Holly Production in Oregon

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Cover plate—One of the largest holly plantings in Oregon is the George Teufel planting at Wilsonville, a 40-acre block of 15-year-old trees planted 25 feet apart.
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The culture and marketing of Christmas holly has become a major item in the horticultural specialty crops industry of Oregon and the Pacific Northwest. Commercial holly growers in Oregon ship annually an average of more than 50 carloads of holly greens from the Portland area alone, besides numerous smaller shipments from other points. The return from this crop to the growers is estimated at $150,000 annually. This holly is produced on approximately 750 acres, less than half of which is now of productive age. This does not include the many trees and hedges cut each year in home plantings.

The planting phase of this industry is still underway and in time this acreage will be increased materially. It is true that a part of the present acreage is or will be unsuitable for commercial shipment, as the trade is demanding an increasingly higher quality product. Although the demand at present would seem to justify some expansion in acreage, it is not sufficient to warrant the planting of holly which because of wrong variety or growing conditions will not meet the rigid requirements that are sure to develop by the time it comes into production.

Commercial Production Presents Problems

The rapid development of holly production in the Pacific Northwest during the past 20 years has brought about an interest in this ornamental plant from the orchard production standpoint, as well as for use in landscape planting. The problems involved in growing English holly in large orchard tracts for commercial production are different from those of the landscape planting, where the question of variety, maturity, and yield are not so important. The handling, shipment, and sale of cut holly further complicates the problem.

The Oregon Agricultural Experiment Station has been conducting research on holly production problems for the past 15 years. The results of these studies and the experiences of growers have done much toward solving some of these problems. As these studies progress more detailed information on some phases of holly production will be forthcoming.

Note: This bulletin is revised from and is to supersede the mimeographed Station Circular of Information 409, a preliminary report now out of print.
English holly may be cut rather severely without injury to the tree. Since very heavy cutting in one year may result in a light crop the following year, planned cutting is necessary for a sustained yield.

Species of Holly

There are several ornamental species of holly adapted to parts of Oregon, but the one used for the production of Christmas sprays and wreaths is known as English holly or *Ilex aquifolium*. Another species, *Ilex opaca*, or the American holly, native to the South Atlantic states, is also used for Christmas greenery in the East, but does not compare in quality to the English. For this reason it is seldom planted in the Pacific Northwest.

Varieties of English Holly

There are many varieties of *Ilex aquifolium*, which early British horticulturists carefully described. The Kew Gardens in England, as well as several commercial nurseries, have many of these varieties. Early issues of the Gardeners' Chronicle carried detailed descriptions and illustrations of over 150 varieties found in England. A number
of these varieties have found their way into Northwest collections. Of these, the so-called Common English, Dutch, and the variegated forms are commonly used as Christmas greens.

In the early days propagation by seedlings resulted in numerous variations from these original varieties and in some cases it appears that hybrids between two or more of these may exist. The number of these strains or new varieties is limited only by the number of seedling variations that developed. Holly seedlings, like our common fruit plants, tend to resemble their parents in many respects, but there is sufficient difference in most cases to make them distinct varieties.

As the interest in commercial holly production developed, selections of desirable types were made from seedling plantings. These selections have been kept fairly true-to-type by vegetative propagation. In most cases, however, these original selections were made from several desirable trees and do not represent a true clon or variety, but a mixture of varieties with similar appearance. The trend at present is to propagate a true variety from one tree and thereby produce a uniform product.

**English varieties**

The common English varieties vary considerably in wood, foliage, and berry character. They have in common a solid green leaf of more or less spiny character and berries which are either red or reddish-orange. The principal wood difference is that of color, which may be either blue or green or a blending of the two colors. This characteristic of stem color has been used to roughly classify varieties into two groups, blue- or green-stem types. One of the principal types in commercial production today is a collection of blue-stem varieties commonly referred to as French-English. The same is true of the more or less green-stem types of which the Bleeg selections are typical. A third group that contains several intermediate stem color types is found in the Sickler selections. These groups do not represent true clons or varieties, however, since they are mixtures to a greater or lesser extent of seedling types which have in common only stem color in many cases.

The original plantings of the so-called French-English holly were apparently of a mixed nature, since considerable variation is found in orchards supposedly of this origin. While some of this variation is no doubt owing to location and growing conditions, there are several distinct types found as mixtures. Varieties of French-English (Select French-English) have been known variously in the trade as Peyran, Gigharbor, Falco, Brotje, and Bluestem. Until the
variations that exist from one planting to another and within the same orchard can be explained, they cannot be considered as true clonal varieties.

As a group the French-English hollies produce trees of relatively heavy blue-stemmed wood with good foliage. The principal objection to this group is the late-ripening habit of its berries. This is variable, however, and may not be the case with all varieties classed in this group. This late-ripening factor is known to vary with location and the degree of pollination. This group produces large numbers of parthenocarpic berries, which are later ripening than those with completely developed seeds as a result of adequate pollination. Pollination requirements of the French-English hollies have in some cases been overlooked, since it was considered "bi-sexual." The French-English berries are firm and handle well compared with some of the earlier ripening types. The best of these French-English trees should be selected, named, and kept free from mixture by vegetative propagation from the original tree. Only those trees that produce berries that ripen well before Christmas should be selected.

Both the Bleeg and Sickler (Bailey) groups contain seedlings that have good foliage and wood character. Since they also have early-maturing berries in most cases, they are being used further in the selection of desirable commercial types. A desirable single tree selection has recently been made from the Sickler collection and named Rederly because of its early berry ripening and other desirable characteristics. Further selection and naming of varieties will probably occur in this group as well as in other groups in the future.

