CHRISTMAS TREES
a Missouri Crop

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Fig. 1—Some common terms used in discussing Christmas trees.
Trends in the Industry

Like other thriving industries, the growing and marketing of Christmas trees is a dynamic process. The grower must keep himself alert to the apparent trends in the market in order that he may more effectively control the numbers, kinds, sizes, and quality of trees that he is growing, or the manner in which they are being marketed. Some changes are long-term in their development and hence, predictable. Others, being more sporadic, are harder to follow.
BIG SALES INCREASE IN 3 DECADES

1930 - 1 tree sold for every 14 people in U.S.

1963 - 1 tree sold for every 4 people in U.S.

Christmas Tree Market Growing

The steady rise in population brings more customers into the market each year. From 1930 to 1963 the number of U.S. citizens climbed from 129 million to around 187 million, but this is only part of the story. During this same interim, Christmas tree sales rose from an estimated 9 million to 45 million trees per year. This means that the ratio of Christmas trees to people has narrowed from around 1 to 14 to about 1 tree for every 4 people.

Americans have become more urbanized and relatively few are cutting the family tree. Moreover, there has been a further infusion of the Christmas tree tradition. In most homes the Yuletide focal point has shifted from the no longer common family hearth to the family Christmas tree.

Fads Come and Go

Short-term trends frequently cause temporary impacts of perhaps several years duration in the market. A good example occurred in the late 1940s when many buyers wanted long-needled pines. Later there was an upsurge in the practice of artifically finishing trees, using paints or flocking materials of various colors. More recently, large numbers of artificial trees, mostly aluminum or plastic, have been sold, but indications are that the public is tiring of these. Artificial trees are rather like artificial flowers and fruits. At best they are but a facsimile of the real product. Most buyers who obtain such oddities soon find them unexciting; and the average consumer has always preferred well-formed, fresh, natural trees.

More Trees from Plantations

An important and steady trend of significance to the grower is the increase in the number of trees being sold from plantations. One report (2) states that marketers of plantation-grown trees rose from 3.5 million in 1955 to more than 8 million in 1960. Based on total sales for the respective years, this relatively short-term change was from approximately one plantation tree in every ten trees to one in five. The strong trend is becoming more-accelerated. By 1962, plantations were yielding 38 percent of the nation's Christmas tree harvest, or almost two of every five sold (8). Natural stands of satisfactory quality are increasingly difficult to find. Production rates have kept pace with demand only through the cutting of vast numbers of low-grade trees. Thus, although there has been no shortage of trees as such, and local markets may be flooded some years, good trees are scarce.

Fig. 4—Though trees from natural stands still account for 62 percent of sales, production trends indicate that the U.S. Christmas tree market will soon rely primarily on trees from plantations.
**Emphasis on Quality**

From all indications, good trees will continue to be in short supply and will continue to move readily in the market at premium prices. In a series of Missouri marketing tests, conducted over a period of years, high-quality trees have consistently sold quickly. Meanwhile, at the same times and places, average to poor trees were selling slowly, if at all, even though offered at about half price. The trees still on retail yards Christmas day are characteristically of low grade, which attests to the public's good average judgement.

It is therefore not surprising that quality has become the primary basis for pricing Christmas trees. Accordingly, the successful grower must gear his operation toward quality production. To do this, decisions in the overall process must rest on an ability to evaluate traits that affect the grade of a Christmas tree. The Christmas tree grower, like the grower of any crop, must know the kind of product he is trying to produce.

**Characteristics of Good Christmas Trees**

The perfect Christmas tree, seldom achieved in all respects, would be imbued with the following traits (study Fig. 1 for descriptive terms):

1. A single and straight main stem, including a well-developed but not excessively long leader.
2. A dense to moderately dense crown. ("Crown density" refers to the compactness and amount of foliage present and is controlled by such factors as size and number of branches per whorl; distance between whorls; angle of branching; number, vigor, and disposition of branchlets per main branch; years of needle retention by the evergreen; needle length; and the closeness of needle placement on the twigs.)
3. A symmetrical crown that approaches a conical shape.
4. The crown should be neither too broad nor too narrow in terms of height. "Taper" is a term used to describe the width of a tree relative to its height (Fig. 6) Taper (in percent) = \( \frac{\text{width}}{\text{height}} \times 100 \). A taper below 40 percent is termed "candlestick" and a taper above 90 percent (70 percent for species other than the pines) is described as "flaring". A taper of 40 to 90 percent for pines (40 to 70 percent for other species) is considered normal.
5. The tree should have a good over-all balance. To evaluate "balance," the crown is considered in terms of completeness or fullness on four faces (quarters or sides) and three segments of length (bottom, middle, and top).

6. The bottom whorl of branches should be strong and regular, because this provides the optical foundation over which the rest of the crown is developed (Fig. 8). Moreover, when the tree is upright, you should not be able to view large woody segments of the basal branches—a condition variously described by such terms as "leggy," "woody base," and "barren lower whorl."

7. The tree should have a handle sufficient in length for mounting the tree in a holder (usually 1 inch for each foot of tree height, plus a small allowance for sawing to obtain a fresh cut preparatory to mounting the tree in water). The "handle" is that part of the main stem below the bottom whorl of branches.

8. The tree should be fresh, healthy, and clean. "Fresh" needles are pliable and firmly attached. A "clean" tree is practically free of undesirable foreign material.

Fig. 6—Left, a balsam fir with a taper of 40 percent. A narrower tree would be downgraded as "candlestick." The Scotch pine at right has an excessive taper of 110 percent.

Fig. 7—Because of uneven density, this tree would score poorly on balance. Also, the base is woody or barren.

Fig. 8—As shown at left, this Scotch pine is weak in the lower crown. Right, same tree cut higher up to achieve a strong base and good over-all balance.
9. The tree should hold its needles throughout the Christmas season. Freshness is a factor here, but spruces have the fault of poor needle retention.

10. Certain miscellaneous and perhaps minor features—such as a pleasing fragrance and a bearing of cones—also enhance a tree's attractiveness, more for some buyers than others.

Because quality is the primary factor in the pricing of trees, and because this consideration gives rise to many marketing problems all along the line in producer-wholesale-retailer-consumer relationships, a system of tree grading has been adopted by the Agricultural Marketing Service, U. S. Department of Agriculture (1). Many of the desirable traits listed above are involved in the minimum requirements for the three grades of marketable trees recognized under these standards (see table). "Culls," a fourth grade considered unmarketable, are those trees that fail to meet even minimum requirements under the Standards. Whether or not growers market their trees by grade, they can use such a set of grading rules as a criterion for judging their crops.

**MINIMUM REQUIREMENTS FOR THREE MARKET GRADES OF CHRISTMAS TREES**

<table>
<thead>
<tr>
<th>Factor</th>
<th>U.S. Premium</th>
<th>U.S. Choice (or U.S. No. 1)</th>
<th>U.S. Standard (or U.S. No. 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crown Density</td>
<td>Medium or better</td>
<td>Medium or better</td>
<td>Light or better</td>
</tr>
<tr>
<td>Taper</td>
<td>Normal</td>
<td>Normal</td>
<td>Candlestick or flaring</td>
</tr>
<tr>
<td>Undamaged faces</td>
<td>All Four</td>
<td>Three</td>
<td>Two adjacent</td>
</tr>
<tr>
<td>Foliage quality</td>
<td>Fresh, clean, healthy</td>
<td>Fresh, clean, healthy</td>
<td>Fresh, fairly clean, healthy</td>
</tr>
</tbody>
</table>

1 Trees are graded in part in terms of characteristics typical for the species. Trees of all grades should be well trimmed. When a lot of trees is said to meet a specified grade, certain tolerances are allowed: By count, 10 percent may fail to meet requirements of the grade, but not more than 5 percent shall fail to meet the requirements of the next grade lower.

2 "Damage" actually refers to various described defects such as a decided gap (abnormal space between branch whorls), unduly long branches, uneven density, weak or broken branches, barren lower whorl, curved stem, an opening in the crown of considerable size, handle not proportionate to tree height, excessive leader length, multiple leaders and more than one main stem.

### The Species Question

Growers soon learn to appreciate the fact that highly different results are obtained in planting the same tree species. This is partly because of the high genetic variation commonly found both between and within geographic and local races of a species. This gives rise to questions that must be answered in appraising the prospective use of a given kind of tree. Within the species under test, what races or strains, if any, will yield sufficiently in trees that combine the desired traits of a conical symmetry, a fulness and balance of foliage, and good color? Can a given kind of tree be satisfactorily established in the area, and what kind of nursery stock should be used? Is it hardy under extremes of local climate? What kinds of soils are most favorable? What is the rate of growth? How does this kind of tree respond to various cultural practices? Are there any unusual problems of protection, including serious insect pests and diseases? Finally, does the public like this kind of Christmas tree?

The testing and improving of a species for Christmas tree use is a long-term and continuing problem.

