Circular No. 83 - Planning, Planting, and Caring for Young Orchard

Francis M. Coe
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A WELL-LOCATED UTAH ORCHARD.—On bench land where cold air drains off below, giving protection from spring frosts. This orchard also has protection from canyon winds which blow on clear, cold nights.

UTAH AGRICULTURAL EXPERIMENT STATION

UTAH STATE AGRICULTURAL COLLEGE

Logan, Utah
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FRUIT GROWING offers many advantages to the farmer of the intermountain west, chief of which is the high return possible from a relatively small farm. Few crops will give as high an acre-yield or return as a properly located and managed orchard. Acre-yields of from 500 to 800 bushels of apples, pears, or peaches are not unusual. The work is pleasant, interesting, and healthful, as well as remunerative when properly conducted.

These attractions, coupled with the added incentive of high prices and long profits on certain varieties and fruits, are stimulating the planting of new orchards in the more protected districts of the intermountain region.

Unfortunately, high returns are the lot of only a small proportion of the present bearing orchards, and failures are all too common. To prevent these failures and to elevate the general level of success attained with the newer orchards by helping planters of new orchards to avoid the numerous mistakes so commonly made, this publication has been prepared.

Because of the permanent nature of an orchard and the time and investment required to bring it into heavy bearing, unusual consideration should be given to every factor which may affect its success. Mistakes in location, choice of varieties, or early management have caused many orchards to be unprofitable. Once planted, the orchard cannot be changed in many important respects, any one of which may limit its profitableness.

ECONOMIC CONSIDERATIONS

Types of Orchard Enterprises

THREE TYPES of orchards are generally recognized, based on the method of disposal of the crop: (1) Commercial shipping orchards, (2) local market orchards, and (3) home orchards. Frequently two or more of these types are combined in the same enterprise. The requirements, particularly in the choice of varieties and kinds of fruits to be grown, differ materially.

Commercial Grower Should Plant Few Best Varieties

The strictly commercial orchard should be so planned as to enable the grower to ship straight carloads of varieties most in demand in the general markets. The size of the orchard and climatic and soil conditions must be such as to produce the best possible market quality at the lowest cost. This necessitates high yields, since the cost of production per unit is governed largely by this factor.

1Contribution from Department of Horticulture, Utah Agricultural Experiment Station. Publication authorized by Director, January 18, 1930.
On the other hand, local market orchards may profitably have a wider range of kinds and varieties so as to give a greater selection to customers and to provide fruit for sale over a long season. Such a fruit farm should be planned to supply all the fruits needed by its community which can profitably be grown in the district. It should be planned for a definite market and planted only after a careful survey of the preferences, future demand, and supply of fruit in sight for that market.

Home orchards may be planned to suit the owner's tastes and requirements rather than the dictates of business policy and market requirements. Many varieties of superior flavor may be grown in spite of shortcomings of appearance or yield which makes them unsuited to commercial culture. The home orchard should include all the fruits that can be grown and should be planned to provide fruit from the earliest cherries to the latest keeping winter apples and pears.

Consider Future Market Conditions

COMMERCIAL ORCHARDS should be planted only after favorable consideration of all the factors that determine future prices, i.e., those which affect supply and demand.

Among those factors which tend to increase future supply and so to depress prices and make the outlook for new plantings less favorable are: (1) New plantings, their area, their location in regard to markets, pests, regularity of crops, nature of the care they are likely to receive; and (2) the decrease in acreage of old trees. The status of new plantings in competing districts which ship to the same markets and at the same season as the proposed orchard should be considered with especial care.

On the demand side, increase in population, shift of population from rural sections to the cities, trend of purchasing power, competition of citrus and subtropical fruits, changes in demand to higher-quality fruits, advertising of fruit, and refrigerated transportation service and rates all affect the future demand and should be considered as thoroughly as the information obtainable will permit.

Requirements of a Good Fruit Region

COMMERCIAL ORCHARDS should be planted only in regions which can compete in quality and cost of production with the most successful competing sections or in those regions which have a decided advantage in closer markets or lower freight rates. Such a region must have a climate well-suited to the fruits to be grown. Peaches, for example, require warmer summers than do apples and stand less winter cold. Frost hazard must be a negligible factor.