**Dutch varieties**

The Dutch types of English holly differ from the Common varieties in leaf and berry character. They are smooth-leaved without the spiny margins so commonly associated with Christmas holly. The berries are generally larger and of more uniform round shape. The berries ripen quite early and are sufficiently firm to withstand handling. These desirable berry qualities have placed the Dutch hollies in demand for wreath berries. Seedlings have been found that resemble in some ways both the Dutch and Common types. It is entirely possible that hybrids between the two distinct types exist.

**Variegated forms**

The Variegated forms of English holly are assuming increasing importance as cut holly. The Silver Variegated with its white or silver-penciled margins is in favor for both spray and wreath holly; so much so that to date it commands a higher price per pound. There
is some variation in the Silver Variegated group as a whole. The variegated trees are ordinarily shy berry producers. Some propagators believe it possible to select and propagate a variety with higher berry production. Since the leaf margin may vary from pure white or silver to less pleasing shades, only the best types should be grown. Until such time as the most desirable of these silver-margined forms are selected and propagated as a clone, holly growers should take care to get the best type available and not some off-type mixture.

The Golden Variegated, Yellow-berried, Splash or Pinto hollies and other novelty varieties may find special uses as time goes on. These are being propagated more or less true-to-type, and may be considered true varieties.

Horticultural Variety Studies

The importance of obtaining the right variety cannot be over-emphasized. The prospective grower should not plant his orchard until he is sure he has the best varieties of holly available. Plantings made now will come into bearing at a time when competition will be such that only the very highest quality holly will be marketed. It may be desirable to grow two or three of the best varieties in order to supply the varied uses to which the greens are put.

Until a holly is propagated vegetatively from one-tree foundation stock, free from mixture, it cannot be considered a variety. A collection and study of holly varieties grown in Oregon and Washington are being made at the Experiment Station near Corvallis and at the Astor Branch Experiment Station at Astoria in an effort to assist the holly industry in selecting the best varieties for naming and propagation as true clonal varieties. This is most important to the future development of a standardized product.

The variety collection at the Oregon Agricultural Experiment Station contains over 60 selections and more are being added continually. On the next page are listed those which have been given horticultural variety names by various propagators and are generally available in the trade.

It is hoped that variety studies will make possible the accurate description and evaluation of the various holly varieties while growing under similar conditions. Such studies are of a long-time nature, however, and observations over a period of years are necessary before any conclusions can be made as to the relative merits of these many varieties. Until this can be accomplished, it behooves the prospective grower of holly to investigate carefully the varieties of holly being grown and make his selection with an "eye to the future."
Green varieties
Bailey's Pride
Brownell's Special
Callison
Christmas Eve
Coleman
Drew's Early French-English
Early Commercial
Escort (male)
Firecracker
French-English (Peyran, Falco, Gigharbor, Brotje, or Bluestem)
Pilkington
Rederly
Oregon Select
Sherwood
Strong's Redberry
Teufel's Green-stem
Teufel's Large-berry
Yuleglow

Variegated varieties
Silvary
Silver Trim
Teufel's Silver Variegated

Requirements of Commercial Holly

The growers and shippers of Christmas holly are not entirely agreed on all the points desired in a commercial holly, but there are certain requirements generally accepted. These requirements will vary somewhat depending on the form in which the holly is to be marketed.

The ideal spray holly should have:

Stems: (1) that have a well-balanced branch development.
(2) that are not excessively coarse or woody.
(3) with the leaves distributed uniformly along their entire length.
(4) resistant to withering and dropping of leaves in shipment.
(5) that may be either green or blue in color.

Leaves: (6) that lie flat and at right angles to the stem.
(7) of deep green color and gloss even when carrying a heavy crop of berries.
that do not drop or lose color when heavy crops of berries are set, or under adverse growing conditions.

(9) that are seldom if ever smooth in character, but flat at midrib and ruffled and spiny on the margins.

(10) that are not coarse, but of good size and substance.

Berries: (11) of uniform size and shape with bright red color well before Christmas.

(12) well distributed throughout the spray and not clumped in a few heavy clusters.

(13) that are firm and resistant to bruising and darkening when red-ripe.

(14) that do not shatter when ripe.

Holly for wreath making has essentially the same requirements as those outlined for sprays, with the exception of berry types. The berries used in wreaths are “made up” from extra large berries borne in clusters by some varieties especially adapted to this use. They must be of bright red color and sufficiently firm to stand considerable handling without bruising or shattering. Some of the Dutch strains have the berry size and quality to meet these requirements. Well-developed terminal shoots are ordinarily used in supplying the green for the wreath.

Certain types of English holly are grown in pots to a height of one to two feet as little Christmas trees. Some of the variegated foliage types are quite decorative without berries. The selection of a variety or method of growing which will set berries while the tree is small and not more than three years old is the ultimate objective.

Still other varieties need to be selected for landscape use. Some have a columnar habit of growth. There are weeping forms and small bush types. Others are especially suited for hedge work. Color of leaf and berry would no doubt be a factor in their ornamental use.

A variety of holly that will reach maturity for cutting at an early age has a decided advantage. The foregoing requirements, however, should not be forfeited in order to gain two or three years in getting the trees in production. Some varieties will produce sufficient growth and berries in six or eight years so that cutting may be started, while other varieties may require a period of nine to ten years before the first crop can be harvested.
Berry Ripening Is Important

In selecting the variety to grow, the question of berry ripening should not be overlooked. With the trend toward earlier cutting to lengthen the harvest period, the necessity for growing varieties that ripen their berries well before Christmas becomes important. Berry ripening will vary from year to year with seasonal climatic conditions, age of the trees, and varied growing conditions in different locations. Studies have shown that pollination also has its effect on berry maturity. Some varieties, however, are by nature so late in ripening their berries as to be useless for commercial purposes.

