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Filberts

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Filbert growing is a proved industry in the Willamette Valley of Oregon. Filberts are especially suitable as a diversity crop.

The Barcelona with suitable pollenizers constitutes most of the commercial acreage. More than one variety as a pollenizer may insure the needed extra pollen in unfavorable seasons.

Plant 25 feet apart on deep, fertile soil. Cultivate only to kill weeds or cover crops and establish a shallow mulch.

Begin cover cropping the first year and continue each year. Use any means available and economical to maintain vigorous growth and productivity.

Prune lightly to shape the tree and prevent crowding. Sucker frequently.

Filberts

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INTRODUCTION

THE filbert has been cultivated from early days. Pliny narrates: "Filberts and hazels which also are a kind of nut and were called heretofore Abellinae, of their native place. . . They come out of Pontus into Natolia and Greece and therefore they be called Pontick nuts. . . These filberts likewise are covered with a soft bearded husk, and as well the shell as the kernel is round and solid, all of one entire piece." He refers to Cato and Theophrastus as early writers mentioning hazels. The filbert was connected with European mythology and witchcraft, and even today many people use a hazel wand to locate underground water.

The name filbert is supposed by some to have originated from "full beard" referring to the husk entirely covering the nut. By others it is thought to have been derived from St. Philibert, as August 22 is dedicated to him, which date corresponds in England to the ripening date of the earliest filberts.

DISTRICTS ADAPTED TO FILBERTS

The Willamette Valley of Oregon and corresponding territory in Washington have been proved suitable for filbert growing. Here the filbert has been growing for three decades, and results show that its production is a commercial success in these places. Tests have been made in various other sections of the state for the past few years and indications are that filberts can be grown more or less commercially in other territories outside of the Willamette Valley. The fact that the catkins are killed at a temperature of about 15° below zero Fahrenheit when fully dormant will prohibit commercial production of filberts in some parts of Eastern Oregon. Along the coast the success of filbert growing has not yet been fully demonstrated, although in the Coast Range mountains some orchards are doing very well. There is still considerable experimental work and testing to be done before the value of this fruit can be definitely determined for many sections.

LOCATION

In the Willamette Valley of Western Oregon the chief factor in locating a filbert orchard is the soil. Any soil whether hill or lowland is suitable if it meets the requirements as outlined later. No slope has any particular advantage over the others except that on the south and west slopes the soil is usually more shallow and dries out more rapidly. Orchards on hill soils will probably average smaller in size of tree and less in production than those on the lower soils which are generally deeper. Elevations greater than 1,200 to 1,400 feet above sea level have been tried out so seldom that little is known as to the suitability of the high-lying locations.

There is no great advantage in locating on sites free from spring frosts as filberts bloom during January, February, and March, when temperatures below 32° Fahrenheit regularly occur. No appreciable loss in the crop with the commercial varieties is known to have resulted from cold weather during the blooming season. Catkins of early blooming varieties are occasionally damaged or killed. Pistillate flowers may be killed back or frozen back to the bud scales but unless nearly mature will continue to elongate and will be capable of producing fruit.

SOIL

The exact type of soil best adapted to filberts varies in different districts, but in all cases it should be deep, fertile, and well drained.

Depth. A good filbert soil should be 8 to 10 feet or more in depth. Recent investigations show that it is doubtful whether a soil 6 feet deep will maintain a mature orchard in regular, heavy production. The deep soils naturally afford a large supply of water and plant nutrients during the dry season. The effective depth of any soil is determined by the distribution of tree roots in it. If roots can grow to a depth of only 3 feet, the soil is a shallow one regardless of what is below. The idea that filbert trees are shallow rooted has practically been discarded since investigations have shown that under favorable soil conditions the roots readily grow to a depth of 8 to 11½ feet. Root penetration in a soil is stopped by rock, impervious hardpan, water table, sand or gravel, and lack of aeration in the soil. All of these conditions except the lack of aeration can be located in the field with a soil tube by borings which should be made to a depth of 8 to 10 feet. The aeration of the soil can now be determined only by laboratory methods. As all of the area of the Willamette Valley is included in the various county soil maps, a legal description of the land by section, township, and range will show on what soil type the tract is located.

With this knowledge and from the information gathered during the past few years, the suitability or unsuitability of a soil can in part be told. On file at Corvallis with the Oregon Agricultural Experiment Station and the United States Department of Agriculture are performance records of filbert orchards on many soil types together with chemical and physical analysis data for these soils which indicate their comparative value for filbert production. As soils of the same series vary so much according to location, it is advisable to make a detailed study of each particular soil, if possible, under the advice of the county agent. Soil-tube borings should be made and the information mentioned above should be used to determine the suitability of the soil. Soil samples sent in for chemical analysis or similar tests are of little or no value in determining the suitability of a soil for filbert orchards.

Fertility. A fertile soil is essential to the proper development of the filbert tree. As the fruit is largely borne laterally on one-year-old wood, plant-food materials should be present in the soil in sufficient quantity so that, with a plentiful supply of moisture, good vegetative growth can be obtained each season. Attempts to obtain this growth by means other than high fertility will in the end meet with failure.

In maintaining the fertility of the soil, a program that will insure the incorporation of large amounts of organic matter into the soil is of first

importance. Growing cover crops is the cheapest and usually the most satisfactory method of supplying organic matter. Vetch with some grain such as wheat, oats, or rye is the most commonly grown cover crop and the one most widely adapted to various soils. Vetch seed is sown at the rate of 30 to 60 pounds per acre with an equal or variable amount of grain. In many cases the greatest growth occurs in the late spring after the time the crop should be turned under to avoid the loss of moisture from the soil. The tendency is to delay turning under the vetch in order to obtain a greater quantity of green manure. Such delay in most seasons is very detrimental to the trees. In normal seasons no cover crop should be allowed to grow after the middle of April. All cover crops should be sown early, preferably the first part of September, in order to obtain as much growth as possible before cold weather.

