



WALNUT *Growing* **in Oregon**

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TABLE OF CONTENTS

	Page
Introduction	3
Districts for Walnut Growing	4
Temperature Requirements	4
Low Temperature	4
High Temperatures	5
Soil Requirements	6
Soil 8 to 10 Feet Deep Needed	6
Soil Types	9
Special Practices to Improve Soil Conditions	10
Elevation	11
Varieties	11
Pollination	11
Propagation	12
Stocks	12
Planting the Nuts in a Permanent Place	14
Setting an Orchard	14
Planting Stock	14
Planting Time	15
Allow the Tree Plenty of Space	16
Setting the Trees	16
A Planting Board Is Necessary	16
Roots Need Protection While Being Transplanted	16
Care in Transplanting	16
Staking the Tree	17
Culture	17
The Walnut Tree Needs Plenty of Moisture	17
Cover Crops	18
Irrigation and Thinning of Stand	18
Commercial Fertilizers	18
Intercropping	19
Use Annual Cultivated Crops for Intercropping Where Possible	20
Pruning and Training	20
Balance the Top and Roots at Transplanting	20
Low Heading Back No Longer Popular	20
Training the Tree	20
Later Pruning	24
Reinvigorating Old Trees	25
Top Working	26
Worthless Seedling Trees Should Be Top Worked	26
Small Cuts Best	27
Top Working "Sleepers"	27
Harvesting	27
Drying	30
Several Types of Driers in Use	30
Bleaching Walnuts	30
Grading Walnuts	31
List of Bulletins of Interest to Walnut Growers	31

Cover illustration—

Normal distribution of nuts on a vigorous healthy branch.

Walnut Growing in Oregon*

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INTRODUCTION

No species of walnut is indigenous to Oregon. Settlers coming directly from eastern United States frequently brought with them nuts of the eastern black walnut, *Juglans nigra* L., and some coming by way of California brought from there the two western black walnuts, *J. californica* S. Wats (the southern California walnut) and *J. hindsii* Jepson (the northern California walnut). A few trees that grew from these nuts are still to be found on homesteads taken up by the early settlers.

The oldest surviving Persian walnut trees (*Juglans regia* L., commonly known as the English walnut) (Figure 1) were planted in the early fifties near Scottsburg, Oregon, on the donation land claim of Jean Gagnier (John Garnier). As time passed, other small plantings of walnut trees were made in the state but no commercial orchards were planted for many years. One of the first orchards was that of J. W. Houck, near Marion, Oregon, planted in 1892 from seedlings grown from nuts brought from California, of the varieties Chaberte, Bijou, Praeparturiens, and Mayette. These nuts were stratified in the fall of 1891 and, when sprouted in the spring of 1892, were planted where the trees are growing today. This orchard was 14 acres in extent and a part located on the better soil is still bearing well. It did not attract attention, however, resulting in the planting of new orchards, as did those orchards planted later. A few others were planted soon after this one but they had little influence on the development of walnut growing in Oregon.

The real beginning of commercial walnut growing in Oregon started in 1897, when the first part of the orchard of Thomas Prince was planted. Not only did Prince plant trees for himself but he imported nuts from France, grew young trees, and actively promoted the walnut industry. Many of the old seedling orchards existing today can be traced back to Prince's nursery, from which the trees were sold at a uniform price of 25 cents each.

In the eighties grafted trees were introduced into the Pacific Northwest, but it was not until the Vrooman Franquette became established as a desirable variety that they were accepted by growers in preference to seedling trees. Since 1920 grafted trees have constituted practically all the walnut nursery stock sold in Oregon.

In this publication the word "walnut" is used to refer to seedlings or varieties of Persian or "English" walnut. Other species are designated by their accepted common names.

Since most of the walnuts in Oregon are grown in the Willamette Valley, the recommendations given are especially applicable to that area. In general, they also apply to other sections where walnuts are to be planted. When the prospective grower is in doubt concerning the suitability of the soil, climate, location, and other local factors, the county agricultural agent should be consulted.

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On account of the heavy production of walnuts on the Pacific coast and the prospective increase in tonnage in the future, the planting of walnut orchards in Oregon has been limited during the past several years. Production has been greater recently than the domestic consumption of walnuts in the shell, and the surplus has been disposed of as shelled nuts and by exports to foreign markets. The Federal Government has made diversion payments on the nuts exported or cracked in an effort to maintain returns to growers above the cost of production. Because of these conditions, land owners have been slow to plant new orchards. Anyone contemplating planting new walnut orchards should take the necessary precautions to locate them so that at bearing age they will rank with those that have high yield and low production costs. Orchards yet to come into bearing that will have from average to low yields with from average to high costs can not be expected to be profitable. In the past such orchards have been profitable only because of the high value per pound of the nuts and will undoubtedly be retained because they have been in bearing long enough so that the original investment has been returned to the owner. If the orchards were removed, the land they are on would not produce any greater gross income from any other crop. It certainly would not be advisable to develop new low yielding orchards under present conditions in view of prospective low prices for nuts in the future. From an investment standpoint, even the development under present conditions of a high yielding orchard must be carefully considered from all angles.

DISTRICTS FOR WALNUT GROWING

The Willamette Valley is the main commercial walnut growing district in Oregon. There is in addition a small acreage in the Umpqua Valley and a still smaller one in the Rogue River Valley. Outside of these districts there is no indication that commercial walnut growing can be successful in the state. In restricted localities outside of these valleys a few old bearing trees are found occasionally, usually the survivors of much larger plantings.

The coastal region has a cool growing season and in some years even black walnuts fill poorly and mature improperly. The late spring rains aid in spreading the bacterial blight of walnuts and if not controlled the greater part of the crop may be lost because of that disease.

East of the Cascade Mountains walnut production is limited chiefly by cold winter temperatures together with late spring and early fall frosts. In a few favorable locations enough nuts can be grown for home or local use but commercial production of walnuts is apparently not possible.

TEMPERATURE REQUIREMENTS

The walnut tree is quite sensitive to climatic conditions and both low and high temperatures must be considered as factors affecting walnut growing.

Low temperature. The walnut tree if fully dormant is somewhat comparable to the peach tree in winter hardiness. Under the mild climatic conditions of the Oregon walnut growing sections the trees seem to be rather slow in attaining full dormancy in the fall or early winter. As a consequence, cold periods occurring early may kill many trees. In 1935 a temperature of 15° F., when the trees were in full leaf, caused a heavy loss of walnut trees but very little injury to other fruit trees. In 1919 when -15° F. was recorded just after the foliage had fallen walnut trees were injured just about to the same

degree as were other trees. Late winter freezes seem to cause less injury to walnut trees than to other fruit trees. When snow is on the ground the reflected warmth is absorbed by the tree trunk during the day, and if followed by low temperatures at night, fruit trees may have strips of bark on the trunks killed; but walnut trees suffer less than other fruit trees under such conditions. Low winter temperatures may cause the trunk to split open, but usually this results in little or no permanent injury to the trees.



Figure 1. Two of the oldest trees in the state, at Scottsburg, Oregon.

The susceptibility of walnut foliage to frosts makes it imperative to locate the orchard and select varieties so that this form of injury can be avoided. Varieties that require a long growing season and that leaf out early in the spring are not at all suitable for culture in Oregon because of the danger of injury by late spring frosts. Even varieties like Franquette that start growth late in the spring must be planted on land that is as free as possible from such late frosts.

Early fall frosts often result in serious losses when they occur before the nuts or the current shoot growth has matured. Such frosts may cause poorly filled nuts at harvest. If the shoots are frosted when they are still immature the injury may not be apparent to the casual observer until the following spring when the injured portions may fail to leaf out. These early fall frosts evidently are in part the cause of "winter killing" that is so often reported from some localities, and when they are combined with low winter temperatures prevent successful walnut growing.

High temperatures. Excessively high temperatures are not a limiting factor in any part of the state, but occasional temperatures approximating 100° F. may cause sunburn on the nuts. This injury varies from black specks on the kernel to a complete failure in the development of the kernel.

SOIL REQUIREMENTS

Soil 8 to 10 feet deep needed. Large, vigorous trees are necessary for the production of large crops of nuts. Shoots that elongate at least 5 to 8 inches each year tend to bear annually while those of shorter lengths bear less regularly (Figure 2). To maintain a vigorous annual shoot growth of at least 5 to 8 inches on a greater part of the tree requires a soil that is deep, fertile, and well drained.