Location, Sites, and Soils

The Pacific Northwest with its mild, moist winters and relatively cool summers is especially well-adapted to growing English holly. It has been demonstrated that holly can be grown successfully both in the valleys and along the coast in western Oregon. This area does not extend farther south than Douglas County in the interior valleys because of the relatively hot, dry summers unsuited to the best growth of holly. The southern range of holly adaptation along the coast is yet to be determined, although individual specimen trees of good growth are found throughout the coastal area.

The largest part of the present holly acreage in the state is centered in Washington, Clackamas, and Multnomah counties with lesser acreage in Marion and other valley points. A few plantings have been made on the coast in the vicinity of Tillamook, Seaside, and Astoria.

Coastal vs. interior valleys

There are advantages to be found in both the coastal and interior locations. The cool, moisture-laden air of the coast, even in summer, is conducive to the development of the finest type of holly foliage. These same conditions, however, have been thought to delay maturity of the trees and subsequent berry production. The influence of these climatic factors on berry ripening has not been determined. It is likely that varieties can be selected which are especially adapted to growing under the specific climatic conditions in this area. The advantage in soils and nearness to shipping centers in favor of the valley areas cannot be overlooked. The advantages of one locality over the other, however, are more apparent than real and, in all probability, the acreage will continue to increase in both sectors.
Selecting the site

The ideal site for the holly orchard has not been determined. The question of slope does not seem to be critical. There are good orchards growing on level sites on the valley floor and on slopes with all possible exposures. There seems to be some advantage in north and east slopes for shade. For the best growth of holly and berry production the site should be protected from strong drying winds, in order to prevent excessive dessication or drying out.

The importance of good soil drainage should not be overlooked. Holly trees like most other tree crops are not adapted to wet, poorly drained locations. The orchard should not be exposed to seasonal river floods. If flooding does not actually interfere with harvesting operations, it will leave deposits of silt and debris that make the crop unfit for cutting. The orchard should be readily accessible at all times of the year.

Soil requirements

A deep, fertile, well-drained orchard soil is a decided advantage in growing good holly. Although holly will grow on a wide range of soil types of high and low fertility, the planting should not be made on marginal tree land. The problem of maintaining foliage quality along with heavy sets of berries will not be easy unless the soil is naturally quite fertile. The soil should be retentive of moisture throughout the summer months. Soils three to four feet in depth and liberally supplied with organic matter should grow good holly. Like many of the other broad-leaf evergreens, holly responds to soils high in organic matter. It is a generally accepted fact that slightly acid soils are best. It has not been determined, however, how critical a factor this may be, and at present holly is found growing on soils of varying acidity. It is quite probable that holly orchards on exceedingly acid soils may be benefited by liming, if for no other reason than to promote cover crop growth. Whether an excess or lack of soil acidity can be associated with some present orchard ills is yet to be demonstrated.

Pollination Requirements

Male and female trees

English holly is a dioecious plant, that is, one in which the male and female flowers are borne on separate trees. The female (pistillate) or berry-bearing trees produce flowers without viable pollen and are dependent for pollination upon the male (staminate) trees, which produce no berries. See illustrations on pages 24-25.
The importance of male trees for pollination is shown in this graph. Points on the graph show the per cent of berries with seed as a result of proper pollination. As the distance increases from the only male tree in the orchard there are fewer seeded berries. The berries without seeds (parthenocarpic) tend to drop throughout the summer.

The fact that certain strains of holly set more berries than others in the absence of male trees (pollinizers) is owing to the tendency of some varieties to produce considerable numbers of parthenocarpic fruits (berries which develop with sterile seeds). Of the leading commercial types studied, however, none produce sufficient numbers of these berries for commercial purposes. It seems probable that the popular concept of a "bi-sexual" condition (both male and female flowers on the same tree) in holly has been brought about by the fact that some varieties were observed to produce berries in this manner.

Pollinizers necessary

Studies made by the Oregon Experiment Station during the past several years have shown conclusively the necessity of having sufficient numbers of male trees in the holly orchard to provide adequate pollination and berry set. The number of pollinizers (male trees) required, however, is small when compared with other tree crops. Limited observations indicate that one male tree for every fifty female or berry-bearing trees will be sufficient to supply the
The immature berries of two varieties of English holly cut transversely to show the difference in size and structure of parthenocarpic and seeded fruits. Note the large size and full development of the seeds in the lower (pollinated) row as compared with the small size and lack of seed development in the upper (unpollinated) row of fruits.

necessary pollen in normal years. Increasing the proportion of male to female trees beyond this point may result in too heavy a set of berries in some years with a resultant loss in foliage color. Male trees should be selected that have desirable foliage for wreath making and in addition a capacity for producing large amounts of viable pollen at the time the berry-bearing trees are in bloom.

A comparison of the fertilized berries and the sterile (parthenocarpic) fruits produced by a given variety of holly shows that the fertilized berries are considerably larger, heavier, earlier ripening, and are more likely to remain on the tree until harvest. Parthenocarpic berries are inclined to drop when growing conditions are unfavorable. Fertile berries developing as a result of pollination do not wither and shrink to the extent of those produced without pollination.

Experimental evidence indicates there is a correlation between adequate pollination and early maturation or ripening of the berries. Varieties of holly that have a tendency to mature their berries late and have poor color at cutting time may be helped materially by providing adequate pollination. This is but one of the factors involved, however, and some varieties are by nature so late in ripening their berries that they are worthless for commercial purposes. Mixed seedling orchards will almost always show a few specimens of this late-maturing type.