Where they can be grown, early maturing cover crops offer an important source of organic matter. Winter-hardy crimson clover sown 10 to 15 pounds per acre, turnips 2 to 5 pounds, and even wild radish, commonly called mustard, sown 2 to 10 pounds per acre, respectively, give heavy crops on some soils. These crops mature early and the seed is relatively cheap. The seed for common mustard should be screened out of winter grain. Seed screened from spring-sown grain has very low germination.

On some soils cover-crop growth can be greatly increased by the use of commercial fertilizers and is the most satisfactory method of using commercial fertilizers in filbert orchards. Commercial fertilizers applied directly to the trees has so far shown no profitable and beneficial results.

Drainage. Filberts will not thrive in water-logged soils. The trees will survive under very adverse conditions, but tree growth and yield of nuts will be in proportion as the conditions approach the optimum for filberts. A filbert orchard soil should be well drained during the entire year, yet it should be capable of storing a large quantity of water for the use of the trees during the dry season. Filbert roots make a very extensive growth during the winter time in Western Oregon, but if the soil is water-logged this growth is retarded, or entirely inhibited. All growth of the tree is dependent on the formation of new rootlets and root-hairs. When root growth is inhibited or prevented by any cause, tree growth is correspondingly decreased. As a result of the lack of root growth when the demand comes during the growing season for large amounts of plant food materials and moisture, the root system has not made the increase in size to provide for a good vigorous growth of the top.

It has often been stated that the filbert will do well where the wild hazel grows. Without doubt where the very large, vigorous wild hazel grows, there filberts will grow well. While the wild hazel will grow in many places, yet its growth may be only that of a small shrub. The planting of filberts where the wild hazel grows, therefore, should be only on those soils where the wild hazel grows very large and vigorously.

With the filbert plantings being made at the present time and with the importation of nuts from foreign countries, it would seem without doubt that competition in the filbert industry will in the future be as keen as exists now in other kinds of fruit growing, so that orchards located where production will be only average or below will in most cases prove unprofitable. There is enough fertile land in Oregon for all the filberts needed without locating them on soil that is doubtful in depth, fertility, or drainage.

VARIETIES OF FILBERTS

A number of filbert varieties have been grown and tested in the Pacific Northwest. Some individual collections now contain more than 80 named varieties of filberts. Furthermore, a large number of seedlings have been under observation, and a few have come to public attention.

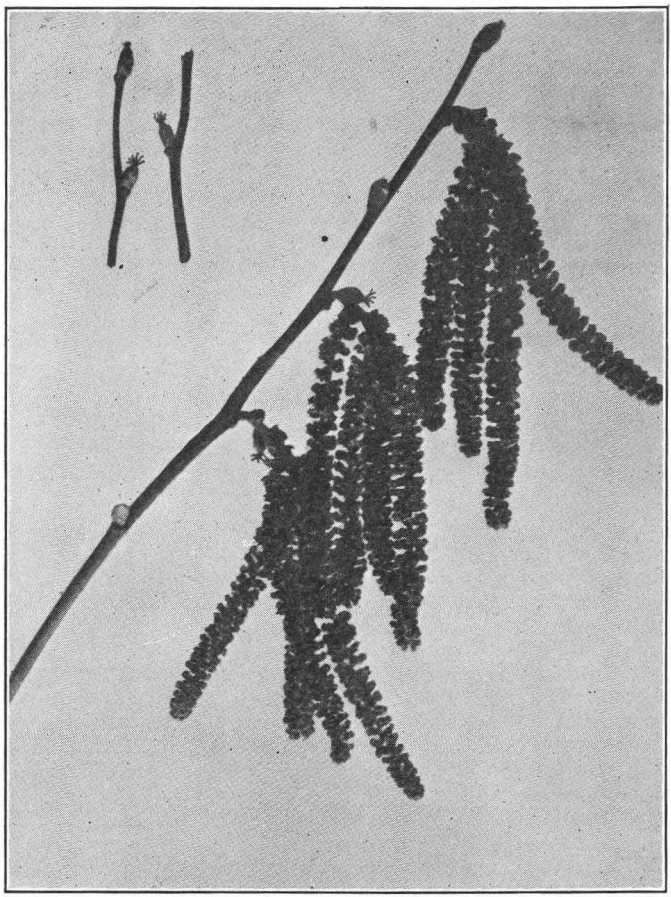

Figure 1. Filbert flower: *Above,* female or pistillate. *Below,* male or staminate, commonly called catkins.

The variety Barcelona and the varieties required for pollenizing it make up nearly all the commercial orchards in Oregon. The Brixnut has been planted to a limited extent. In Washington the DuChilly has been planted commercially as a companion variety to the Barcelona in some sections and as the sole commercial variety in others.

Barcelona (Grosse Blanche, Grosse Blanche de Angleterre, D'Alger, Rouge Ronde). Tree spreading, vigorous, productive; nut medium to

large, oval to triangular in cross-section outline; base fairly flat, swelling out above and coming to a more or less blunt point. Shell medium thick; color rich brown with darker striping lost in pubescence on upper one-third of shell. Husk one-third longer than nut, opens and sheds nut freely. One to eight nuts in a cluster.

Brixnut. Tree moderately vigorous, spreading, with heavy production becoming drooping. Production heavy, especially when young. Nuts large, roundish at base, tapering sharply to apex, base flat. Shell medium thick, covered with light pubescence on upper half making color slightly dull. Drops freely from husk. Has been planted commercially.

VARIETIES FOR POLLENIZERS

Below are listed a few varieties grown in commercial orchards in Oregon as pollenizers.

Daviana (Des Anglais). Tree vigorous, upright, close growing, very light producing. Nut quite similar to Cosford. Tree very subject to bud mite. It has proved a good pollenizer for Barcelona and in some seasons for DuChilly.

DuChilly. Tree medium vigorous, spreading, growth distinctive as shoots tend strongly to come out at right angles. Production medium. Nut large, long, flattened; shell medium thick, slightly rough. Husk one-third to three-fourths longer than nut. Nut does not drop freely. Pollenizer for Barcelona.