Since the average rainfall for the six summer months, April to September inclusive, is but 7.32 inches, water stored in the soil from winter rains is the main source of moisture for the trees. A deep soil is necessary to store the quantity of moisture required and the nature of the subsoil must be such that the tree roots are able to penetrate it to obtain this moisture. Earlier recommendations suggested soils 4 to 6 feet deep as being very satisfactory for walnuts, but recent studies on root development show that the heavy producing orchards are those where the roots are fairly evenly distributed throughout the

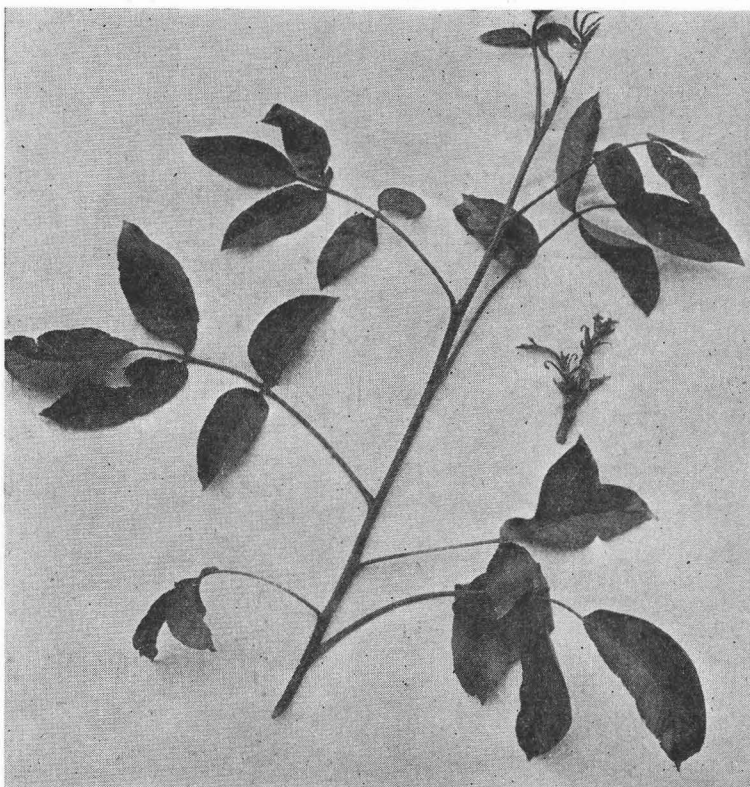


Figure 2. Two extremes in shoot growth from a walnut tree. The larger shoot, if now nonproductive, will later furnish opportunity for development of fruiting laterals. Small shoots, similar to the one shown, seldom produce fruit.

soil to a depth of 8 to 10 feet. If any physical condition, such as compact subsoil, water table, rock, gravel, and a similar condition, restricts root penetration to a depth of less than 8 to 10 feet, it can be anticipated that the resulting size of the tree and crops will be correspondingly smaller. Small trees do not produce enough shoots of the optimum length to bear large crops of nuts.

Judging the nature of a tract of land for walnut growing by the appearance of neighboring young orchards is a common error to be avoided. Young trees make good growth in many cases, but as they begin to bear they slow down markedly in growth and never attain heavy production. If a subsoil that abruptly limits root growth is reached the central part of the top of the tree may almost stop growing, while the side limbs continue to grow but at a

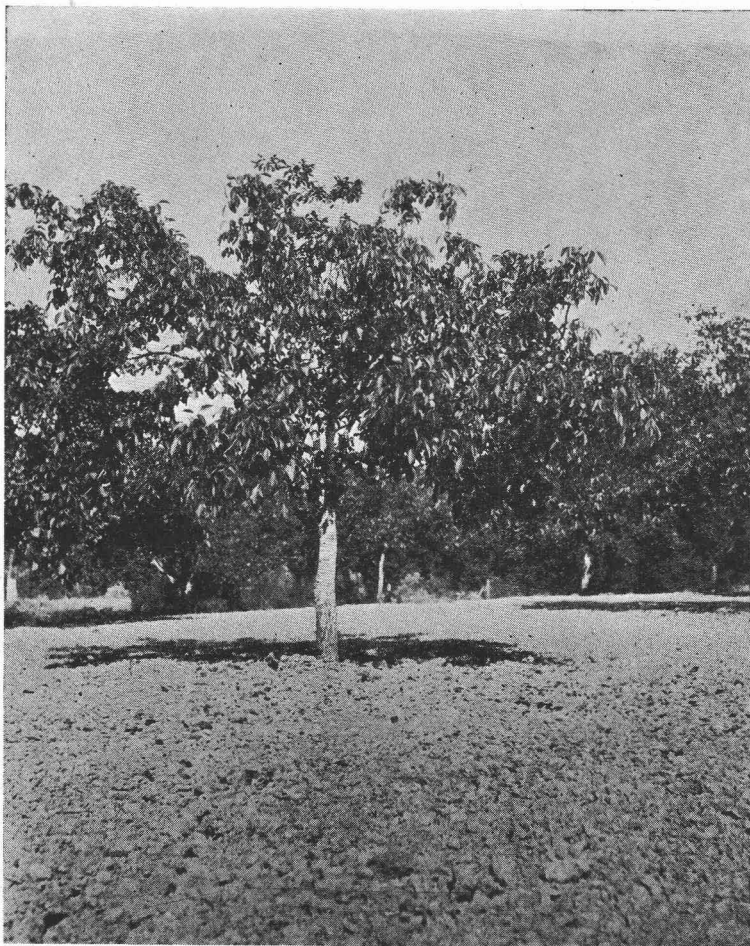


Figure 3. Flat headed tree on shallow bedrock.

slower rate. This forms a flat headed tree of questionable value (Figure 3). If root penetration is only partly restricted the whole tree develops at a slow rate, resulting in a small tree with low production. These same responses generally are not very noticeable during the first 5 to 10 years of the orchard's life, but develop later, so that the suitability of land can not be judged by the growth of young trees.

In judging the suitability of a site for walnut production, a cursory observation of the surface soil is of little value. The soils in all counties of the Willamette Valley have been mapped by state and federal workers and such maps are of value in selecting an orchard site. These maps are available either as free copies or are on file at the county agent's office. During past years in making surveys of walnut orchards it has been noted that almost without exception the upper 3 feet of soil in all orchards was suitable for walnut growing regardless of whether or not the soil was supporting a good or a very poor orchard. The value of the soil for walnut production was found to be determined by the depth of the subsoil that would permit root growth, and not the approximately 3 feet of surface soil.

The soils classified as a certain type vary considerably in their depth and suitability for such crops as walnuts. It is not to be taken for granted, therefore, that if walnuts have been grown satisfactorily on a certain soil all soils of the same type are suitable. Before the suitability of a soil can be fully determined it should be thoroughly investigated. These investigations can only be made with an auger, soil tube, post hole digger or similar tool by which the subsoil can be studied to a depth of 8 or 10 feet. Solid rock is often found under shallow soils and is easily recognized as a barrier to root growth. Compact subsoils with a mottled color indicating poor drainage are often found. Besides affording few or no openings large enough for roots to enter, this kind of a subsoil layer often supports a water layer that further restricts or inhibits root development. Other subsoils may become tighter and harder in the lower



Figure 4. Defoliated tree stands in shallow soil over coarse gravel. Other trees in full leaf are on deep soil.

levels with a minimum of mottling, and these also serve as a barrier to roots. Still others are easily dug with tools but the soil particles are so minute that no open pore spaces are to be found that are large enough for roots to enter. These small pore spaces are usually filled with water continuously so the soil may be waterlogged or saturated without standing water being present. This type of subsoil is difficult to recognize except by experience and a knowledge of the soils in which they are to be found. Loose gravel and coarse sand have such large pore spaces that the excessive aeration and lack of soil moisture permit little or no root growth (Figure 4). All of the types of subsoils discussed are found in the Willamette Valley and when one of them occurs close to the surface it prevents the tree roots from going deeper than the surface soil, and thus the effective depth of the soil is established.

Soil types. Soil types on which walnut orchards are commonly found are: (1) Newberg and Chehalis of the river bottoms, (2) Willamette of the valley floor, (3) Olympic and Aiken, basaltic soils of the hills, and (4) Sites and Melbourne, shale and sandstone soils of the hills. Orchards are less often found on Salkum, Polk, Amity, and Carlton types and only a small part of the original plantings made on these soil types have survived or are profitable today.

In the case of the Newberg and Chehalis soil types, sand and gravel subsoils are commonly found and when they are located close to the surface the soil must be considered shallow. In the upper part of the river valleys the Newberg and Chehalis soil types are apt to have coarse sand and gravel subsoils closer to the surface than farther down the valleys. Trees planted on these soils quite generally make a vigorous growth and are productive until they become large enough to exhaust all the moisture in the soil above the sand



Figure 5. Irrigation under way in a mature orchard on river bottom soil.

or gravel prior to the maturity of the crop and before the fall rains begin. When the exhaustion of soil moisture occurs during August or September in bearing orchards the condition becomes serious and unless irrigation water is available and applied, the crop may be lost. (Figure 5.)

Soils of the Willamette series are of good texture in the upper 3 feet, and are fertile unless they were poorly farmed in the past. Below a depth of 3 feet a wide variety of subsoils have been found in the soils classified as Willamette. Where the character of the subsoil has one or more of the undesirable features discussed, the value of the land will depend on the depth of the soil above this subsoil stratum.

Olympic and Aiken soils may be underlaid by a tight, compact, impervious subsoil at a depth of 10 feet or less, or sometimes by rock itself. When sampled with a soil auger or soil tube the surface of the subsoil samples has a glossy bright red color. When this subsoil is very tight and difficult to bore and the surface of the samples appears waxy, few roots will be able to enter this layer and it can be considered as determining the effective depth of the soil.

Soils of the Sites and Melbourne series that have been derived from both sandstone and shale are extremely variable. Two undesirable kinds of subsoil are often found in both of these soils. One kind is a tight, compact, sandy layer varying in thickness. A thin layer of this material can be penetrated by the tree roots, which will develop a profusion of fine rootlets in the more open horizons below. If this layer is more than a few inches thick it effectively limits root penetration. The second unfavorable subsoil type is composed of such minute particles of clay and colloidal material that there is no space for roots although it is moist and appears friable. Consequently, if it occurs near the surface of the soil it causes that soil to be shallow so far as tree growth is concerned. This is one of the most difficult subsoils to recognize except after experience with it.

