entire tree. A slender tree produces vigorous leaders and "shoulders" (lateral branches towards the top) but very little growth from the ground up to the "shoulders."This results in a lack of foliage density in the lower part of the tree.

Trees of proper size and shape to be marketed the following Christmas should receive special attention. These trees should be shaped by the most experienced workers. The last shearing should be lighter than the previous ones; less foliage should be removed to give trees a natural look. Light shearing is especially important for white pine since the current year's crop of needles is all that will remain on the trees at time of sale.

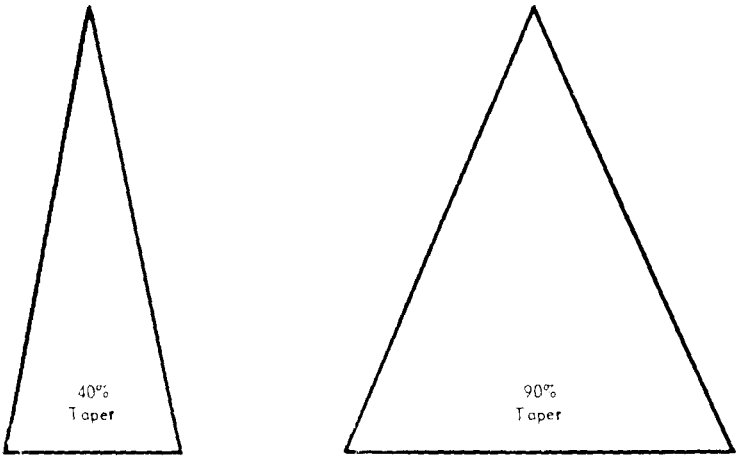


Figure 20: Taper refers to the relationship of the width of the tree to its height. For example, 70 percent taper means the width is 70 percent of the height. The following terminology is used: less than 40% = Candlestick, 40-90% = Normal, and more than 90% = Flaring. (Reprinted from* United States Standards for Grades of Christmas Trees, *USDA, 1973.)

How to Shape Spruce and Fir

Spruces and firs naturally develop many lateral buds along the current leader; therefore, it is not necessary to shear to get good bud set. Shearing of spruces and firs should be lighter than for pines to obtain the same quality.

Shaping is started by using a hand pruner to cut back the leader to about 12 inches. Make this cut above a strong bud and at an angle down towards that bud. To prevent forking, break off any buds near the one selected to be the new terminal. Proceed to shear lateral branches to obtain a cone shape using hedge shears or knives. Use the hand pruners to remove "turn backs." Such erratic shoots interfere with normal branch development, particularly in Fraser fir.

Basal Pruning

When trees are 3 to 4 feet tall, bottom branches may be removed so that a limb-free handle about 8 to 12 inches long is produced at the base of the stem. The handle is that portion of the trunk that fits into the tree stand. If basal pruning is done too soon, it can reduce tree growth. Also, early base pruning may increase the chances of having Virginia pines fall

Figure 21: A smooth stem is obtained when the cut is made down towards the bud at about a 45 degree angle.

over. Some growers, especially those who sell a number of live Christmas trees, have chosen not to do any basal pruning.

To meet U.S. Premium Grade standards, it is usually necessary to have at least four strong branches in the bottom whorl. Removing incomplete whorls above the minimum handle length will accomplish this. However, such basal pruning will reduce tree size or increase rotation length.

Lammas Shoots

Normally, white pine has only one flush of growth per year, taking place in April and May. After the initial flush, growth is usually limited to needle elongation, stem diameter growth, and root development. However, some trees will have a second, although shorter, flush of growth in the top. This growth originates from buds formed earlier in the summer and is called "lammas shoots."

The percentage of trees having lammas shoots, number of shoots per tree, and length of shoots varies with genetic makeup, soil and water conditions, and timing of summer shearing. If available soil moisture is

high in August, a large number of trees will exhibit lammas growth. Early shearing will increase both the number of trees with lammas growth and length of shoots. This is one of the reasons why younger plantations should be sheared first (June), while shearing of marketable trees can be delayed until late summer.

Most growers believe that lammas growth is detrimental because it may disfigure a tree. Leader elongation and resulting yellow-green juvenile foliage on top of dark-green, mature needles is certainly undesirable when trees otherwise are ready for market. On the other hand, lammas growth may be used to a grower's advantage during preharvest years by reducing time needed for growing a marketable product.

CHAPTER EIGHT

PROTECTION

Trees must be protected from destructive agents until harvest. Most agents are highly unpredictable, and some, like drought, are not controllable. Others, like weeds, are more predictable, and control measures can be planned in advance.

Weeds, insects, and diseases are commonly referred to as pests, and chemicals used to control them are called pesticides. It is often economical and convenient to apply a mixture of two or more pesticides. These products must be compatible with each other, or sedimentation may occur, which causes poor distribution as well as clogged equipment. Labels and compatibility charts are helpful in making up tank mixtures. When trying a new mixture, it is better to mix up a small amount of pesticides with water in the proper proportions. Everything should mix well when the mixture is stirred or shaken and should not settle out rapidly upon standing. It is risky to mix two different types of formulations, for example wettable powders (WP or W) with emulsifiable concentrations (EC or E).

The inclusion of a pesticide in this publication does not necessarily mean that the Environmental Protection Agency (EPA) has presently cleared its use. Neither does it imply an endorsement by The University of Tennessee. It is the responsibility of applicators to read the label to determine if the compound is legal to use. Applicators should also be aware that labeling can change. As new pesticides become available, Christmas tree growers should contact their local extension office to determine if they are recommended.

Applying a water-soluble pesticide by spraying is the most common control method. Equipment ranges from hand-operated backpack sprayers to tractor-mounted mist or spray equipment. Choice of equipment is governed by size of operation and accessibility of the trees with a tractor. Most garden tractors can be fitted with a pump and a 20 to 30 gallon capacity tank. If equipment has been used for herbicides, rinse 3 times with water and a good detergent before applying insecticides or fungicides to crop trees.

Addition of a spreader or wetting agent to the tank mix will usually improve effectiveness. If spray droplets bead up on the foliage, add more spreader. If spray droplets run together and off the lower edge of leaves, reduce the amount of spreader. The combination of nozzle orifice and pressure is important for proper application of pesticides. Herbicides are applied using low pressure (20-30 lbs.). Some growers even use a flooding nozzle. Fungicides and insecticides require small openings and high pressure, about 100 lbs.

Only use recommended doses of pesticide. The following table of equivalent measures will be helpful:

3 level teaspoons	=	1 tablespoon
2 level tablespoons	=	1 fluid ounce
8 fluid ounces	=	1 cup
2 cups	=	1 pint
2 pints	=	1 quart

Moderately to highly toxic pesticides require an applicator's license. In Tennessee, users of these pesticides are required to attend an approved training session to be certified. Such sessions are given by the extension leader in each county.

Safety

Many chemicals are available to Christmas tree farmers, including some very toxic herbicides, insecticides, and fungicides. All must be transported, stored, and applied with care.

When working with these pesticides, it is important to avoid skin contact by wearing gloves, a long-sleeved shirt, overalls, and a hat. Wear a respirator when using chemicals in a powder form or a fine mist. Exposure to pesticides is increased by applying chemicals on windy days.

Great care must be exercised in handling the concentrates, especially in mixing. Never use more chemicals than recommended. Many problems with pesticides are avoided through proper dilution with water.

In addition to protective clothing and dilution, time may be the most important factor in protection of workers. Pesticides take time to be absorbed. Work clothes may become nearly saturated with chemicals, but if clothes are washed daily, chances of absorbing these chemicals diminish. Work clothes should be washed separately from regular family clothes. Workers should take a thorough shower each evening after using pesticides and wash hands between working with chemicals and eating or smoking.

Children have been poisoned by ingesting improperly stored pesticides. Store chemicals in labeled containers under lock and key.

Fire

In Tennessee two-thirds of the forest fires are incendiary; one-third are accidental. Fires in Christmas tree plantations are also man-caused. Fuels present determine a fire's potential to spread, to do damage, and to resist control efforts. Current weather conditions determine the extent to which this potential will be realized.

Most Christmas tree plantations are laid out with harvest lanes spaced 12 to 20 rows apart. When mowed, these lanes tend to reduce the spread

of fires and provide fire fighters easy access. Under extreme conditions these lanes could be used to start backfires. To prevent fires from burning into a plantation, fire lanes should be disked around boundaries, especially where a plantation borders high risk areas such as railroads, highways, and garbage dumps. *If a grower does not have ready access to a tractor and disk, a non-selective herbicide for bare ground control may be used.*

There are 3 types of fires: incendiary, accidental, and controlled. Incendiary fires are always undesirable, and there is little one can do to prevent them except patrol during days of high fire danger. Accidental fires may be started by the grower or a neighbor. It often starts as a "controlled fire," but because of poor judgment or change in weather conditions, the fire gets away. If a neighbor started the fire, that person is liable for any damage caused by the fire. Similarly, the grower is liable for damages of a fire started on the grower's property. As opposed to incendiary and accidental fires, a controlled fire is confined within previously constructed fire lanes and is kept under control by a properly equipped crew. Tennessee Division of Forestry personnel are available to give advice on construction of fire lanes and proper burning procedures.

For a Christmas tree grower there are 2 situations that may call for a controlled fire. First, fires may be prescribed to burn wood out of windrows created in site preparation. Second, a controlled fire may be used at the end of a rotation to consume cull, diseased, and insect-infested trees after they have been cut and left to dry. Before starting a fire, check to see what is downwind; smoke could drift into a neighbor's house or create hazardous driving conditions.

In Tennessee it is unlawful to start any open fire between October 15 and May 15 within 500 feet of woods or grasslands without first securing a permit. Such permits may be obtained from most TDF employees but not sooner than 24 hours prior to the time set for the fire. The exception to this rule is that after 5:00 p.m., when the relative humidity usually goes up and the temperature drops, no permit is required. During days of high fire danger, keep a backpack sprayer filled with water in your vehicle at all times. Also, carry a chemical fire extinguisher when operating power equipment. Exhaust sparks and broken fuel lines are common causes of fire. In addition to saving expensive equipment, the fire extinguisher may save a few thousand dollars worth of Christmas trees. If a fire gets started and the initial control efforts have failed, immediately call for professional help. The sheriff's office in each county has a list of fire control units operated by TDF and will relay the call.