White Aveline (Aveline Grosse Ronde, White Filbert). Tree medium size to small; usually not very vigorous, production medium. Nut distinguished from Red Aveline by white skin of kernel. Catkins have grayish yellow color as compared to the red or purple of Red and Purple Aveline. Excellent pollenizer for Barcelona.

Bolwyller (Hall's Giant). Tree upright, compact, distinguished by pointed, bright red buds. Nuts large, round in cross section, broad base coming to sharp point. Color bright, glossy, rich brown. Production usually light. Known as Hall's Giant. Used with the Brixnut.

The ones listed below are all old varieties but have been relatively scarce. As they are now being propagated in greater quantity they are being listed as proved pollenizers for the Barcelona.

Du Province (Creswell, Du Provenz, Norelius, Clark County Cob, Emperor). Tree upright, spreading, vigorous. Nut small, round. Shell medium thick. Husk trifle larger than nut. Sold as Creswell.

Montebello. Tree moderately vigorous, upright, productive. Nut medium size, pinched at base, very flat at apex. Color grayish brown with distinct stripes. Shell medium thick.

Nottingham. Tree vigorous, upright, close growth and fairly productive. Nut medium to small, long, slightly flattened, increasing in width up to two-thirds of length then abruptly tapering to point. Color dark brown, with very fine striping. Shell thin, husk one-third longer than nut; nuts drop freely.

In the near future many new varieties will undoubtedly be introduced to the public. Thousands of seedling trees are fruiting in this area, and from these many promising ones are being selected and named. Such qualities as large size, very thin shell, and white kernels are to be had which make the nuts appear very attractive. Any new variety, however, before becoming established, must be grown for years under commercial conditions. Some growers may be justified in planting a new variety, but those wishing the safest investment will plant the old standard varieties. As any list of new varieties now being put on the market will be out of date within a very short time because of the elimination and addition of varieties, no list of such varieties is given.

POLLINATION

The self-sterility of filbert varieties makes interplanting a necessity in order to provide for cross-pollination. As the planting of one single variety will invariably produce a few scattering nuts, self-sterility can not be said to be absolute, but in a commercial sense it is near enough so to be considered as sterility. This has been shown to be true both in an experimental way and from the past experience of growers.

Under normal conditions the blooming season of the filbert extends over a period of at least three months, counting time from the beginning of the pollen shedding by the early varieties to full bloom of the pistillate flowers of the late varieties. Within this period there is a natural sequence of blooming for many varieties. There is considerable variation, however, from any sequence that could be established. There is also a wide variation from season to season in the length of time during which a variety may be in bloom. These variations are a result of climatic conditions. Seasons have been noted where late blooming varieties have shed pollen at the same time as normally early blooming varieties.

With the Barcelona there is a long period during which the pistillate flowers are opening (Figure 1). The period of pollen shedding of any of the pollenizers is relatively short. In some years the short pollen-shedding period does not coincide with the maturity of the greatest number of pistillate flowers. Because of this fact, if any one variety is used as a pollenizer, pollination may not be satisfactory. This is apparently the case in the orchards where the DuChilly has been used alone as a pollenizer for Barcelona. The DuChilly sheds its pollen fairly late and therefore in some seasons pollenizes only the later Barcelona pistillate flowers.

If any single pollenizer is used for a variety it should be one that normally sheds its pollen during the middle of the pistillate blooming time of the main variety. Thus with the very long blooming season of the Barcelona, the Daviana has been used alone in many plantings, as it practically always sheds its pollen at a time when a large number of pistillate flowers of the Barcelona can be pollinated. A study of the blooming records of the varieties would seem to indicate that for the most regular production, early and late blooming pollenizers in addition to the mid-season varieties would aid in getting a set of nuts in certain seasons. In the first orchards of DuChilly in the Pacific Northwest only one variety for pollenation purposes was included with the DuChilly. At the present time there is a decided tendency to use two or three varieties.

For pollenating the Barcelona the combination of White Aveline, Daviana, and DuChilly has been very successful. If only one variety is used, it should be the Daviana. The White Aveline is the least satisfactory of the three from a growth standpoint. Because of bud-mite infestations, the Daviana seldom bears heavily. The DuChilly occasionally bears a heavy crop which is generally followed by light catkin production.

The Bolwyller is used as the pollenizer for the Brixnut and in that combination bears more heavily itself than in any other so far noted. The nuts can be mixed with Brixnuts. The Bolwyller has been known to bloom out of season for the Brixnut. It has sometimes been used as a late pollenizer for the Barcelona.

The Du Province sheds its pollen from midseason to late for the pistillate bloom of the Barcelona. It seems to produce a regular crop of catkins. The nuts can be mixed with the small-sized Barcelona.

The Montebello is an early blooming variety and may be used to supplant the White Aveline. Care should be taken that the young trees have been propagated from a strain that is interfertile with the Barcelona. Different introductions from Europe have shown considerable variation in this respect. The nuts can be mixed with the Barcelona.

The Nottingham has a pollen-shedding season quite similar to that of the Daviana but generally averages a few days earlier.

In addition to the foregoing varieties, a good many seedlings have been tested. Many of these have proved interfertile with the Barcelona, but too little is known regarding their season of blooming, catkin production and other important factors for any of them to be recommended. Furthermore, very few of them are available for planting.

One pollenizer to eight Barcelona trees has been the regular practice. The use of one pollenizer to five Barcelona trees is not out of proportion when the orchards are young or later in unfavorable seasons. In favorable seasons and in older orchards a smaller number of pollenizers than one in eight will be effective. Some growers have planted pollenizers in the ratio of one to fifteen or one to twenty-four. It is in the unfavorable seasons that occur so frequently that a greater number of pollenizers will undoubtedly prove their worth.

When the pollenizers are used in the ratio of one to eight, a pollenizer placed every third tree in every third row gives the best distribution of pollen. When trees of more than one variety are used as pollenizers the varieties are planted in rotation. In that case any one variety may occur not more than every sixth or ninth tree in every third row. If the orchard is located on a site where there is a prevailing wind during the blooming season, pollenizers should be planted in the outer row toward the direction of the wind.