Introducing pollinizers

The introduction of pollinizer limbs by grafting or budding scions from male trees into the orchard is one method of providing
pollen. The addition of male trees to the orchard will probably be the more economical method to use in orchards since so few trees are required. In any case, they should be so placed as to be equally distributed among the berry-bearing trees. The use of bouquets of male blossoms in the orchard during the blossoming season will help until male trees can be introduced. Since holly is insect pollinated, the presence of a few stands of bees in or near the planting will make the pollen that is present go farther.

**Holly Propagation**

English holly can be propagated by either seedage or vegetative means. The use of seeds, however, is responsible for the wide range in plant types and the excessive numbers of male trees in seedling plantings, and for that reason cannot be recommended as a method of propagating commercial planting stock. The variations in leaf and berry character, as well as in berry ripening dates, make the production and marketing of holly from seedling orchards difficult. Such plantings should be either top-worked or replanted to uniform types of commercial value. Many seedling trees are useless for commercial purposes as their berries mature too late in the season. They are also unreliable as to time of tree maturity, some being rather late in coming into bearing.

Holly seedlings may be used as understocks on which to graft or bud desirable selected varieties. This method is still used by some propagators, but with the development of root-inducing chemicals for cutting propagation this method has lost favor in recent years. The germination of holly seeds is a slow process, usually taking from one to two years. It is then necessary to grow the seedlings an additional year or two to get sufficient size for budding or grafting. It is true that a larger tree which temporarily has a more extensive root system results, but this advantage is soon lost after a few years in the orchard. One objection to budded trees on seedling roots is the possibility of suckering below the union, which will result in seedling branches being produced in the otherwise select tree. These may be overlooked until they start to produce off-type berries or no berries at all, if the seedling happens to be a male. With properly budded trees this should not be a problem to a grower who is familiar with grafted trees and their care. Some very fine holly orchards in the state are growing on vigorous seedling understocks, which were budded or grafted in the nursery row. Propagation by this means, however, should be reserved for the experienced propagator and cannot be recommended for the amateur.
Vegetative propagation

Holly may be propagated from cuttings, layers, or by budding or grafting. Propagation by these methods has a distinct advantage over reproduction from seed. Plants resulting from this type of increase are true to type, that is, they have the identical characteristics of the plants from which the wood was taken.

Tip cuttings made from well-matured current season's terminal growth and treated with the proper rooting hormone are the quickest and most economical means of increasing English holly. Trees produced from cuttings have both branch and root systems identical to the parent stock.

The cuttings can be taken at any time after the current season's growth has matured its wood, i.e., usually in late July or August. Cuttings taken during this early period are often more easily rooted than those made later in the year when they have entered the rest period. Cuttings of English holly, however, have been successfully rooted as late as February in tests at the Experiment Station. Taking cuttings this late is not recommended as a general practice; they should be made between mid-August and January. Changes taking place within the cutting wood just prior to the resumption of growth in the spring do not seem conducive to a high percentage of rooted cuttings.

Use of root-inducing hormones

The cuttings should be taken from well-matured terminal shoots. These terminals give better formed young trees than do cuttings without the terminal bud. Where full utilization of the cutting wood is desired, several cuttings may be made from a single shoot. The cutting should be made approximately four to five inches in length, with all but two or three of the tip leaves removed at the base of each petiole. The cuttings should then be treated with one of the several commercial forms of root-inducing chemicals having as its active ingredient indole-butyric acid or with the pure chemical itself. If one of the commercial forms is used, the recommendations of the manufacturer should be followed. There are some commercial materials for rooting cuttings that do not contain indole-butyric acid as an active ingredient. These cannot be recommended for holly cuttings. Tests at the Experiment Station and elsewhere have shown the superiority of indole-butyric acid for the rooting of most species of woody cuttings, English holly in particular.

Those who plan to propagate large numbers of cuttings should familiarize themselves with the use of this rooting chemical, indole-butyric acid in its pure form. The acid crystals can be obtained from
Harvest season for Oregon’s fast-growing holly industry
most chemical supply houses or through local druggists. A small amount of the chemical will treat many hundreds of cuttings.

There are numerous ways of applying the chemical to cuttings, but the most successful method for holly has been the solution-immersion method. The bases of the cuttings are soaked in a dilute solution for a definite period of time.

**Preparation of hormone**

A solution, ready for use, is made by dissolving the indolebutyric acid crystals (previously weighed by the propagator or by a druggist) in a few drops of 95 per cent ethyl alcohol. This is then diluted with the required amount of water to give a concentration of 50 ppm (parts per million), the recommended strength for holly. A simpler method, where large numbers of cuttings are to be treated over a period of time, is to make up a stock solution of the chemical for later dilution as needed. If stored out of the light and in a cool place, the solution will keep for weeks without much, if any, loss in effectiveness. This stock solution can be made up to fit the needs of the propagator. One method is to dissolve 1 gram of the acid crystals in 200 cc. of 95 per cent ethyl alcohol. This amount of stock solution is sufficient to make 5 gallons of the dilute solution for treating the cuttings. Smaller quantities can be made by proportional dilution. One quart of a 50 ppm solution, for example, can be prepared by adding 10 cc. of the stock solution to 1 quart of water.

**Application of hormone**

The cuttings to be treated are tied in small bundles and placed in a suitable container (not metal) of the solution so that the basal ends of the cuttings will be immersed to a depth of at least one inch in the liquid. They should be treated for 24 hours. The solution can be used three times if the successive treatments are made within a week, and if evaporation and exposure to sunlight and high temperatures are prevented. During treatment, the cuttings should be out of direct sunlight but still in good light. A moderately dry, warm atmosphere (65-70° F.) has given good results. The rate of absorption of the chemical varies with humidity and temperature, and unpredictable results will occur with too great a deviation from the above conditions. The temperature of the solution itself may be a factor and should correspond to normal room temperatures before treatment is started. It is generally recommended that the cuttings be rinsed off in tap water immediately after treatment.