### Scotch Pine Best

With respect to the questions above, Scotch pine (Pinus sylvestris L.) has earned an undoubted superiority in the budding Missouri Christmas tree industry (Fig. 9). This popularity is not simply regional, for Scotch pine has recently edged out Douglas-fir to become the most abundant species in national production (8). In part, this reveals the mounting impact of plantation-produced trees in the industry, for Scotch pine is not native to North America. Its natural range spans most of Europe and much of Siberia. This species has proved especially dif-
Fig. 9—Scotch pine, a European species that has become the leading American Christmas tree, performs well on many Missouri upland soils.
difficult to test, because its many geographic and local races differ so greatly in straightness, growth rate, branching habit, and foliage characteristics. Some forms, such as Austrian Hills stock, turn yellow in winter.

Of the Scotch pine origins now available from commercial tree nurseries, which should the Missouri grower plant? Based on limited performance trials, the dark green to bluegreen French races and a Spanish race from the Guadarama Mountains are recommended. Some other sources across southern Europe look promising, but the necessary field testing of trees from these areas is incomplete.

Scotch pine usually requires 5 to 7 growing seasons after planting to yield Christmas trees. Year in and year out, 2-year-old seedlings (2-O stock) have survived and performed better than either 3-year-old seedlings (3-0) or transplants, such as 2-1 stock.

Other Species

Growers often feel a need to add variety to their crop by planting several species. Customers differ widely in what appeals to them as Christmas trees. As previously mentioned, this is sometimes influenced by fads within the industry, such as a sudden and perhaps short-lived desire among the general public for short-needle or long-needle trees. Also, the extensive planting of a single species increases vulnerability to insect or disease problems associated with the one kind of tree. Thus, although selected races of Scotch pine probably will continue to be planted most heavily within the foreseeable future, it seems fortunate that certain other species have proven productive enough to merit consideration by Missouri growers.

Jack pine (Pinus banksiana Lamb.) ranks second, when growth rate, adaptability, and consumer acceptance are considered (Fig. 10). Major objections to jack pine are an overly high percentage of poorly formed trees and winter yellowing. Efforts are under way to improve the percentage of good trees in jack pine plantations through the breeding of select trees. This species has the advantage of easy establishment and fast growth. When field-planted as 1-0 seedlings, jack pine produces Christmas trees 3 to 5 seasons later.

Eastern white pine (Pinus strobus L.) is a favorite ornamental tree over much of the East and Midwest. For some reason, however, despite its excellent symmetry (Fig. 11), this species has received only limited acceptance nationally as a Christmas tree. Because of two production problems, a low initial survival of seedlings and heavy deer browsing of seedlings that do survive, eastern white pine has not been tested in the Christmas tree market by the Missouri Agriculture Experiment Station. Young seedlings of the species sunscald easily and are best established under some shade, such as moderate weed cover, or by planting older nursery stock. Test results show that the problem of low survival can be largely overcome by planting 2-1 stock rather than the 2-0 seedlings that have been in common use. Approximately six to eight years would be required after planting to produce eastern white pine Christmas trees.

Limited plantings of Rocky Mountain sources of Douglas-fir (Pseudotsuga menziesii var. glauca [Mirb.] Franco) have given excellent results on deep internally well-drained soils (Fig. 12). High-quality Christmas trees have been obtained in six to 12 seasons after planting 2-2 stock. This species is difficult to establish, however, and hardy three- or four-year-old transplants or root-pruned seedlings are needed. Examples of the class of nursery stock required are 2-1 or 2-2 transplants, 3-0 seedlings root pruned late in the second season, or 4-0 seedlings root pruned late in the second and third seasons.

Once established, Rocky Mountain races of Douglas-fir have proven hardy under conditions of sustained drouth, high atmospheric temperature, and other rigors of climate. Site requirements need emphasis, however. Good nursery stock may survive well initially on poor soil, but the trees will gradually succumb. Although minimum requirements are not known, a higher availability of soil nutrients is needed for Douglas-fir than for the various pines. Root aeration is necessary too. Among a wide variety of planting sites tested, ridge tops and slopes where soils have a good internal drainage have been found most suitable. It is recommended that use of Douglas-fir begin with small test plantings on untried but likely soil areas.

Douglas-fir makes a slow initial growth. Seedlings may remain low and bunchy for a number of years. Some trees start height growth well in advance of others. Once height growth has begun, the rate of subsequent growth is good. One important aspect of Douglas-fir Christmas tree production is that excellent additional trees can be obtained from stumps after the first trees have been cut. Moreover, these extra crops can be obtained on a much shorter rotation. The degree to which the species lends itself to stump culture (p. 39) would seem to justify the higher investment required in establishing a stand of Douglas-fir.

Eastern redcedar (Juniperus virginiana L.), native and easily established over much of Missouri, is the traditional Christmas tree in many areas, but its acceptance in a competitive market has been limited. Also, bagworm (Thyridopteryx ephemeraeformis Haw.) and a foliage disease (Cercospora sequoiae var. juniperi Ell. & Ev.) are occasionally serious problems in eastern redcedar stands.

Research workers Minckler and Ryker (6) have shown that the quality and growth rate of Christmas

*The first number indicates years in the seedbed; and the second number shows the number of years, if any, spent in transplant bed. A third number (e.g., 2-1-1) would show a further transplant history in terms of years in a second transplant bed.
Fig. 10—Jack pine is easily established and makes good growth. Many jack pine trees are crooked and have an irregular branching habit.

Fig. 11—The eastern white pine is a beautiful and symmetrical tree. Its successful establishment requires a hardy nursery stock.

Fig. 12—Some excellent Douglas-fir Christmas trees have been produced in Missouri, but the species is more site-sensitive than some of the pines.

Fig. 13—Douglas-fir 12 years after planting 2-2 stock in St. Charles County. These trees were never pruned or given other cultural treatment. The pitch pine trees in the background were planted at the same time.

Fig. 14—Eastern reedcedar is the traditional Christmas tree of many Missourians. This species does not command a good price, however.
trees obtained in eastern redcedar plantations are strongly related to the geographic source of seed. Throughout its range this species has long been cut by natives for Christmas trees. In that the best remaining Christmas tree types have been continuously cut, man has depleted, in untold measure, the inherently best Christmas tree stock while conserving the worst. Most wild Christmas trees today are of very poor quality. Eastern redcedar yields could be improved considerably through a careful selection of seed parents and, ultimately through the selective breeding of proven trees.

In limited marketing tests, both Austrian pine (*Pinus nigra* L.) and ponderosa pine (*Pinus ponderosa* Laws.) have sold quickly as Christmas trees. Each is characterized by long needles, a symmetrical crown, and good winter color. One risk to the Christmas tree grower, however, is that both the Austrian pine and the ponderosa pine are subject to serious needle diseases. The Austrian pine may have its needles severely killed back by a needle blight (*Dobistroma pini* Hulbary). Ponderosa pine is subject to similar injury and eventual mortality by the brown spot needle blight (*Scribbia acicola* [Dearn.] Siggers).

The severity of these diseases appears to increase during wet periods of the climatic cycle and, perhaps, during periods of high dew deposition. This disease problem may be related to soil type and racial origin. Each of these species has an extensive natural range and contains many different races.

Additional testing of Austrian and ponderosa pines is warranted. Field plantings are made with 2-0 seedlings or, better, 2-1 transplants. Early growth is rather slow, and 8 to 10 years are required to produce Christmas trees.

**Virginia pine** (*Pinus virginiana* Mill.), **shortleaf pine** (*Pinus echinata* Mill.) and **pitch pine** (*P. rigida* Mill.) are all readily established in Missouri as 1-0 seedlings. They make fast early growth. None of the three, however, shows much promise in a competitive Christmas tree market. Their branching is irregular, and voids in the crown are common. Virginia pine and shortleaf pine are highly susceptible to attack by the Nantucket pine tip moth (*Rhyacionia frustrana* Comst.). When under heavy attack by this insect, these two pines will prove of further detriment to the Christmas tree grower, because heavy broods of the moth will move out from the highly infested plantings and cause uncommon damage to less susceptible species of the hard pine group, such as Scotch pine and jack pine.

Various other species have received some testing and presently cannot be recommended. Red pine (*Pinus resinosa* Ait.), also known as Norway pine, is not sufficiently resistant to occasional periods of severe drought accompanied by hot, dry winds. It may, however, perform satisfactorily in a series of normal years, especially on sites protected from southwesterly winds. Several of the firs—balsam fir (*Abies balsamea* [L.] Mill.), *Fraser fir* (*Abies fraseri* [Pursh.] Foir.), and white fir (*Abies concolor* [Gord. & Glend.] Lindl.)—have failed under Missouri field conditions. Those few firs that did survive and grow during a series of cool, moist years succumbed during prolonged periods of heat and drought. Even in regions where firs can be grown successfully, the plantation production of Christmas trees is relying largely on the pines. Firs are harder to establish than pines, requiring older nursery stock, and they make extremely slow growth in their early years.