Grafting one limb in every tree to a pollenizing variety provides the best distribution of pollen but presents several difficulties unless the nuts from these limbs are very similar to those of the commercial variety or so small they will not be picked up. If all are harvested together tolerance in grading rules may be exceeded. Grafting pollenizing varieties in the trees will delay production of the trees as the blossoming of grafted limbs will be behind the main part of the tree. The difficulty of obtaining a good stand of scions has often still further delayed nut production. In some cases several years have been required to graft in the required number of pollenizers.

Pollination can be provided in an orchard lacking it by bringing in limbs with unopened catkins of the proper variety. If this is done just as the first pollen is being shed and the limbs put in buckets of water which are suspended in the trees considerable viable pollen will be shed that will aid in setting a number of nuts. This procedure is not practical on a large scale but can be used in a limited way until the trees planted or grafted for pollination purposes begin to produce pollen.

Many growers have attempted to pollinate their orchards with wild hazel pollen, brought in on branches at the time pollen was being shed. This has failed in every case noted as the pollen of the native hazel is incompatible with the filbert.

PROPAGATION

Seedlings. Seedling filbert trees are comparable to seedling apple trees and should not be planted for orchard purposes.

Cuttings. From the earliest writings up to those of the present time, directions have been given for the production of trees from cuttings. Directions are given for the use of hard-wood, semi-hard-wood, and soft-wood cuttings taken from either top or sucker growth. As sucker growth is more easily obtained, these instructions more often call for 8- to 12-inch cuttings made from the suckers. Suckers that come from far enough below the ground have lighter colored bark on that portion than on the part above the ground. Cuttings made with the light-colored bark at the base may root under proper conditions. Twenty to fifty per cent of such cuttings will root even if a whole sucker is used. This is the only condition under which general rooting is obtained, but better results can be had by allowing the suckers to root while attached to the tree. As the use of bottom heat and various media and stimulants has failed to furnish satisfactory results, the propagation of filberts by cuttings in any form is unsatisfactory.

Layerage. Practically all filbert orchards have been planted with trees propagated by some form of layerage. Good layered trees have the base of the roots concentrated in a small space at the basal part of the tree trunk. Suckers usually originate from this part of the tree trunk and from the old layered sucker material from which the tree was produced (Figure 2). If the roots on the layer tree are scattered along the layered sucker, the more of this sucker producing wood will be planted from which will develop a great number of suckers. Good trees can be produced with the roots massed on 2 to 4 inches of base of the tree.

Except when high prices for nursery stock prevail, propagation by layerage cannot be advised in a bearing orchard, as it is detrimental from the standpoint of tree growth and nut production. In young orchards the aim should be to produce an orchard that will yield heavily, therefore suckers should be removed and not used for propagation purposes. Layerage of suckers from trees that have been grafted or budded can not be used owing to the fact that the rootstocks from which the suckers arise are seedlings, and therefore the new trees will not be true to the variety.

Mound layerage. Mound layerage is probably the simplest and oldest method of propagating the filbert. Suckers grow up from the base or crown of the trees. If they come from deep enough in the soil or if the

soil is mounded up so that the base of the suckers is in moist soil throughout the season, they will take root. The oldest suckers, or the ones that started growth first in the spring, may take root by the end of this year, but most of them will take longer to root. Even when rooted by this method the development of the roots is so sparse and limited that the trees are usually not suited for planting in the field.

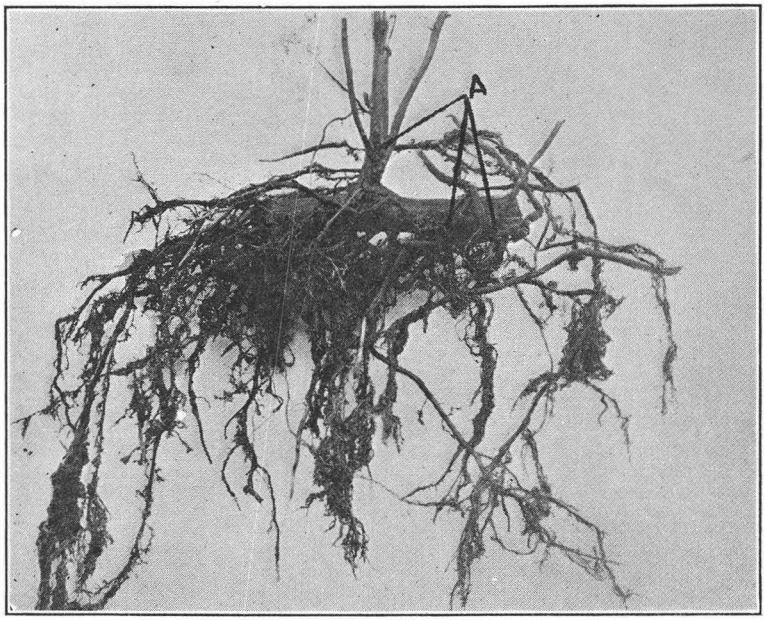

Figure 2. Suckers may originate from the portion of the old layered sucker that produced the tree and from the base of the tree trunk (A). This type of tree has caused great dissatisfaction with layered stock.

In order to obtain nursery trees which when permanently planted will produce few suckers only the roots nearest the surface should be left. The wood below this part with the roots should be cut off. They should then be grown in the nursery for a year or two until these roots have become strong and vigorous.

Continuous layerage. During recent years this form of layerage has been almost abandoned. At least 90 per cent of the trees propagated by this method will be fan-shaped for the first few years. Roots tend to develop on the old layered wood and often at some distance from the new upright shoot. As a consequence a large amount of old layered wood is planted with the young tree that will be a source of never-ending sucker growth in the future.

Tip layerage. Nearly all the commercially layered trees are produced by tip layerage. In propagation by this method shoots are bent in a V-shape and the lower parts are buried at least 6 to 8 inches deep. The ends or tips of the shoots are placed in an upright position, from which growth

is continued to form the tops of the new trees. Adequate soil moisture should be maintained so that root development will take place on the upright tip above the crook or V.