Special practices to improve soil conditions. Special practices such as drainage and blasting of the soil have very seldom proved satisfactory under Oregon conditions in changing soil conditions. Soils needing drainage are so shallow above the compact layers carrying the water that even if drained they do not have sufficient depth of suitable soil to support large, healthy trees. The difficulty in blasting is that the layer to be broken up seldom if ever is dry enough to shatter when blasted. Unless dry, the blasting simply packs or puddles the layer, usually forming a "jug" that retains the water. A few subsoils have shown benefits where thin, rocky layers or tight gravel and sand layers have been blasted, and the effective depth of the soil was increased thereby. The ordinary tight, compact, moist subsoil as it usually exists has never been benefitted or improved sufficiently for walnut growing to justify the costs of such operations. Soils apparently needing such treatments are not suitable for walnut planting.

What has been said about soils applies not only to those under consideration for future planting but also and with even greater force, to those that have already been planted. As the trees in an orchard become larger adverse soil conditions become increasingly serious through reducing tree growth and restricting the yield of nuts because of insufficient moisture in the soil adequately to supply the trees through the season. A study of the soil will help the owner determine if the unsatisfactory performance of his trees is due to a shallow soil. Theoretically, when the soil depth is limited by an impervious subsoil, the thinning of the stand of trees in the orchard should be of benefit to the

trees that are left. Unfortunately, records thus far made on thinning the stand of trees have been in the better orchards and not in those located on shallow or marginal soils, and the information obtained is of little value in indicating the results that may be expected to follow in orchards on marginal soils.

If it has been determined that the orchard is located on a shallow soil and that little or nothing can be economically done to improve the soil conditions, then the owner should manage the orchard with as small a cash outlay as possible. Although the orchard may be located on an unsuitable type of soil it is doubtful in many cases if any other crop could be grown that would bring a higher immediate income than the already established walnut trees even though they produce small crops. In such cases, income would not be figured on the original investment but on the value of the bare land as it would be if the walnut trees were removed and the land planted to other crops.

Elevation. Walnut orchards are located mostly between the valley floor and an altitude of 800 feet above sea level. Only a very few orchards are located higher than 800 feet and practically none higher than 1,200 feet elevation. The orchards located on the river terraces or valley floors have on the average sustained greatest losses from cold injury, but have been the heaviest bearing orchards since they are on soils that are deeper, more fertile, and better supplied with moisture than those on the upland soils. Frosty locations with poor air drainage should be avoided for walnut orchards but in most localities this is of secondary importance and suitability of the soil should be given first consideration.

VARIETIES

The Franquette is the only variety of the Persian walnut that has been planted commercially for a number of years. In older orchards a few minor varieties like Mayette, Wiltz, Meylan, and others are to be found but none has been planted for years except those thought necessary as pollenizers for the Franquette.

Practically all the newer varieties of Persian walnuts developed on the Pacific Coast have been tested in Oregon. Those that have originated in areas of warmer climates and longer growing seasons invariably require a longer growing season than exists in Oregon and are entirely unsuitable for planting in this state. A few varieties requiring a relatively short growing season have shown no promise of being any better than the Franquette. With almost a cessation in walnut planting at present, little interest is shown in new varieties.

Among the black walnut varieties Thomas, Stabler, and Ohio are now being sold by nurserymen. The Thomas and Ohio seem to be superior to the Stabler because the latter is rather light in production and often produces poorly developed kernels. Young trees of the Thomas variety grow rapidly and often break down with the first fall rains. There is at present no prospect for a commercial development of black walnuts. The varieties named seem to be the ones most suitable for home plantings and for trials in the colder sections of eastern Oregon.

POLLINATION

Pollination of the Franquette is not much of a problem as this variety is self-fertile and is capable of setting fruit with its own pollen if the pollen is shed at the proper time. In the average season and on young trees most of the pollen is shed before the pistillate flowers are receptive but in mature orchards

there are nearly always plenty of late developing catkins on the weaker inside wood to produce enough pollen for pollination. In young orchards late catkins are often lacking and in such cases cross pollination by a late blooming variety is of advantage. Only in very unusual seasons will mature orchards of Franquette be benefited by cross-pollination. On the whole, it is not the lack of pollination but the lack of strong, vigorous shoot growth necessary to produce female flowers that most generally limits the crop of walnuts.

Cross-pollination of the Franquette can be effected by the late blooming strain of the Meylan, the King, or almost any seedling walnut that sheds its pollen at the proper time. Cases of intersterility seem to be rare or non-existent.

Black walnuts of different species have not proved to be as suitable pollenizers for Persian walnuts as have varieties or seedlings of the same species. Controlled cross pollinations made between the various species of black walnut and the Persian walnut have consistently resulted in a very low percentage set of nuts.

PROPAGATION

Walnuts are regularly propagated in this state by grafting scions of the desired variety on seedling root stocks. Experience has shown that budding is not nearly so successful as grafting in the propagation of walnut trees and budding is rarely used.

Stocks. The northern California black walnut (*Juglans hindsii*) was used almost exclusively for a long time as a root stock for the Persian walnut

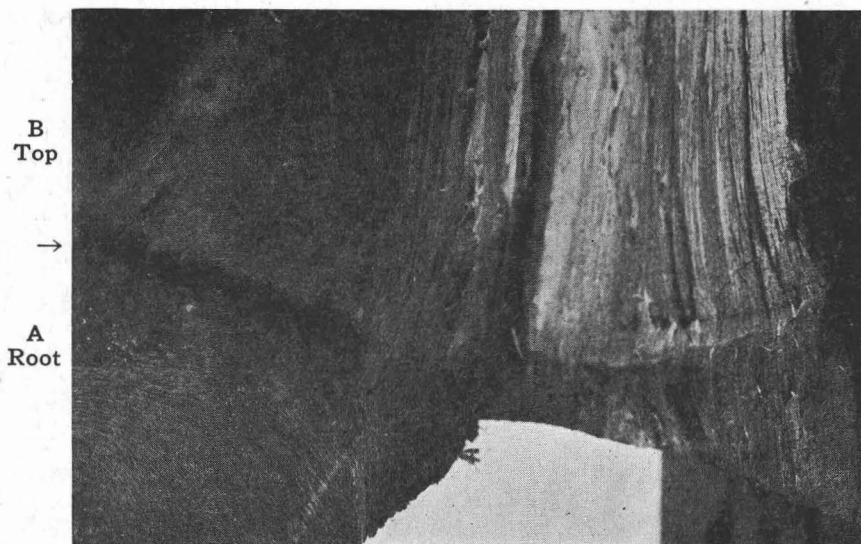


Figure 6. Showing the failure of the graft union between root and top of a Persian walnut grafted on a black walnut stock. Arrow indicates the break between the wood of the root A and of the top B.

since it seemed to be entirely satisfactory. About 1928 it was found that a few trees more than 20 years of age were dying from a girdling or breaking apart of the wood at the point of union between the black walnut root and the scion or top (Figure 6). The first indication of this trouble usually is that a number of suckers develop from the seedling root and at the same time there is little shoot growth made in the top. Between the top and root tissue at the point of girdling is found a dark brown corky layer about as thick as paper that later becomes much thicker. At first this layer may be only an inch or so in length at the line of union but it gradually increases in extent and finally encircles the tree, and kills it in from 3 to 5 years (Figure 7).



Figure 7. Final stages in the death of a tree resulting from the failure of the graft union.

Rootstocks that are hybrids of *Juglans hindsii* and some other species are considered more susceptible to this trouble than those of pure *J. hindsii* parentage. In a few orchards the loss of trees has been heavy because of the poor union between stock and scion. On the whole, the percentage of loss of trees from this cause has been small so far but the importance of the problem should not be overlooked.

Seedlings of the variety Franquette have been used as rootstocks by some who are propagating Persian walnut nursery stock. They justify this practice on the basis that Franquette scions grafted on seedling rootstocks of the same species have never been known to develop this graft union trouble. Such rootstocks are very susceptible, however, to mushroom root rot (*Armillaria mellea*) and can only be used on land free from that disease. Due to the wide prevalence of the fungus causing the disease in newly cleared land and the length of time it survives in the soil, caution must be exercised in the use of Franquette seedlings as rootstocks.

Unless the soil is known to be free from the mushroom root rot fungus, the northern California black walnut is still the best rootstock to be used, even though some loss of trees from its use may be expected.

Planting the nuts in a permanent place. Some orchards have been developed by planting the nuts of *J. hindsii* in the field at the places where it is desired to grow the permanent trees. When the black walnut trees attain the desired size they are topworked to the Franquette variety. Those advocating this practice do so for several reasons, two of which are most often given:

(1) The resistance of the trunks of black walnut species to winter and mechanical injury. During the past 20 years there has been little difference between the Persian and black walnut such as *J. nigra* or *J. hindsii* in trunk resistance to winter injury. The northern California and the eastern black walnut are undoubtedly more resistant to low winter temperatures when fully dormant than is the Persian walnut. But the injury noted has more often not been from extremely low temperatures in winter but from unseasonable cold periods at times when the trees were not fully dormant. Under varied conditions of temperature, the injury may be greater one season to the black walnut and the next season to the Persian walnut. The trunks of black walnut trees may be slightly more resistant to mechanical injury than those of the Persian, but if so the differences are slight and of little importance. Because of these uncertainties and the delays experienced by so many growers in successfully top working the northern California black walnuts to the Franquette it would seem more economical and time-saving to plant trees grafted in the nursery.