Spruces also have the disadvantages of poor field survival in Missouri and slow growth. Another disadvantage of spruces is that they hold their needles poorly following cutting. Several test plantings of Norway spruce (*Picea abies* [L.] Karst.) and white spruce (*Picea glauca* [Moench] Voss) have not been productive. Better results are being obtained in limited trials of blue spruce (*Picea pungens* Engelm.), but this species is still under test.

In some states to the south of Missouri, Arizona cypress (*Cassapis arizonica* Greene) has received considerable acclaim as a Christmas tree. As a basis for Missouri trials of this species, special planting stock was produced from seed obtained in six Arizona localities, representing in part, the northernmost natural occurrence of the species. Field tests conducted over a series of years showed Arizona cypress to be intolerant of heavy clay soils and insufficiently tolerant of winter conditions in central and northern Missouri. Arizona cypress may be adaptable to the fine sandy soils of southeast Missouri, where further testing of the species seems warranted.

In the foregoing review of species, the hardy pines, especially Scotch pine, are seen to be best adapted to the needs of Missouri growers. The remaining pages will pertain mainly to these species. Any special consideration of other trees will be given as needed.
Selecting a Planting Site

Three considerations should control the selection of a planting area:

1. Soil

Although some advantage is gained by planting on cooler east and north slopes, the importance of slope direction is outweighed by physical factors of the soil such as depth and internal drainage. Shallow or excessively rocky soils are too drouthy. Claypan soils are typically winter-wet and often summer-dry, especially where the pan is less than 2 feet below the surface. Trees survive better, grow straighter, and withstand drouth longer on deep soils that, because of good vertical drainage, provide aeration and moisture storage in depth. It is best not to plant on rich soils, unless the grower is prepared to control a vigorous growth of grasses and weeds. Abandoned old fields on upland slopes and ridges usually provide the best planting sites.

2. Protection

Livestock must be kept out of the plantations. Browse and antler damage by deer can reach serious levels. Unless the plantation area can be closely guarded, roadside locations increase the likelihood of fire and theft. Experience has shown that too many people unscrupulously raid young evergreen stands. The stealing of trees for Christmas or for landscape planting constitutes a serious protection problem for plantation owners.

3. Location Relative to Market

There is a decided advantage in having plantations near good market areas. Transportation costs are less. Sales contacts are easier to make. Some growers near population centers build up a choose-and-cut or self-service retail trade at their plantations or operate retail yards in town. At no point in the State, however, are lands too remote for profitable Christmas tree production. The suitability of a given piece of land to this use and the ability of the grower control success more than does the distance to markets.
Establishing

a Plantation

Survival and vigor in tree plantings are determined largely by a combination of factors such as the suitability of the species and race to the planting site, quality of the planting stock, and climatic circumstances. On these the planter often lacks the measure of control he would wish. However, he can exercise other important direct influences on the establishment and growth of his trees, including the following.

Prepare Planting Site a Year Ahead

A site preparation schedule should stay about a year ahead of the planting operation. Clear the area of trees and shrubs. Leave no stumps, for these will interfere with future operations. Sprouting can be much reduced by plowing, followed by disking. A deep and full plowing also speeds a good root development of newly planted trees and this, in turn, brings about an earlier above-ground growth of the plantation. Jack pine is more responsive to a deep cultivation of the soil than is Scotch pine, but good site preparation helps all species.

On many lands, however, a rank growth of weeds and grasses follows plowing. The planter, therefore, is warned against soil cultivation unless he is also prepared to control weed and grass growth. Furthermore, complete plowing in one operation can result in soil erosion, even on gentle slopes. This can be prevented by plowing alternate strips along contours, so spaced that planting can be done in the plowed soil. Later, after the strips first plowed have healed, the untreated strips can be cultivated.

If numerous white grubs are found in the soil, preplanting control is advisable. When applied at the prescribed rate, either dieldrin or aldrin is an effective insecticide for these pests.

Fertilization

Questions are often raised concerning the possible benefits of fertilizing Christmas tree plantations. The pines do not require high nutrient levels. Yet, as with all forms of life, certain nutritional needs must be met. Based upon considerable experimental evidence, some generalizations can be made about the use of fertilizers in Missouri pine plantations. However, the individual grower must be warned that such generalizations may not apply to his particular circumstance.

In almost all cases, pines planted on agriculturally poor, “farmed-out” lands in Missouri can be expected to show little or no response to fertilizers. (This does not apply to Douglas-fir or the spruces, which have higher nutrient needs than the pines.) Under field conditions normally encountered, the physical properties of the soil and their influence on such important factors as water uptake, internal drainage, root aeration, and moisture storage are more controlling on plantation establishment and development than are any chemical supplements that can be administered.

Repeated tests have been conducted with the major elements (nitrogen, phosphorus, potassium, and calcium), applying them at various rates in all possible combinations. The trace elements have also been tried. These are also very important but need be available only in small amounts. In general, the trace elements are not considered to be lacking in Missouri soils, but a problem in availability could occur due to disbalanced ratios between some chemical constituents. Applying chelating compounds* as a foliage spray to some trees and as a soil drench around others, separate tests have been made of magnesium, iron, copper, manganese, and zinc. Soil applications of sulfur and boron were also made.

The only striking effects came from the boron and nitrogen applications. Borax at the rate of 20 lbs. per acre

* Termed chelates (from the Greek chelai, meaning claw), these compounds employ an appropriate agent that will link with the element under test. The agent "holds" the element, takes it readily into solution, and thereby makes it available to a plant.
Nitrogen applications had a twofold effect. On newly established plantations, this element proved indirectly harmful in that it caused a luxuriant growth of grasses and weeds, choking out the tree seedlings. Thus, nitrogen should be applied only where good weed control can be maintained. In older plantations, where the trees had gained command of the planting site, nitrogen improved the needle color. For winter-yellowing strains of trees, however, this improvement was only temporary, and the needles underwent their characteristic discoloration in November and December.

Despite the general lack of response (and sometimes harmful effects) in the fertilizer trials referred to above, very serious nutritional problems can occur in tree plantations. It is therefore recommended that the Christmas tree grower have soil analyses made as needed to include the distinctly different soil conditions found among his plantations. Many tree roots are found in the upper level of the soil, but other roots go deep. As a practical matter, it will be sufficient to sample a given soil area at two depths. One sample should represent the upper soil, the top 7 inches being a reasonable sampling depth. The second sample should represent the deeper soil, say 8 to 24 inches. In each case, a representative test will require that the soil sample be a composite of approximately equal bits of soil taken from at least four randomly located sample spots in the area being tested.

It is advisable to supplement a soil when unusually low levels of nitrogen, phosphorus, and potassium are found in the tests. None of the applications need be high in the usual agricultural sense. As an index of nitrogen, organic matter commonly is found in a range of around 2 or 3 percent on good Christmas tree sites, and such levels are adequate. Phosphorus and potassium are more likely to be too low. In the light of present knowledge, these should be raised to at least 100 lbs. of P₂O₅ and 150 lbs. of K per acre.

A recent case on a Missouri Christmas tree farm emphasizes the importance of correcting any serious chemical deficiencies in the soil. Following some cutting the previous year, a Scotch pine stand had been brought to its fullest production stage. After some six weeks of dry weather, the trees took on a dull-green cast. An alarming number of trees became yellow in the most vigorous parts of the crown (in the top whorl and leader and at the tips of stronger lateral branches). Some trees cast needles heavily in these yellowing areas. Plausibly, this might have seemed to be a drought effect; but this was not the way that Scotch pine had been observed to behave under sustained conditions of a much more severe drought. (Actually, with the exception of red pine, all species of pine that have been planted in Missouri have been found amazingly resistant to drought and accompanying high temperatures.)

Close inspection of the damaged trees revealed no disease or insect problem; but, notably, some of the trees showed few to no buds in response to a well-timed pruning. All symptoms suggested a phosphorus deficiency, and a soil study showed a range of 6 to 16 lbs. of P₂O₅ per acre at various test spots and depths. Fifty pounds per acre is considered low. Although it is too early to report final results, a full recovery of the plantation is expected following the necessary soil amendment. Many trees that had been beautifully shaped for the market, however, could not be harvested as expected.
Frequent soil tests are not necessary. Perhaps every ten years or at the end of a crop rotation would be a reasonable interval of time. Under normal forest operations, the tree foliage with its mineral content is returned to the soil. In Christmas tree harvests, however, through the removal of the live tree crowns, relatively large amounts of essential elements are soon lost from an area. With respect to the rate of soil nutrient depletion, then, Christmas tree crops are more similar to vegetable and field crops than to timber cutting.

**Care of Planting Stock**

The quality of the planting stock and the care given to it have much to do with a successful Christmas tree venture. Directly involved are the percentage of trees that will survive and the vigor of those that do live. The seedlings should be neither too spindly nor too large. When large seedlings are lifted from the nursery bed, too much of their root systems is often lost. The result is a disbalance between root and crown. Good planting stock has a well-developed root system within an efficient planting depth of 8 to 10 inches. Larger stock, with root systems up to 12 inches deep, can be easily planted with a good machine. A stocky stem is a better index of seedling vigor than is height (Fig. 22).