The cuttings should never be allowed to become dry. After treatment they should be placed immediately in the propagating
frame in a media of one-half clean sharp sand and one-half peat moss by volume. If bottom heat can be provided to keep the base of the cuttings at 60-70°F, it will materially hasten rooting. The tops of the cuttings should be kept five to ten degrees cooler for best results. The bed should be kept moist at all times, but only moist enough to prevent drying out of the cuttings. The cuttings should be placed deep enough in the media so that the foliage is just slightly above its moist surface and the media firmed well about them. This will help prevent drying out of the stems and foliage. If the leaves become withered or drop because of excessive moisture and high temperatures, there is little chance of the cuttings rooting.

Three or four months are normally allowed for rooting although some cuttings will root in less than a month’s time if properly handled. The above treatment has given excellent results in rooting holly for several propagators. Ninety per cent rooting of cuttings taken in December and January is not out of the ordinary.

Transplanting care

After rooting, the cuttings are given more space by transplanting to pots or shaded beds. A good garden loam incorporated with liberal amounts of peat moss will make both a good potting and bedding mixture. During this operation care must be exercised to prevent drying out or breakage of the newly-formed roots. Shading and careful watering of the plants for several weeks following this first transplanting are necessary. Ordinarily the plants need not be moved again until the following spring, when they are of sufficient size for lining out in the nursery row. Two to three years are required for cuttings to produce holly trees large enough for orchard or specimen planting. After the first transplanting from the propagating frame, the young trees should always be moved with a ball of soil about the roots. Transplanting is usually done in late winter or early spring but may be done in the fall after the rainy season starts.

Propagation by layers

This method of propagating holly is rather cumbersome where large numbers of plants are desired but may be used where only a few specimens are needed. The climate along the coast seems especially suited to layering, as natural rooting of some of the lower limbs occurs where they touch the moist soil. Holly growers on the coast may find this a rather easy means of obtaining limited numbers of new plants. Covering a portion of these lower limbs with soil will tend to hasten this natural layerage. The tip of the branch is left exposed. Roots develop from the buried portion. A small cut, one-third or more of the way through the underside of the stem where it is to be
buried, usually hastens the rooting process. After rooting occurs, the limb is severed from the parent stock and left with its own root system. The new plant should be left in place for another year before transplanting to the new location. This will avoid the shock of moving the plant before it has a sufficient root system.

**Budding and grafting**

The common shield-bud method as commonly used with fruit plants has been satisfactorily used to bud holly seedlings to selected varieties. This method may be used also to top-work small trees where the wood is still under one-half inch in diameter. The buds are ordinarily inserted in August or early September but can be placed at any time after the budwood is sufficiently hardened. The stock plants to be budded should be actively growing in order that the bark will slip satisfactorily. The budwood is selected from current season’s growth that has matured. Care should be taken to select only leaf buds and not flower buds. The leaf buds are the more pointed buds found on the more vigorous of the current season’s shoot growth. The leaves are trimmed off, with about one-fourth inch of the petiole left to serve as a handle for inserting the bud into the bark incision. The shield-bud method is fully described with illustrations in Oregon Extension Bulletin 528, Grafting and Budding.

Grafting has been successfully employed in propagating English holly in Oregon. A few propagators still use this method of producing selected varieties on seedling roots. It has also been used in a limited way by some growers in top-working older trees. It is not used to the extent that it was in the past, however, and the number of experienced holly grafters is limited. Grafting over old trees is an expensive and laborious operation and should be resorted to only in special cases. It can be used to an advantage for introducing pollinizer branches into isolated female trees or in occasional trees in the orchard to supply necessary pollen.

The common whip graft is ordinarily employed in holly grafting, although the cleft graft reportedly has given good results. These two methods are described in Extension Bulletin 528. The scions are selected from well-matured, last season’s shoot growth or from two-year-old wood. They are cut four to five inches in length and all leaves are removed. They should be collected while the plant is still dormant and stored in a moist pack under conditions sufficiently cool to keep them dormant until ready for use. The proper time to graft holly is being studied, but experienced propagators recommend that the scions be inserted just before the new growth starts in the spring. This is indicated by swelling of the buds.
Since grafting demands special experience and equipment, it cannot be recommended for general use by the untrained holly grower. Where grafting becomes necessary, it will pay the grower to hire experienced propagators to do the work unless he wishes to take the time to learn the principles and methods involved.

**Establishing the Planting**

Before planting the trees, the soil should be well prepared by the addition of large amounts of organic matter in the form of barnyard manure and cover crops. This treatment will help materially the problem of soil management during the early growth of the young trees. Serious weed pests should be brought under control at this time.

The question of planting distance for all orchard trees is always open to argument, but there appears little if any advantage in crowding holly trees. Observations made in old, established orchards show the necessity of allowing at least 20 to 25 feet on the square for the permanent planting. The use of filler trees to be later removed does not seem feasible with holly since the trees reach crowding size by the time there is sufficient production to offset the added cost of their establishment and later removal. It is also difficult to persuade an orchardist to remove mature trees, even though they may be interfering with orchard operations. It takes several years after their removal for the remaining trees to reach the same spread had they not been crowded. Holly trees make a wide spread when given ample space. The annual cut from such trees will be as great as from a larger number of smaller, crowded trees and the quality of the sprays will be better. In addition, orchard operations will be greatly facilitated. The rate of growth and development of various holly varieties will have a bearing on what planting distance should be used, but accurate information on this subject is not now available.