Trespassing

Most trespassers have no intent to steal or destroy property. Hunters may occasionally be a nuisance, but the risk landowners take by permitting this type of activity is not great. Current Tennessee law [Tenn. Code Ann.

Sect. 51-804) frees landowners from all liability if a nonpaying guest is injured unless (1) the injury results from willful or malicious failure to guard or warn against a dangerous condition, use, structure, or activity (Tenn. Code Ann. Sect. 51-805-1) and (2) except in situations where injury was caused by persons granted permission (such as hunters) to other persons with legal reason to be on premises (Tenn. Code Ann. Sec. 51-805-3).

Most theft consists of one or two trees and usually happens at night. Considering that it only takes a few minutes to crawl through a fence, cut down a tree, and load it in a car, little risk is involved. There is not much that can be done about this except to keep on friendly terms with neighbors and ask them to report suspicious activities to the sheriff. Under no circumstances should neighbors confront potential thieves.

Only a few cases of wholesale theft have been reported in Tennessee. However, on several occasions unauthorized trucks have loaded cut trees in North Carolina. Leaving cut and baled trees in the field overnight is risky business but difficult to avoid during the busy harvest season. Some growers hire watchmen for their most critical locations.

Animals

Damage to plantations from domestic animals has been rare. By law, domestic animals must stay within fences, and the Christmas tree grower does not have to fence them out. However, if a neighbor lets fences deteriorate, cattle can stray into a plantation and cause damage. To save good neighborly relations, it may be better to come to an agreement about sharing expenses of fence maintenance.

In the past wild animals have caused little damage to Christmas tree plantations. However, the deer population in Tennessee is growing rapidly, and browsing of Christmas trees may soon become a problem. Three deer repellents, Arasan 42S, Hinder, and Deer-Away, are being evaluated in Tennessee. A 5-wire permanent fence using smooth 12-gauge high tensile wire and a low impedance charger is very effective.

Cotton rats and 3 species of voles occasionally damage Christmas trees. These rodents are especially attracted to Virginia pine and have caused mortality in young plantations by completely girdling trees at ground level. Recommendations for annual control of pine voles are 4 lbs. per acre of ready-mixed 2 percent zinc phosphide on cracked corn placed in runways. Broadcast 10 lbs. per acre of the same material for control of prairie voles, meadow voles, and cotton rats. However, using good chemical weed control will lower the quality of the vole habitat, and less damage should occur.

CHAPTER NINE

VEGETATION CONTROL

There are 2 basic methods of vegetation control — mechanical and chemical. Most growers use a combination of these 2 methods.

Mechanical control includes everything from cutting hardwood sprouts competing with crop trees to mowing grass and broadleaf weeds between the rows. With proper site preparation there should not be many hardwood sprouts. Grass and broadleaf weeds should be mowed at least 3 times during the first and second growing seasons. When the trees become larger, 2 mowings per year will usually suffice.

Frequency of mowing will, to some degree, depend on the equipment used. A few acres may be maintained with a 6 to 12 horsepower mower or a garden tractor with a mower attached under the tractor. However, such equipment does not work well in tall grass. It may be necessary to mow more frequently, or the equipment will bog down.

Larger plantations are maintained with tractors outfitted with a 3-point hitch and a bushhog. As trees become larger, the tractor wheels can break

Figure 22: As trees approach marketable size, the mower keeps down weeds that would interfere with proper development of lower branches.

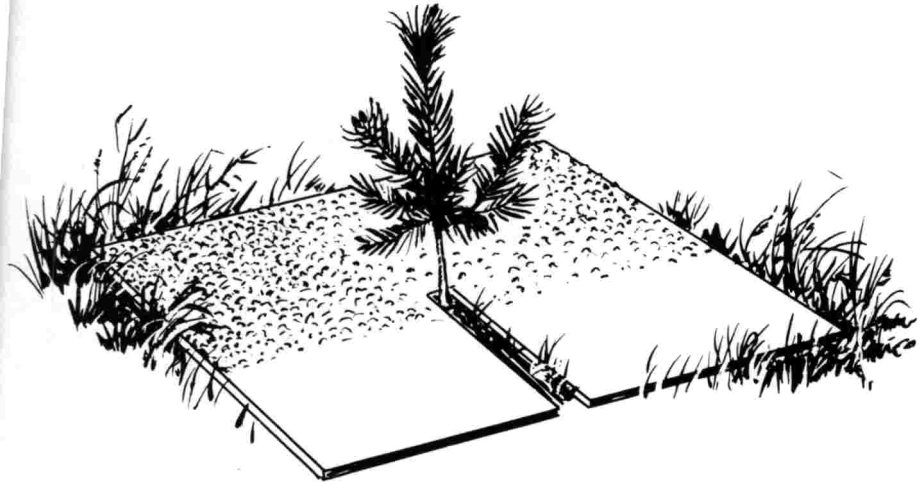


Figure 23: Roof shingles kill grass in the immediate area around seedlings.

or bend down the lower branches. To prevent such damage, some growers construct shields over the wheels.

While vegetation between rows can be controlled by mechanical means, competition by weeds within rows can be a problem, particularly if the trees are not cross-mowed. Use of mulching materials such as plastic sheets or asphalt roof shingles will give some protection against weeds that shade the lower branches and compete with trees for water and nutrients.

There is increasing evidence that certain compounds found in plants will leach out and have harmful effects on tree growth. One such example is the detrimental effect of fescue turf on growth of pines. Therefore, weeds need to be killed for reasons other than direct competition.

The use of herbicides in bands about 2 feet wide is a practice that has gained acceptance by most growers. Shields that permit placement of a herbicide on weeds while keeping it off crop trees have been devised. Shields vary in complexity from a simple plastic funnel attached behind the nozzle of backpack sprayers to those on tractor-mounted applicators.

Herbicides are classified as pre-emergence or post-emergence, depending upon when they are effective. Pre-emergence herbicides, such as Simazine, will prevent weed seeds from germinating while post-emergence herbicides affect plants after they have become established. Some herbicides, like Kerb, have both pre- and post-emergence activity. Other products, such as Paraquat, have only post-emergence activity.

No single material will control broadleaf weeds and grasses under all conditions without damage to crop trees. Herbicide effectiveness is governed by several factors such as time of application, size of weeds, temperature, soil texture, organic matter, and moisture. A given chemical may be safe to use on some species but not on others. Time of growing

season and whether the trees are actively growing may determine if the chemical can be sprayed over the top. Some herbicides will only control specific broadleaf weeds but not grasses. Poast and Fusilade are new herbicides that are effective only on grasses. Some herbicides are taken up by the roots while others are effective only through contact with foliage. Addition of a surfactant to post-emergence applications may improve weed control but could also alter properties of the herbicide so that crop trees are damaged. Read and follow label directions regarding species, stage of growth, surfactants, placement, etc.

In most cases herbicides should be mixed in sufficient water to allow a final spray volume of 20 to 30 gallons per acre on a treated acre basis. Since most growers only treat a 2-ft-wide strip and leave a nontreated strip between rows, this amount will cover from 2.5 to 3.5 planted acres, depending on spacing between rows. When the sprayed band is 2 feet wide, 4 miles of tree rows will comprise 1 acre.

A mistake in calculating necessary amounts for the tank mix may result in an overdose that damages or kills trees. If the concentration is too low, weed control will be unsatisfactory. The same undesirable results may follow inadequate mixing of powders with water. Growers should calculate rates carefully and use sufficient agitation to insure uniform application.

Princep (Simazine) and AAtrex (Atrazine)

Princep is available as a wettable powder (80W), a liquid (4L), wettable granules (90 DF), or granules (4G). One of the oldest herbicides, it has been used extensively for pre-emergence control of grass and broadleaf weeds. It is often mixed with AAtrex to give more consistent weed control. Such a mixture is more effective than Princep alone on clay soils in East Tennessee. Apply tank mix of 2 to 4 lbs. active ingredient (a.i.) of Princep 80W and 2 lbs. a.i. of AAtrex 80W per treated acre. Do not exceed a total of 5 lbs. a.i. in any one year. AAtrex is not recommended on sandy or loamy soils as tree injury may result. On lighter soils use Princep alone at 3 lbs. a.i. per acre. The tank mixture or Princep alone may be sprayed over the top of trees 10 days or longer after planting in February and March. Although not currently labeled, this treatment has been successfully used by a number of growers.

Surflan (Oryzalin)

This herbicide is formulated as a 75 percent active wettable powder and a 4 lbs. per gallon aqueous suspension. Surflan, under proper conditions, provides pre-emergence control for 8 to 12 weeks. It is more active on grasses than on broadleaf weeds. The combination of Surflan and Princep resists leaching and controls a larger spectrum of weeds than either

chemical alone. Apply Surflan as a directed spray to the surface or over established trees at 2 to 4 lbs. a.i. per acre combined with Princep at 2 to 3 lbs. a.i. per acre. Application of Surflan-Princep combinations in early spring (March) has been most successful.

Kerb (Pronamide)

This product is available as a 50 percent wettable powder. It has both pre- and post-emergence activity and is absorbed through the roots. Therefore, moisture is essential to move it into the root zone of the target weed species. The manufacturer recommends fall application of up to 2 lbs. a.i. per treated acre. In Tennessee, adequate soil moisture is usually present in the winter, and application in January or February should result in control of most grasses. Control of broadleaf weeds will improve with addition of up to 4 lbs. a.i. of Princep per treated acre.

Roundup (Glyphosate)

This product contains 4 lbs. active ingredient isopropylamine salt per gallon. It is a non-selective, translocated, post-emergence herbicide and has given excellent control in Tennessee.

Protect tree foliage with some type of shield, particularly when trees are actively growing. However, some growers have found that Roundup can be sprayed "over the top" of Norway spruce after the middle of July. White pine keeps growing into the fall and remains susceptible to damage although to a lesser extent than at the peak of activity in spring and early summer. Do not use a wetting agent if Roundup is sprayed "over the top" of Christmas trees. Many growers will apply a pre-emergence herbicide in March and have relatively good weed control until July. They then apply Roundup as a directed spray to extend the control period long enough to prevent serious reinfestation.

Johnson grass and fescue are controlled at rates of ⅓ gallon per treated acre. Results are noticeable within 10 days.