In addition to these important climatic factors, such regional conditions as water-supply, cost and skill of labor-supply, cost of land, possibilities of cooperation, severity of pests, transportation facilities, and distance from markets should be considered.
Advantages and Disadvantages of the Intermountain Region

THE INTERMOUNTAIN REGION, while distant from eastern markets, enjoys greater proximity and lower rates to growing middle western markets, which have access to fewer local supplies than do those of the east, and to the rapidly expanding Pacific Coast markets. These latter markets absorb large quantities of red apples and are using increasing amounts of Utah peaches and cherries to lengthen their season. The Middlewest will always be a market for late peaches, sweet cherries, and apricots.

Because of its arid climate, the intermountain region enjoys greater freedom from disease as well as a high finish on its fruit. Cool nights and sunny days give higher color to apples and pears, while certain districts, favored by natural agencies which modify the climate, have sufficiently mild winters and warm summers to produce high-quality peaches, apricots, and sweet cherries.

Fig. 1. SQUARE PLAN WITHOUT FILLERS.—Particularly suited to the more closely planted fruits, as peaches, apricots, plums, sour cherries, Bartlett pears. This diagram illustrates full-bearing peaches planted 24 by 24 feet.

LOCATING THE ORCHARD

Choosing the Orchard Site

IN LOCATING the orchard, consideration must be given to the site, the soil, and the water-supply. Freedom from frost is the most important consideration in choosing the site. An ideal site is one which is located well above the surrounding country, one which has protection from dependable canyon winds, or a combination of both.

Elevation gives "air-drainage", i.e., the cooled air is allowed to drain away and be replaced by the warmer air which rises. Upper benchlands are preferable be-
cause of their superior air and water drainage. Narrow valleys entirely surrounded by mountains are not as free from frost, as are the wider, more open valleys like the Salt Lake Valley. Level benches provide suitable orchard sites if they are not too wide to enable the cold air to drain off to the lower levels.

Slope, or aspect, is not so important. However, pronounced south and west slopes are earlier, warmer, and drier than are north and east slopes. Trees on such slopes bloom earlier and consequently are somewhat more susceptible to frost injury. For fruits requiring more than the usual summer heat and a longer growing season, such slopes are to be preferred. The land should have sufficient slope to provide drainage and to facilitate irrigation. Steep slopes are not only difficult to cultivate, to spray, and to irrigate but also increase production costs.

Soil Requirements and Adaptations

DEPTH AND TEXTURE, or coarseness, of soil is more important than is fertility, although the latter is by no means a negligible factor. There must be no hardpan, rock ledge, or high water-table to interfere with deep rooting. Fruit trees do well on a wide range of soil textures—from coarse gravels and rocky soils to clay loams. Special adaptations are recognized, however. Apples and pears are better adapted to soils of a silty or clay-loam character, although they also do well on rocky, gravelly, and sandy loams which are deep and well-supplied with organic matter. Red apple varieties, requiring a long growing season, like the Winesap group, for example, do not color as well on heavy fertile soils. Likewise, certain vigorous varieties, like the Arkansas Black, which tend to be shy bearers on heavy soils, fruit heavily on the lighter soils. Varieties tending to be small are more easily grown to marketable size on the heavier, more moisture-retentive soils.

Peaches and apricots do best on warmer, more open-textured soils. Apricots are particularly drought-resistant. Sweet cherries are less tolerant of drought and tend to be short-lived on dry, shallow soils. Sour cherries also require moisture-retentive soils. To be suitable for orcharding, coarse, gravelly, and stony soils must be relatively deeper than loam soils. Gravel benches with only a foot or two of gravelly loam underlaid with almost clean gravel should be avoided. Four or five feet of good soil should be considered a minimum, and additional depth is preferable. Morris and Luce2 consider 2700 cubic feet of “good” soil (30 x 30 x 3 feet deep) as a minimum for an apple tree to produce well, and 5400 cubic feet (30 x 30 x 6 feet deep) as more nearly ideal. Where the soil is half gravel or stones, twice this volume of soil should be accessible to the roots of each tree. Similarly, 1200 cubic feet (20 x 20 x 3 feet deep) should be considered a minimum amount of soil for each peach tree, with 2000 cubic feet preferred.

Moisture-Holding Capacity More Important than Fertility

Fertility of the soil is of secondary importance. Fruit trees, because of their deep root systems, often make satisfactory growth on soils of moderate fertility. Most soils of the intermountain region with sufficient

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fertility to grow field crops successfully will grow good orchard trees. In most of the fruit soils of this section, the limiting factor determining growth and fruiting is probably capacity to store moisture rather than fertility. Since addition of organic matter increases both water-holding capacity and the amount of nitrates available to the trees, practices such as manuring and plowing-under of green-manure crops are usually beneficial. Soil management practices in the young orchard should be planned with this factor in mind.