**Intercropping May Be Practiced**

Intercropping may be used to provide cash returns before the orchard comes into bearing. Low-growing crops such as vegetables, strawberries, and bulb crops can be used. Growers have combined poultry with holly, using the orchard as runs to an advantage. Intercropping greatly increases the demands on soil moisture and fertility so should be practiced only on good soils which are properly managed. This system, under good orchard management, can aid in lowering the cost of getting the holly into production.
The young holly trees should be kept in the nursery row until they are two to three years old and two to three feet in height. At this age they can be transplanted without undue shock. Well-balled trees can be moved to best advantage in late fall or early spring. Frequent rains during this time of the year help them to become established before the growing season commences. A mulch of manure, leaves, or sawdust around the young trees will aid in conserving moisture during this period of establishment.

**Soil Management**

Although more needs to be known about the soil requirements of holly, practices successful with other orchard crops in a given locality will not be far wrong in the holly orchard. The practice of clean cultivation during the growing season followed by a cover crop during the fall and winter months is generally accepted by holly growers. If turned under at the proper time in the spring, the cover crop will tend to maintain the fertility of the soil, as well as reduce soil erosion during the winter months. This is also one of the best and most economical means of maintaining the soil's organic matter, so important in moisture conservation. A cover crop greatly facilitates orchard traffic during harvesting operations at Christmas.

**Avoid excessive cultivation**

Summer cultivation should be confined to killing weeds. Excessive cultivation, besides cutting off many feeder roots, tends to dry out the soil and to destroy humus. Where irrigation is feasible, the possibility of permanent legume cover crops should be explored. Holly, like the other broadleaf evergreens, responds to cool, undisturbed soils of uniform moisture throughout the growing season. A permanent mulch of sawdust, straw, leaves, or barnyard manure will create such conditions if these materials are available in quantity. A ring mulch about the tree with the remaining area cultivated and cover-cropped would be ideal. The addition of commercial fertilizers through the mulch and to the cover crop area as needed would tend to take care of the soil management problem.

**Use of commercial fertilizers**

As the trees get older and are cut heavily, it may be necessary to resort to commercial fertilizers to maintain the annual growth. The choice of a fertilizer to use depends on what the soil is deficient in, as well as what mixture or proportion of plant food elements the holly trees may require. The proportion desirable for holly is yet to be determined. The best commercial fertilizer and how and when
to apply it will need to be determined for each location or orchard. This can be determined by the grower through the application of standard complete fertilizers in varying amounts to a few experimental trees and a study of their responses. At present, early spring applications seem desirable since there is some indication that nitrogen fertilization, if late, may result in delaying the ripening of both wood and berries. Fall and winter applications will lose much of their value through leaching. A study is being made of the fertilizer requirements of holly and more specific information will be forthcoming.

Harvesting and Pruning

Holly varieties will vary in the age at which the first sprays can be cut. Some varieties will produce trees of sufficient size and berry set to make cutting possible in from six to eight years. Most varieties, however, should not be cut much before ten years. This of course depends a great deal on growing conditions and no set rule can be made.

Cutting should be light during the first few years of harvest in order to allow the tree to further develop its productive area. This early cutting of sprays can be combined with pruning, using this opportunity to space the branches properly to overcome crowding in the more dense parts of the tree. Multi-stemmed trees do not seem to be of any particular disadvantage, since the problem in framing the tree is to get the maximum cutting surface. It quite often becomes necessary to top-back single leader trees as they get older, and force out growth below. There is some danger of crowding with resultant development of poor quality sprays, however, if all leaders are allowed to compete. They should be spaced and trained in a manner that will allow ample room for proper development.

As the tree becomes older, the old and devitalized wood should be removed whether marketable or not. This treatment will tend to promote the development of vigorous sprays of good quality on new wood. If the trees are properly fertilized and ample moisture is available, there should be a minimum of unusable material.

Amount of cutting varies

Harvest can begin at any time after the berries are red ripe providing the sprays can be preserved in good condition till they reach the consumer. Holly berries do not develop further red color after being removed from the tree. The question of the amount of wood or sprays to remove in a single harvest is a controversial one. The holly tree will tolerate severe cutting in any one year but such
Male flowers, which are borne in large clusters, are conspicuous with their long stamens covered with pollen. The non-functional ovary does not develop further, and after the pollen is shed the whole flower withers and falls. Male trees produce no berries.
While stamens are present in the female flower, they are non-functional and do not produce pollen. The large ovary is the most conspicuous part of the flower and, if pollinated, will develop into the familiar, decorative red berry which will contain viable seed.

This is the Female Holly Blossom

Photos courtesy Brownell Farms
cutting will tend to put the tree out of production for at least two and possibly three years, depending on the vigor of the tree. In addition, unduly heavy cutting has a dwarfing effect on the tree and will result in decreasing the total production over a period of years. It would seem advisable to remove only a portion of the marketable sprays each year and thus maintain a sustained yield from closer balance between roots and top. If the trees are not trimmed too heavily they will increase their size and amount of foliage more rapidly and return larger yields later. The failure of some varieties to produce good crops of berries in some years, however, might make it desirable to cut more heavily in years of heavy berry set.

Combining pruning with harvesting

In cutting the sprays, care should be taken to avoid cutting back the central leader of the tree and its several scaffold or main lateral branches. Heading back may become necessary when the tree gets excessively tall or widespread, but on the young tree this will tend to delay the tree in expanding its bearing surface. Some growers prefer to remove the limbs around the base of the tree to facilitate cultivation and to eliminate inferior sprays. This may not always be desirable, however, as these lower limbs, when left, shade the ground sufficiently to keep down weed growth in many cases, and will prevent too close cultivation near the trunk.