Growers using backpack sprayers need guidelines for mixing and spraying Roundup. Assuming that 30 gallons of water will be used per treated acre, the amount of Roundup to mix per gallon of water will be 1.4 fluid oz. This mixture is sufficient to spray a 2-ft-wide row of 145 trees planted 5 feet apart.

Since Roundup must be translocated, it is important that the weeds have a relatively large leaf surface and be actively growing. For best results avoid application during periods of drought or extreme temperatures. Do not apply if rain is expected within six hours as the chemical requires this much time for absorption. Apply Roundup when there is little or no wind and use a coarse, directed spray (low pressure) to avoid drift. Probably no Christmas tree species is completely resistant, and cumulative

effects from multiple doses may damage trees several years later.

Ammonium sulfate may improve broadleaf and grass control up to 10 and 25 percent, respectively. Directions on the 1985 Roundup label suggest adding 17 lbs. of ammonium sulfate per 100 gallons of water (2¾ oz. per gallon).

Paraquat

This herbicide contains 2 lbs. a.i. per gallon and is a "Restricted Use Pesticide" that can be sold only to certified applicators. Great care should be taken in mixing, handling, and applying this material.

Paraquat is a non-selective, contact herbicide with rapid action, especially on warm sunny days. It is completely soluble in water and much more effective if a small amount of wetting agent (6 to 10 oz. in 30 gal. of water) is used. One fluid ounce of Paraquat per gallon of water is sufficient to kill grasses and weeds down to ground level. It does not translocate to the roots; therefore, it will not kill most perennial weeds. Drift or misapplication on desirable foliage will cause extensive damage.

Phenoxy Herbicides

For Christmas tree growers the low volatile ester formulation is more effective than the amine form. Prices vary according to type of formulation and amount of herbicide per gallon (acid equivalent). Both 2,4-D and 2,4-DP are selective, post-emergence herbicides, which do not harm grasses but are absorbed by foliage of broadleaf weeds, shrubs, vines, and (unfortunately) Christmas trees. Turgid leaves absorb herbicide most rapidly, and photosynthesis stimulates movement out of the leaf and down the stem. By using low pressure and a directed spray, it is possible to avoid most damage to crop trees. However, release of conifers from hardwood sprouts and vines by foliage spraying is safest late in summer. At this time most conifers have formed buds and "hardened" while hardwoods, vines, and weeds have not.

Christmas tree growers find that "brush killers" are most useful for 2 purposes. First, they prevent encroachment from woods and fence rows of "brush" (hardwood sprouts, vines, and briars). As long as there is no wind, the spray may be broadcast in early summer, just after the leaves have fully expanded. Second, they prevent brush from becoming established in the rows of Christmas trees. Use a directed coarse spray and delay spraying until the first week of September. To avoid damage to Christmas trees, do not use "brush killers" containing dicamba.

Be sure to follow directions on the label. If more chemical is used than is recommended, chances are that immediate kill or burn of the foliage will occur. As a result, the herbicide will not be translocated into the root system, and the target species will soon resprout. If a formulation with

2 lbs. acid equivalent per gallon each of 2,4-D and 2,4-DP ester is used, it is sufficient to mix 1.5 fluid oz. with 1 gallon of water. A small amount of good wetting agent will greatly improve the results. Foliage of the target species should be barely wet with this mixture. Best results from foliage treatment are obtained when soil moisture and temperature conditions are favorable for weed growth. Brush kill may not be evident for 2 to 3 weeks.

Goal (Oxyfluorfen)

Goal 2E is an emulsifiable concentrate containing 1.6 lbs. of active ingredient per gallon of product. Outstanding results have been obtained in conifer seedbeds when application is made after seeding but prior to germination of conifers. If such pre-emergence application was not made, a post-emergence treatment should be applied at least 5 weeks after conifer germination. However, by that time weeds may be too tall as Goal will effectively control weeds only up to a height of 4 inches. Use 1 tablespoon of Goal 2E in 1 gallon of water per 1000 square feet of nursery space. Water immediately with ½ inch of sprinkler irrigation. Two post-emergence applications may be necessary for season-long weed control.

Transplants of Christmas tree species are tolerant to pre-emergence and post-emergence applications as long as Goal is applied before bud break or after the foliage has had an opportunity to harden off. This herbicide is very effective on grasses as long as they are in the 2-leaf stage. Use 4 to 8 pints per treated acre (1.5 to 3 oz. per 1000 square feet) and add a recommended wetting agent. For optimum weed control, pre-emergence applications should be made immediately after transplanting. Post-emergence applications should be made to weeds less than 4 inches in height. Heavy rainfall on the day of application may reduce effectiveness.

Poast

This post-emergence herbicide for control of annual and perennial grasses does not harm Christmas tree species, even when sprayed directly over the top. Within an hour of application, Poast is absorbed by the foliage, reducing the chance that rainfall will diminish effectiveness of the treatment. Symptoms exhibited by treated grasses progress from reddening of foliage to leaf tip burn and burn back of the foliage. These symptoms are observed over a 3-week period. Grasses should have some new growth at the time of application but less than 5 inches for best results. Poor results may be expected if grasses have started to flower or are under stress due to lack of water.

Poast by itself is not very effective. It has to be combined with a nonphytotoxic oil (crop oil) in a 1:1 proportion. To control 1 acre of fescue, apply 1 quart of Poast and 1 quart of crop oil in 25 gallons of water. This

is a 1 percent spray solution. Do not add a wetting agent; the crop oil has a surfactant in it. This 1 percent solution is very useful in spot treatments using backpack sprayers. For example, Johnson grass may be killed without having to worry about damage to Christmas trees.

CHAPTER TEN

INSECT CONTROL

Potential damage from insects in Tennessee Christmas tree plantations is less than in many other states. Nevertheless, frequent inspections are required, and prompt spraying with insecticides or other control measures must be initiated when an infestation is discovered. Inspections should determine the severity of infestation (how heavily the trees are infested) and the extent of the infestation (how many trees are infested). For many insects the best inspection time is during shearing when each individual tree receives maximum attention. When an infestation is not extensive, it is practical to mark (but not shear) infested trees with plastic flagging and spray at the end of the day. Shearing and removal of flagging should be delayed until inspection indicates that the insect has been controlled.

Control methods range from physical removal and burning of infested trees to soil treatments, but spraying an insecticide is most common. The following is a discussion of the major insect pests and their control. Mention of insecticides does not preclude the use of other chemicals, which may be just as effective but have not been extensively used in Tennessee.

Bagworm

Of the approximately 24 species in the eastern United States, the common bagworm causes the most damage in Tennessee. All Christmas tree species can be attacked. The wingless, grub-like adult female bagworm lives within the protective cover of her tough bag. Shortly after mating she lays 500 to 1000 eggs, which remain in the bag throughout winter. This is the time when bags should be picked and burned. By the end of May, eggs will hatch and larvae will start feeding. If picking is neglected, spring spraying of the foliage with Cygon 2E (2 quarts per 100 gallons or 4 teaspoons per gallon), Orthene 15.6E (1.5 tablespoons per gallon), Diazinon 50W (2 teaspoons per gallon), or Dylox 80SP (½ tablespoon per gallon) is necessary. Control becomes increasingly difficult to attain later during summer. Growers with environmental objections to insecticides may want to use *Bacillus thuringiensis* (sold as Thuricide or Dipel).

Balsam Twig Aphid

This insect is very small and often covered with a white, cottony material. The most obvious sign of twig aphid presence occurs during

spring when developing needles of infested Fraser fir curl upward. Aphid eggs hatch in April, and the young feed on succulent needles. Feeding, development, and reproduction continue into May when winged aphids develop and fly to other trees. By the end of June, all feeding forms disappear, leaving only eggs, which will hatch next spring. Damage from twig aphids includes needle distortion, premature needledrop, and reduced needle retention after cutting.

Twig aphids can be controlled in early spring as new growth begins and before needles are severely curled. Plantations that had trees with needle curl in the fall should be sprayed in the spring of the following year with Malathion 57EL at a rate of 1.5 pints per 100 gallons or 2 teaspoons per gallon of water. Cygon 2E (Dimethoate) may also be used (2 quarts per 100 gallons or 4 teaspoons per gallon).

Balsam Woolly Aphid

Since its introduction into this country at the turn of the century, this aphid has become a major pest and threatens the natural stands of Fraser fir with extinction. However, most trees killed by the aphid are larger than Christmas tree size. Thus, the main problem for Christmas tree growers is the loss of a source of seed.

Usually, the balsam woolly aphid has 2 generations per year. Eggs in the first generation hatch in late June and July with the second generation following in September and October. The first immature ("crawler") stage is the only stage in the aphid life cycle when it is capable of moving. Once a crawler begins feeding, it covers itself with "wool" and never moves again. In the feeding process, the aphid injects a salivary substance into the tree, which causes growth abnormalities. Initial symptoms of aphid attack include gouting of buds or twig nodes. Growers collecting wildlings should treat their collected plants with Lindane when transplanting.

Recent research indicates that application of "soaps" (1 percent oleic or linoleic acid) can be very effective in controlling the balsam woolly aphid. Lindane 20EC may be applied as a directed, forceful stream to the entire tree. Mix 1 to 2 tablespoons per gallon of water (2 to 3 quarts per 100 gallons) and spray in June and July to catch the aphid in the crawler stage.

Pine Bark Aphid

This insect is endemic on white pine in Tennessee but has become epidemic in some Christmas tree plantations. The aphid is tiny and covered with white woolly wax. Heavily infested trees appear to be white-washed. Aphids feed on the stem, the underside of branches, and the base of needles on new growth. Small trees may be badly stunted while larger trees have reduced growth.

In the spring females lay eggs that hatch into nymphs, which develop into winged or wingless females. The wingless forms remain on the host and may produce 5 or more generations. Some of the winged females fly to other trees to lay eggs.

A heavy infestation of pine bark aphids is difficult to control in a Christmas tree plantation. Due to high foliage density, it is difficult to obtain an insecticide stream of sufficient force to reach the trunk and underside of infested branches. Several insecticides have been tried, including Malathion 57EL (2 teaspoons per gallon) and Cygon 2E (4 teaspoons per gallon). Control of a heavy infestation requires sufficient spray volume to thoroughly wet foliage and bark when the aphid is in the crawler stage.