(2) The tap root is not cut as it is in transplanting. It has been found that although the tap root of the grafted nursery tree is cut in transplanting, the lateral roots will penetrate as deeply into the soil as the nature of the subsoil will permit roots to grow. It seems that cutting the tap root, therefore, has little if any effect on the establishment of the transplanted tree or on the ultimate distribution of its root system.

SETTING AN ORCHARD

Planting stock. Large, well-grown nursery trees with a 1-year-old top should be used in planting an orchard. Not only the size of the tree but also the time required to grow the rootstock that develops the large, 1-year-old top, should be considered. A large tree on a 5-year old root is probably not as desirable as one of the same size on a 3-year-old root. A root stock that

grows slowly in the nursery can be expected under most conditions to maintain that rate of growth in the field. Rootstocks that attain grafting size in the nursery within 2 years and the following year produce a grafted top 6 to 8 feet high have a better chance to develop into large, vigorous trees that will produce heavily in the orchard than do slower growing ones. A rootstock that grows very slowly and then produces a small nursery tree after grafting can not be counted on to produce a large, vigorous tree. One should avoid planting trees that have large, dead unhealed wounds resulting from grafting, as they often rot readily or heal over very slowly.

Planting time. The planting season extends from late fall to early spring, whenever the soil is suitable for such work. Under western Oregon conditions roots of fruit trees develop throughout the winter season. Seldom do the temperatures become so low that root growth is stopped. Although an effort is made to get the main roots when digging the trees from the nursery, most of the root system that supplies the tree with moisture and plant food elements is left in the soil. Fall or early winter planting allows the trees to develop new roots to partly replace the ones lost in transplanting, so that the trees are in a position to start growing early in the spring. Walnut trees are often slow in starting growth the first year under the best of conditions, so late spring planting should be avoided if possible. In order to plant in the fall the mistake should not be made, however, of obtaining trees that have had the leaves stripped off in the nursery before the wood has become mature. Some nurserymen, in order to fill early orders, will dig the trees before they are matured and then strip the leaves off. Very frequently the rapidly growing young trees are so late in maturing that if digging is delayed until they are mature it is too late for fall planting.

Allow the tree plenty of space. A planting distance for the permanent trees of 50 to 60 feet between trees is recommended. Walnut trees will continue to increase in size for more than the lifetime of the average man. In order to continue bearing, growth must be strong, vigorous, and unhampered by adjoining trees. At the usual rate of growth, if trees are planted 40 to 45 feet apart, thinning out of the trees will be necessary very soon after the trees are in bearing, but unfortunately that is seldom done until the trees have been injured by crowding and a few poor quality crops have been produced. A tree with the large growing habit of the walnut can not be kept within the space used by a smaller tree like the apple or peach. Single whips set in a field 50 to 60 feet apart appear to be at an extreme distance but by the time the trees are in good bearing, or at 12 years of age, this seems a reasonable distance. By the time the trees are 30 to 35 years old they are none too far apart and may even be crowding each other. On account of the longevity of walnut orchards it is apparent that in the crowded orchards the painful operation of thinning the stand of trees is being passed from one generation of owners to the succeeding ones.

Approximately 32 per cent of the bearing orchards surveyed in a cost production study during 1929 and 1931 had been planted 40 feet apart with the idea of taking out one half of the trees when they began to crowd. At that time only one owner had carried out the original program. Only 22 per cent of the owners of the orchards studied indicated that if they were to plant new ones they would set the trees 40 feet apart. This survey showed that 78 per cent of the bearing orchards had been planted with filler trees while of the non-bearing orchards only 19 per cent contained filler trees.

When walnuts were selling at very high prices growers found the close planted orchards very profitable in many cases, but with the decline in prices that inducement has been greatly modified. The very evident damage that has occurred in many orchards by delay in thinning at the proper time also has resulted in a general tendency to plant at distances of 50 to 60 feet apart. Since cost records show that the most economical method of bringing orchards to the age of production is by the use of intercrops, especially annual crops, rather than by using filler trees, use of intercrops in the wide spaced plantings has become most common.

Setting the trees. Usually holes dug for walnut trees are 3 feet square and 3 feet deep. The root system of the walnut is large and this size of hole has generally been adopted as most satisfactory. Blasting powder is sometimes used to break open and loosen soil in the holes; afterward they are cleaned out with a shovel. Most of the holes, however, are dug entirely with shovels. The holes should be dug only a short time ahead of planting to avoid drying and hardening of the soil on the sides of the hole.

A planting board is necessary. After the orchard has been laid out so that the exact location of each tree has been determined and marked with a stake, a planting board should be used in planting the trees. The planting board is a board 4 to 5 feet long with a notch cut at each end and one in the center. The tip of the notch in the center and those at the ends should be in line to insure accuracy. Before digging the hole, place the board with the center notch against the stake where the tree is to be set. Then place a stake in each end notch and remove the center stake and board. After the hole has been dug and when ready to plant the tree, replace the board in contact with the two end stakes. With the tree held against the center notch, the alignment of the planting can be maintained. After the tree has been planted the planting board is removed and the two end stakes are pulled up. Unless a planting board is used, it is very difficult to set the trees accurately in place so that they will line up with the others in the orchard.

Roots need protection while being transplanted. The tree roots should be protected against drying out as much as possible from the time they have been dug in the nursery until they are again planted in the orchard. The roots may be covered with wet burlap or similar material or placed in a barrel of water. The large roots of the walnut tree apparently are not as susceptible to injury from drying out as are the roots of some other trees, nevertheless, the greater the care taken in protecting the roots against drying out or injury otherwise the better the tree will respond.

Care in transplanting. Too much emphasis cannot be placed on proper care in transplanting walnut trees. In refilling the holes top soil should be used in all cases and it should be worked around the tree roots so that no air pockets are formed. The top soil is more fertile, contains more organic matter, and is in every way better suited for root growth than is the soil removed from the tree hole that was below plow depth. As top soil is filled into the hole it should be tightly packed or tramped so that it comes in contact with the tree roots.

Although early planting is urged, the trees should not be planted when the soil is too wet to work. It should be dry enough to be friable and to crumble. Soil that is too wet cannot be thoroughly worked around the roots and thus air pockets are left that will interfere with the growth of the trees. Further-

more if wet soil is packed too firmly around the roots it may become so puddled that it retards root growth of the tree.

Staking the tree. During the period of rapid growth of the walnut trees, the wood is frequently too soft to withstand the wind, especially if it is mainly from one direction during the growing season. This often results in the trees leaning decidedly away from the wind instead of maintaining an upright position, and necessitates staking young trees for a few years.

Suitable stakes are from 7 to 10 feet in height. They are set on the windward side and from 6 to 8 inches from the tree. The stake will be more likely to maintain the tree in an upright position if leaned slightly away from the tree. The stakes can be most easily set at the time the trees are planted.

Tying the tree to the stake can be done with many kinds of material, but the difficulty is to find something that will last more than one season and not chafe the bark. One of the best ties developed is made of a 3-ply strand of baling wire wrapped in burlap. The wires and burlap are placed on the side of the tree opposite the stake, then brought back of the tree and the wires crossed. After crossing, the wires are led around the stake to the back, where they are twisted together and held from sliding down by a nail driven into the stake.

Particular care is necessary to avoid tying the tree too tightly. The walnut grows rapidly, and unless plenty of space is left for the tree to develop, it will be choked and girdled.

CULTURE

The walnut tree needs plenty of moisture. The size of the shell and the filling of the kernels to a great extent depend on the moisture supply from the soil. As the walnut orchards of Oregon have become older and the trees larger, the demand for moisture in some soils and in certain seasons has become so great as to bring about a shortage. Shriveled kernels have frequently resulted to such an extent, at times, that whole crops have been nothing but cracking stock.

Cultivation is a method used to conserve the moisture, but no known means of cultivation can bring back moisture once lost or furnish to the trees more moisture than can be stored in the soils. The object of cultivation is to limit as much as possible the escape of moisture through other channels than the walnut trees. Cultivation aims to avoid the loss of moisture through evaporation direct from the soil or transpiration from vegetation other than walnut trees.

To be most effective cultivation should begin early, wherever possible not later than the first part of April. Delaying later than this will in many seasons allow cover crops or other vegetation to remove more moisture from the soil than is replaced by rains during the time of delay. Allowing cover crops to attain a large growth often necessitates keeping them growing after the heavy rains are over, thus removing moisture that should be left for the trees. Whenever spring vegetation other than walnut trees removes more moisture than is replaced by rainfall, irreparable damage to walnuts may result.

Methods of cultivation have been undergoing a decided change in the past few years. Plows in orchards have been rapidly superseded by cover-crop disks. This has been reported as being economical where the acreage is large enough to justify the heavy equipment. It has also resulted in better soil tilth

as the work has been done more nearly at the proper time. Cover-crop disks cover the acreage much more rapidly than plows.