The cutting should be distributed over the whole tree surface, removing a certain amount from each branch system. The smaller laterals to be used for sprays may be cut in one of two ways. Ordinarily, it is necessary to leave a stub a few inches long at the base of the lateral in order that a new spray can develop from its latent buds. If the growth is too dense so that the lateral should be removed permanently, however, the cut is made flush at its point of origin on the main branch. This will not leave buds to replace the branch with new growth and thus will eliminate it.

In combining the harvesting and pruning operations, the cutters should be instructed to discard all unmarketable holly in the field since the extra labor and cost of hauling this material into the packing shed for grading is not justified. Some growers prefer to cut only marketable holly and let the pruning go until the rush period is over. This of course means another operation and will too often be avoided altogether.

The tips of the past season's terminal growth are used in "making up" wreaths. Heavy cutting of these tips from trees to be used for spray production cannot be recommended. The return from these tips may not be sufficient to offset the loss in well-bal-
anced sprays later on. The return from sprays is somewhat more per pound and cutting is much more rapid if the sprays are well-balanced both in branch and berries.

**Handling Cut Holly**

The whole question of handling holly from tree to consumer is in a developmental state and no one method can be said to be superior at present. It will pay the beginner to observe the methods being employed by large growers and handlers of holly who have pioneered in developing satisfactory means of preserving the fine appearance of the product.

**Holly is a perishable product**

One reason that holly is used for Christmas greenery is that its foliage retains its shape and color even when partially withered. Nevertheless, holly must be considered a perishable product. Its bright, fresh appearance may be seriously depreciated by exposure to dry air. It is also subject to defoliation and browning of the leaves.

With the present tendency toward early cutting, the problems of storing cut holly are becoming increasingly important. Early cutting reduces the facilities and personnel required to handle large quantities of holly. The earliest date for cutting depends on the date of berry maturity and the storage life of cut holly. Some growers begin cutting two or three weeks ahead of the latest shipping date, which in recent years has been around the tenth of December for express shipments from Portland to New York. Thus a storage period of two to five weeks is required if the product is to reach the ultimate consumer in first-class condition. Wreath makers will begin cutting the first of November or even earlier if they can be assured of successful storage.

Holly varieties differ greatly in the length of time which they can be stored. One variety may have twice the storage life of another under the same storage conditions. Observations made by the Oregon Experiment Station and by holly growers, however, indicate that handling methods which give good results with one variety are likely to give good results with other varieties.

**Handling cut holly in the field**

After the grower has decided on the day to begin harvesting, the next problem is to plan the field operations for the maintenance of quality. Quality may be lost by withering, mechanical injury, defoliation, and browning of the leaves.
Withering is prevented by avoiding exposure to direct sunlight and drying winds and storage in heated rooms. If holly is cut in warm, dry weather it should be moved to a cool, moist place within the hour.

Cut holly is often thrown from the tops of the trees into the crates or onto a canvas and dumped into the crates. Most varieties seem to tolerate this treatment, but excessively rough handling may cause cracks and scratches on the leaves. These injuries are inconspicuous at first but form discolored areas during storage. Severe damage may result if holly is handled when frozen. Cutting should be postponed if the temperature is much below 32° F.

**Defoliation and its prevention**

Holly which is kept moist from the time it is cut will begin to drop its leaves in a week or ten days, the time depending on the variety and storage temperatures. There are three means of controlling defoliation in cut holly: (1) partial drying, (2) hormone treatment, and (3) cold storage.

Allowing holly to dry out slightly before packing or using a porous package to permit slow drying during transit may be used as a means of preventing defoliation. A serious objection to this method is that the drying may proceed too far before the holly reaches the consumer, resulting in an inferior product.

Hormone treatment is now being used successfully to prevent defoliation for about two weeks, if the holly is held at common storage temperatures. In trials at the Oregon Experiment Station the most effective treatments prevented defoliation of “French-English” holly for four weeks at 50° F. This was as long as this holly could be stored at this temperature without discoloration. Thus, in long storage, the major problem is not to keep the leaves on but to prevent the tissues from dying and turning brown. It should be remembered that cut holly is alive and that it must be kept alive if it is to retain its best appearance.

The life of detached plant parts can be prolonged by reducing the rate of respiration. This is accomplished by cold storage. For storing holly longer than two weeks a combination of hormone treatment and cold storage is recommended.

**Preparation and use of hormone dip**

The hormone used is alpha-naphthaleneacetic acid. A concentration of 30 ppm is recommended as a minimum. Higher concentrations give a more lasting effect and may be needed where defoliating conditions are severe. Concentrations as high as 100 ppm have caused no injury to cut holly.
Alpha-napthaleneacetic acid may be purchased as such from chemical supply companies, or it may be obtained in commercial preparations used for delaying apple drop. If the pure compound is used, it should be dissolved in alcohol (just enough to dissolve it) before being added to the water. One ounce to 200 gallons gives a solution of 37 ppm. The addition of a spreader, such as used in sprays for pest control, may give better wetting.

Most growers find the commercial preparations easier to use. A concentration of 30 ppm is obtained by using three times the strength recommended for spraying apples. There are three forms of these materials on the market: (1) powders containing a large portion of filler, usually a wetting agent, (2) solutions containing oil and an emulsifying agent, and (3) solutions not containing oil. Among some of the powders are “App-I-Set,” “Fruitone,” “Niagara-Stik,” “S.N.A.,” “Stafast,” and “Vitatone.” Any of these brands are satisfactory for treating holly when used at three times the strength recommended for apples. If used in higher concentrations, some of them may leave a noticeable deposit on the foliage after drying.