An alternate control measure is soil application of Di-Syston 15G or Furadan 15G. The advantage of this treatment is that only 1 spring application is needed. Disadvantages include the high cost for chemicals and applications in addition to high toxicity (Restricted Use Pesticides). Apply 1 tablespoon Furadan with a planting bar or an "E-Z feeder" about 1 foot from the stem. Furadan is toxic to birds; therefore, the hole must be filled with about 1 inch of soil. Rubber gloves that fit tightly around the arm and frequent washings are necessary safety precautions.

Pales Weevil

This weevil is potentially the most serious insect pest of Christmas tree plantations in Tennessee. Adult weevils are attracted by the odor of resin from fresh stumps and lay their eggs in the lateral roots. Larvae feed on the inner bark tissue of roots. On emerging, adults feed on tender bark of seedlings or twigs of older Christmas trees, leaving small holes. When feeding is heavy, the holes tend to fuse and girdle the stem or twig. Females lay eggs throughout 2 growing seasons but produce no more than about 50 eggs in a lifetime. White pine is a preferred host, but Norway spruce and Scotch pine are also attacked.

This insect can be controlled by delaying planting in cut-over areas for 1 year. However, most growers prefer to treat stumps and seedlings with a suitable insecticide. High stumps should be cut off at ground level before an April spraying with Lindane 20EC at a rate of 4 ounces per gallon of kerosene.

Before planting, seedlings may be top-dipped in Imidan 50W at a rate of ⅔ lb. per gallon of water. Using rubber gloves, swish tops around in the liquid for 10 to 15 seconds, taking care not to soak the roots. Elevate roots on a draining board and let tops dry while roots are covered with wet moss. Five gallons of mix is sufficient to treat 10,000 seedlings. Established seedlings can be protected by spraying with Lindane (⅔ oz. per gallon water) in April and again (if needed) in August.

Nantucket Pine Tip Moth

Control of tip moth is necessary to grow good quality Virginia pine Christmas trees. Scotch pine may also be attacked. Early larval feeding occurs on the surface of new growth or at the base of needles. This feeding is usually preceded by construction of small tent-like webs between new needles and the stem. Later injury occurs as the larvae bore into buds and growing shoots. Only new growth is attacked, but heavily infested trees can be severely stunted.

Cygon 2E can be used for control, but there are some difficulties in determining the best time of application. Tip moths produce 2 to 3 generations per year, and the spray should be applied 10 days to 2 weeks after peak emergence in the spring and 5 to 7 days after peak emergence in summer. As a generation emerges, the moths can be seen flying around the trees in the evening.

Use of Furadan removes some of the uncertainty of timing the application. The first application should be in early spring, just before the trees break dormancy. In East Tennessee, only 1 application may be needed; however, a second application may be required in West Tennessee, usually in July. Success of the summer application is dependent upon adequate rainfall. Most growers use ⅓ teaspoon for newly planted seedlings, 1 teaspoon for 1-year-olds, 2 teaspoons for 2-year-old seedlings, and 1 tablespoon for 3-year-old and larger trees. A planting bar can be used to treat a small number of trees; for larger plantations the "E-Z feeder" is a good investment. The prescribed amount is deposited in a single hole about halfway out from the stem to the end of an average branch.

Sawflies

Several species of sawflies cause damage to Christmas trees in Tennessee. The presence of summer sawflies and their damage is easy to spot as these gregarious feeders are found in large groups on branches, devouring all needles. Small trees may be completely defoliated from the top down, but normally the populations are kept under control by a number of natural enemies.

Chemical control of sawflies is not difficult to attain, but frequent inspections are important to detect a sawfly infestation before severe defoliation takes place. Most insecticides will control sawflies, including Malathion 57EL (2 teaspoons per gallon) and Cygon 2E (4 teaspoons per gallon of water).

Spider Mite

These mites suck sap from the needles of most conifers, especially Fraser

fir, resulting in a yellow stippling of the needles. When heavily infested, needles turn brown and strands of webbing may be found. Hot, dry weather favors the buildup of mite populations. The presence of spider mites can be detected by striking the foliage with one hand while holding a piece of white paper under the branch with the other hand. Spider mites can be seen moving about on the paper. Another procedure is to look for nymphs on the tips of new foliage in early spring using a 10X hand lens. There are many generations per year; therefore, large mite populations develop rapidly, especially when there is no natural control.

A number of effective miticides are approved for control of spider mites in Christmas tree plantations. Spraying is most effective in late summer or early fall, but foliage sprays may be applied as mite numbers and/or feeding damage appear. To avoid buildup of resistance to a pesticide, it may be best to alternate the use of miticides such as Kelthane 35WP at 1.5 tablespoons per gallon (1 lb. per 100 gallons) and Metasystox-R 25SC at 1.5 teaspoons per gallon of water (1.5 pints per 100 gallons).

White Pine Aphid

These aphids are about ¼-inch-long, black insects with white spots along the sides of their body. They suck sap from branches and shoots of white pine. Trees may become severely stunted as a result of feeding by large populations of white pine aphids. Additionally, honeydew is secreted by the aphids and collects on branches and foliage. A black, sooty mold grows on the honeydew; this mold is unsightly, interferes with normal tree growth, and reduces tree quality. Several generations of the aphid are produced each summer. When white pine Christmas trees are brought indoors, any aphids present will become a nuisance.

Control white pine aphids by applying an approved insecticide as a forceful spray directed at the infested portions of a tree. An inspection should be made in the middle of May to determine the extent of infestation and if a control program is needed. This inspection can coincide with bagworm inspection. Trees infested with either of the two pests should be treated individually when the extent of infestation is low. Broadcast spraying may kill the natural enemies of these 2 pests and should not be used unless many trees are infested. The tank mix should be the same as for bagworm control.

White Pine Weevil

The adult weevil is a brownish snout beetle about 1/5-inch-long with irregular, small patches of grayish and yellow scales. The primary host is white pine, but the weevil has been known to attack both Norway spruce and Scotch pine. In the spring the appearance of tiny drops of resin exuding

from holes made by adults is the first evidence of an infestation. Eggs are laid in small punctures in the bark of leaders and hatch in about 1 week. Larvae bore downward in the inner bark and girdle and kill leaders.

The most effective control is to prune and burn all infested leaders before new adult weevils emerge. Since white pine shearing is usually completed before the middle of July, such control can easily be accomplished. Extensive infestations can be controlled by spraying leaders in early spring when the first signs of attack occur (resin drops and needle wilt). Use 1 tablespoon Lindane 2OEC per gallon of water as a directed spray or 5 oz. Metasystox-R (25SC). Apply 2 to 4 gallons of the mixture per acre. Salvaging trees that have lost their leader may be possible by tying up a lateral branch to the main stem.

CHAPTER ELEVEN

DISEASE CONTROL

Diseases are always present in Christmas tree plantations. Generally, trees are seldom seriously affected until tree vigor declines. Reduced vigor may be caused by low fertility, drought, poor drainage, insect attacks, herbicide injury, or mechanical damage. To maintain trees in good vigor, it is important to match species with site, provide adequate soil fertility, control insects, and avoid damage from herbicides and tractors. Sanitation is equally important to maintain a healthy stand of Christmas trees. The grower should remove dead branches, high stumps, and infected trees.

Infectious Diseases

Occasionally there will be an outbreak of infectious disease in well-managed plantations. Early detection and control with appropriate pesticides are essential. The infectious diseases described below account for most problems encountered by Christmas tree growers in Tennessee.

Phytophthora Root Rot

This fungus disease is associated with poor internal soil drainage. It can be serious in nurseries having excessive soil moisture and is a cause of mortality in Fraser fir, Norway spruce, and white pine planted on poorly drained sites. Such sites are common in the mountains of East Tennessee where annual rainfall exceeds 60 inches and water losses are slow due to low temperatures and high relative humidity. Since Fraser fir grows well in such an environment, *Phytophthora* has become associated with this species.

The disease occurs on trees planted in clay soils and on shallow sandy soils underlain by clay or rock. Needles of affected trees will first develop a light green color. In late summer these needles will turn brown if subjected to water stress. Roots of infected trees have a reddish-brown color.

Chemical control is not practical in plantations. In the nursery, control is obtained by fumigating seedbeds with methyl bromide. This treatment should last for the 2 years needed to produce a good seedling. Transplant beds must also be fumigated. The systemic fungicide Subdue may also control *Phytophthora* root rot. Broadcast spray 2.5 pints of Subdue 2E in 50 gallons of water per acre on new seedbeds or transplant beds. Use 5 pints per acre for established seedlings and transplants.

Brown Spot

Initial infection of pine needles results in development of small, circular spots of grey-green color that later turn brown. As the fungus continues to grow, a brown necrotic area encircles the needle, resulting in needle death. Fruiting bodies develop and produce conidiospores. These spores may be spread for short distances by splashing rain or for longer distances by shearing tools. A second type of spores (the sexual stage of the fungus) is produced on dead needles during early spring. These spores are spread long distances by wind but play a relatively minor role compared to the conidiospores. Although the pathogen may attack foliage of large trees, it is common only on trees with foliage within 18 inches of the ground. Infected needles are usually found on the lower half of the tree, especially on the north side.

Brown spot may be controlled by spraying with a Bordeaux mixture (8 parts copper sulfate and 8 parts lime in 100 parts water) every 2 weeks from June to September. To avoid spread of the fungus, trees with brown spot symptoms should not be sheared at the same time as healthy trees.

Lophodermium Needle Cast

Needle cast is fairly common on white pine Christmas trees in Tennessee. Infected trees survive but are not marketable during the following holiday season. New needles are infected in early summer. Entire needles turn yellow and eventually brown, causing the tree to have a scorched appearance. Black, football-shaped fruiting bodies, which can be seen with the aid of a hand lens, form on the dead needles. Wind spreads spores to healthy needles. Infected trees usually recover and develop new foliage the year following an attack.

Pines should not be planted on cool, moist, northern slopes where needle cast is prevalent. Such sites are better suited for spruce or fir. Control is obtained by spraying with Maneb 80WP (1 oz. per 4 gallons of water) every 2 weeks from August 15 to October 1.