Accompanying this change in methods has been a reduction in the amount or number of cultivations. Instead of cultivating every week or 10 days the aim is to give only enough cultivation to keep down the weed growth, a practice which at the same time maintains a light mulch. It is no longer considered necessary to have a deep dust mulch over the surface of the orchard soil.

Cover crops. Cover crops are used to maintain or possibly increase the fertility of the soil as well as to aid in preventing run off and holding the soil moisture through incorporation of organic matter in the soil.

Legumes have been favored due to their fixing of nitrogen from the air in the root nodules of the plant. Vetches have proved to be the best legumes, and spring or hairy vetch is commonly used. This is planted at the rate of 40 to 50 pounds per acre accompanied by variable amounts of grain such as oats or barley. The exact grain to be used depends on local conditions. If a soil has not previously grown vetch, inoculation of the seed is necessary.

The great objection to the use of vetch as a cover crop is that it frequently makes little growth until spring. By the time it should be plowed under the growth is not enough to justify this procedure. The tendency then is to allow the cover crop to grow late in the spring and thus use so much moisture that the effect is more detrimental than beneficial.

Some use is being made of turnips, mustard, and rape, for cover crops.

Early seeding of the cover crop will help establish the crop so that heavy early growth in the spring may result. This early seeding is practical in young orchards but in bearing orchards the growth may be so heavy by harvest time that it interferes with harvesting. The crop is sown usually by September 15.

Irrigation and thinning of stand. In any walnut orchard a time will come when the absolute limit of moisture storage and use is reached. The trees will increase in size up to a point where the demand for moisture is greater than can be supplied by the soil. There are two methods that may be used when this point is reached.

Irrigation will furnish extra moisture to the trees and maintain for a time a heavy production of good-quality nuts. The limited use of irrigation on walnuts in the Willamette Valley has been very successful. Undoubtedly more orchards could use irrigation efficiently.

Even with irrigation, experience in other sections shows that the trees may become too crowded and part will have to be removed. Where irrigation is not possible, and this is true of most of the walnut orchards of Oregon, removal of excess trees will be necessary whenever the moisture shortage becomes acute. The time at which this will occur varies with the soils and location of the orchards. Many orchardists are now confronted with this problem and a few growers have pulled one-half of the trees in the orchard and have been able for a time to overcome the moisture shortage in that way.

Commercial fertilizers. Commercial fertilizers have been used on walnut trees only in an experimental way. There is no proved schedule that can be used profitably. None of the tests conducted by either the scientific workers or by the growers themselves give any indication of profitable returns for the use of these fertilizers. Two hundred to three hundred pounds of ammonium sulphate applied annually for 3 to 4 years has resulted in a slight darkening in the color of the foliage. Later tests in which sufficient fertilizer to carry

5 pounds of nitrogen per tree has been applied annually for 2 and 3 years has not as yet demonstrated any value in producing increased crops.

Cover crops can be greatly increased in growth by chemical or commercial fertilizers in most cases. Since walnut orchards are found on all soil types on which fruit trees will grow, the best fertilizer to use is a localized problem. Again, the wide range of cover crops in use complicates the use of the fertilizers. Information about the most effective fertilizer for any particular cover crop should be obtained from the local county agent. In general, it can be said:

(1) Nitrogen is usually one of the deficient nutrients, but it has been of very little value when used alone in the fall and also may have no value used alone in the spring. Nitrogen combined with phosphorus or sulphur or both has given greatly increased growth of nonleguminous cover crops but none with legumes by the time cover crops should be turned under.

(2) Fall applications of fertilizer on soil supporting considerable native vegetation such as annual blue grass, chickweed, rye grass, and other weeds may force a quick early growth of this vegetation that will choke out the sowed cover crop, but at the same time not develop a compensating amount of organic matter. With such soils, spring applications of fertilizers are more beneficial to cover crops than fall applications.

(3) The usual rate of application of fertilizers is of very little benefit to cover crops on the poor soils or on soils where old orchards are growing. Instead of the normal amount recommended for growing field crops the rate must be increased two or three times before an appreciable increase in growth can be had. Again the amount and material to use must be determined by trial or on advice of the local agricultural advisors. A recommendation can not be made that will be generally suitable for amounts and kinds of fertilizers to use on all types of soils and cover crops.

Intercropping. On account of the length of time it takes a walnut orchard to come into bearing, few people are financially able to develop such a planting without income from the land in the meantime. With the trees planted great distances apart, much of the land will lie idle for years unless intercrops of some kind are grown.

Several different kinds of fruit crops have been used for interplanting. Of these, possibly cherries have been the least satisfactory, owing to the large size of trees, while prunes have proved the most satisfactory. With the interest in nut planting, filberts have been suggested. Filberts are just as long lived as walnuts, and gradually increase in size and bearing over a long period, hence are far from being an ideal filler tree. The ideal filler should bear early and make only a small-sized tree.

With fillers interplanted among the walnuts, the growth and bearing of the walnuts will probably be retarded to a certain extent, but the income derived from the intercrop should greatly overbalance this slight loss. As the filler trees begin to crowd the walnut trees they may gradually be removed. It is better to remove those that first compete with the walnuts than to allow all the fillers to remain for a longer period of time and then pull them all out at the same time. The balance in income derived from walnuts and fillers will in that way be better maintained.

Small fruits are well adapted to intercropping. The rows next to the walnut trees may be removed as they encroach on the walnut trees, and thus the intercrop will be gradually reduced to suit the demands of the walnut trees. If the small fruit intercrop requires trellises, as is usually the case, the cost of cultivation will be increased, since it can be carried on in one direction only.

Use annual cultivated crops for intercropping where possible. The annual cultivated crops make the best intercrops as the soil can be kept in best condition, the land can be more effectively used while the trees are young, and the area devoted to intercrops can be more easily adjusted each year to the needs of the walnut trees.

Grains and hay are the least satisfactory intercrops, but can be used if sufficient cultivated space is allowed the trees. In calculating the space for open cultivation around the trees, increase by one-half the estimated spread of the top at the end of the season's growth. This is to avoid competition between the roots of the walnut and those of the intercrop.

A fertilization program suitable for the intercrop and the soil should be followed. Continued cropping of the soil is so apt to decrease fertility that the walnuts will be unable to make the growth desired. None but the very richest of the soils in the state will be able to withstand such a practice without danger of injuring the walnut trees.

PRUNING AND TRAINING

Balance the top and roots at transplanting. When the young tree is dug in the nursery only a small part of the root system is removed with all of the top. If the whole top were left after planting, too great a leaf surface would develop for the reduced root system to supply the water and nutrients needed. So the top should be headed back to balance the root system. Heading back is often done for the purpose of establishing the height of the head but this purpose should be subordinated to that of balancing the top and roots. Trees that have had their tops cut back to balance the roots will make larger growth in the same time than would trees that have their tops cut back very little or none at all.

Heading back to from 3 to 5 feet in height is satisfactory for larger trees but is not for small ones. Trees of the 8 to 10 foot grade can be cut back to that height and thus partly compensate for the loss of roots. With a 4- to 6-foot grade, cutting back to the same height would do little to balance the top and roots. Heading back should be done according to the height of the trees even if, as is rarely done, 2- to 3-foot trees are planted, with the idea of balancing top and roots. The height of the head can be determined by later pruning. Few men cut back the walnut trees at the height they ultimately hope to have the head, but gradually raise its height to the desired level by later pruning.

Low heading back no longer popular. As an extreme attempt to balance fully the top and roots, it has been recommended and practiced by some growers to cut back the top to a height of 8 to 16 inches. Following this extreme cutting back, only one bud was allowed to grow into a shoot, which formed the trunk of the tree. The rapid growth and soft wood developing after this treatment was so easily distorted and bent by the wind and other forces that extra care in staking and tying was necessary. At present this method has been almost entirely discarded in favor of higher heading, which results in a type of growth that is more easily handled. Good, well developed trees should, if properly handled, transplant readily and give nearly a 100 per cent stand without the practice of severe cutting back.

Training the tree. In training the tree the aim should be to anticipate the need for large cuts by making the cut when shoots are small. Removal of

a shoot just after growth starts causes much smaller loss to a tree than when the shoot is allowed to grow for one or more seasons and is then removed. Whenever any wood growth is removed by pruning, it is a loss to the tree. The smaller the loss, the larger the tree at the end of a given period of time. Removal of wood by pruning or otherwise results in a reduced size of tree. The less a tree is pruned the larger it will be, but some pruning must be done in order to build a strong sturdy tree. It is best, therefore, to select the branches that are to form the main framework of the tree during the first and second growing seasons, and remove the excess branches at that time.

When the trunks are cut back at planting time to 3 to 5 feet, it sometimes happens that every bud starts growth and unless the unwanted buds are removed, by fall the trunk will be covered with a large number of small weak branches. As soon as growth is well started it is best to select the strongest shoots that are well placed on the trunk and then rub off or pinch back those not needed. This confines the growth of the tree to a few branches that will be longer and stronger than if more shoots were allowed to grow. Following this practice, the total growth in length made by the shoots during the first year may be somewhat less than when all of the shoots are left, but after the winter pruning is done those trees not summer pruned or cared for in the early part of the year will have less total shoot length than those that have been properly cared for.