A primary objective in tree planting is to transfer the seedlings quickly and safely from nursery bed to fields. Pick up bales of planting stock promptly at delivery points. Add cold water as needed to the bales and store temporarily in a cool, shaded location. If the planting

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**Fig. 22**—These 1-0 jack pine seedlings represent excellent nursery stock. Note strong root development within an efficient planting depth. Stem diameter is a better index of vigor than is seedling height.

**Fig. 23**—These tall, spindly 2-0 Scotch pine grew in an overly crowded nursery bed.

**Fig. 24**—These are poor 2-1 Scotch pine transplants received from one nursery. Sixty percent of the stock was like that in A, considered unplantable; 28 percent was like B; and 12 percent like C. All are too small. One possibility is
Fig. 25—Here seedlings are being heeled-in on the shady north side of an old barn near the planting site. First, a V-shaped trench of adequate depth is dug. The seedlings are spread evenly along one side of the trench (center); then soil is firmed over the root systems (right).

operation can’t be completed within a few days, either put the bales in cold storage at 35° to 38°F, or remove seedlings from the packing and firm their roots into trenches dug in moist soil. The latter operation is known as “heeling in” (Fig. 25). Never allow root systems to dry or to heat.

Planting the Trees

Spacing: Even within a species, trees differ in natural spread of crown and, hence, in the space they will occupy. On the average, a spacing of 5 x 5 feet (1742 trees per acre) seems to allow fullest use of a planting area without overly crowding pine Christmas trees before time of first harvest. Many pines have been planted more closely in the past, but the trend has been toward a wider spac-

that this stock had been culled as 2-0 seedlings because of size and placed in transplant beds.

Fig. 26—Variation in size and quality, below, as found in a shipment of 4000 eastern white pine, labelled as 2-1 transplants. The small and spindly stock at the lower right and those with their root systems mostly destroyed in lifting (above) could not be expected to survive.
A sharpshooter spade (left) and the KBC planting bar (right) are excellent hand-planting tools. The KBC bar features a 4" x 12" pointed blade that is shallowly triangular in cross section. The flat, small blade (3" x 10") of the other planting bar (center) makes it unsuited to the plastic clay soils often encountered in Missouri.

Hand Planting: A good planting job can be accomplished with various hand tools. Planting bars and sharpshooter spades are common examples (Fig. 27). Large seedlings may require hole planting, but the faster slit method is suitable for average-sized stock with root systems 8 to 10 inches deep (Fig. 28). A slit of suitable depth is opened with the planting tool and the roots are inserted. Then the soil is firmed around the seedling by inserting the blade of the tool into the ground 2 or 3 inches behind the seedling. With the tool thus set, a backward pull on the handle will close the bottom of the slit around the seedling roots. Next, a forward thrust will close the top of the slit. When the tool is lifted, close the second opening with a kick of your heel.

Regardless of planting method, the object is to obtain a good depth and maximum contact between soil and the root system. The main roots should be directed downward and the lateral roots should be well spread. Don't permit roots to turn back toward the surface. Leave no air pocket around or near the root system. Seedlings should be planted slightly deeper than they grew in the nursery bed.

Machine Planting: More and more seedlings are being machine planted (Fig. 29). In the typically heavy soils of Missouri, hand-planting rates vary from about 300 to 600 seedlings per man day. Two men with a machine can plant around 8000 trees in a day. Arrangement can be made through the local Farm Forester to rent a planting machine for a nominal charge. (Write to Forestry Division, Missouri Conservation Commission, Jefferson City, to obtain the address of your nearest Forester.)

When machine planting, it is advisable to walk the planted rows to check and improve the planting job. Some seedlings may be covered with soil or nearly so; others will need to have the soil firmed around them and, in tightening loose soil around the roots, the seedlings can often be brought into a more upright position. This supplemental work is highly rewarding on clay soils, especially if the planting has been done by a machine of light weight that fails to firm the soil well around the seedlings.
ling is set slightly deeper than it grew in the nursery bed. Main roots are deep and the laterals well spread. A few inches back, the tool is again inserted into the soil, and a second pull and thrust of the handle (D) closes the planting hole. This second hole is closed and soil is firmed as needed around the seedling with the boot heel (E). Result is a well-planted young tree (F).

In addition to speeding and economizing the planting operation, machine planting usually produces straighter rows and better control of spacing between rows than does hand planting. The advantages of straight and uniformly spaced rows can be readily appreciated when cultivating the soil or mowing the area after planting.

**Weed Control**

Although not absolutely essential, shallow between-row cultivation or mowing when needed helps the young seedlings survive and gain vigor. This kind of care conserves valuable soil moisture and assures adequate sunlight for the seedlings. The ranker the grass and weed cover, the more essential is some measure of control. It should be remembered, however, that some herbaceous cover will be needed to prevent soil erosion, even on what may appear to be gentle slopes.

Simazine, a pre-emergence herbicide, has been used successfully to spot-treat around seedlings. Simazine has a long residual effect and a tendency to remain at or near the soil surface, so it may have some hold-over effectiveness through a second growing season. Such chemical treatment is expensive, however, and has not been found necessary when a good mechanical management of the plantation is provided.

**Other Protection Problems**

Trees of seedling size are subject to various forms of weather and animal damage. On bare spots of heavy soil seedlings may require a mulch to prevent frost heaving. A mulch may also be beneficial in conserving soil moisture and holding down soil temperature in summer. Straw and, when available, pine needles make excellent mulches.

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**Fig. 29—**Machine planting is more efficient than hand-planting. Moreover, straight rows and uniform spacing between rows is easier to obtain with a machine than by hand.
Fig. 30—The jack pine at left has been severely browsed by deer. Top browsing of the tree at right has resulted in two leaders and other deformity.

Fig. 31—Heavy damage by deer antlers at the edge of a Douglas-fir stand.

Fig. 32—Scotch pine that has been killed back to its base by deer antlers.

Fig. 33—A diagonal severance of the seedling stem indicates rabbit damage. Seedlings thus injured may die, or they may sprout from adventitious buds below.

Damage by livestock or winter browsing by deer can be severe. Plantations may be destroyed. Trees that survive such injury will be stunted and deformed in their development. Also, after trees reach heights of 3 feet or more, they may be damaged or wrecked by deer antlers (Figs. 31 and 32). Rabbits cut many seedlings some winters (Fig. 33). Such damage may not kill young trees but it will retard their growth. Deer and rabbit repellants are not always reliable. The effectiveness of any promising repellant will be determined partly by the care used in its application, its weathering ability, the severity of the season, and general food availability. The heavy hunting of an area offers some solution.

Long dry periods can cause high seedling mortality the first season after planting. During such periods of stress some supplemental watering can be the difference between a high survival and an almost complete loss. In the unusually severe drouth conditions of 1954, the metering out of a quart of water per seedling as needed resulted in survivals above 95 percent in Scotch and jack pine seedling stands planted that spring. On unwatered check plots, only 10 percent of newly planted trees lived. Once seedlings have survived the first year, they are highly drouth resistant.

Fire can suddenly and completely destroy a Christmas tree plantation, and all too frequently Missouri weather conditions are conducive to such loss. As already mentioned, the likelihood of fire is a paramount consideration in selecting a plantation site. Since no location can be sufficiently safe, however, plans for the development of an area should be based in part on the possibility of fire. Trees should be planted in blocks, between which a system of access roads and fire lanes can be maintained. The grower should take advantages of any organized program of fire protection in his area. Moreover, he should be prepared to fight a fire himself.
Protection problems do not end once the young trees are given a good start. A fire-fighting plan must, of course, remain in force, alerted to times of high danger. Livestock must always be kept out of plantations. Activities by deer continue to be a concern, in part because the cumulative year-to-year effects of tree breakage and de-barking by deer antlers can seriously lower the quality of a Christmas tree crop. Also, some species, notably eastern white pine and jack pine may be browsed heavily by deer during winter.

Other protection problems that confront the Christmas tree grower throughout the life of his plantation pertain specifically to insects, diseases, and to the sometimes persistent competition by hardwood sprouts.

**Insects**

The most serious insect pest in Missouri Christmas tree plantations at present is the Nantucket pine tip moth (see page 12). Symptomatic of the presence of this pest are dead buds and needles at the ends of branches, especially at the top of the tree. Eggs are deposited singly on the flat surface of pine needles by adult females in April, June, and August (Fig. 35). During an incubation period of one or two weeks, depending on weather, the tiny pancake-shaped eggs change color from pale tan to blackish.

Upon hatching, the tiny larvae may mine briefly in the needles that supported the eggs, but within several days they make their way to the succulent branch tips. There they begin feeding inward, spinning a protective web at the surface. Most of the larval stage is spent inside the twigs, where they mine out the tips and buds of the new growth. Pupation also takes place inside the twigs, followed by emergence of the adult moths. Less than a half inch in length, the moths have wings of mottled silver and brown. When at rest, the wings are folded back over the abdomen.
The effect of the feeding habit of the pine tip moth is to kill newly formed buds and branch tips, especially on the leader and more vigorous lateral branches. This retards height growth and causes a crooked development of the trees, flattened tops, and void spaces in the crown, due to the killing of some branch clusters in their formative stage (Fig. 37).