Tip-layered trees will have the buds and resulting limbs in a whorl around the trunk instead of in the form of a fan as with the continuous-layered trees. First-class tip-layered trees do not have a crook at their base and have the roots massed within a space of 2 to 4 inches (Figure 3).

Budding and grafting. Budding and grafting have been used to a limited extent during recent years in the propagation of filberts. On the whole, the success of these methods has not been very encouraging because of failure to obtain good stands of buds or grafts. These methods are used chiefly to propagate new varieties for which there is not enough material available for layerage purposes and for propagating the standard varieties on non-suckering stocks. The process of budding and grafting of filberts seems to demand more care than is usually necessary with other fruits. Even under best conditions uniform success is very rare. The cleft and whip graft are used in grafting and the shield bud in budding. All scions in either budding or grafting are usually covered with paraffin, which must be kept shaded.

Seedling trees for ordinary rootstocks to be used in budding and grafting are grown from nuts of the commercial varieties, usually the Barcelona. The nuts can be stratified during the winter in moist sand and then planted in the field in the spring, or they can be planted directly in the field in the fall after harvest. The first method avoids loss of nuts during the winter caused by rodents robbing the plantings. Seedlings grown from such seeds are not suckerless. Some will have very few suckers while others will have many; on the whole such seedlings will probably average fewer suckers than layered trees of the Barcelona variety.

There is a limited use of the Turkish filbert, *Corylus colurna*, for rootstocks on account of its non-suckering habit. Unfortunately the behavior of this rootstock has been so variable under different conditions and so many conflicting reports have been received as to its suitability that no definite recommendation can be made at present.

PLANTING

Time of planting. Early winter planting should be practiced with all fruit trees. By early winter planting is meant that the trees should be planted as soon as they can be obtained from the nursery in a dormant condition and when the soil is in fit condition to be worked. Early planting usually results in the trees developing new roots throughout the winter season. When growth starts in the spring the trees planted in early winter make more and stronger growth than spring-planted trees. Late planting does not give time for new roots to be formed before the buds start growth. With a small root system it is impossible for the tree to take in a sufficient supply of water to cause good strong growth of the recently planted trees. Late planting should be avoided under all conditions wherever possible, as the trees will more or less stand still throughout the summer.

Planting distance. The minimum distance apart for planting filbert trees is 20 feet, but as a rule 25 feet will not be too far. On good soil, trees will increase the diameter of the top more than a foot a year. In some

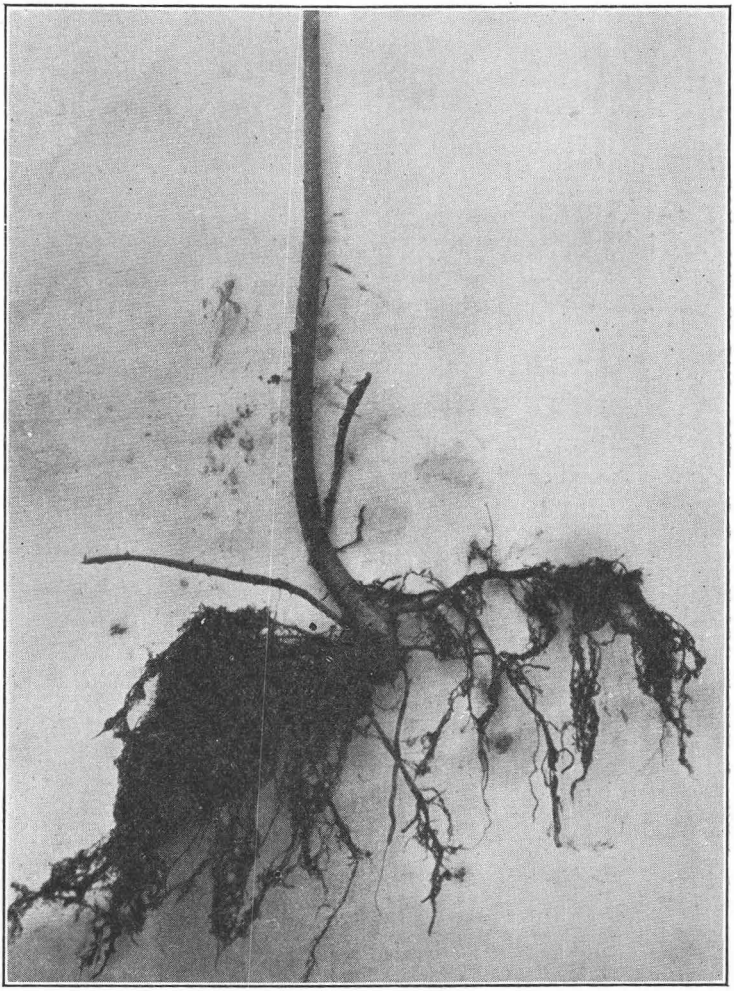

Figure 3. The base of the roots is confined to a short space. If such a tree is set shallow with the root pressed downward, suckering is reduced to a minimum. This tree grew a year after being taken from the layer.

cases trees planted 20 feet apart have been crowding at 15 years of age. Some growers are now setting the trees more than 25 feet apart.