The lower buds frequently start growing vigorously and soon outdistance the upper shoots. Often this is followed by dying back of the upper foot or two of the trunk. Removing these lower shoots early in the season will tend to force the upper shoots into more active growth.

In the old seedling orchards there are many trees with central leaders since these trees were planted as very small trees and the terminal growth was never headed back. The lateral branches on these trees are distributed over a long space on the trunk and strong crotches are formed (Figure 8). Not all trees in these orchards have central leaders as the tendency is for a few large laterals to develop at some point and these may dwarf the central leader (Figure 9). With grafted trees, central leaders are still more difficult to develop as the loss of roots when transplanted necessitates cutting back the trunk and this forces a number of buds into growth of about the same vigor. If the terminal shoot is selected and left unpruned and the other shoots are cut back it may be possible to develop a central leader tree, otherwise the tree will have an open head. This cutting back of the branches, however, will reduce the size of the tree and delay the time of coming into bearing. With the best of care and training central leaders are difficult to maintain, as there is a definite tendency in the Persian walnut for them to be suppressed in growth and position by a more vigorously growing lateral shoot.

Trees with well developed central leaders on which the laterals are well spaced make the strongest trees, since they have crotches that resist breakage.

Open headed, or vase shaped, trees in which the main scaffold branches originate from near a common point on the trunk break down more readily from a heavy load of nuts than do central leader trees (Figure 10). Such trees often require bracing and wiring of the branches together as they become older in order to prevent breakage.

Three to five main scaffold branches form a good tree. Usually not all these branches can be obtained the first year on the trunk as it is left after heading back, but they can be chosen later from well spaced shoots on the upper branch developing as a terminal. If this upper shoot, as often happens, fails to develop, the tree should be accepted as it is and no attempt made to make it

over, for much time and tree growth may be lost when an attempt is made to force a tree into a predetermined shape.

In a desire to obtain high headed trees it is the practice of some growers to strip off the lower limbs, leaving only the central leader. As fast as any side buds develop they are removed. This leaves only a small tuft of leaves at the tip of the young tree. The few leaves are insufficient to furnish enough food for any considerable growth. This is continued for one or more seasons, ultimately allowing the branching of the tree at a height of 6 or more feet. If such a high headed tree is desired it may be obtained more quickly by allowing the lower limbs to grow for several years before they are removed. The leaves on these lower limbs help feed the tree and greater strength is thus obtained in the upper part of the tree, with consequent better growth of the leader. The lower limbs, if allowed to remain, will also aid in forcing the new growth of the leader in an upright direction. On the other hand, taking off these lower limbs will act as a set-back in the development of the size of the tree. The

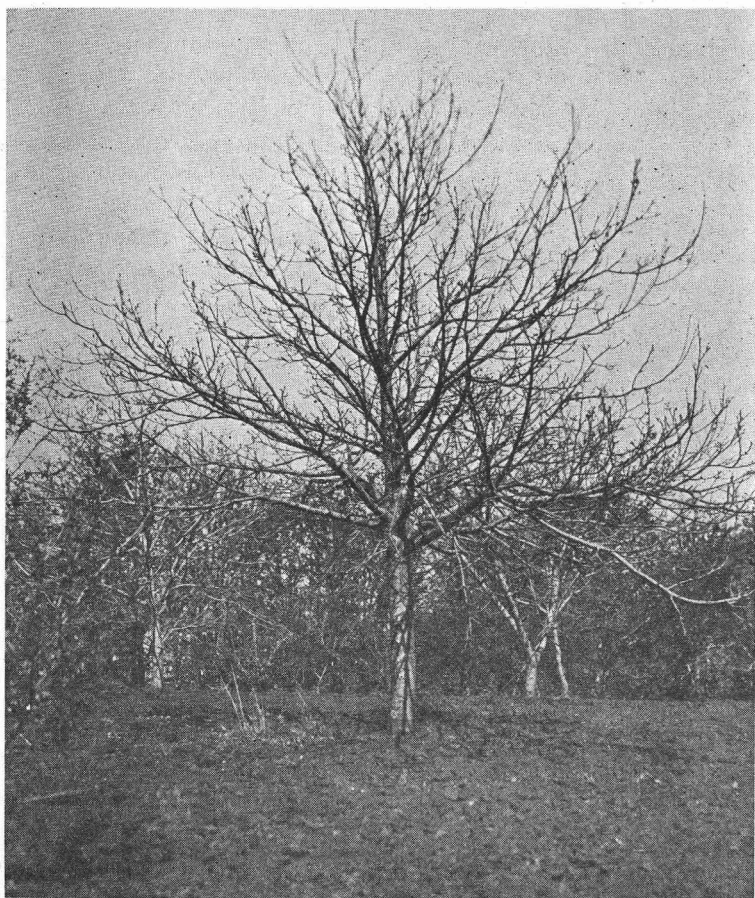


Figure 8. Central leader in a tree that had never been pruned.

trees would be larger if the lower limbs were not removed. The desire for a high headed tree can be satisfied only by decreasing the rate of increase in tree size.

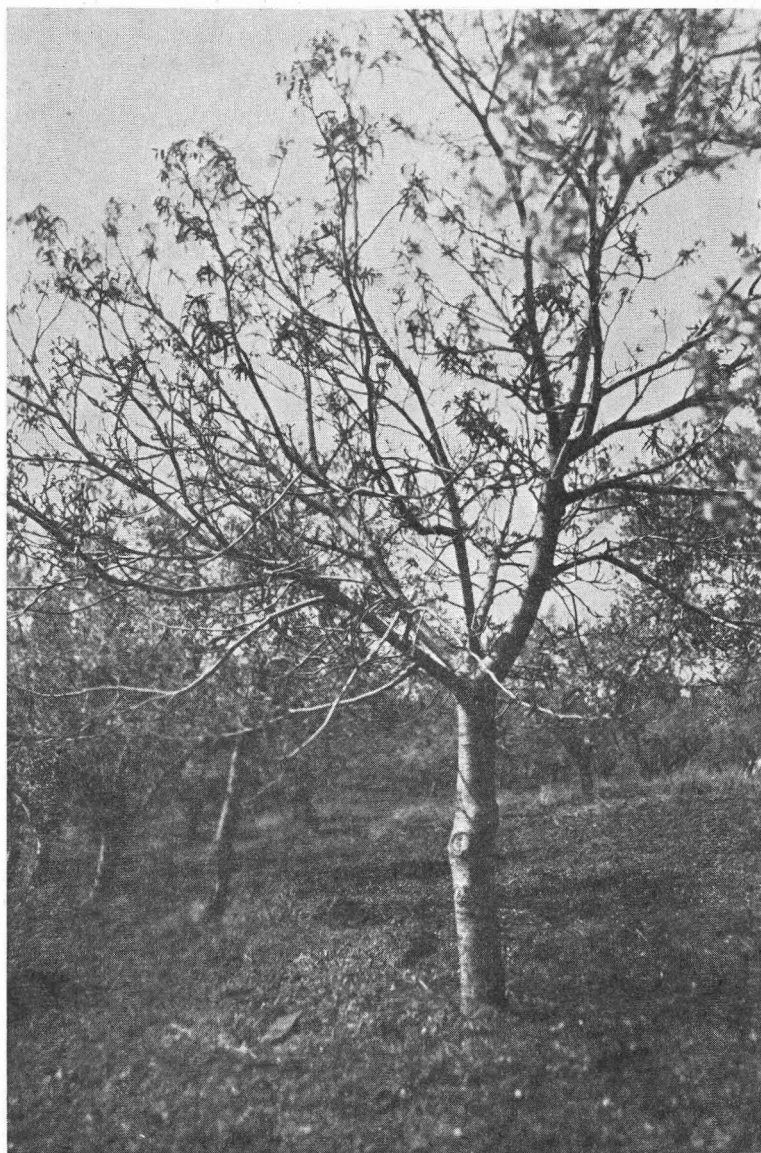


Figure 9. Showing how a central leader may be choked by lateral limbs coming out at one point on the trunk.

Later pruning. After the trees have come into bearing very little pruning is required and often this is confined to removing the drooping limbs that interfere with cultivation. Pruning or thinning out the top sufficiently to keep vigorous fruiting wood throughout the inside of the tree apparently has never



Figure 10. Common form of branching that results in a weak tree.

been achieved and it is doubtful if it would be practical since it would require the removal of too much of the fruiting wood located in the outer portions of the tree. In the natural growth of the tree the wood produced during the last 5 to 8 years in the periphery of the top contains nearly all the vigorous fruiting wood. Inside that fruiting area, if any wood is weak, it will produce small inferior nuts. If this weak wood is pruned out the source of many small nuts is removed. A complete removal of weak wood is not advisable as such wood generally produces late developing catkins that are very helpful in providing an adequate pollen supply. Within the main fruiting area are two types of branches that are of little value. One is the branch bearing shoots that elongate each year but put out few laterals for fruiting, so that production for one whole branch may be reduced to a single fruiting bud. The other type of branch is 5 to 8 or more years old and produces many terminals and laterals, but these are so short that few of them are vigorous enough to bear fruit. This kind of branch is continually appearing in a tree as the more vigorous limbs outgrow and overshadow others. The removal of these two classes of branches will eliminate nonproductive wood and give added space to the fruitful wood. Branches on which the terminal growth is from 8 to 18 inches long and on which laterals can develop and bear fruit should not be pruned out to open up the tree. A vigorous branch bearing laterals totaling in length more than the length of the branch itself should not be cut out since such branches are very fruitful. If vigorous fruiting wood could be maintained throughout the tree there would be no need of pruning, but unfortunately, that does not seem possible. Some branches are always crowded by others until they become unproductive and need to be pruned out.