The pine tip moth is difficult to eradicate because of its three generations per year. It can be held in check, however, and damage minimized, by spraying branch tips in middle to late June with a 0.5 percent DDT emulsion. The spray should be directed especially at the tips of branches in the tree tops, where most damage is done. This control measure is applied during the late egg or early larval stage.

As previously stated, pines vary in their susceptibility to tipmoth attack. Though generally not as vulnerable to tipmoth as some species, Scotch pine and jack pine may be heavily attacked if some of the highly susceptible shortleaf, Virginia, or loblolly pines are growing near them. In repeated tests, tipmoth damage to Scotch pine and jack pine has been greatly reduced by eradicating any Virginia, shortleaf, or loblolly pine growing in the vicinity.

Probably because of natural parasites and predators, the pine tip moth is usually less active near forests than out in open expanses of land. This pest has been of less concern recently than a few years ago. In many areas where damage was very severe in the mid-1950s, the problem no longer exists. Field observations indicate that the tip moth is being held in check by a natural agent, probably one of the lady beetles, but this lacks confirmation. More research is needed in this kind of control. A biological agent (perhaps man controllable), such as the use of lady beetles to control scale insects in citrus groves, can be infinitely more effective than repeated and expensive applications of insecticides.

Other than the pine tip moth, no serious insect problem has been experienced in Missouri plantings of such common Christmas tree species as Scotch pine, jack pine, eastern white pine, and Douglas-fir. The bagworm, a serious pest on eastern redcedar and other junipers,
Bagworms often seriously defoliate and may kill eastern redcedar and other junipers. Bagworms may also be found on other evergreens such as the pines and Douglas-fir, but damage to these species is usually light.

Mites May Do Damage

There have been several known cases of severe mite damage to Christmas tree plantations. Trees are weakened by the piercing and sucking activities of these pests. This form of injury is indicated by a dull and yellowish to bronze mottled discoloration of needles. Such damage is more likely during periods of drought.

Mites, when shaken from infested branches onto a piece of paper, become more conspicuous as tiny moving dots. Observed under a hand lens, the adults are seen to have four pairs of legs. Thus they are not insects, which have three pairs of legs. The use of insecticides on trees may actually help bring on a mite problem because beneficial insects which prey on mites may be destroyed. When spraying with DDT, for example, it is advisable to include in the formulation an effective miticide such as aramite, which is chemically compatible with DDT. Mites may also be controlled with malathion or Kelthane at prescribed rates. Two sprayings with an interval of 7 to 10 days are sometimes needed.

New techniques and materials for controlling insects and similar pests are being developed rapidly. Recent changes in recommendations for handling such problems can be obtained at the University Extension Center in your county.

Diseases

Happily, no serious disease problems have been encountered in Missouri plantings of the more common Christmas tree species. As previously stated, some very destructive needle slights may be associated with plantings of Austrian pine, ponderosa pine, and eastern redcedar. No economical means of controlling these foliage diseases have been developed.

Hardwood Control

Young hardwood trees and shrubs must be kept out of the plantation. Competition with these would result in spindly or lopsided Christmas trees (Fig. 42). A good job of site preparation will minimize this problem. Usually a periodic cutting back of any small hardwood growth will suffice, especially right after the strong flush of

Fig. 40 — Bagworms often seriously defoliate and may kill eastern redcedar and other junipers. Bagworms may also be found on other evergreens such as the pines and Douglas-fir, but damage to these species is usually light.

Fig. 41 — Cercospora sequoiae var. juniperi Ell. and Ev., a foliage disease, is a serious problem in many eastern redcedar stands.

Fig. 42 — Hardwood sprouts cause lopsided and spindly trees.
growth in spring. If persistent vigorous sprouting is encountered, however, chemical treatment may be needed. Use a basal application of one of the standard brush killers, such as a commercial mixture of 2,4-D and 2,4,5-T.

Soil Cultivations and Mowings

Any post-planting discing or plowing should be shallow, primarily a hoeing action at the surface. Between-row cultivations are not recommended beyond the second year, because of possible injury to feeder roots near the soil surface. Repeated cultivations also may bring about or extend an erosion problem.

On the other hand, mowing will continue to be beneficial throughout the life of a plantation, for the following reasons:

1. Soil moisture that would otherwise be used rapidly by other vegetation is conserved for the trees.
2. The fire hazard is lowered.
3. Mowing renders the area less favorable as a rodent habitat.
4. Control of hardwood sprouts is greatly facilitated.
5. The lower parts of the Christmas tree crowns can develop more fully.
6. Other work in the plantation is made easier and more pleasant.

Some walk-type garden tractors of a special rugged design are suitable for mowing small plantations. As operations expand in size the use of larger equipment becomes increasingly advisable (Fig. 43). Areas will differ in their needs, but most plantations on upland old fields will require two mowings in a growing season, the first perhaps in late May or by mid-June and the second in August. Especially when the trees are small, any mowing should be done early. Once the small tree seedlings become obscured by a rank growth of weeds and grasses, the rows are difficult to follow with a mower and some of the trees will be needlessly cut. This is especially so when tree rows are crooked. The advantages of having the trees in straight rows, with a uniform spacing between rows, have already been emphasized.

Another highly necessary phase of tending a Christmas tree crop, the artificial shaping of trees, deserves a detailed discussion, which is supplied in the following section.
Increasing Tree Quality Through Pruning

Pruning, sometimes referred to as shearing or shaping, is a most effective and necessary means of adding quality to Christmas trees (Fig. 45). Most trees will enter the better grades only through such help, and few are the trees that cannot be improved by a well-applied pruning at some point during their development. The importance of this cultural practice cannot be overly emphasized.

Because no two trees are alike, and many trees differ drastically in growth and branching habit, each tree must be studied individually and pruned as (and only if) needed. Such decisions are quickly made by the experienced pruner. The beginner, however, should proceed slowly and studiously. Speed must not be developed at the expense of a necessary quality in the work, and a correctness in procedure must rest on a fundamental knowledge that governs pruning practice. It is toward this end that the following objectives, procedures, and related discussions are presented.

Pruning Objectives

1. To allow only one main stem and, therefore, only one leader.
2. To assure a sufficiently compact crown.
3. To develop a symmetry and balance in the crown.
4. To locate and improve the base of the tree.

General Pruning Procedure

To achieve these objectives, most trees will need some pruning each year. This work normally begins when the trees are around 3 feet tall, at which point a faster rate of height growth has begun. If a tree is forked, remove all but the one best stem. This prevention of forking can start earlier, before the trees are 3 feet high, and is best done in late fall or winter when reserve energy in the trees is high. As will be explained below, however, the cutting back of overly long leaders and general shaping work on pines must be done in late spring or early summer, depending on the species of pine.
Some objectives of the pruning task are (1) to prevent more than one stem; (2) to prevent more than one leader, which would cause a forking of the main stem; and (3) to control density by regulating the distance between whorls of lateral branches.

After it is determined that the tree has only one stem, the rest of the work can be done systematically, proceeding from the top downward.

The first question to ask is whether there is more than one leader? If so, remove all but the best one (Fig. 46). Sometimes, and especially in the case of multiple leaders, there will be no prospective leader that approaches the vertical (Fig. 49). Given pruning help, most such trees will correct themselves, but some growers use wire trainers, available commercially, to force a straighter development.

Next, is the leader too long? If so, cut it back to the length of 12 to 15 inches, using a slanted cutting angle. The annual reduction of overly long leader length prevents too much space between the strong whorls of branches along the stem. As will be explained later, the leader length that can be allowed depends in part on the angle formed between the lateral branches and the stem. A strong upsweep of side branches will, obviously, permit more leader length. Contrarily, leader length must be shortened as the angle of branching becomes more horizontal or "flat."

After regulating the leader length, start pruning the lateral growth as follows: The top whorl of branches usually needs a strong treatment. Cut these new side branches back to lengths of about 6 inches in order to produce a desired taper. Then, following this same line of taper, continue into the lower part of the crown.

Routine pruning treatment normally starts when the trees are about 3 feet high.

The prevention of more than one stem or a forking of the main stem should start early, before the trees are 3 feet tall.
Fig. 49—Examples of problems encountered in pruning Scotch pine tops and how they may be handled.

Fig. 50—Examples of some Scotch pine pruning subjects and how they were treated. It would be advisable to cut the strong laterals somewhat shorter than is shown.
Work down and around the tree, cutting back branches as needed to obtain a conelike symmetry.

Sometimes certain strong side branches persist in making an excessive growth (Fig. 51). Such branches tend to force an unshapely crown or, if numerous enough, will result in a flaring (excessively wide) tree. Some regulation of this problem is obtained by pruning these overly strong branches back to a node, causing a distribution of subsequent growth among branches forming that node. In the case of Scotch pine, no pruning back to a node should be done on a tree during the two seasons prior to its harvest. This is because nodal pruning in Scotch pine often produces ugly openings, and time is needed for additional branch development that will close such voids. Inasmuch as a new bud development is not required at the point of pruning, branches may be cut back to a node at any time of the year.