Pine Stem Rusts

The most common stem rust in Christmas tree plantations is the eastern gall rust that occurs on Virginia and Scotch pines. The disease causes formation of round- to oval-shaped galls that may deform stems and branches. Wood rotting fungi are often secondary invaders of the infected area.

Infection begins in the current year's shoot. A year later a swelling develops at the point of infection, and it enlarges annually. The best control measure is to prune and burn branches that have galls present. Pruning must start when the trees are 2 to 3 years old so that Christmas tree quality can be obtained by the end of the rotation. Galls on the stem and main branches of Scotch pine account for many cull trees in this species.

Pitch Canker

Pitch canker attacks Virginia pine and occasionally Scotch pine. The fungus enters through small insect wounds on twigs or mechanical wounds on the bole. Shoots may be girdled and killed within weeks, but it takes a few years to girdle the bole of a tree. The most diagnostic characteristic of this disease is the heavy pitch soak that gives the wood beneath the canker an oily appearance. Cankers often yield pitch that flows down the bole.

Significant damage was noted in a 6-year-old Virginia pine progeny test plantation on a poorly drained site in Sullivan County. Trees had broken over at a point 6 to 18 inches above the ground. There is strong evidence that resistance to pitch canker is inherited.

Presently, no chemical control exists. Damage from pitch canker may be reduced by planting Virginia and Scotch pine on well-drained sites. Pruning and burning of dead and dying branches as well as removal of infected trees are good sanitation practices.

Pinewood Nematode

This nematode is a microscopic worm that has caused the sudden death of many Scotch and white pines in several counties in Tennessee. It always causes fatality in susceptible pines, especially introduced species such as Scotch pine. Although trees less than about 15 years old do not appear to be invaded, these losses seriously jeopardize breeding work with Scotch pine.

In 1980 a severe infection occurred in two 20-year-old Scotch pine breeding orchards. Within several weeks the color of infected trees changed from a healthy green color to a reddish brown. The brown needles persisted for almost a year before falling. Laboratory examination found nematodes throughout the stems. Dead pines may harbor untold millions of nematodes, which are spread to healthy trees by a pine sawyer beetle. Nematodes migrate to resin canals of new hosts and feed on cells lining the canals. They multiply rapidly; one generation can be completed in 4 days!

If pinewood nematodes are suspected, a diagnostic sample should be made. Cut 2 stem sections about 4 inches thick from 2 locations along the stem, about one-third and two-thirds up from ground level. Put sections in a paper (not plastic) bag and ship to:

Extension Entomology and Plant Pathology
The University of Tennessee Institute of Agriculture
P. O. Box 1071
Knoxville, Tennessee 37901-1071

Provide the following information: (1) species; (2) age; (3) date when symptoms first were noticed; (4) percent occurrence in plantation; (5) date of sampling; (6) location of plantation; and (7) name and address of owner.

Dead and dying trees should be cut to the ground line and burned immediately. Unfortunately, the flight range of sawyer beetles is at least 1 mile, making it difficult to eliminate all sources of the nematode.

Non-infectious Diseases

Non-infectious tree diseases are those caused by extremes in temperature, water supply, chemicals (both in the soil and air), and mechanical injuries rather than fungi, bacteria, viruses, or nematodes. Often a tree is weakened by some "environmental insult," enabling fungi or insects to enter and further injure or kill the tree.

Scotch pines are resistant to drought, but an unusually dry summer can cause significant mortality in established white pine and spruce plantations. Lack of rainfall also causes a decrease in bud set and a general loss of vigor, which may precondition trees to insect and fungi attack.

Frost injury most commonly occurs in late spring. Most Christmas tree species are susceptible, especially when planted in depressions where cold air cannot readily drain away. Native species usually survive, but exotics such as Douglas-fir may be killed by spring frosts even at low elevations.

Some trees are injured by warm, dry winds that desiccate the needles when water uptake is restricted by frozen ground. Red and brown foliage become apparent in late winter and early spring. Occasionally, such winter drying is complicated by drought.

Improper application of herbicides may cause injury to trees. Symptoms vary with the herbicide used, but usually the needles will turn yellow or brown, and succulent shoots will curl and become deformed. Trees usually survive, although they may become stunted and of poor quality.

Chemical pollutants emitted by manufacturing plants, automobiles, and steam plants can injure trees. Toxic compounds that damage vegetation may be many miles away from the source. In Tennessee most air pollution is caused by coal burning steam plants emitting sulphur dioxide (SO_2). Unfortunately, white pine is highly susceptible to this particular pollutant. In extreme cases, new needles become short and yellow, older needles drop prematurely, and trees are stunted. Trees that have sustained such damage should be removed since they will never be harvestable. The best insurance against SO_2 damage is to plant trees with a high degree of resistance. Research indicates that white pine seed from Anderson, Morgan, Scott, and Polk counties in East Tennessee will produce resistant seedlings.

CHAPTER TWELVE

HARVESTING

To maintain freshness, time between cutting and delivery at the retail lot should be kept at a minimum. Every step of the harvesting operation can cause damage. Growers should closely supervise the cutting, dragging, baling, storing, and loading of trees. If a significant percentage of trees is damaged during harvest, the buyer should be informed and a price adjustment made if necessary.

Marking

The actual marking (flagging) of trees to cut is a harvesting operation, although it can be done concurrently with the inventory. Marking can be done anytime after shearing has been completed. Mark trees in each size and quality class with different colored plastic flagging.

Trees tend to "shrink" between inventory and shipment, mainly because persons marking trees often ignore requirements for handle length. Trees should be cut to provide a good lower whorl of branches plus a 6 to 14 inch handle. If handles are estimated when trees are measured, field inventory and number of trees sold in each category will agree closely. However, trees are usually measured from the ground up, so a few inches should be added to the base of the measuring stick to account for handle requirements and allow for the stump. With experience a grower can develop a measuring stick that will yield an inventory that varies only slightly from the actual number.

Applying Colorants

Most trees are more marketable when sprayed with a "natural colorant." Scotch and Virginia pines have a tendency to turn yellowish-green before Christmas, becoming almost unsaleable. Coloring may be especially important for choose and cut growers who normally have off-colored trees following 1 or 2 seasons of high-grading by their customers. Spray only trees flagged for harvest. White pine can be colored with a more dilute solution than that recommended by manufacturers while Scotch and Virginia pines may require more concentrated solutions.

August and September are good months to apply colorants in Tennessee. For small numbers of trees, a backpack sprayer is adequate. The colorant should be applied with high pressure (about 60 psi). If more than 1000 trees are sprayed per year, a tractor-mounted spray rig may be a good investment.

Some growers use 1 cup of a high-quality detergent in 100 gallons of the tank mix. The detergent improves distribution of colorant on the needles and reduces clogging of spray equipment. Spray equipment must be cleaned each day when using colorants. Do not mix pesticides with colorants; they are usually not compatible.

Colorants do not harm the trees in any way. If for some reason the colored trees are not harvested, they will continue to grow. Colorants can be stored from year to year but do not allow them to freeze.

Cost of coloring is extremely variable, depending on tree size, natural tree color, foliage density, equipment used, topography, number of trees per acre, labor cost, and concentration of colorant. An average cost may be about 30 cents per 6-foot tree, but it can vary between 10 and 50 cents.

Cutting and Butting

Use of chain saws has significantly reduced labor cost in harvesting Christmas trees. However, some growers prefer the bow saw, particularly those cutting white pine, which has soft wood. Chain saws are more efficient in harvesting species with harder wood, such as Scotch pine, but they pose safety problems, especially when the number of trees to cut per acre is small. Walking long distances from tree to tree with a running chain saw is neither economical nor safe.

Harvesting is always easier in recently mowed plantations and when trees have been basal pruned. Tall grass and broadleaf weeds make it difficult to see branches, rocks, and other obstacles. In a weedy plantation the chain will dull quickly and clog up.

If trees have been properly basal pruned, errors by the cutter should be infrequent. Cut the tree down to yield a low stump, then trim the "handle" to proper length of not less than 6 inches or more than 1¾ inches per foot of tree height. The cut must be at a right angle to the trunk.

If trees have not been basal pruned, the cutter has more opportunity for making mistakes, particularly if the grower is selling by USDA grades. Following this system all grades require that trees have to be "butt trimmed" and have a proper handle. Scotch and Virginia pine often have a crook at the base of the trunk, and it may be difficult to decide what should be the lower whorl of branches. Poor judgment may easily result in a drop in grade. However, a significant reduction in height resulting from severe butting should only be considered when the tree gains 1 quality grade. Since butting may have considerable influence on profits, most smaller growers either cut trees themselves or assign this task to their most experienced worker.

Dragging

After cutting, the trees must be dragged to a harvest lane. If the distance between harvest lanes is relatively short, dragging will be a small part

of the total harvesting cost. On slopes most trees are dragged downhill, and the workers spend most of the day climbing hillsides. Dragging then becomes a job for the strongest crew members.

Avoid dragging trees over bare spots. Grade and saleability are reduced if trees are muddy. If the work area is dirty, carry the trees.

Stack trees at right angles to harvest lanes with butts toward the lane. On relatively level ground, trees can be fed into the baler from both sides of the harvest lane. Trees dragged downhill are stacked on the uphill side of harvest lanes.

Baling and Tagging

Trees should be baled to avoid damage in loading, trucking, and unloading. Tree limbs can safely be bent toward the top to compress the tree. Once tightly compressed, limbs are protected from being snagged and broken. Baling simplifies loading of trees and more than doubles the number of trees that can be loaded per truck.

A manual net baler requires 2 or 3 people: 1 to feed the tree into the cone and, depending upon tree size, 1 or 2 to pull it through the cone. Most growers mount their baler on skids so that it can be easily moved. Plastic netting is available in diameter sizes corresponding to the neck diameter of balers. Trees with flexible limbs, such as white pine, can be baled with 12-inch cones. Large Scotch pines require an 18-inch cone. Mechanical balers for both twine and net may be equipped with a variable size cone, which maintains constant compression regardless of tree size.

Trees are baled by pulling them, butt end first, through the cone of the baler. As the tree is pulled from the small end of the cone, it is wrapped in twine or a plastic mesh sleeve to keep it compressed. Either type of wrapping can be used, but twine requires a mechanical baler to be efficient. Balers equipped to dispense plastic netting can be mechanical or manual.