REINVIGORATING OLD TREES

Many of the old trees are so low in vigor that they are unproductive. This may be caused by planting the trees too close together so that they crowd each other and thus the lower parts of the trees receive little sunlight and bear few or no nuts. It may also be that the supply of soil moisture is deficient or that the soil nutrients have been depleted to the point where there is not sufficient plant food for all of the trees.

The first step in reinvigorating old trees is to thin the stand by removing a number of the trees, either one-half the walnut trees if there are only walnut trees in the orchard, or all the filler trees if they are still present. On good land the trees will increase in vigor in 2 to 3 years. On the poor, infertile soils the response of the trees following thinning will be slower than if located on fertile soil.

After the stand of trees has been thinned, pruning will usually be a great help in stimulating the vigor of trees located on fertile soil. This pruning should consist of removing the partly or completely dead limbs and the wood of low vigor on the inside of the tree. Even if the trees respond with increased growth this nonvigorous wood on the inner part of the trees will not be greatly reinvigorated so it should be removed at this time.

In the case of trees located on unsuitable soils, pruning can not be expected to aid a great deal in stimulating new vigorous growth. Such trees usually do not have a very compact top. Heavy heading of the branches will give an immediate response but the trees will quickly return to approximately the former rate of growth for the same reason that caused the original nonvigorous condition. Heavy heading back or thinning out of the outer part of the tree may result in sunburn on the main branches.

Since such old orchards are usually sufficiently cultivated, additional care must come from the use of cover crops, barnyard manure, or some such means, to add organic matter to the soil. These unthrifty orchards invariably have soils low in organic matter, in which a large part of the available nutrients are held. This low organic matter content of the soil should be increased so that the supply of available nutrients will be more nearly adequate for the trees, and cover cropping is the most practical way of adding the needed organic matter. Commercial fertilizers could and can be profitably used on the cover crops to increase their growth and the organic matter produced. Subsequently, when they are returned to the soil, nutrients contained in them will become available to the trees.

TOP WORKING

Worthless seedling trees should be top worked. In every seedling orchard a certain percentage of the trees on coming into bearing are found to be unsatisfactory for one reason or another. If individual records of the trees are kept, the unsatisfactory ones can be definitely located so that they may be grafted and not kept as unprofitable "boarders" in the orchard. Records should be kept of the time of leafing out, the amount of blight, the amount of crop, and the quality of nuts produced. Some of these data, such as the amount of crop, need not be absolutely accurate but if recorded as a relative amount for several years, it will be possible to locate the poor trees and top work them with some standard variety or to one of the desirable seedlings.

The principles of top working walnuts are practically the same as those applied to other trees. With old trees it is not the best practice to top work the whole tree at once. If all the scions take, it is well, but if a large part fail, as often happens, the work and time necessary to finish top working later is very great. Grafting one-third or one-half of a large tree each year allows the tree, in a measure, to manufacture plant food for new top growth and does not permit the root system to starve out. Where the whole tree is top worked at once, there is little chance for elaboration of plant food until late in the

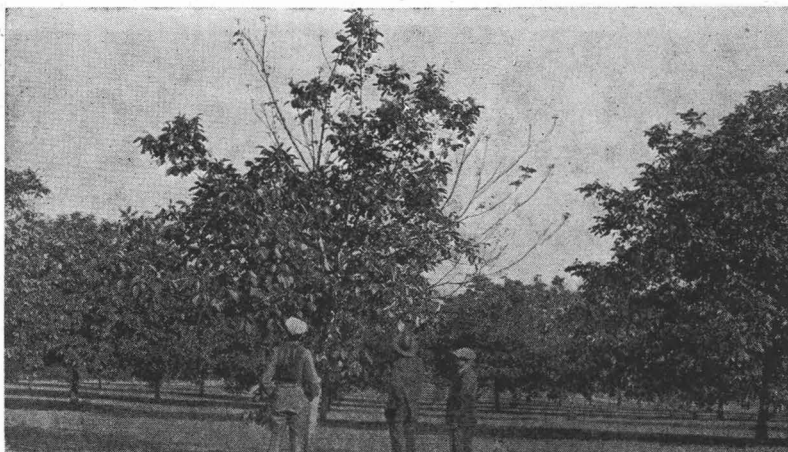


Figure 11. A "sleeper" tree partly top worked.

summer and even then only a small amount of the food is furnished to the root system. Many trees have been badly devitalized and a few have died from the effects of attempting to top work the whole tree at one time.

Small cuts best. The best practice in top working large trees is to make small cuts—usually not to exceed $2\frac{1}{2}$ to 3 inches in diameter. This size of wound heals over readily, in contrast to larger ones. The use of small cuts greatly increases the cost of top working since many more scions have to be set in each tree. When a person can do the work himself, this cost is not so important, but when the work is paid for at so much per scion it amounts to a considerable sum of money. This added cost, however, is rather quickly repaid since the trees that are not so severely cut back in top working come into production more quickly and bear larger crops than similar ones cut back more severely.

The modified cleft graft is commonly used and is claimed to be the strongest form of graft. It is often objected to on the ground that the opening of the cleft provides a place for the entrance of heart-rot, especially if the wounds are very large.

Inlay and forms of bark graft are also used by some in top working trees. Some growers claim the cleft graft is stronger than bark grafts, but others claim the opposite. More top working is done by cleft grafting even though a higher percentage of living scions is claimed for the bark grafts.

Top working is most successfully performed in the spring shortly after the buds have opened, or a little later. The professional grafters work long before and long after this time. Scions have been made to grow when set as early as January 1 and as late as July 4.

After the grafts have been made, the scions are enclosed in manila paper sacks to protect the young shoots as they form. Later the sacks are torn open as the shoots develop. Provision must be made to support the new shoots. Supports of 1" x 1", or 1" x 2" lumber are nailed to the stubs and the new shoots are tied to them. If this is not done, the new shoots often assume undesirable shapes and seldom grow in the same direction as the supporting limb. Furthermore, if the scion shoots are not supported they may be broken off by the wind.

Top working "sleepers." One kind of seedling tree that is of little value is the one known locally as a "sleeper" (Figure 11). Such trees do not come into leaf until late in the season, sometimes not until July. Then, too, they have a tendency to go into dormancy early so their growing season is very short. Nearly all of the sleepers are unproductive. Top working these trees to a variety having a normal period of growth sometimes is successful, especially with the sleepers that do not start growth very late and have a relatively long growing season for the type. The nearer the length of the growing season of these trees approaches that of a variety like the Franquette, the more satisfactory are the results from top working. It is reported that many sleeper trees are very difficult to graft to any variety of walnut.

HARVESTING

Walnuts drop freely from the husk when sufficient rain and moisture are present during harvest. Usually the first picking consists of the nuts that drop early and they are the poorest filled of the crop. Later, it may be necessary to shake the trees to hasten the drop of nuts, especially during dry seasons. If the humidity is low at maturity, the husks crack but do not open and thus

hold the nuts tightly and prevent them from dropping. When that condition exists mold develops and discolors the shell. Shaking is then used to force the nuts down. Under local climatic conditions there seems to be little discoloration of the kernel from allowing nuts to remain on the tree after they are mature. In some sections high temperatures at harvest time cause the kernels to be discolored. In the Pacific Northwest high temperatures during the summer months may cause some kernels to be darkened and otherwise discolored.

Shaking or knocking the nuts off the trees before the husks have loosened and then loosening them by various means has not proved practical for the Franquette walnut. The blooming and ripening period extends over such a long time that the practice of shaking or knocking brings down many immature nuts that on drying contain very poorly filled kernels. In occasional seasons when the blooming period lasts only a week or 10 days, such harvesting practices may be used satisfactorily, but generally the nuts should be allowed to drop naturally.

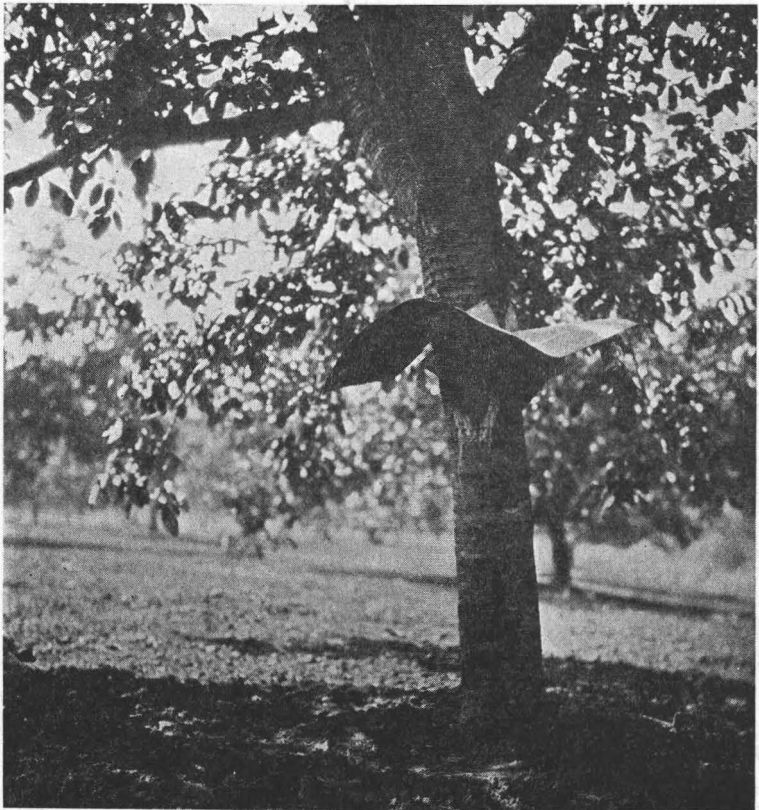


Figure 12. Shields placed around tree trunks to keep down deprecations of squirrels.

