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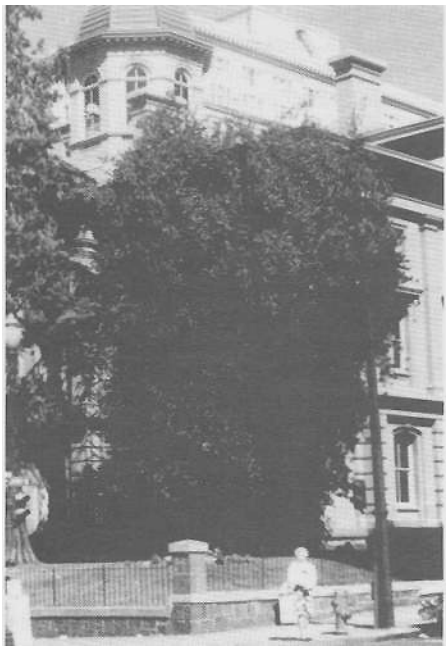
OVERVIEW OF COMMERCIAL PRODUCTION OF CUT ENGLISH HOLLY (ILEX AQUIFOLIUM) IN THE PACIFIC NORTHWEST

English holly, *Ilex aquifolium*, has been used for Christmas decoration in England and Europe for centuries and was used in Roman celebrations even earlier. *Ilex aquifolium* is native to England, France, Germany, southern Europe, northern Africa, and Asia.

Introduction of English Holly to the Northwest

Date of the first introduction of seeds or plants into the Northwest is not known, but a shipment of plants from Europe was received in 1869. Proof of the suitability of the Pacific Northwest climate for this plant is its naturalization in woodlands and hardens in the region. One of the earliest dated English holly trees in the Northwest is the tree planted on the grounds of the Pioneer Court House in 1874 which is still flourishing beside the Transit Mall in downtown Portland.



Dating from 1874, this massive English holly has been a landmark on the site of the Pioneer Post Office in Downtown Portland, Oregon. The trunk of this great holly measures approximately three feet in diameter and eight feet in circumference and soars to fifty feet in height.

Commercial Production of Cut Holly

Interest in holly as a crop in the Northwest started in the 1890's with shipments of cut branches from landscapes and small plantings to California. Initially holly was cut from trees and hedge plantings in yards. Then in 1891 forty trees were planted as an orchard at the Meeker place in Puyallup, Washington; the first holly was cut for sale from them in 1898.

Production Statistics

Cut English holly is a unique product from the Pacific Northwest. Growers in the region (coastal and valley regions of British Columbia, Washington, and Oregon) ship an average of 100-carload equivalents of holly greens and manufactured items by rail, truck and air from November

until about one week before Christmas. Conservative estimates are that the holly is grown on approximately 1800 acres in the Northwest, returns over two million dollars to the region's economy, and supplies over 85% of the world's crop. returns over two million dollars to the region's economy, and supplies over 85% of the world's crop.

By 1948 in Oregon there were an estimated 750 acres of cut holly production. A survey in 1957 by Melvin Conklin (OSU Agricultural Economics Department) identified 1380 acres of holly in Oregon (1130 acres of green and 250 acres of variegated holly) and 399 acres in Washington (376 acres of green and 23 acres of variegated holly).

In 1970, based on a survey, Roland Groder (OSU Marketing Specialist) estimated there were 1730 acres or 162,640 holly trees in Oregon. Many of the orchards are near Portland, and urbanization since 1970 has resulted in removal of some of the acreage. However, increased production from the remaining trees has prevented a drop in supply. Almost all the 50 holly farms in Oregon are family operated.

Marketing Information

Based on the 1957 survey results, Conklin reported that over 50% of the cut holly was sold in the Eastern U.S., 25% in the Midwest, and 25% in the Pacific and Southwest regions. Three-fourths was sold in bulk, - mostly to the florist trade. The balance was in 1/2 to 3 pound packages and wreaths. Approximately 92 percent by weight was sold at wholesale.