Because it has many more and slenderer branchlets, jack pine is more responsive to nodal pruning than is Scotch pine. Moreover, because of its tendency toward a more irregular and unbalanced growth, this treatment is more frequently needed on jack pine. In one study, nodal prunings only in late autumn or early winter produced as many good jack pine Christmas trees as did the usual early-growing-season practice.

One question remains: Does the tree have enough strength in its lower crown? Remember that a good Christmas tree requires a strong whorl or aggregation of branches at its base. This means that the logical base of some Christmas trees is found several feet up the stem, rather than near the ground (Fig. 8, p. 7). Also, remember that the tree needs a handle of approximately 1 inch for each foot of tree height, plus a little allowance for a fresh cut at the time of mounting the tree in its holder.
Thus, some attention must be given to the lower extremities; first, to locate a satisfactory base and, second, to provide a clean handle. It should be pointed out here, however, that if stump culture (p. 38) is to be practiced a few branches must be left below the point where the tree will be cut. Most evergreens, including the common Christmas tree species, don't sprout beyond the seedling stage.

Pruning around the bases of trees is often delayed until time of harvest. Some producers, however, speed and improve their harvesting operation by locating their tree bases and cleaning tree handles as a routine part of pruning. When trees are thus prepared, even an inexperienced cutter can see instantly where to cut a tree. Time is precious during the harvest season, and the previously cleaned handles will not need further treatment. Furthermore, the necessity of rebutting many trees is avoided.

The character of growth in the lower branches often determines the need for basal pruning. Occasionally, unless removed, an overly large branch on an incomplete lower whorl will develop strongly upward, interfering with a tree's best development above. As in removing more than one stem or in pruning branches back to nodes, the cleaning up of a tree's base can be done anytime during the year.

**Pruning vs. Shearing**

Although in Christmas tree parlance the terms *pruning* and *shearing* are often used interchangeably, they are not synonymous. *Shearing* is a process whereby trees are trimmed to shape without consideration of individual branches, as in shaping a hedge. *Pruning*, on the other hand, involves the studied and selective removal or cutting back of individual branches in an effort to achieve a compact, symmetrical, and balanced crown while, at the same time, maintaining a natural appearance of the tree.

Given this distinction of shearing vs. pruning, it becomes obvious that a well-executed shaping of Christmas trees is mostly a pruning process. Overly long leaders are judiciously *pruned* back to a suitable length. Extra stems or leaders are *pruned* away, exceptionally strong side branches are *pruned* back to a node, and the bases of trees are cleaned by the *pruning* away of any superfluous or dead branches. The general regulation of other branch growth can be accomplished through either a shearing or a pruning operation—or with a combination of the two processes. The discerning grower, however, comes to realize that the branch-to-branch selectivity of the pruning process yields trees with a more natural appearance.

This quality of naturalness is a most important consideration, for it enhances a tree's acceptance in the market. When a tree has been skillfully shaped, there is no outward suggestion that its image was molded with pruning or shearing tools. On the other hand, when overly sheared, the trees take on a hedgy and artificial look. In recent years many sheared trees appearing in the market have not only an artificial aspect. They have also looked mangled. It is often the case that such trees have not had time to recover from a mutilation given them in the reckless use of some shearing tool.

**May Reduce vigor**

A careless or excessive cutting of branches can have other undesirable consequences. A tree's vigor can be unnecessarily retarded. The removal or overly severe cutting back of branches can permanently reduce the amount of foliage at points so treated and even bring about voids in the crown. In this connection, too many pruners, once they get the general idea, lapse into a wanton slashing of branches. Such should not be the case if the beginner will work slowly at first, concentrating on a mastery of the essential considerations described in following pages. Once the controlling principles are well understood, a satisfactory working speed can be developed through an improved familiarity with the problems encountered and a more adept use of the tools.

**Suggested Tools**

What is a satisfactory pruning or shearing tool? Personal preference, determined in part by one's training, is a factor here (Fig. 52). Small pruning shears of the anvil type are an excellent choice. They are available in several sizes and are light and less fatiguing than most cutting instruments. The ease with which they can be used in a wide range of pruning situations enables the worker to be more selective in the branches he cuts. The neat and

![Fig. 52—Some common pruning and shearing tools. Left to right, hand pruners of anvil type, grass hook, and hedge shears.](image)
natural effect obtainable with these small shears make them a superior tool in the final shaping of trees for market. In a general shearing operation, several branches can be gathered by hand and cut simultaneously. In using hand pruners, work is made easier and faster by using the free hand to feed branches to the instrument. Caution is needed, however, lest the cutting tool “hawk” and severely cut the feed hand.

Many workers use hedge shears, feeling that they are faster than the small hand pruners, but time studies have failed to confirm this. Given either tool and a good worker, approximately 3000 trees per man per day can be treated when the trees are around 3 feet tall. Pruning rate, of course, decreases with tree size. When heights range from 5 to 7 feet, the production rate of a worker may decline to only 450 to 500 trees per day. One factor here is that some lots of trees require more pruning than other lots.

Regardless of the kind of tool used, it should be maintained in a sharp condition and any moving parts well oiled. Resin accumulations should be periodically scraped from the tool’s surface or removed with such solvents as turpentine or mineral spirits.

A faster but cruder tool that can be used successfully in skilled hands is the grass hook. This is also the most dangerous instrument of the three. To speed the pruning task and yet maintain a preciseness in the operation where quality of the work is most important, a 2-step combination of tools may be used, as follows:

Fig. 53—After the top of the tree has been pruned with a more accurate tool, the lower crown can be shaped with a sharp grass hook (left), but not in the year during which the tree will be harvested. The tree above is at least two seasons away from the market and therefore lends itself especially well to a fast grass-hook shearing.
Fig. 54—These two jack pine exemplify the wide variation of trees as pruning subjects. Because of crook and a wide, sparse branching habit, the tree at the left has practically no potential as a Christmas tree. The tree at the right can be easily shaped into a high-quality product.

**Step 1:** Use hand pruners to cut back leaders to the desired length of 12 to 15 inches. Then cut back lateral branches in the top whorl to balanced lengths of about 6 inches.

**Step 2:** After Step 1 has been completed in the entire plantation, rewalk the rows with a grass hook, shaping the lower portion of the crown as needed. It is especially important that the grass hook be maintained in a sharp condition and that a precision be obtained in its use. Don't use a grass hook or other shearing tool on trees that will be harvested the following December.

In an effort to further speed the task of artificially shaping trees, long machette-sized but thin knives are being used by some growers. One practice is to slash heavily into the side growth. The result is narrower and very compact crowns, most artificial in appearance. Although protective gear is worn when shearing with knives, danger to personnel is still high. Use of knives and other special shearing tools are subject to the same restrictions and precautions as described above for the grass hook.

**Variation Challenges Pruner**

The Christmas tree grower never ceases to be impressed with the differences among his trees. Some display an innate tendency toward such objectional traits as spiral, crook, repeated forking of the main stem, and an open crown due to widely spaced branching and only a few branches per whorl or node. A tree having any one or more of these traits in a marked degree may be an impossible pruning subject. Studies have repeatedly shown that some such trees, even though given disproportionate time in the application of a shaping treatment, persist in maintaining their unwanted features.

Happily such individuals are few when the right species and suitable seed sources are used. Given good nursery stock, most trees will have satisfactory straightness, will be central stemmed in tendency and can be made moderately dense to dense and balanced in crown. In other words, they will respond well to pruning. To obtain their best potential, however, the pruner must have some knowledge of the varied growth patterns found among trees.

Some kinds of trees, such as eastern redcedar and Arizona cypress, have a multiplicity of branches well distributed all along their boles and limbs. Tiny, hairsized branchlets are cloaked with minute scalelike leaves. These species can be pruned or sheared at any season. Other groups—such as the Douglas-fir, the true or balsam firs (Abies spp.), and the spruces—have along their leading growth well-distributed lateral buds, normally giving rise to weak "internodal" branches. These lateral buds respond well when, as a result of pruning, they are placed at or near a terminal position. Consequently, the Douglas-fir, the true firs, and spruces can also be pruned at any season. This in not true of the pines.
How Pruning Affects Pine Growth

To understand the results obtained from pruning pines, it is helpful to know that each of the bundles of needles that characterize the genus *Pinus* is actually borne on a much-reduced dwarf shoot. These tiny and unseen shoots have the latent ability to form normal shoots, but this capacity is lost with age. The right situation for activation of the dwarf shoots is created when the normal vegetative buds are removed by pruning tool, insect activity, or other cause.

Properly timed, the cutting back of a young pine branch can force a development of the dwarf shoots at or near the point of pruning. A bud appears between the needles of each bundle in the region of response. Of the buds thus formed from dwarf shoots, those nearest the point of pruning, i.e., those most terminal, will be the largest. Based on this observation, it seems reasonable to suspect that it is better to cut the leader on the diagonal rather than straight across. This, seemingly, would reduce the number of large buds at a pruned tip, thus retarding the formation of multiple leaders from such buds.