Quite often it has been advocated that the trees be planted close together with the idea of removing the extra trees later when they have

begun to crowd each other. Some very heavy crops have been harvested during the early life of orchards planted this way, but to date this has not been established as an economical practice. From a theoretical standpoint it should be possible to obtain heavier yields while the trees are young and

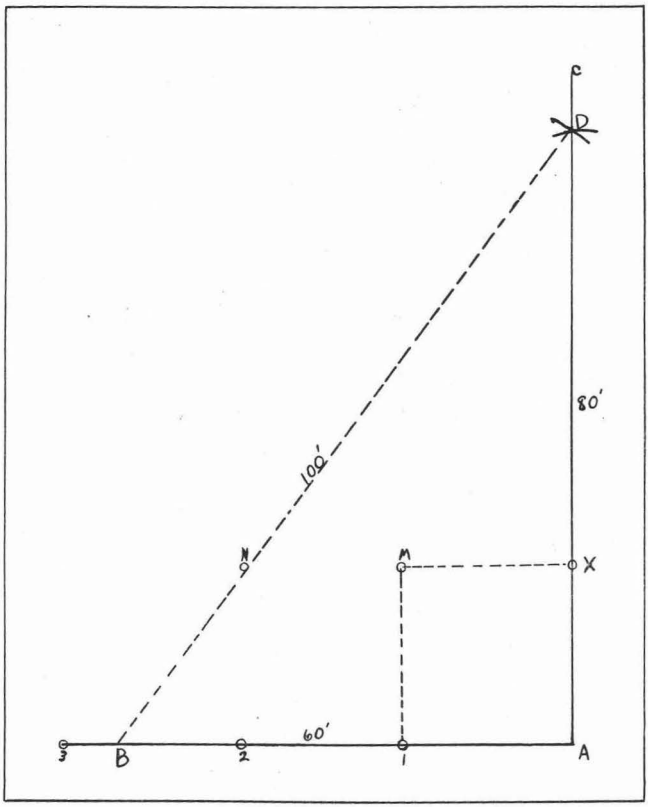

Figure 4. Laying out the orchard by the square method.

to maintain the heavy production by gradually removing the crowding trees so the remaining ones will develop without interference. So far this theory has not been successfully demonstrated and furthermore few people will remove vigorous bearing trees at the proper time.

Staking the orchard. The first essential in laying out an orchard is to establish base lines—two or more where the trees are to be planted on the square system, and one where the orchard is to be laid out on the hexagonal system.

For the square system select one side of the field from which a line can be laid off parallel to the fence or road, using this side as the base line AB (Figure 4). With a tape or other measure lay out 60 feet on this line AB. Then on the line AC approximately at right-angles to base line AB, lay off 80 feet, striking an arc using A as a pivot point. From point B with

a line 100 feet long strike another arc at point D. Where the arc of AD and BD intersect will be the point through which the line AC may be located permanently and at right-angles to the base line AB.

It is generally of advantage to lay off another base line at the opposite point of the field from A on the base line AB.

As equipment in laying off by the square system, or by the hexagonal system, one should be provided with a set of wires of the same length as the distance apart that the trees will be set out. These are two wires with one end joined together in a small ring and the free ends fastened to separate rings. After staking off the base line at the intervals desired for the tree, staking of the tract can commence. By placing the wire over stake 1 and stake X, and drawing it taut, a stake can then be placed at point M. Move the wires over so that the ring can be placed over stake M and stake 2; a stake can then be placed at the center ring at point N. This process can be carried on indefinitely, backward and forward across the field, until the field is completely staked out. The wires should be held in the same plane and drawn up to the same degree of tautness. Occasional checking by sighting or by remeasuring the wires will be necessary to straighten out the rows, especially if the field is uneven.

Other methods of staking out can be used, such as the use of transit or by sighting from two sides of the field with a man to set the stakes at the points desired. On the whole it will probably be found that the use of wire is the quickest and simplest method that can be employed for land not too uneven.

A single long wire with soldered points on it indicating the points at which stakes are to be set is often used alone.

The triangular or hexagonal system of planting requires only one base line. The base line should be measured off into the regular intervals at which the trees are to be planted and stakes driven at each point. Placing the rings over stakes 1 and 2 (Figure 5), the wires are drawn tight and a stake is set at M. Then move over until the rings are over stakes 2 and 3; the stake is then placed at N and so on throughout the field. In using this method the rows will each time become shorter so that it will be necessary to fill out the side of the field. By placing one free ring over M in the second row and O in the third row, as illustrated, a stake can be placed at Y so that the third row will be lengthened out to the normal length.

Using the planting board. To keep the trees in line after the field has been staked out the planting board is of value. This board is three to four feet long with a notch at each end and another at one edge in the exact center. Before digging the hole for the tree the board is so placed that the stake, showing where the tree will be, fills in the center notch. Then place a stake at each end of the board after which the center stake and the board can be removed. After the hole is dug, place the planting board over the two remaining stakes. With the tree trunk in the center notch, the alignment of the original staking will be retained. The tips of the notches in the board should be in line with each other and the board must be used in one position only.

Setting the tree. It is not advisable to dig the tree holes considerably in advance of planting. Exposure of the soil to the weather will tend to harden the sides of the holes, especially with certain types of soil, so that the tree roots will not easily penetrate the soil.

During all operations incident to transplanting the trees, care should be taken to prevent the roots from drying out, especially in the case of one-year-old trees whose roots are fibrous and very tender. The trees should be kept in a barrel of water or covered with moist earth or burlap at all times until finally planted.

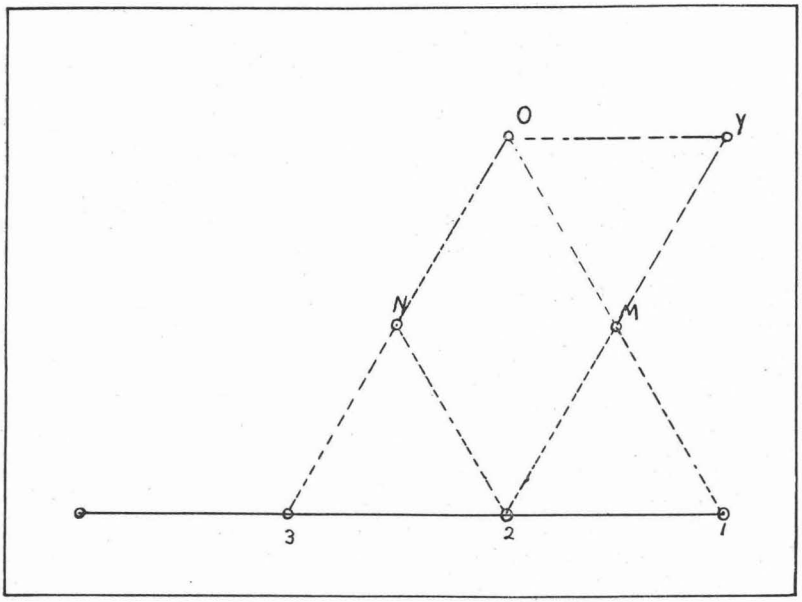

Figure 5. Laying out the orchard by the hexagonal method.