A report in the November-December 1963 issue of the Union Pacific Railroad publication stated that approximately 300 tons of cut holly was shipped annually via Union Pacific: 70% to New England and New York, 20% to midwestern states, and 5% each to California and the south.

Culture

Insect Problems:

With increased planting came pest problems such as insects, pathogens, and birds. A report from the Western Washington Experiment Station in 1928 stated there were no diseases and only a few insects. In 1930, California put a quarantine on holly because of scale. The cut holly had to be dipped in insecticide or inspected and certified that it was free of scale. The quarantine was lifted in 1938.

In the 1930's, the holly bud moth and holly leaf miner became established in the Puget Sound area and later moved south. The holly scale*, Dynaspidiotus (Aspidiotus) britannicus* (Newstead), is different from the soft scale. The female scales are round, almost one-eighth inch in diameter, flat, and brown, with a small yellow spot in the center of the scale. Control sprays should not be applied until late August.

The holly bud moth, *Rhopobota naevana ilicifoliana* Kearfott, has been present in the Northwest for more than 40 years. Injury results from the feeding and webbing of caterpillars in the new growth. Caterpillars hatch just after leaf growth begins in the spring. Control sprays are applied just after new growth starts, but prior to blossoming. Holly is the only known host.

The holly leaf miner, *Phytomyza ilicis* (Curtis), is the larval stage of a small fly. The flies are present in May and June and lay eggs in the young holly leaves. The maggots which hatch from these eggs feed between the upper and lower layers of the leaf cells. Evidence of their injury is first apparent in August as small red spots. By midwinter, feeding has been extensive enough so that light-colored blotches, one-half inch or more in diameter, are present.

Pathogens:

The disease caused by *Phytophthora ilicis*, a foliage pathogen, was first reported in Oregon by Milbrath (1939). In 1957 the cause of the disease was determined to be *Phytophthora ilicis* by Buddenhagen and Young, OSU Plant Pathologists. The disease was first observed in coastal holly orchards which were surrounded by Salal (*Gaultheria shallon*). D. L. Coyier (USDA Horticultural Crops Research Laboratory, Corvallis) has determined that the pathogen is present on salal and can be transferred both ways. It later spread into the Willamette Valley of Oregon during the 1960's. By the 1970's it was widespread and was causing heavy losses if a spray program for control was not followed.

Phytophthora ilicis infection produces black spots on the leaves and fruit, followed by defoliation and development of twig cankers. It is a cool weather disease which becomes active after the fall rains start. The fungicide "Fore" is currently registered for use on holly as a preventative, foliar application prior to infection in the fall. The pathogen appears to over summer in cankers on the stems and in the soil beneath the trees. The efficacy and phytotoxicity of dipping cut holly shoots at harvest into 30, 60, 90, 120, 150, 180, 210, 240, 270, and 300 ppm of copper was evaluated: There was no defoliation at 30 or 60 ppm. Defoliation then increased with increasing amounts of copper to 46.5% at 300 ppm. (For additional information on diseases of English holly in the Pacific Northwest, see Young and Buddenhagen, 1957. MacSwan and Young, 1970).

Leaf Variegation:

Foliage variegation of a given variety may vary with light intensity. The golden color in the foliage of 'Sunny Foster' is maximum in full sunlight. Shaded leaves will be dark green. Current year's foliage of the variety 'Moonlight' is gold-colored, but as the leaves grow older the green pigmentation increases in intensity.

Leaf color and variegation is a genetic trait, but intensity may vary with environmental and cultural conditions.