The Water-Supply

The amount of water required depends upon the nature and water-holding capacity of the soil, the kind of fruit, the rainfall, and the system of soil management to be used after the orchard reaches bearing age. Coarse, open soils of low water-holding capacity require more water and more frequent applications than do those with a retentive subsoil. It is more difficult to irrigate such soils without waste through seepage. To secure proper penetration, heavy, rather imprevious soils require water less often but for much longer periods.

Apricots and peaches are more drought-resistant than are other fruits and also somewhat less sensitive to fluctuations in the water-supply. Peaches, however, require plenty of late water to "size-up" the fruit, while apricots, maturing earlier, require less water in late summer and fall. This difference in time of demand may well be taken advantage of by the grower whose late water-supply is limited.

Cherries, particularly sweet cherries, even though maturing their crop early, are sensitive to lack of water and easily injured by drought in late summer. The short life and "die-back" in orchards suffering from late water shortage may be attributed in part to this cause.

Apples and pears also require considerable moisture in the late summer and fall when the fruit is maturing. A mature apple orchard needs about 30 inches of water, including rainfall, where it is well distributed and conserved by cultivation. Where sod culture (alfalfa, sweet clover, or grass) is used, an additional 30 inches should be provided.

PLANNING THE ORCHARD

Determining the Size

The best size for an orchard depends upon the kind of fruit, other enterprises to be carried on as a part of the farm business, and upon the ultimate market.

As far as labor is concerned, 15 to 20 acres of orchard is considered a 1-man unit, with additional help needed for pruning, spraying, thinning, and harvesting. Thirty to 40 acres is considered a 2-man unit. Where poultry, vegetable, or crop enterprises are conducted, less time will be available, and therefore less orchard should be planted unless additional help is to be employed. Larger units are preferable from an equipment and cost standpoint since they make possible efficient employment of power tillage, spraying, and packing machinery and equipment. High-pressure spraying outfits are required for successful fruit-
growing. Where peaches, apricots, and cherries, which require from one to three sprayings, are grown the spraying can often be hired or the sprayer shared with other growers. With apples and pears, which require five to seven sprayings, each orchard should have its own power sprayer of adequate capacity.

Unless supplemented by other sources of income, 15 to 20 acres should be the minimum acreage necessary to provide an adequate income for the average family. Where the marketing is handled locally by the grower at wholesale or retail prices, a somewhat smaller acreage may suffice, particularly where small fruits make up a part of the enterprise.

**The Use of Fillers**

Because of the time necessary to grow trees of the larger kinds to the size where they will utilize all the space which must be allowed them at maturity, some means of increasing returns from the orchard during its early years is desirable and usually necessary. Two means of increasing returns are open to the grower: (1) fillers and (2) inter-crops; a third means of increasing returns might be a combination of both.

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**Fillers Produce Heavier Yields While Orchard is Young**

**Fig. 2. RECTANGULAR PLAN.—Permanent trees form a square with fillers in the rows only. Particularly adapted to intercropping. Diagram illustrates apple permanent with peach fillers.**

Fillers are temporary trees set between the permanents to increase the yields before the latter can use all the space. They are removed before they crowd
the permanent trees. They may be early-bearing varieties of the same fruit or early-bearing, shorter-lived fruits, such as peaches, apricots, and sour cherries.

Fillers of the same kind of fruit have the advantage of being handled the same as the permanent, while a different fruit, such as peach fillers in the apple orchard, requires different spraying, harvesting, etc. On the other hand, peaches, apricots, and sour cherries bear earlier and more heavily, and hence give a higher return before removal is necessary.

Filler planting is best adapted to the slower-growing, wider-spaced fruits such as apples, Anjou pears, and sweet cherries. With the apricots, peaches, plums, and sour cherries it is not so desirable, as these fruits grow rapidly and soon reach their full size.