Before planting, prune away the remaining parts of the original layered shoots as much as possible. On two-year-old trees remove the old layered shoot and smooth off the broken ends of the main roots.

In planting the tree avoid deep planting, yet set the tree so that the roots will be in moist earth during the dry season. Late-planted trees will have to be set deeper than earlier-planted ones owing to the fact that the root system will not be so completely developed by the time of the dry season. Some growers set the tree on a small mound within the hole and then press the roots downward along the sides of the mound so that the ends of the roots will be in moist soil throughout the summer. Sift fine earth around the roots and pack with the hand to avoid open air spaces, which allow the roots to dry out. After this, place two or three inches of soil on the roots and tramp down firmly. No damage will result from trampling if sufficient soil is placed on the roots before being packed. Above this, place loose soil that will form a mulch to prevent evaporation from the firmly packed soil beneath.

PRUNING

Pruning at time of planting. After the tree is planted, the top should be headed back to balance the root system. In transplanting, the roots

have been lost to a great extent and thus the water-absorbing capacity of the plant has been materially reduced. If the tree top is left the original size, the root system will be unable to provide sufficient moisture to replace that lost by transpiration and the tree will die back and in some cases may completely die. Generally cutting the trees back to a height of 18 to 30 inches will be found satisfactory. Trees cut back as directed generally attain a larger size in less time than similar ones not cut back.

The exact height at which a tree is cut off when planted does not always have relation to the height of the tree in later years. With an upright growing filbert tree the relation is direct, but with that type of filbert tree attempts to develop the high-headed tree are not of much importance. With a drooping, spreading filbert tree, the later training and pruning are of greater importance than the height at which it is cut off when planted. If the tree is a straight whip, cut it off at the desired height. If the tree is branched, the laterals may be cut back to a few buds, or all laterals may be removed and the tree treated as a whip.

Pruning young trees. Pruning, whether cutting back or thinning out of the new growth of young trees after they have become established will result in smaller trees as compared to similar unpruned ones. The young unpruned trees will be the largest, will be the first to come into bearing, and will produce the heaviest crops. Unpruned trees, however, usually develop branches close together, and crossing limbs, which almost of necessity must be removed later in the life of the tree. Cutting off large limbs makes large wounds which provide a place of entrance for various fungi, and the filbert seems to be especially susceptible to wood rotting fungi. Furthermore, it takes longer for a filbert tree to heal over a wound than most other kinds of trees. Removing the excess branches while they are small results in wounds that readily heal over and is advisable even though this early pruning results in a decreased size of tree.

Three to five shoots can be chosen as permanent scaffold limbs from the new shoots that will come from the buds left or from adventitious buds. These shoots should be spaced as far apart as possible. Probably only part of them can be selected the first year. As a modified leader type of tree is very difficult to grow in the filbert, too much effort should not be spent in an endeavor to develop this type of tree or in spacing the limbs. The filbert naturally develops a bushy top and readily lends itself to an open or vase type of tree. Outside of breakage from snow or sleet, no reports have been received as to trees breaking down in the crotches. The extra strength developed in a modified leader tree is not so essential in the filbert as it is with many other kinds of fruit trees.

A large number of laterals will be produced from the base to the tip of the scaffold branches. Most of these laterals will be short and only a few will have length and diameter enough to be secondary scaffold limbs. If these secondary laterals are too numerous or poorly located they should be removed. The small, weak shoots, if left, will become the first fruiting wood. After a few years these small, weak shoots will be shaded out and die or they can be removed after their fruitfulness is past. Leaving the small weak shoots in the tree largely prevents the formation of undesirable water sprouts, which will appear if such growth is removed. Water sprouts are in most cases very unproductive and tend to grow upright, interfering with the development of the permanent part of the tree.

Pruning bearing trees. No definite information is yet available as to the best pruning practices to follow with mature bearing trees. The heaviest bearing orchards have received a minimum of pruning. In most cases what little pruning has been done has consisted mainly of removing the drooping, low-hanging branches that interfere with cultivation and harvesting. This was clearly brought out in recent surveys where data were taken on 54 plantings including 657 acres of orchards 6 years old or older. Of the 54 orchards, only 30 were reported as having been pruned at all and then the work done averaged .54 day per acre per year. In only a few cases was one day or more per acre per year spent in pruning.

A filbert tree typically becomes thick and bushy as it attains maturity. A little later it is more or less filled with dead wood, caused partly by shading and also by the fact that short fruiting shoots usually die. This dead wood should probably be removed. Short, weak and unproductive shoot growth often follows heavy production and it is intensified when the trees are crowded or are growing on poor shallow soils. Thinning out this weak shoot growth is beneficial to a limited extent, but so far it has not given the results desired. Severely cutting back the trees has resulted in the production of vigorous new wood, but insufficient information is now available to establish it as an economical practice.

Thinning the stand of trees in crowded orchards would probably be the best practice to follow in orchards where production has declined because of poor growth. Increasing the fertility of the soil is the greatest need in many such orchards and there is no other practice that can be substituted for it.

CULTIVATION

Cultivation practices for filberts are essentially the same as for other kinds of fruit trees. Under conditions prevailing in the filbert-growing districts of the state, cultivation is primarily for the purpose of conserving moisture during the growing season. During the past few years the tendency has been for the growers to reduce the frequency and the depth of cultivation given the orchards. This tendency is in line with results obtained in soil investigations, which show that cultivation which destroys all weed or cover-crop growth and maintains a shallow mulch is sufficient.