After trees have been baled, measure and tag them for easy identification of size classes. Trees can be sized by 1-foot classes or other broader classes such as "less than 5 feet," "5½ to 7 feet," etc., according to the sales agreement. Use the color code specified by *U.S. Standards for Grades of Christmas Trees:*

Tag Color	Tree Height, Feet
Purple	4 to 5
Blue	4 to 5½
Yellow	5 to 6
Red	5½ to 7
Orange	6 to 7
Green	7 to 8
White	8 to 10

Suppliers of large numbers of trees typically use color coded, plastic labels preprinted with their name. The label is attached to a bottom limb. Smaller growers use different colors of flagging.

Loading and Unloading

There are 2 major concerns in loading Christmas trees: (1) protect the trees from unnecessary damage and (2) reduce costs by shipping as many trees per load as possible.

Trees are loaded parallel to the length of a truck bed in successive tiers. Each row of trees overlaps the previous row; i.e., the butt of one tree is placed over the top of the next tree like sardines in a can so that each layer is flat. Each layer must be loaded compactly to allow a person to stand on the trees without damaging them or falling through a gap.

Once loaded, trees should be securely tied down. After a few miles the load will settle, and it may be necessary to tighten the ropes. Drivers with no experience in hauling Christmas trees have used load binders to such an extent that ropes cut through and destroyed the top layer of trees. To protect the top layer from rope damage and "burn" from sun, wind, and diesel exhaust, some growers place a layer of eastern red cedar or cull trees over each load.

If trees are delivered to more than one location, different orders must be separated by some highly visible material, such as colored twine or plastic sheets. It is helpful if the grower makes a chart on the Bill of Lading indicating how many trees of each species and size are loaded in each part of the trailer.

Disagreements and ill feelings between growers and retailers can be avoided if both parties insist on a businesslike procedure for counting trees at loading and unloading. The task of counting is simple, but workers may get bored, start talking, and promptly loose count. Two methods work equally well for loading and unloading: (1) one person is assigned the task of tallying trees by species and size class, and no one is allowed to talk to that person, or (2) workers count out loud the trees they carry on or off in a continuous manner until the crew reaches 100; then they make a tally and begin again with number 1.

Problems may be avoided if the following steps are taken:

1. The driver must have the Bill of Lading, instructions on how to find the retail lot, the name and telephone number of buyer, and name and telephone number of grower so that any problem that may delay arrival or unloading can be reported.
2. The grower should call the retailer when the truck leaves and give an estimate of arrival time.
3. Instruct the truck driver not to start unloading before a crew arrives. The driver should call the retailer about 50 miles from destination. This gives the retailer time to organize an unloading

crew.

4. The buyer must understand that unloading is the responsibility of the lot operator and that no adjustments will be made for trees damaged in this operation. Crew members should slide trees over the side so that they drop butt down to the ground and not in a pile. Any complaints should be registered in 3 days and before any trees have been sold.
5. Call the retailer to make sure everything is satisfactory.

CHAPTER THIRTEEN

MARKETING

Christmas tree marketing is a year-round business. Salesmen for brokers start visiting wholesalers and retailers shortly after Christmas to obtain orders for the next season. Trees are sold by growers to brokers, wholesalers, retailers, or directly to consumers. Large growers often broker or wholesale their own trees as well as those produced by smaller growers.

Most trees sold in Tennessee are grown in other states or Canada. Surprisingly, most trees produced in Tennessee are now sold out-of-state.

When to Cut

The specific year to market a tree or a field depends upon both economic and biological factors and varies from farm to farm and field to field. Growers may elect to cut the whole field or sell it on the stump based on price per tree to be paid at harvest time (growers must retain economic interest to qualify for capital gain taxation). In either case, all saleable trees are cut.

If genetic variation among trees is small and the site is relatively uniform, relatively little phenotypic variation can be expected among trees. A commercial clear cut followed immediately by removal of the few culls, site preparation, and planting of a new crop will, in most cases, be to the greatest advantage.

If there is much phenotypic variation present due to genetic variation (in species such as Scotch, white, and Virginia pines) and/or much variation in soil characteristics, growers may elect to remove the crop over a period of 2 to 4 years. A general rule is to leave individual trees as long as (1) they do not greatly affect establishment and development of the next crop, (2) the net value increment is greater than the rate of return from an alternate investment opportunity, and (3) the trees left do not interfere with each other. In large operations, particularly those committed to machine planting, it is difficult to start the next generation by interplanting. An opportunity cost for not starting the new rotation 1 or 2 years earlier may then have to be considered.

Small growers can use interplanting and a flexible rotation. The value increment can be high if there are many vigorous trees left, especially when they are No. 2 grade and about 5 feet in height. Most of these trees will be U.S. No. 1 and 6 feet tall next year. However, if the remaining trees are not vigorous, they may not be of a higher grade next year. A negative value increment may actually occur if mortality or losses to theft

become important during the next growing season. Another consideration is that such slow-growing trees may harbor insects and serve as a source of infestation.

Inventory

The grower must make an inventory of saleable trees. For a choose and cut (C&C) operation this inventory does not have to be very accurate. A simple count of trees in the popular sizes (5 to 8 feet) will suffice to make sure that an adequate supply exists. Sales to retailers or wholesalers require an accurate inventory by species, size, and quality.

Growers must be familiar with tree grades. Some wholesalers use their own grades, such as "Fancy" or "Select," but these terms are misleading. Four grades are recognized by the U.S. Department of Agriculture: Premium, Choice (No. 1), Standard (No. 2), and Cull (see Appendix Two). Growers usually combine Premium trees with No. 1 Choice trees.

Inventories are made after shearing but not later than July or August. Although growers usually have some general agreements with their customers before this time, a detailed inventory is needed so that sales agreements may be consummated.

Advertising

Advertising in the Christmas tree industry is classified into 2 categories. There is promotional advertising directed at expanding the overall market for Christmas trees. Such programs are designed to increase sales of real Christmas trees at the expense of plastic substitutes. The National Christmas Tree Association (NCTA) conducts such programs. The second type of advertising is proprietary and used by individual growers or distributors to increase their own sales. If effective, such advertising tends to decrease sales of competitors.

Support promotional advertising by joining the NCTA. Promotional material produced by NCTA is used by television stations, radio, and newspapers.

Since Christmas trees are sold only once a year, there is little carry-over effect of advertisements. Advertisements on TV, radio, or in big city newspapers are expensive and probably only cost effective for large retailers. Smaller towns have newspapers with reasonable rates and good readership. The Tennessee Press Association (1345 Circle Park, P.O. Box 8123, Knoxville, TN 37996) will help develop an advertisement schedule.

Public association of quality trees and fair prices with signs and location is a factor when considering competition. This relationship is especially strong for C&C operations where customer loyalty is easiest to develop. One such operation in East Tennessee has 59 percent of its customers

returning. Maintenance of a customer mailing list for direct mail is time consuming, but this form of advertisement can be very effective.

Sales

Most retailers order their trees through a local wholesaler who combines orders and places them with brokers and/or growers. Brokers work on the national and international level, buy from many growers, and are able to provide wholesalers and retailers with a variety of species, grades, and sizes. Of course, this service costs money. Some wholesalers and large retailers bypass brokers and buy directly from one or more growers.

A grower usually receives less money for trees sold to a broker or wholesaler compared to that received in direct sales to retailers. When growers retail their own trees or sell them directly to retailers, they assume the functions of a broker or wholesaler including shipping, credits, and adjustments. Selling directly to an independent retailer may be risky. A check of references may reveal that the retailer has a history of short-counting, quality adjustments, overdue payments, and non-payments. "Savings" by selling directly to retailers may soon be gone.

Retail

Operating a retail lot in a nearby town or metropolitan area can be an exciting and profitable experience but could also be frustrating and costly. Regardless of outcome, growers will learn to appreciate the problems of retailers and develop a more sympathetic attitude toward the people engaged in marketing their product.

A Christmas tree retail lot should be located on a well-traveled street, but high-speed highways are poor locations. Provide ample parking with easy, safe entrance and exit from the street. The lot should be well-lighted for nighttime sales, and one or more high quality signs should be prominently displayed. Many trees, approximately 10 percent of the total inventory, should be displayed in an upright position and individually priced.

Advertisement, Christmas music, balloons, and even a live Santa will attract people. However, success involves building up the business over many years with repeat customers who know where they can purchase quality trees at reasonable prices.

The retail price of a Christmas tree is largely determined by height, species, and quality (density, shape, stem straightness, etc.). To make a reasonable profit, retailers must almost double their cost per tree (including transportation) to the consumer. This relatively high mark-up is needed to pay for lot rent, labor, insurance, advertising, and unsold trees. However, all trees should not be marked up the same amount. In a given shipment of U.S. No. 1 trees, there will usually be some U.S. Premium

grade and a few U.S. No. 2 trees. If all trees of the same size were priced the same, the best quality trees would quickly be sold, and the retailer would be left with a large number of lesser quality trees with an unrealistically high price. Retailers soon learn that it is necessary to price according to quality; an exceptionally fine tree may be sold for 3 times cost while a U.S. No. 2 may be sold at cost or less. A Christmas tree grower visiting a retail lot may be upset by observing a tree that was sold for $10 when it left the farm now sells for $30. The fact that some of the grower's trees are sold for $9 on the same lot may go unnoticed.

Choose and Cut

To attract a reasonable number of customers, C&C operations should be within a relatively short driving distance of major population centers. There may be 5 to 10 times as many customers on a weekend as on a weekday, so plan parking facilities for the maximum load. If 500 customers are expected on a Sunday afternoon, parking for 100 vehicles is needed. Purchasing a C&C Christmas tree is a family affair, and customers usually stay longer than when buying from a retail lot. The average family takes about 1 hour to select and harvest a tree.

At the gate or barn, hand out instructions, register the customers, and give them a bow saw. The customers are on their own to choose, cut, and bring the tree of their choice back to a designated spot, usually a shed or barn. At this place the tree is measured, baled, and paid for. Usually customers load their own trees. Some cut trees should be available for customers who do not care for walking in the fields or those arriving after dark.

A C&C farm with customers in a festive mood is an ideal place for selling other products as well. Stands, garlands, wreaths, and ornaments as well as balled and burlapped trees are excellent sales items. A concession stand can provide coffee, hot chocolate, doughnuts, etc. at low cost by using self-service and the honor system.