Apples, Pears,
Sweet Cherries
Adapted to Planting with Fillers

Apples, pears, and sweet cherries are not so desirable to use as fillers since they are slower to bear commercial crops. Early bearing varieties of apples, such as Jonathan, King David, Grimes Golden, Winter Banana, Golden Delicious, Wealthy, and Yellow Transparent, are sometimes used for fillers, particularly where the more precocious stone fruits are not well-adapted. Bartlett pears are sometimes used as fillers with Anjou pears and apples. They are not as rapid growers as the stone fruits, but they bear relatively early and are less likely to crowd the permanent trees than are the faster-growing stone-fruit fillers. They also have the serious disadvantage of being susceptible to the fire-blight disease and may serve as centers of infection from which the disease may be spread to the less susceptible pears and apples. Where blight is carefully controlled, this disadvantage may be overcome.

The major disadvantage of fillers is the delay so often seen in their removal. They must be removed before they touch or shade the permanent trees. Two or three years of crowding can ruin the shape of the permanent trees by shading the lower, horizontal branches and forcing a tall, upright, less productive type of growth. Unless fillers are removed promptly, they may do much more harm than good. Where moisture is ample, the fillers can be retained without harm for a few additional years by cutting back or “fanning-in” the sides of the fillers next to the permanent trees. This is particularly true where fillers are planted only one way, as in Figure 2.

Where moisture is the limiting factor because of water shortage or because of low water-holding capacity of the soil, it is not advisable to use fillers; if used, they should be removed much earlier than would otherwise appear necessary, to avoid stunting the permanent trees.

The Orchard Plan

Preparation of a plan of the orchard drawn to scale on cross-section paper is very helpful in determining the best arrangement. Allowance should be made both for extra turning space at the ends of the orchard and for driveways. To lessen the number of turns, rows should run the length of the field. The rows should run the same way as the orchard is to be irrigated.
Planning, Planting, and Caring for the Young Orchard

Choosing Varieties

VARIETIES should be chosen only after careful investigation of the experience of growers in the same community and other communities with similar conditions, consultation with local nurserymen, fruit dealers, and horticultural officials, consideration of the advice of the state experiment station, study of prospective markets, and best of all, first-hand acquaintance with the fruits, trees, fruiting habits, adaptations, season, and susceptibility to insects and diseases of the more important varieties.

Planting Systems

FOUR STANDARD SYSTEMS of arranging trees in the orchard are recognized: (1) The square, (2) the rectangular, (3) the quincunx, and (4) the hexagonal. All of these systems, except the fourth, are illustrated in Figures 1 to 4. The description, adaptation, advantages, and disadvantages of each system are as follows:

The Square System.—Trees are set in the corners of a square, with equal distances each way. **Advantages:** Simple, easy to lay out, rows run parallel with the sides of the field making it easier to cultivate, spray, irrigate, and harvest fruit. This plan is well-adapted to either permanent planting

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**Fig. 3. QUINCUNX PLAN.—**Permanent trees form square with filler tree in center. Useful where fillers are wanted rather than intercrops. Leaves square plan where thinned. Shown here with cherry permanent 30 feet apart and apricot fillers 21 plus feet apart.

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*Mimeograph Sheets Nos. 37-42, inclusive, on varieties of fruits for Utah are available in limited number at the Utah Station.*
without fillers, particularly of kinds like peaches, apricots, and sour cherries which are planted relatively close without fillers (Fig. 1) or to plantings of fruits such as apples and Anjou pears, which make large, long-lived trees and require a great deal of space when mature, planted with double fillers, as in Figure 4. The square plan forms the basic permanent plan of the rectangular and quincunx plantings illustrated in Figures 3 and 4. the placing of the filler trees making the difference between these and the square plan. The square plan is fairly well suited to intercropping. Disadvantages: The more or less theoretical one of fitting a round tree into a square space, giving less trees to the acre than with the quincunx or the hexagonal method.

The Rectangular Plan.—(Fig. 2) The trees are set on the corners of a rectangle, being farther apart in one direction that in another. This is not desirable for a permanent plan as either the land will be inefficiently used, or crowding of the trees on two sides will result. It is adapted to use with single fillers planted in the rows as a temporary plan where maximum space is desired for intercrops. Where this is done, the permanent trees should be placed equal distances apart, resulting in a square orchard after the fillers are removed. This system is particularly adapted to medium and large kinds of fruits (apples, pears, sweet cherries, apricots), with early-bearing small-tree sorts (sour cherry, peach, apricot) as fillers, where land values are high and intensive intercrops profitable.
The Quincunx Plan.—(Fig. 3) Since all operations must be carried on diagonally from corner to corner after the trees grow large, this system is not as desirable for permanent use as is the square plan. It is, however, well-adapted to use as a temporary plan to accommodate fillers in orchards of medium-spaced permanent trees which do not have space for filler trees in the rows but do have space for such trees in the center of the square formed by the permanent trees. When the fillers are removed, a square plan remains. This plan is particularly useful where intercrops are not desired after three or four years, and where quick-bearing filler trees promise greater returns than intercrops. Often the size of the enterprise makes intensive intercrops impracticable because of their high labor requirement, while filler fruit trees can be handled along with the permanents until their removal is made necessary by impending crowding.