Nuts allowed to remain on the ground for long periods of time are seriously discolored, even to the point where satisfactory bleaching is difficult. The best practice is to make several pickings during the season.

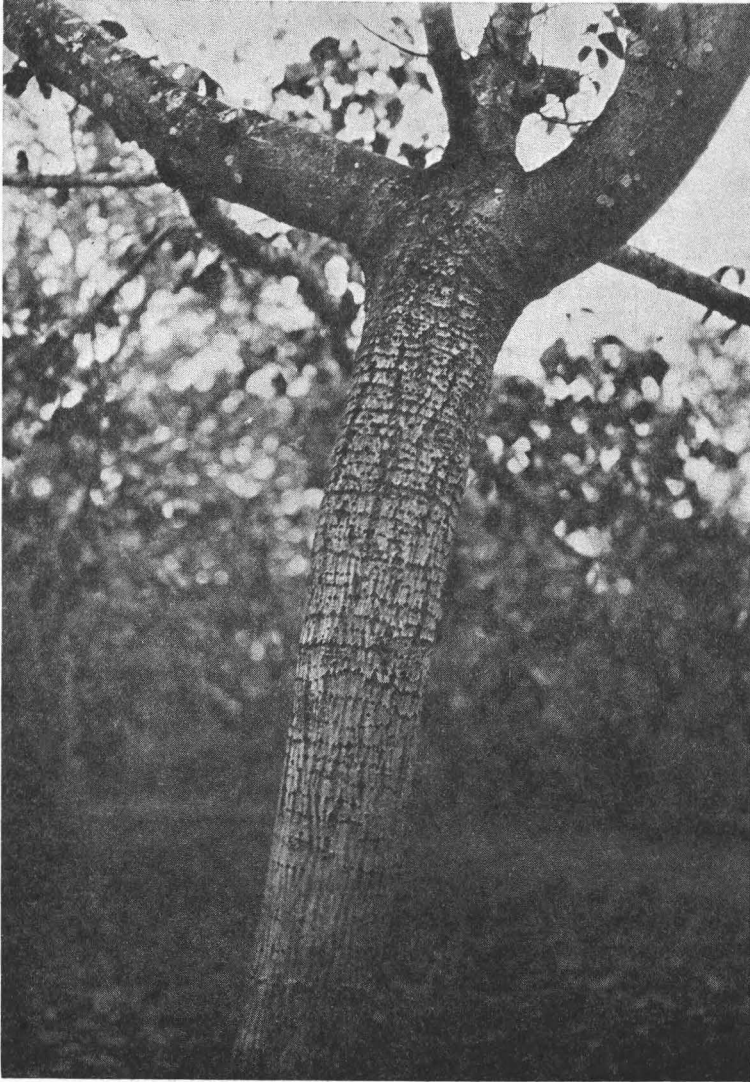


Figure 13. Damage caused by the work of sapsuckers. The only practical control is the destruction of the birds.

DRYING

Artificial drying is necessary with walnuts in Oregon. Many methods are in use but the underlying principle is to have circulation of air at a temperature of not higher than 90° to 100° F. around the individual nuts, though some operators claim successful drying can be done at 100° to 110° F. High temperatures spoil the quality of the nuts by causing rancidity of the kernels and by cracking the shells.

Owners with but one or two trees can dry the nuts by placing them on screen trays over stove or furnace outlets so the air can pass around the nuts and carry off the moisture contained in them. They can also be dried if laid out in single layers in dry warm rooms. Nuts put in sacks, tight pans, boxes, or other tight receptacles, however, do not dry out satisfactorily and their quality may be spoiled. They may ultimately dry, but the kernels are very apt to have a bitter flavor.

Commercially, nuts are dried so their moisture content is from 5 to 8 per cent. At this stage the kernels when cool will snap when bitten into.

Several types of driers in use. Many walnuts are dried in prune driers, or in Oregon tunnel driers. This is because such driers are commonly present on the ranches and it is not necessary to build another drier especially and solely for walnuts. These driers are fairly satisfactory, but owing to the low temperature required in drying walnuts, the circulation of air in the natural-draft type is very slow, as there is not enough difference between the temperature in the tunnel and that on the outside to promote a rapid movement of the air; therefore little moisture is carried off and the drying process is prolonged. When provided with fans, this type of drier is capable of producing dry walnuts in a relatively short time.

The kiln type drier, such as is used for hops, has proved somewhat more satisfactory, being a little quicker in drying, and also somewhat cheaper to operate. Few of these are being built, however, as the orchards are seldom large enough to warrant the expenditure necessary to build them when the tunnel type drier is so commonly found in the neighborhood.

Bin type driers of different design are in use and with forced draft are economical to operate. At times they are arranged with one bin above another, wet nuts being put in the upper bin and the air circulated from the lower, drier binful to the upper moist one. In effect, it is using the warm air repeatedly. In other cases the bins are placed alongside each other.

Recirculation of air is seldom used, as the amount of heat required to bring the air to drying temperature is so little that it does not pay.

Drying time varies from 18 to 72 hours, depending on the type of drier, humidity of the air, and condition of the nuts. The bin type of drier with a fan usually dries the walnuts in 18 to 24 hours, while the tunnel drier often takes from 60 to 72 hours.

Many old buildings have been converted into driers on farms producing small crops. It is essential in the construction of such a drier to place the drying floor 8 to 10 feet above the source of heat and to provide large openings in the top of the building to permit the escape of the warm air carrying the moisture from the nuts.

Bleaching walnuts. Bleaching walnuts for the market is a regular packing plant practice with which the grower has little concern. For those who wish to bleach small lots of nuts at home the following formula and directions are given:

Commercial chlorine bleach	2½ gallons
Water	35 gallons
Sulphuric acid	3 ounces

The sulphuric acid is mixed with 2½ gallons of water in a glass or stone-ware receptacle. The commercial chlorine bleach is mixed with 32½ gallons of water contained in a vessel that will hold a much larger quantity of material. The bleaching solution and the acid are not mixed until immediately before use. Extreme care must be used in mixing the acid and water. *Always pour very slowly the sulphuric acid into the water. Never the water into the acid.*

The equipment consists of two tanks, barrels, or other containers, with a drain board between slanting back to the first container. For draining, a regular drain board may be used, or a third tank leading to the first one. In the first tank put the bleaching solution composed of the above mixture. The walnuts are put in some sort of basket and immersed for 2 to 3 minutes, as needed, to get the desired bleach. They are then placed on the drain board for 2 minutes and finally dipped in the last receptacle containing clean water. After rinsing, the nuts are dried at a low temperature until they are surface dry.

Grading walnuts. The requirements to be met in grading walnuts are now specified by state law. These requirements for walnut grades can be obtained from the State Department of Agriculture at Salem, Oregon.

LIST OF BULLETINS OF INTEREST TO WALNUT GROWERS

- Station Bulletin 315—Costs and practices in establishing walnut orchards in Oregon, A. S. Burrier and C. E. Schuster. June 1933.
- Extension Bulletin 500—Blight and insect pests of walnuts, P. W. Miller and B. G. Thompson. February 1937.
- Extension Bulletin 498—The control of mosses and lichens on fruit and nut trees, P. W. Miller. February 1937.
- Extension Bulletin 528—Grafting and budding, W. P. Duruz. September 1939.
- Extension Circular 338—Miscellaneous nut crops, C. E. Schuster. September 1939.
- Extension Circular of Information No. 201—Drying and bleaching walnuts, E. H. Wiegand and L. O. Van Blaricum. June 1939.
- Station Bulletin 372—Soil moisture, root distribution and aeration as factors in nut production in western Oregon, C. E. Schuster and R. E. Stephenson. June 1940.
- Extension Circular No. 359—Walnut blight control in Oregon, P. W. Miller. February 1941.
- Reprint entitled "Current investigations on the control of walnut blight in Oregon" by P. W. Miller. Reprinted from Proceedings of Western Nut Growers Ass'n for 1940; 32nd Annual Rept. of Oreg. State Hort. Soc., 1940, pp. 135-139.
- Station Bulletin 396—Cost of producing walnuts, G. W. Kuhlman and C. E. Schuster. 1941.
- Extension Circular No. 362—Pollination requirements of nuts in the Pacific Northwest, C. E. Schuster. 1941.

Soil Testing Twenty Years Too Late



The use of a soil auger or similar tool is essential in determining the suitability of a soil for walnut growing. This should be done before planting trees.

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