Obvious advantages of a C&C operation are: (1) no leftover cut trees on Christmas day and (2) a substantially higher per tree income than with sales to wholesalers or retailers. Disadvantages are: (1) some trees are cut with high stumps, (2) it is difficult to control the cutting, leading to longer rotations, and (3) poor weather can ruin a season.

Trucking

Today practically all Christmas trees are transported by trucks, particularly trailer trucks. For Christmas tree growers the most useful type is a flatbed trailer because it is easier to load and unload and can carry a greater number of trees than a box type trailer. A flatbed trailer will

Welcome To Valhalla Farm

We hope your visit will be enjoyable. In addition to getting a fine fresh tree, we think that a "cut-your-own" may be an educational experience for the whole family. Although the white pine may grow to be a large timber tree, the trees on Valhalla Farm are grown specifically for Christmas tree and landscaping purposes. They are harvested when between five and ten feet tall and new ones are planted to take their place. Every summer the trees are sheared to make them dense and well shaped. White pine has soft needles 3-5 inches long and they will not drop off the trees for several weeks after cutting. Norway spruce has needles less than one inch long which tend to drop off about three weeks after cutting; keep it in water at all times after cutting. Scotch pine, on the other hand, has stiff needles about 2 inches long that will stay on for months.

STEPS TO FOLLOW

1. Register at barn and check our posted price list.
2. Check out a saw
3. Locate the tree you like; be sure it is **at least five feet tall.**
4. Cut tree close to the ground. Any trimming needed will be done at the barn; you will only pay for the useable part of the tree.
5. Carry tree to barn.
6. Return saw. Be sure your name is checked off. We charge $5.00 (our cost) for a lost saw.
7. Pick up your registration card; get your tree measured and priced.
8. Please pay with cash or personal check made out to Valhalla Tree Farm.

PLEASE NOTE

1. No smoking in barn.
2. No axes or chain saws.
3. If you cut one tree, but changed your mind – please bring both trees to barn. You will only be charged for the one you want.

DRIVE SAFELY AND HAVE A MERRY CHRISTMAS

Figure 24: Instruction sheet distributed on an East Tennessee C&C farm.

carry about 700 Scotch pines (5.5 to 7 foot) or 1000 white pines while the box type only hauls about 500 and 700 trees, respectively. Since transportation cost is the same for either truck type, it is more economical to use the flatbed. One disadvantage is damage from diesel "burn," which occurs if exhaust pipes are pointed toward the load. Make sure that the load is protected before it leaves the farm. Another disadvantage is that flatbeds are not always easy to obtain as most freight is hauled in enclosed trailers.

A Bill of Lading (B/L) should be executed before the truck leaves. There should be at least 3 copies of this legal document: 1 for the grower, 1 for the trucker, and 1 for the person receiving the trees. Both grower and trucker should sign the B/L when loading is completed. At the time of unloading, any shortage as well as damage to trees from diesel burn or other causes should be noted on this document.

It is the buyer's responsibility to unload the truck and count the trees by species, size class, and grade. The driver should be an active participant in this operation. Any disagreement with regard to number and sizes should be resolved immediately by measuring and/or recounting. Disagreements about quality are often more difficult to solve on friendly terms. If trees were sold according to USDA grades, it may be necessary to call in a USDA Christmas tree grader. Unfortunately, relatively few Christmas trees are marketed under USDA rules, and considerable time is spent annually negotiating quality adjustments. Under all circumstances, the retailer should immediately call the wholesaler, broker, or grower responsible for the shipment; they are then responsible for sending a representative who will try to solve the problem. Damage caused in transit is the responsibility of the trucker.

Most truckers are responsible businessmen trying to make a living under difficult circumstances. There are, however, a significant number of truck drivers that cause serious problems every year. When a truck arrives a day late, it may be due to mechanical troubles, but the driver should have called the broker or grower who again would have called the retailer so that a crew would not be standing by for many hours.

Even when a truck arrives on time there can be problems. Drivers sometimes neglect their duties of checking the counting of trees being unloaded. This neglect can result in a short count and money lost by a grower who signed SL&C or any combination of letters that stands for "Shippers Load and Count" on the Bill of Lading. A grower should never mark "SL&C" on a B/L but rather insist that truck drivers participate in the counting. "Shippers Load and Count" relieves the trucker of responsibility for shortages.

The retailer must (when there is no SL&C) either accept the number of trees and sign the B/L or contact the shipper. Shortages must be settled before the retailer accepts the trees from the trucker; it is not sufficient to note a shortage on the B/L. If trees were shipped "freight collect," the

retailer should calculate the value of the shortage and reduce the check by this amount. If the shippers pay the trucker, they must be notified of shortages immediately so that they can withhold payment.

Storage

In Tennessee storage of cut trees on the tree farm is normally of short duration and seldom creates problems. Combinations of poor and steep roads with snow and ice will, however, create access problems and cause storage over longer periods than initially contemplated. At such low temperatures there is little deterioration of the trees if shade is provided.

Drying of a Christmas tree begins upon cutting. Spruce species will soon start shedding needles. Virginia pines may not have hardened off sufficiently before cutting and could wilt in storage. For both spruce and Virginia pine it is essential that they are not harvested too early; under no circumstances should they be harvested before Thanksgiving. White pine and Fraser fir can be harvested during the entire month of November.

Most trees grown in or imported to Tennessee go directly to a retail yard and will usually arrive between Thanksgiving and the first weekend of December. Trees arriving on the retail lot toward the end of this period will usually be in better condition for the following 3 weeks of sales. These trees may have been cut later, and storage conditions on a wholesale yard are usually better than those on a retail lot.

On most retail yards there are no protected areas that can be utilized for storage. This means that for a period of up to 4 weeks, trees will be exposed to fluctuating temperatures and humidity, wind, sun, and careless salespeople and customers. The practice of rotating piled trees will help prevent sun-scald. Trees may be better protected by standing them up on their butts. Whatever method used is of little help if customers are allowed to freely browse among trees in storage.

Other Products

The main difference between a cut Christmas tree and a landscape tree is method of harvesting. Landscapers prefer trees less tightly sheared and with no basal pruning. However, they will buy balled and burlapped (B&B) Christmas trees for landscaping purposes. Individual customers that cannot "waste money" on a cut Christmas tree will buy a living tree, put it in their home for a couple of weeks, and then plant it in their yard. In the Knoxville area these sales account for less than 5 percent of the total number of Christmas trees sold.

The price obtained for a B&B tree is about twice that of a cut tree. Income from B&B sales is considered ordinary income and does not qualify for capital gains taxation. If the grower has a combination of C&C and B&B,

Figure 25: A living Christmas tree appeals to ecology-minded people and those not wanting to "waste money" on a cut tree.

it is extremely important to have holes filled immediately after digging. Without such precautions the C&C customer's health may be jeopardized for which the grower must assume liability.

Most growers have some trees that do not meet requirements of the U.S. No. 2 or Standard Grade. Those trees can be cut for "brush" to be used in making wreaths or garlands (roping). Additional brush may be obtained from the regular harvesting operation. If proper cold storage facilities are available, production of wreaths and garlands can start several weeks before tree sales. These products lend themselves well to C&C operations because they can be made when workers are not busy waiting on customers.

Payment — When and How

In the retail business, including C&C, payment is made in cash or by personal check at the time of purchase. Checks will occasionally be returned for insufficient funds but when redeposited will generally clear. In the Knoxville area there is fewer than 1 bad check per 1000 deposited.

By attending meetings of the Mid-South Christmas Tree Association and checking price lists of other growers, prospective sellers on the wholesale market may estimate what their trees are worth. It is not always in the grower's best interest to accept the highest offer. Consider the amount

of down payment (deposit) and credit-worthiness of the customer. Unfortunately, there are some customers who pay late or not at all. When dealing with a wholesaler or retailer for the first time and the credit rating is unknown, it is a good idea to require a deposit (25 percent is normal) when the order is accepted. The balance should be paid by check or cashier's check at time of delivery. If an order is accepted with a deposit,the grower will have 2 advantages: first, the customer will not switch the order to another grower; second, interest is earned on the money.

The National Christmas Tree Association has established a Credit Reference Service. This service is available to anyone for an annual subscriber's fee. Subscribers provide the Credit Reference Service information reflecting credit experiences with their customers.

Written sales agreements should specify prices for different species, sizes, and grades with terms and conditions of payment. If trees are sold FOB farm, the grower is responsible for loading. Cash customers should show the money before a single tree is loaded. Likewise, do not unload a single tree on a cash customer's lot until the money or cashier's check is presented.

The Outlook

Christmas tree planting has expanded greatly in the South. Estimates from North Carolina indicate that in 1981 some 3000 growers planted about 4.5 million Fraser fir, 3 million white pine, and 1 million Virginia pine. If only half of these 8.5 million trees are marketed, North Carolina alone will supply about 15 percent of the current national demand.

The South was once a major market for northern grown trees. As southern markets become saturated with local trees, northern growers will probably sell their trees in the South at depressed prices. West Coast markets are already saturated. In fact, western trees are marketed in Oklahoma, Kansas, and other Midwest states that traditionally have been markets for eastern trees. Overproduction anywhere will result in movement of trees to other markets.

Some major producers are shipping a few trees to Europe. However, England, France, and Germany will soon have an oversupply, calculated on planted acres. Marketing efforts are presently made in Central and South America as well as Mexico, but results have been poor due to the present high value of the U.S. dollar.

The bright spot on an otherwise bleak horizon is the C&C operation. C&C growers are taking an increasing share of the total market and are in a good competitive position because they have no transportation cost.

There has been a "glut" twice since World War II. The first oversupply was in 1957-60 and the second in 1965-68. In 1957, Pennsylvania alone

had 30 million trees ready for the market. The sellers' market will probably be over in 1986, but some growers will manage their farms efficiently and maintain profitability even at reduced prices. Changes in federal taxes may futher erode profitability.