Berry Production:

The genus *Ilex* is dioecious in nature, that is male and female flowers are borne on separate plants. Female hollies will only produce berries containing seeds after insects, usually bees transfer pollen from the male to the female flowers. Dr. A. N. Roberts, OSU, studied pollination in 1946 and 1947 in a large planting of 'French-English' which had been planted without any male trees. Differences in fruit set and berry persistence were attributed to pollination or non-pollination from a naturalized male tree that was found in nearby woods. Roberts examined the fruit to determine the percent of berries with seed at distances up to 900' from the male tree. In 1946 at 300 feet distance from the male tree 80% of the berries had seeds (in 1947, 63% of the berries had seeds). However, at 900 feet from the male tree in 1946, only 25% of the berries had seeds (in 1947 at the same distance, 5% of the berries had seeds). French-English female trees could set fruit without pollination, but the non-pollinated fruit would drop under stress.

Because various species of *Ilex* differ in flowering dates (April 16 - June 19, English holly blooms from approximately April 29 to May 12), it is necessary to have a male of the same species or interspecific hybrid origin to insure pollination.

One of the problems in commercial production of cut holly is the variation in quantity of berried sprays from year to year. -This is particularly true with the variegated forms of English holly. Coller and Ticknor (1983) reported that production of berried shoots during the 1969-1981 period varied from 39.6 pounds per tree in 1977 to 0.29 pounds in 1978. They speculated that poor pollination weather during the blooming period may be responsible for some of the variation. It may also be accentuated by the tendency of growers to cut a tree heavily when there is a good berry crop and a good market available.

Post Harvest Care:

Discoloration, dehydration and defoliation must be prevented.

Defoliation:

Holly is a perishable crop which needs to be stored at temperatures of 32-34°F if it is to be held from early harvest till Christmas. Storage near ripening fruit or near holly that is infected with phytophthora will result in defoliation from ethylene. Ethylene was recognized as a cause of defoliation of cut holly during the 1930's. An NAA (alpha-Naphthalene Acetic Acid) dip to reduce defoliation was developed at Oregon State University in the 1930's and was described in Oregon Experiment Station Bulletin 413 "The Causes and Control of Defoliation in Cut Holly." When mixed with water the hormone (30-100 ppm NAA) is used as a dip. NAA-treated holly will store 14 days at 45ºF, almost two months at 32°F, and will freeze at 26°F. Holly is killed at 12°F.

Enclosing an ethylene absorber, such as a packet of zeolite impregnated with potassium permanganate, within the holly pack was shown by Fuchigami or Ticknor (unpublished research) to reduce defoliation by 60%, but defoliation (31%) was still unacceptable. Foliar application of silver nitrate (250 ppm) injured the foliage (Ticknor, unpublished research).

Preventing Dehydration and Discoloration:

Coating the leaves and berries with materials to reduce transpiration appears to be a logical procedure to reduce water loss. Waxes and antitranspirants tested to date by Ticknor (Apl-Lustr, Pear Wax, Greener) caused the leaves to discolor (darken) due to anaerobic respiration. Polyethylene bags are probably the best means of preserving moisture.

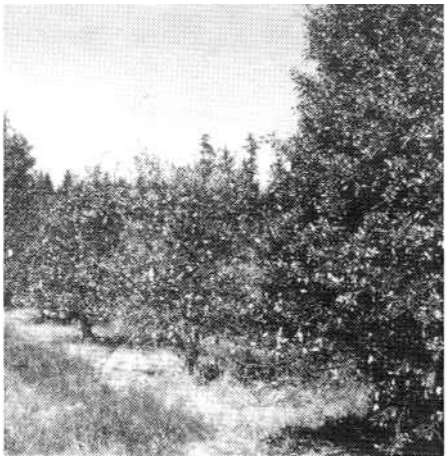
Cut holly in a vase solution of 4% sucrose + 8 HQC at 4.0 pH may have a useful vase life of 12 days.