Among the solutions containing miscible oil are “Kling-Tite” and “Parmone in Oil.” Oils appear to increase the effectiveness of the naphthaleneacetic acid. They must be used with caution. Holly which is cut and stored without ventilation seems to be more susceptible to oil injury than holly on the tree. Only light summer oils of high quality should be used. The emulsion in the dipping vat should not have a film of oil on the surface and should not contain over 1 per cent of oil.

Other materials have been tried in combination with hormones. Whenever holly can be given its maximum storage life with hormones alone, there would seem to be little reason to add other materials which, under some conditions, might produce injury.

**Dipping holly**

Treatment is usually applied by dipping. If the dipping vat is large enough, the crate containing the holly may be immersed. A typical vat is made of galvanized sheet iron reinforced with angle irons, holds three or four hundred gallons, and is equipped with a drain at the bottom. Cleaning is simplified by having the bottom taper toward the drain. The drain and valve should be of sufficient capacity to remove the loose berries and other debris that accumulates in the tank.

The holly is not allowed to soak in the solution but is merely dipped and allowed to drain. Some mechanical device should be used for lowering and raising the crates. The operation may be
speeded up by the use of a sloping drainboard beside the tank. In order to keep the solution as clean as possible, the crates must be kept clean. Dirt in the solution necessitates frequent renewing of the solution.

If the holly is dry before treatment, the volume of the solution will be gradually reduced. Tests show that one ton of dipped holly will retain 30 to 40 gallons of water after it has drained. To compensate for this loss, fresh solution can be added as needed until it becomes necessary to drain and refill the tank.

If the holly is wet before it is dipped, as is often the case, the dipping solution will be diluted. If the liquid level in the tank is not lowered at all, it may be assumed that every ton of holly adds 30 to 40 gallons of water and removes an equal amount of solution. Thus five tons of wet holly dipped in 400 gallons will reduce the concentration from 30 ppm to about 20 ppm. The solution could be brought up to its original strength at this point by adding hormone, one-third the amount originally used. These calculations are approximations at best and apply only where the holly that is being treated is so wet that the liquid level in the tank remains constant. When the holly coming in from the field is wet but not saturated, calculations based on changes of level in the tank might be made. The operator may prefer to start with a solution of double strength (provided the material used is known to be safe at this concentration) and to refill the tank after five or ten tons of holly have passed through.

Dirt, depletion, and dilution have been mentioned as reasons for renewing the solution. Another reason for renewing is deterioration of the ingredients. The rate of deterioration depends on temperature, aeration, and other factors. Until more information is available, it is not advisable to use the solution for more than three or four days.

**Packing and storing holly**

Holly is packed after it is dipped and before it dries off. It should be drained sufficiently to prevent the package from dripping. Usually it is culled, trimmed, and packed by hand from a bench or conveyor. One grower dumps it into the package from a chute. This reduces labor in the packing shed but necessitates more careful cutting and handling in the field.

Holly is usually packed soon after it is cut and is then stored in the package. The storage period includes the time it is in transit and in the hands of the distributor as well as the time it remains in the packing house. During this period its quality may be affected by the following environmental factors: (1) humidity, (2) temperature, and (3) presence of ethylene in the atmosphere.
Humidity is maintained by proper packaging. Cartons holding 3, 5, 10, and 25 pounds are commonly used. Smaller packages may be used for the mail-order trade. The cartons are lined with heavy moisture-proof paper, such as locker paper, and are sealed with gummed tape. This type of package is not completely moisture-proof but should retain some moisture on the surface of the foliage for at least two weeks under reasonably good storage conditions.

The ideal storage temperature for holly has not been determined. In tests conducted at the Oregon Experiment Station, holly remained in good condition 50 per cent longer at 32° F. than at 45° F. It is not a safe practice to store holly longer than two weeks without the use of cold storage. Most holly shipped from Portland to New York travels by refrigerated express. Holly should not be exposed to temperatures much below freezing. If it should become frozen, injury will be minimized by allowing it to thaw out slowly without handling or shaking the package.

Minute quantities of ethylene in the atmosphere will accelerate defoliation. Ethylene gas is produced by ripening apples, pears, and bananas; therefore holly should not be stored with these fruits. Another source of ethylene contamination is leaky gas pipes and incomplete combustion of gas and oil.

Holly for wreaths or corsages may be stored in bulk. The same principles apply in bulk storage as in storing within the package. In order to check discoloration from bruising, berries for wreaths or corsages sometimes are allowed to dry slightly before they are used.

In recent years there has been considerable interest in the use of transparent wrapping materials for small packages of holly. Large scale use of these materials, however, has been retarded by reports of severe defoliation and discoloration resulting from this type of pack. Storage tests at the Oregon Experiment Station have shown that both defoliation and discoloration are more rapid at a relative humidity of 98 per cent than at 85 per cent. Most holly packages are not moisture-proof and therefore not likely to maintain a relative humidity near 100 per cent, especially when subjected to high temperature and long storage periods. On the other hand, certain transparent wrapping materials can maintain a saturated atmosphere within the package; and it seems probable that the severe deterioration of holly that sometimes occurs in these packages is owing to this factor in combination with high temperature and long storage periods. If holly must be exposed to high temperatures, it may be advisable to use a package that will allow it to dry out slowly, since dry holly is less objectionable than brown holly. The many types of
transparent wrapping materials now available have widely different permeabilities to water vapor. Some are excessively permeable for this purpose.

**Diseases and Insects**

Disease problems should be brought to the attention of the Botany and Plant Pathology Department at Oregon State College. Reference (2) contains a discussion of the insect pests of holly and methods for their control.

**References**

1. Oregon Experiment Station Bulletin 528, “Grafting and Budding.”
2. Oregon Experiment Station Circular of Information 228, “Insect Pests of Holly.”
3. Oregon Experiment Station Bulletin 413, “The Cause and Control of Defoliation in Cut Holly.”