APPENDIX ONE

COMMON AND SCIENTIFIC NAMES OF ORGANISMS REFERENCED IN TEXT

	Common Name	Scientific Name
TREES	Arizona cypress	*Cupressus arizonica*
	Balsam fir	*Abies balsamea*
	Colorado blue spruce	*Picea pungens*
	Douglas-fir	*Pseudotsuga menziesii*
	Fraser fir	*Abies balsamea* var. *fraseri*
	Norway spruce	*Picea abies*
	Red cedar	*Juniperus virginiana*
	Scotch pine	*Pinus sylvestris*
	Virginia pine	*Pinus virginiana*
	White pine	*Pinus strobus*
	White spruce	*Picea glauca*
INSECTS	Bagworm	*Thyridopteryx ephemeraeformis*
	Balsam twig aphid	*Mindarus abietinus*
	Balsam woolly aphid	*Adelges piceae*
	Nantucket pine tip moth	*Rhyacionia frustrana*
	Pales weevil	*Hylobius pales*
	Pine bark aphid	*Pineus strobi*
	Pine sawyer beetle	*Monchamus titillator*
	Sawfly	*Neodiprion* spp.
	Spider mite	*Tetranychus* spp.
	White pine aphid	*Cinara strobi*
	White pine weevil	*Pissodes strobi*
DISEASES	Blister rust	*Cronartium ribicola*
	Brown spot	*Scirrhia acicola*
	Eastern gall rust	*Cronartium cerebrum*
	Needle cast	*Lophodermium* spp.
	Pitch canker	*Fusarium lateritium*
	Root rot	*Phytophthora* spp.
NEMATODE	Pinewood nematode	*Bursaphelencus xylophilus*

MAMMALS	Cotton rat	*Sigmodon hispidus*
	Deer	*Odocoileus virginianus*
	Meadow vole	*Microtus pennsylvanicus*
	Pine vole	*Microtus pinetorum*
	Prairie vole	*Microtus ochrogaster*

APPENDIX TWO

UNITED STATES STANDARDS FOR GRADES OF CHRISTMAS TREES*

Revised, Effective April 1, 1973

GENERAL

§ 2851.3085 General.

The standards contained in this subpart are applicable to sheared or unsheared trees of the coniferous species which are normally marketed as Christmas trees. The large majority of the Christmas trees marketed are one of the following species: Douglas fir (Pseudotsuga menziesii); Balsam fir (Abies balsamea); Black spruce (Picea mariana); Eastern Red cedar (Juniperus virginiana); White spruce (Picea glauca); Scotch pine (Pinus sylvestris); Norway spruce (Picea abies); Red pine (Pinus resionsa); Eastern White pine (Pinus strobus); Red spruce (Picea rubens); Fraser fir (Abies fraseri); and Virginia pine (Pinus virginiana).

GRADES

§ 2851.3086 U.S. Premium.

"U.S. Premium" consists of trees which meet the following requirements:

(a) Characteristics typical of the species;
(b) Fresh;
(c) Clean;
(d) Healthy;
(e) Well shaped;
(f) Butt trimmed;
(g) Not less than medium density;
(h) Normal taper;
(i) Handle length, unless otherwise specified, may be not less than 6 inches, or more than 1¾ inches for each foot of tree height;
(j) Four faces which are free from damage by any cause;
(k) For size see § 2851.3090;
(l) For tolerances see § 2851.3091.

§ 2851.3087 U.S. No. 1 or U.S. Choice.

"U.S. No. 1 or U.S. Choice" consists of trees which meet the following requirements:

(a) Characteristics typical of the species;
(b) Fresh;
(c) Clean;
(d) Healthy;
(e) Well shaped;
(f) Butt trimmed;
(g) Not less than medium density;
(h) Normal taper;
(i) Handle length, unless otherwise specified, may be not less than 6 inches, or more than 1¾ inches for each foot of tree height;
(j) Three or more faces which are free from damage by any cause;
(k) For size see § 2851.3090;
(l) For tolerances see § 2851.3091.

§ 2851.3088 U.S. No. 2 or U.S. Standard.

"U.S. No. 2 or U.S. Standard" consists of trees which meet the following requirements:

(a) Characteristics typical of the species;
(b) Fresh;
(c) Fairly clean;
(d) Healthy;
(e) Well shaped;
(f) Butt trimmed;
(g) Light or better density;
(h) Candlestick, normal or flaring taper;
(i) Handle length, unless otherwise specified, may be not less than 6 inches, or more than 1¾ inches for each foot of tree height;
(j) Two or more adjacent faces which are free from damage by any cause;
(k) For size see § 2851.3090;
(l) For tolerances see § 2851.3091.

CULLS

§ 2851.3089 Culls.

"Culls" consist of individual trees which fail to meet the requirements of the U.S. No. 2 or U.S. Standard Grade.

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*Reprinted from *United States Standards for Grades of Christmas Trees*, USDA, 1973

SIZE

§ 2851.3090 Size.

Size of trees shall be stated in terms of height in foot or half-foot steps, and unless otherwise specified, the following color codes may be used to designate the respective sizes:

	Feet
Purple tag	4 to 5
Blue tag	4 to 5½
Yellow tag	5 to 6
Red tag	5½ to 7
Orange tag	6 to 7
Green tag	7 to 8
White tag	8 to 10

TOLERANCES

§ 2851.3091 Tolerances.

In order to allow for variations incident to proper sizing, grading, and handling in each of the foregoing grades the following tolerances, by count, shall apply when a lot of Christmas trees is required to meet a specified grade.

(a) *Off-size.* Ten percent for trees which fail to meet the height specified.

(b) *Off-length handle.* Twenty percent for trees which fail to meet the requirement for handle length but which meet all other requirements for the specified grade.

(c) *Defects.* Ten percent for trees which fail to meet the remaining requirements of the grade: *Provided,* That for the U.S. Premium and the U.S. No. 1 or U.S. Choice grades not more than one-half of this amount, or 5 percent, shall be allowed for trees which fail to meet the requirements of the next grade lower than that specified.

DEFINITIONS

§ 2851.3092 Fresh.

"Fresh" means that the needles are pliable and generally firmly attached with not more than slight shattering.

§ 2851.3093 Clean.

"Clean" means that the tree is practically free from vines or other undesirable foreign material.

§ 2851.3094 Healthy.

"Healthy" means that the foliage possesses a thrifty, fresh, natural appearance characteristic of the species.

§ 2851.3095 Well shaped.

"Well shaped" means that the tree is not flat on one side and the branches of the tree, whether sheared or unsheared, are of sufficient number and length to form a circular outline tapering from the lowest whorl of branches to the top.

§ 2851.3096 Butt trimmed.

"Butt trimmed" means that all barren branches below the first whorl of foliated branches shall have been removed, and the butt of the trunk has been smoothly cut at approximately right angles to the trunk.

§ 2851.3097 Density.

"Density" means the amount of foliage present. Factors contributing to the degree of density are: The number and size of branches within the whorl, distance between whorls, number and arrangement of branchlets on each branch, the extent of internodal branching, needle arrangement, and needle length. Species differ in their habit of growth and some species do not have internodal branches. Density is judged on the basis of species characteristics.

(a) *Medium density.* Means that the whorls or branches are relatively close together, the branchlets or side branches are fairly numerous and the needle population is adequate to cover the branches. The stem may be visible, but not distinctly visible throughout most of its length. To grade U.S. Premium or U.S. No. 1 or U.S. Choice trees must possess at least "medium density."

(b) *Light density.* Means that the whorls or branches may be thinly spaced, the branchlets or side branches may be only reasonably numerous, but the needle population must be adequate to reasonably cover the branches. The stem is usually visible for approximately 70 percent of its length. To grade U.S. No. 2 or U.S.

Standard trees must have at least "light density." Trees that are more open or which do not meet the requirements of "light density" are culls.

§ 2851.3098 Taper.

"Taper" means the relationship of the width of the tree to its height. "Flaring," "normal," and "candlestick" taper are the terms used to describe degrees of taper. At least 75 percent of the branch ends must touch or overlap the line of the cone.

(a) Flaring taper means that the general shape of the tree, judged from its best side, forms a cone the base of which is more than 90 percent of its height.

(b) Normal taper means that the general shape of the tree, judged from its best side, forms a cone the base of which is from 40 to 90 percent of its height.

(c) Candlestick taper means that the general shape of the tree, judged from its best side, forms a cone the base of which is less than 40 percent of its height.

§ 2851.3099 Face.

"Face" means the visible surface area of a tree as viewed from a distance of 8 to 10 feet from the tree. A tree shall be considered as having four faces, each consisting of one-quarter of the surface area of the tree.

§ 2851.3100 Fairly clean.

"Fairly clean" means that the tree is moderately free from vines or other undesirable foreign material.

§ 2851.3101 Handle.

"Handle" means that portion of the trunk between the butt or base of a tree and the lowest complete whorl of foliated branches.

§ 2851.3102 Height.

"Height" means the distance from the base of the trunk to the top of the main leader, excluding that portion of the leader which extends more than 4 inches above the apex of the cone of the taper applicable to the tree. (See § 2851.3098).

§ 2851.3103 Damage.

"Damage" means any specific noticeable defect described, or listed in this section, or an equally objectionable variation of any one of these defects, any other defect, or any combination of defects which materially detracts from the appearance or marketing quality of the Christmas tree.

(a) The following are noticeable defects which generally affect one or more faces and are usually readily observed by casual observation of a tree:

(1) Decided gap (abnormal space between whorls of branches).

(2) Unduly long branches.

(3) Uneven density.

(4) Weak branches.

(5) Broken branches.

(6) Barren lower whorl (no needles on branches of bottom whorl).

(7) Curved stems.

(8) Hole in tree (lack of branches or foliage and appears as an opening of considerable size).

(9) Excessively long main leader (when the main leader or stem above top whorl of branches is not proportionate to the overall tree height).

(10) Incomplete whorl of branches.

(11) Handle not proportionate to height of tree.

(b) The following are defects which individually or in combination with other defects may materially detract from the appearance or marketing quality of a tree to the same degree as the noticeable defects listed above.

(1) Multiple leaders.

(2) Crow's-nest (cluster of short branches which forms a compact nest-type whorl arrangement).

(3) Multiple main stems.

(4) Gooseneck (greater than usual distance between two whorls of branches).

(5) Noticeable presence of galls on the branches.

(6) Abnormal loss of needles.

(7) Abnormal curling of needles.

(8) Noticeable presence of dead twigs.

(9) Vines.

(10) Foreign material.

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
KNOXVILLE, TENNESSEE 37916
E11-0415-00-008-86