Varieties -Breeding, Selection-Evaluation Programs in the Northwest:

The first variety planted in quantity was the French-English which has large, dark-green, glossy, attractively-twisted, spiny leaves and large red berries. For commercial production of cut holly it was a disaster. Its major limitation was the late berry ripening resulting in late harvest date: To spread the work load, it is necessary to start cutting by November 1, but cutting cannot commence until berries are ripe. Berries of the French-English holly variety usually do not ripen until early to mid-December, -too late for Eastern shipments. Because of the late ripening date for the berries, most of the French-English orchards have been removed. Selection and planting of better varieties was started during the 1930's and continues to the present. The following varieties are planted in many of the current orchards: the green varieties ('Rederley', 'Teufel Hybrid' and 'Wieman's Favorite') and the variegated varieties ('Silvary' and 'Teufel's Silver Variegated'). The market demand for variegated holly is increasing.

Many of the early growers had favorite seedlings which they propagated and named. In the 1940's, many of these plants, plus other named selections from breeding programs, were assembled at Oregon State University by Dr. A. N. Roberts for evaluation at Corvallis and at the OSU Experiment Station in Astoria, Oregon.

In 1966, an agreement was signed with the U. S. National Arboretum, and Dr. R. L. Ticknor at the OSU North Willamette Experiment Station began evaluating selections coming from their extensive breeding program in addition to plants received from growers and USDA Plant Introduction Service. Since 1966, 235 selections have been received for evaluation. In 1975, OSU holly evaluation was consolidated when 46 *Ilex aquifolium* and 22 other *Ilex* that had survived the 1972 freeze were moved from Corvallis to the OSU North Willamette Experiment Station.



Differences in cold damage in 1972 reflected the genetic variability of the seedlings being evaluated at Corvallis.

Objectives and Selection Criteria:

1. Cold Tolerance:

Cold periods at Corvallis in 1950, 1955, and 1972 killed some of the plants and froze others to the ground. The low temperature in 1950 was -14°F. Two or three cultivars, including Wieman's Longspra, came through unscathed. In 1955, temperatures were near 60°F prior to the temperature dropping to 14°F on November 11. Most English hollies came through quite well, but American holly (*Ilex opaca*) was badly injured. During the December 1972 freeze, the low temperature was -8°F. Silver Variegated was most injured while Huckleberry #2 was resistant to freeze damage. Direction and amount of wind, exposure to sun, and differences in elevation all make a difference in injury.

2. *Phytophthora ilicis* Resistance:

Since 1977, holly selections have been screened at the OSU North Willamette Experiment Station for resistance to *Phytophthora ilicis*. All cultivars of *Ilex aquifolium* appear to be susceptible to *Phytophthora ilicis*, but there are differences. Many other species appear to be resistant to both infection and defoliation including *I. cassine, I. ciliospinosa*, *I. cornuta*, most *I. crenatas* tested, *I. glabra*, *I. intricata*, *I. latifolia I.perado*, *I. sugeroki, I. vomitoria*. Some interspecific hybrids of *I. aquifolium* with *I. cornuta*, *I. integra*, *I. latifolia*, and *I. pernyi* had low amounts of infection and defoliation.

Using holly selections which showed resistance to *Phytophthora ilicis*, Mr. William Kosar obtained seed from 44 crosses in 1978. These seedlings will be tested for resistance to *Phytophthora ilicis*.

3. Landscape Characteristics:

The wide range in berry color (white, yellow, gold, orange, red, black), leaf shape, color and variegation, and plant habit within *Ilex aquifoliurn* and its interspecific hybrids contribute to the potential of English holly as a landscape plant. Breeding and selection of varieties adapted to areas, in addition to the Pacific Northwest, where moisture and temperature variations may be more extreme would result in extended markets.