This advantage of diagonal pruning has been established experimentally in West Virginia (3). In Missouri, however, a similar study on Riga Scotch pine failed to establish a clearcut advantage of slanted cuts over transverse cuts. Such differences in test results may be genetically based. Some trees, such as the Riga race of Scotch pine, are characteristically straight and grow tall. When their normal development is disturbed, as in pruning, an apical dominance is quickly restored. Trees lacking this trait are more easily disturbed, leading to multiple leaders and other pruning problems.

Since diagonal cutting closely follows the slant of the needles, a more natural effect is created at the ends of pruned branches. That is, diagonal cutting does not produce the cropped effect at branch ends that a transverse cut does. This is a more important consideration in the final trimming and shaping of a tree during the season before marketing. Hence, in addition to the possibility of producing fewer multiple-stemmed terminals, diagonal cuts have an aesthetic advantage over the transverse cropping of both needles and twigs.

**Time of Pruning Important**

In obtaining a good response to the pruning of pine, the timing of the operation is a critical factor. More and larger buds are formed if the treatment is applied during or near those days when young buds are being formed at the ends of young growth. The actual calendar period varies with species. Jack pine, for example, should be pruned in central Missouri during the last half of May, and no later than early June. One does not start pruning Scotch pine in this same area, however, until mid-June, and the pruning period for that species may be safely extended to include all of July.

Species differ in the vigor of their response to pruning. This is reflected in two ways:

First, there is the difference in bud numbers. Scant if any increase in bud numbers can be expected on a jack pine branch as a result of pruning, while Scotch pine branches commonly produce several times more buds at points of pruning than are found in normal bud clusters. (Fig. 55).

Second, there is the difference in time over which buds will form. Using the same two species for contrast, jack pine will form fewer than the natural number of buds and on many branches, none, if pruned after June...
15. This failure to form buds is accentuated under conditions of moisture stress or other cause of reduced vigor, such as a major nutrient deficiency. Also, the lower branches in a tree crown, because of their weaker position, respond less to pruning than do the vigorous upper branches.

Scotch pine, in contrast to jack pine, will continue to form buds, even if pruned late in the growing season, during the winter, or even in the next growing season. These Scotch pine buds, however, become successively smaller with lateness of pruning date, and those that result from late summer or winter pruning are small indeed. The result the following spring is a ball of tiny branchlets, presenting a bird-nest effect (Fig. 56). Unpruned lateral branches turn up and gain dominance over terminals so treated, creating a very misshapen tree.

**Response Declines Late in Season**

Results of research workers Hacskaylo (4) in Ohio and Larsson (5) in Canada agree with responses obtained in Missouri showing that, later in the season, beyond the period of full needle development, Scotch pine dwarf shoots gradually weaken in their ability to respond. In addition to delayed pruning of the growth of the last season, their studies included pruning back to branch parts that were two and three growing seasons old (sometimes referred to as "cutting into the old wood"). Hacskaylo concluded that sparse-crowned Scotch pine, previously unpruned, could be made marketable as Christmas trees, even though 6 to 8 feet tall. When winter-sheared on the growth of the last season, the trees could be marketable after two more seasons. When cutting was back into wood started two growing seasons ago, at least three additional seasons were required for recovery and growth into marketable trees. Death resulted from a more severe treatment, cutting back into 3-year-old wood. One objection to recovering unpruned Christmas trees is that the base of the main stem (the handle) is large for the size of the tree. Hacskaylo emphasized that trees should be pruned and kept under control to produce the best quality trees.

The ability of Scotch pine to respond to pruning over an extended time may be utilized in two ways:

(1) As explained, growers can salvage Scotch pines that, for some reason, have not been given properly scheduled prunings and, as a consequence of long internodes, are overly sparse in their crowns. This is done by pruning back into growth of the past season or, less preferably, two seasons ago. A tree so treated is shaped by uniformly cutting back the terminal and main branches. Remember that any strong upper branch that escapes such treatment will turn up and perhaps gain dominance over the main stem, or, at best, become overly strong. On the other hand, weak branches are likely to fail to form buds. It is best, of course, to avoid delays in pruning so such salvage treatment will not be required.

(2) Some improvement in the taper of overly wide Scotch pine may be gained by a delayed pruning of side branches. This is done by pruning the terminal during a period of optimum response, i.e. from mid-June to mid-July. Later, about mid-August, the laterals are pruned. Again, however, the late pruning should involve only branches of good vigor; weak ones may form no buds, meaning that they must ultimately die back to the nearest node.

**Recovery Ability Varies**

The ability of branches to respond to pruning varies greatly. First, there is the matter of the vigor of the tree itself. Species, age, suitability of the site to the tree's genetic make-up, the presence or absence of insect pests or other injurious agents, and prevailing climatic circumstance influence vigor. For example, indications are that the timing of a pruning operation becomes more critical during periods of drought than when moisture conditions are normal. This adverse effect of drought on bud formation may be accentuated by a low phosphorus content in the soil (p. 15) or perhaps by other nutrient deficiencies. Then, there is the question of branch vigor relative to other branches of the tree. Branches in the upper crown form buds more vigorously than those of the lower crown. In the same general crown area, twigs of larger diameter will respond better to pruning than smaller ones.

**Bud Pruning**

The desired condition in the top bud cluster is that only one dominant bud be found at the very tip. A terminal bud of this sort normally forms next year's leader. Sometimes, especially on pruned trees, two or more equally strong buds are found in the terminal position (Fig. 57). One refinement of the pruning process is to

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![Fig. 57 — Some trees are prone to form two or more equally strong terminal buds, especially in response to pruning, as shown at left. This fortells a multiple-leader problem. At right is the same branch after a bud pruning.](image-url)
Examples of uninodeal pines are Scotch pine, eastern white pine, red pine, and Austrian pine. Most hard or yellow pines are multinodal. These include such species as jack pine, shortleaf pine, and Virginia pine. Because of the stronger and better-balanced whorls, the uninodeal mode of growth excels in natural symmetry.

Due to an irregular branching, more trees among the multinodal species are difficult pruning subjects. On the other hand, the multinodal species may maintain a very fast growth rate without becoming too open or sparse of crown. Some of the fastest growing jack and shortleaf pines, for example, also develop many lateral branches and have a high natural crown density. If uninodeal species such as Scotch pine are allowed to grow equally fast (3 feet per year is not unusual once the trees are well established), they become open and storied in appearance. Thus, while it is necessary to prune back the terminals of fast growing uninodeal species, this is not necessarily so in the case of pines with a multinodal pattern of growth.

**Whorl Spacing Preferences**

How much internodal distance (space between branch whorls) can be allowed and yet maintain a satisfactorily dense or compact crown? Some growers recommend the yearly cutting back of leaders as needed to hold the distance between whorls to 8 to 10 inches. Others feel that as much as 20 inches of internodal distance can be allowed and yet maintain a sufficiently dense crown. A between-whorls spacing of 12 inches is probably the most commonly recommended objective.

As is the case with spacing when planting the trees, there is no single best answer to this question of internodal distance. Again, too many variables are involved, the principal of which are as follows:

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**Fig. 58**—Pine species differ in their manner of seasonal development.

Uninodeal branching --- 1 whorl of branches per growing season

Multinodal branching --- several whorls of branches per growing season

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remove such extra buds by pinching or twisting. This is done during the fall or winter. Such bud pruning helps assure only one leader, thereby maintaining the desired central-stem tendency of the tree. The one leader will be stronger and straighter. Also, following the removal of extra leading buds, the lower lateral buds of the cluster can be expected to make a better development.

Finally, before leaving this question of pine response to pruning, it should be recognized that not all pines have the same pattern of growth. Some species are termed uninodeal in that only one node or whorl of branches is formed each year; others, the multinodal pines form several nodes of branches each growing season (Fig. 58).

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**Fig. 59**—Branching characteristics, very strongly inherent, are expressed early in a tree's development. In the young 2-foot-high Scotch pine below, the allowable internodal distance decreases in the order of A, B, C, D. Also, the lateral branches of tree D must be pruned back more severely to prevent a flaring taper. Little or no control of lateral length will be required for tree B.
Growers differ in their thinking as to how compact the crowns should be. Some, in the author’s opinion, seek to produce an overly dense product. Such trees are disproportionately heavy and difficult to handle. Moreover, they bundle or pack poorly in shipment. Some buyers actually prefer well-shaped trees with rather open crowns. Most consumers, however, want trees of moderately dense to dense crowns. Nevertheless, it should be remembered that other factors weigh heavily too—such as straightness, symmetry, balance, taper and general foliage quality.

The angle of branching is probably the most important trait influencing the allowable internodal distance. In one aspect of their natural branching habits, trees vary from strongly upsweeping to wide-spreading. It follows that trees whose laterals form sharp angles with the main stem can be allowed a considerably longer internodal distance than can those whose branching angle approaches 90°.