Under ordinary seasonal conditions plowing or disking the orchard should be done during the early part of April, as after that time the rainfall usually decreases. Cover crops of any kind then grow rapidly, using not only the moisture received by the soil as rainfall but also a part of that stored during the period of heavy rains. A cover crop can safely be allowed to remain on the soil during the rainy period, but after that time the cover crop should be turned under. Turning under cover crops or other vegetative growth early in the season prevents use of moisture by any plant except the filbert trees. Later rainfall will help replace the water used by the tree. If both trees and cover crop are using moisture from the soil at the same time, the withdrawal of moisture may be so great that in the summer there may be little or none left for the trees. In many seasons the early growth of the cover crops may be poor and there will be very little green manure material to turn under at the time it should be destroyed. As far as the crop of nuts is concerned, however, it is best to plow the cover crop under at the proper time rather than to wait for additional growth to be made.

SUCKERING

All varieties and all rootstocks except the Turkish hazel, *Corylus colurna,* will sucker more or less. Prompt and careful suckering of the trees during their first 5 or 6 years in the orchard will reduce to a minimum the labor required for this operation in later years. Begin the work before the oldest suckers have hardened to any extent. Remove the soil so that the suckers can be pulled or cut off at their point of origin. At the same time rub off all buds that are showing. Suckering must be repeated 3 to 4 times a year. Suckering can not be properly done with deeply planted trees or those which have their roots distributed over a considerable length of trunk base. While the operation must be repeated at the proper time the actual amount of time and labor consumed is not very great. It is doubtful whether suckering once a year will greatly aid in reducing sucker growth. Cutting off just below the surface of the soil instead of at the base of the sucker encourages more suckers. Some growers think that by cutting off the suckers just under the surface of the soil with a hoe or other instrument as soon as they show above ground they can be effectively controlled. Here again the sucker is given little time to grow above the surface and to harden the tissues. In all suckering work the time and labor is increased as the suckers are allowed to grow and the tissues harden.

INTERCROPS

Intercrops have not been commonly grown in filbert orchards. Those who have grown intercrops generally had a small farm and could not afford the loss of income from the land during the development of the filbert orchard. With filbert trees planted 20 to 25 feet apart the area that can be advantageously devoted to intercrops is limited. Practicing intercropping usually means the growing of a high-income-producing crop requiring considerable labor. Truck crops and berries have been profitably used as intercrops especially by growers who already were producing them as a regular practice. As most of the orchards have been set out by tree fruit growers, however, and by general farmers who have not been equipped, located, or inclined to handle such intensive crops, the filberts for the most part have been raised without intercrops.

Annual crops are more satisfactory for intercrops than are perennial crops, as the space required by the filbert trees can be adjusted annually. It is doubtful whether ordinary field crops like grain and hay have ever been profitable. With crops like berries, if planted a sufficient distance from the trees, the inconvenience and added costs of cultivation cause the returns to be very small; if set close to the filbert trees, by the time adequate returns are had from the berries the filbert trees are being crowded. Intercrops as a rule retard the growth of the trees to a certain extent, but this may be offset by the returns from the intercrop.

BEARING AGE

A few nuts may be produced by the trees the first or second year after planting in the orchard. The average orchard can not be expected to return a profit on cultural operations before it is five or six years old. It is not known at what age filbert orchards attain maximum production, but there are indications that the trees increase in production for ten to twenty years

after coming into bearing. Individual trees planted at a great distance from adjoining trees will probably increase in production even later, but the close planting in most orchards will probably cause them to attain maximum production at fifteen to twenty-five years of age.

The yield of nuts in a few orchards and in some seasons may be as high as 3,000 or more pounds per acre. But an average yield of 1,000 pounds per acre over a period of years and a large acreage would seem to be more nearly correct.

HARVESTING AND DRYING

Filberts are picked up after fully maturing and dropping to the ground. The varieties that do not naturally free themselves from the husks must be husked out by hand or machinery. A few husking machines have been made by individuals, but none have been put on the market.

Prompt harvesting of the filbert crop, although desirable, is not so essential as with soft fruits. Filberts should be gathered two to three times during the season. Filberts lying on the ground for any length of time gradually darken. Rainy weather increases the discoloration of the shell.

Damp or undried filberts should not be stored in a sack or large container for any length of time. The kernels become moldy or off-flavored even if such a condition is not evident from the appearance of the shells. If the nuts can not be dried promptly it is better to leave them in the field as they will not mold so easily when spread out on the ground. Such a delay, however, does not produce the best product. As present market requirements demand that the nuts must be clean, washing is in general use. Only under exceptional seasonal conditions will the nuts be clean enough to market without washing when brought in from the field. Various types of washing machines and equipment are used for this purpose.

Artificial drying at temperatures of 90 to 100° Fahrenheit is used in practically all cases. It is only with small crops or in very dry seasons that the nuts can be dried without artificial heat by being spread out in a thin layer. As nearly all filberts are shipped to out-of-state markets, if too much moisture remains in the nuts there will be a loss in weight or spoilage before they are consumed. To avoid any possibility of this loss the nuts are dried until their moisture content is 8 to 10 per cent. Kernels containing 8 to 10 per cent moisture snap if bitten when cold.

Driers of all types are in use—prune driers, hop driers, bin driers. The amount of heat necessary to dry filberts to the required standard is so small that expensive equipment is not needed. Speed in drying is not essential except where large crops are to be handled.

Many inexpensive, fairly efficient driers have been made by remodeling old buildings already on the ranch. The heating unit is placed 8 to 10 feet below the floor on which the filberts are spread and sufficient openings made in the side walls to allow entrance of cold air. The drying floor is made of wire cloth laid on strips 1 by 2 inches or 2 by 2 inches, so that at least 50 per cent of the floor space allows air to pass upward. Outlets of sufficient size to allow free upward movement of air should be provided in the roof. Few growers maintain drying temperatures continuously during the 24 hours of a day. Aid in designing new driers or in remodeling old buildings for drying purposes can be obtained from the Oregon Agricultural Experiment Station.