Orchard Establishment, Fertilization and Soil and Tissue Analyses:

Holly can be planted on flat ground or hillsides if the soil is deep and well-drained. Frost pocket areas should be avoided because tree losses occurred in 1919, 1949, and 1972 in those locations. A holly tree is generally 3-years old and 18 to 24 inches high when orchard-planted. In about 10 years, the tree is six feet tall. The optimum height for the trees in terms of cutting and pruning is about 15 feet, although the trees would grow as tall as 35-60 feet if allowed to grow unpruned. Trees are spaced 15-18 feet apart to ensure good air movement and lower the potential for development of foliar diseases such as *Phytophthora ilicis*. Regular pruning is necessary to

maintain the sharp, pointed leaf shape. Harvesting of berried branches starts when the berries are ripe, usually early November.

In 1960-1961, R. L. Ticknor and A. N. Roberts of the OSU Horticulture Department collected soil and leaf samples in 47 holly orchards in the Willamette Valley and on the Coast to establish general nutrient levels. **Leaf nutrient content varied with geographical area, sample site within an orchard, season, and clone**. All elements except calcium and magnesium were higher in the high rainfall coastal area. Foliar nutrient levels were most stable during the winter period. Tentative standards for the foliar nutrient levels of several cultivars were established from the results of the 1960-1961 survey (Roberts, etal. 1961. Roberts and Ticknor, 1970. Ticknor, etal. 1969).

Two nutritional problems were detected in the 1960-1961 surveys: **Boron deficiency** caused purple spotting of foliage and shoot tip dieback, and **phosphorus deficiency** resulted in yellowing of leaves surrounding ripening berries (phosphorus levels in the leaves decreased rapidly as the berries developed).

In 1983, a soft berry problem associated with low calcium concentration in the berry was studied. Soon after pollination, the total supply of calcium for the fruit moves into the developing berries. If the weather is cool at that time, there is lower calcium uptake. In addition, factors which cause the fruit to become extra large may result in soft fruit. Preharvest foliar-fruit spray applications of 4% calcium chloride prior to cutting will increase calcium concentration and firmness of the berries. Also, the cut branches with berries may be dipped into calcium chloride solutions. In testing concentrations of 0-4 percent calcium chloride and dipping times of 0-15 minutes, Ticknor found no statistical difference between dipping times and found that the holly cultivar 'Rederly' had increased firmness up to 4% calcium chloride while 'Teufel Hybrid' was firmest with a 3% solution.

A second foliar nutrient survey of 47 holly orchards that had been included in the 1960-1961 study was conducted in February 1984 -23 years later. All nine Silver Variegated and six 'Rederly' orchards that had been sampled earlier in the Portland area were still in existence in 1984, but about half of these orchards were neglected. Both the neglected and actively managed orchards were sampled in 1984.

Nitrogen was the element which decreased the most in the neglected orchards in the 1984 survey, and leaf size was markedly reduced on 'Rederely' which was competing with heavy sod. (A permanent sod cover makes harvesting during the rainy period easier and keeps the foliage clean. 1984 survey results emphasize that increased nitrogen fertilization or mowing to reduce competition is necessary when a cover crop is used). The lower levels of nitrogen and calcium in the foliage analyses in 1984 were not significantly different from those of the 1960-1961 survey. However, in the 1984 survey, potassium was significantly lower in the Silver Variegated plants, and magnesium was significantly lower in both the 'Rederely' and Silver Variegated plants. In 1984, foliar levels of phosphorus and boron (the two elements identified as deficient in the 1960-1961 survey) were higher than in 1960-1961.

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HOLLY in British Columbia

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There are ten orchards in south coastal British Columbia producing cut English holly: seven on Vancouver Island, the remainder in the western Fraser Valley. Approximately 33 acres are currently in active production, with about 25 acres on the Island. Of the 33 acres, approximately 4 acres are variegated holly varieties.

While small amounts of holly are sold locally, either retailing directly to consumers or selling to local florists, most of the holly is shipped to eastern markets, primarily Toronto and Montreal.

A major disease problem in British Columbia holly orchards is leaf and twig blight, *Phytophthora ilicis*. Holly leaf miner and scales are the most serious insect problems, although holly bud moth occasionally appears. Sprays are also routinely applied to control green algae.