Trees vary in their secondary branching. Some branch heavily and repeatedly and thus their branches close better to form compact crowns than do those with a light branching habit.

Market size is a consideration. Other variables being equal, longer internodal distances can be allowed with large trees than with small ones.

While the foregoing discussion has the primary objective of directing the pruning process, it should serve further in pointing up one important reality: Trees differ, and people differ in their appraisal of trees. Within the rather broad limits allowed by grading standards, some variation is desired in the characteristics displayed by a crop of Christmas trees. Pruning is an art directed toward this need for both quality and variety. Its refinement is developed through practice, observation of results, and more practice. Among other things, a pruner must develop and maintain a sense of good tree balance and proportions.
Marketing

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Trees

The production of quality trees is the key to success in marketing. Even with the best possible product, however, financial returns depend on the grower's selling ability. A grower should be familiar with United States standards for Christmas trees. Also, he should maintain a familiarity with the market in the area where he will sell his trees. He can then better appraise his crop in terms of the kind of competition he is up against.

Most experienced growers don't try to sell their low-grade trees, for these are a glut on the market, even at low prices. Trees that don't satisfy market standards can be cut up and sold as boughs for wreaths, roping, and other Christmas decorations. All in all, a good selling job requires a knowledge of the market, a good measure of individual initiative, plus some sales ingenuity.

In recent years many Scotch pines of a strain that winter-yellows very badly have been planted in Missouri. These trees are being made much more marketable by spraying them with Greenzit, a water soluble colorant that weathers satisfactorily once it has dried on the trees. Greenzit may be applied as a fine spray or mist. Another procedure is to dip the cut trees in the solution. Experience shows, however, that the application is best made on standing trees in the plantation in October before the onset of yellowing, usually in November. Early spraying requires a weaker solution (1 gal. of concentrate per 40 gals. of water) and produces a more satisfactory result. Once the trees have yellowed, 1 gal. of concentrate per 20 gals. of water will cover less well.

This need to artificially color Scotch pine is looked upon as being temporary. Research now under way should make known those races of the species that maintain a rich dark green to bluegreen color under winter sun. Meanwhile, it should be recognized that winter discoloration does not represent an unhealthy state. It is simply a response to bright light during dormancy. The trees quickly become green again with the advent of spring.

Another means of combating the problem of winter yellowing is to cut the trees early, usually in early to mid-November, following the start of the dormant period in October. Once cut, the trees should be stored in cool, moist locations out of the sunlight. Under field conditions, a suitable storage procedure is to deck the trees in an area protected from direct sunlight. The northern side of a woodland is a good site; a stand of evergreens gives particularly favorable shade (Fig. 61). Close stacking of the trees helps keep them fresh. Another good procedure is to cover the decked trees with culls or other available material. Under dry conditions, a wetting down of the stacked trees is highly beneficial. Early cutting (but not earlier than indicated) helps in moving trees promptly to market, especially in the event of adverse weather.

The local grower can retail, consign, or wholesale his trees; or perhaps a combination of several market outlets will be most advantageous. He may do some retailing, both at his plantation and at well-located retail yards in town. Favorable yard locations, catchy advertising, a good display of trees, and satisfied customers can all contribute to a growing success.

Next to retailing, a consignment arrangement has the greatest potential of financial returns to the grower.
Since the consignee has no investment in the trees, a large share (at least ¾) of the gross receipts are justly returned to the consignor. The two parties should enter into a written contract concerning prices, tree inventories, and the portion of the gross receipts that will be returned to the consignor.

Direct wholesaling by the grower to retailers is another possibility. Trees are delivered at wholesale for approximately half their retail value. Grocery stores, organizations, and responsible individuals are examples of consignment or wholesale outlets. Marketing arrangements are normally made months in advance, regardless of methods employed.

Sustained Production

A well-stabilized and satisfactory marketing process is developed over a period of years, during which time a confident relationship is built up between the grower and his buyers. A very essential part of this going business is a sustained production in the plantations. Ideally, the entire planting area should be uniformly divided into planting units, sufficient in number to span the rotation period. Planning on a seven-year rotation period for Scotch pine, for example, the area given to this species can be divided into eight units. One unit would be planted annually. The extra or eighth unit provides the necessary time for final clearing and preparation of an area for replanting.

Not all trees of the same age will reach their best Christmas tree potential in the same season. Experience shows that any one planting is most profitably cut over a period of about three years. Scotch pine planted in 1965, for example, would be expected to yield a first harvest for the Christmas season of 1969, with additional cuts in 1970 and 1971—after which the area would be cleared for replanting. Annual cuttings should be so conducted that remaining trees in the stand are apart from each other (Fig. 62). When the crowns of adjacent trees "close," i.e., come into contact with each other, they are too close together (Fig. 63).

Fig. 62—A first and second cutting was conducted in this Scotch pine stand during the two previous years. The plantation is now ready for the final harvest. Note that a good spacing has been maintained between trees.

Fig. 63—These jack pine trees are too crowded. Earlier cuttings should have kept the trees spaced apart.
Height Preferences

Such a procedure in crop rotation will provide an abundance of Scotch pines in the popular size range of 3 to 9 feet, heights of 5 to 7 feet being in most demand. The grower may want to reserve occasional groups of trees, adequately thinned as needed to a sufficiently wide spacing that will prevent overcrowding, for further growth into large sizes. Heights up to 12 feet, occasionally taller, are in demand by churches, banks, stores, and organizations. Large trees are difficult to handle and expensive to transport, however. This is especially true of the heavy-crowned, stiff-branched Scotch pine. Prices obtained for big trees too frequently fail to reflect these additional costs.

A question is sometimes raised concerning interplanting, a method that would theoretically result in trees of all ages in the same stand. When a tree is cut under this system, a seedling is soon planted where it grew. This is not advisable, possibly with the exception of operations too small to be divided effectively into even-aged blocks of trees. Interplanting is inefficient in practice;

and, too often, excessive crowding by the older trees causes a spindly development of the younger ones.

Christmas Trees from Stumps

Another rather frequent question concerns "turn-ups." These are trees that develop on stumps after the first trees have been cut (Fig. 65). As already pointed out, stumps of most conifers, including the common Christmas tree species, don't sprout. Branches left on the stump when a tree is cut, however, will turn skyward and develop upright. Theoretically, a stump could be kept in continuous production.

When superfluous branches are removed and the best is given routine pruning treatment, a good tree may result. The reason for removing extra branches, of course, is to prevent their crowding and interfering with the favored branch. By wedging branches apart at a suitable spacing, some managers of Christmas tree stands have produced the novelty of having two or more trees produced simultaneously by the same root system.

On the question of the quality of trees that can be...
obtained from stumps, one generalization can be made: Excellent original trees can be expected to yield good Christmas trees from their stumps. In other words, a superior stand of Scotch pine would be expected to respond much better to stump culture than would Scotch pine of good to average quality. There are differences between species too.

The pines. All of the various pines studied—most notably Scotch pine, jack pine, and eastern white pine—have been productive of additional Christmas trees from the same root systems through stump culture. These supplemental yields, however, have been, on the average, somewhat lower in quality. Stems are less straight and usually the crowns are not as good as those on the original trees. This loss in quality has been serious enough that stump culture cannot be recommended as a general practice in pine stands. In the case of Scotch pine, stump mortality presents still another uncertainty. Stumps of Scotch pine 10 years or older are prone to die, resulting in a scattered stocking of trees.

Douglas-fir. As has been the case in natural stands of the species (9), Douglas-fir plantations have proved to be excellent stump culture subjects (Fig. 66). Branches left on the stump turn up in a very straight and erect manner. This makes possible a production of stump trees that are equal in quality to the original growth. Stump mortality has not been a problem in Douglas-fir.

Stump culture with Douglas-fir has still another advantage: The subsequent harvests of trees from stumps can be obtained on a faster rotation than was realized for the first crop. In one series of experimental plots in St. Charles County, established in 1950 with 2-2 stock, some trees were first cut in 1956. A cutting of other trees followed in subsequent years. By December, 1963, one or two additional trees had been harvested from the stumps, depending on the date of the original cut and the vigor of individual trees. Moreover, heights of the stump trees ranged up to 12 feet, considerably taller than the trees originally cut. It has not been learned how long Douglas-fir stumps will stay in production.
Keeping Pace With the Industry

Staying abreast of problems, trends, and new methodology in the industry is of great importance to the grower, especially in terms of his own production area. Part of this need can be met through an active membership in the Missouri Christmas Tree Producers' Association. Since its organization in 1959 this Association has been holding two meetings annually, one indoors and one in the field. Programs are concerned with techniques and problems in growing and marketing trees at the state level. Members also receive the American Christmas Tree Growers' Journal. This publication carries many timely articles of national interest.

The young Christmas tree industry is evolving rapidly. Research continues to develop new strains and varieties within species. Cultural methods and related equipment are being improved. The life blood to all of this advancement is the work of progressive growers, whose ingenuity is adding much know-how to the art of growing and marketing Christmas trees.

Literature Cited