The Hexagonal Plan.—This plan is somewhat similar to the quincunx plan, except that the trees are equidistant in all directions, forming a hexagon with a tree in the center. This system is not recommended because of the difficulty of carrying on cultural operations. The principal advantage of this plan is that it allows 15 per cent more trees to be planted with the same spacing. It is not adapted to use with fillers and can be thinned only by removal of 75 per cent of the trees.

Planting Distances

CROWDING (with resultant lowered yields and quality of fruit, together with high trees which are difficult to manage) is the most serious handicap to Utah orchards. Formerly, trees were not expected to live for any great length of time in the West; as a result, close planting was the rule. Today there are many peach orchards over 20 years old bearing well, and experience points to much longer life than was expected with most of the western fruits. As a consequence, the far-sighted grower will plant his orchard for a long life of usefulness. The new system of orcharding embraces wider spacing, lighter pruning, more intensive cultivation, and wider use of fertilizers, resulting in larger, more wide-spreading trees with higher yields and lower production costs. Wide spacing is the foundation stone of the plan. Without it, crowding will nullify the advantages gained by the improved cultural practices.

The same benefits of close planting, i.e., heavy production during the early life of the orchard, can be secured by the use of filler trees. It is better to plant the permanent trees the maximum distances required when the trees mature than to have them suffer from crowding.

Crowding of the tops, with resultant shading-out of lower fruiting wood, reduced color, size, and yield in the shaded branches, and forced upright growth in the tops, is not the only form of crowding. Root crowding is not as evident but fully as important as crowding of the tops. Where soils are shallow or poor, and moisture is short, trees compete with each other for the water and plant-food stored in the soil. When this is exhausted, growth is checked and size and yield reduced. Under such conditions trees should
be spaced wider apart so as to increase the amount of soil available to each tree for storage of moisture.

Table 1. Recommended Planting Distances.

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Distance Apart (Ft.)</th>
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</thead>
<tbody>
<tr>
<td>Apples¹</td>
<td>30 - 40</td>
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<tr>
<td>Pears²</td>
<td>25 - 30</td>
</tr>
<tr>
<td>Sweet Cherries</td>
<td>25 - 30</td>
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<tr>
<td>Apricots</td>
<td>24 - 28</td>
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<tr>
<td>Peaches</td>
<td>20 - 25</td>
</tr>
<tr>
<td>Sour Cherries</td>
<td>20 - 25</td>
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<tr>
<td>Plums and Prunes</td>
<td>20 - 25</td>
</tr>
</tbody>
</table>

¹Distance depends upon varieties and soil conditions. **Large tree varieties:** Red Askrachan, Arkansas Black, Black Twig, McIntosh; **Medium-sized tree varieties:** Jonathan, Delicious, Stayman, Winesap; **Small-sized trees:** Rome Beauty, Winter Banana, Wealthy, Grimes Golden, White Winter Pearmain.

²Anjou requires greater distance than does Bartlett.

**Estimating Number of Trees.**—The number of trees which can be accommodated in each acre may be found by dividing 43,560 square feet by the number of square feet occupied by each tree. A handy reference table giving the approximate number of trees to an acre at different distances (the exact number depending on the size of the planting) follows:

Table 2. Number of Trees to an Acre at Different Distances¹ (Square Plan)

<table>
<thead>
<tr>
<th>Distance Apart (Ft.)</th>
<th>Trees to an Acre</th>
<th>Distance Apart (Ft.)</th>
<th>Trees to an Acre</th>
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<tr>
<td>27</td>
<td>60</td>
<td>40</td>
<td>27</td>
</tr>
</tbody>
</table>

¹No allowance is made for extra turning space needed at borders.

**Pollination**

MANY FRUITS will not set heavy crops of fruit under all conditions with their own pollen, i.e., they are self-unfruitful and must have other varieties planted with them to furnish pollen and to set good crops. Such varieties are called pollinizers and usually are good commercial varieties which are planted for their fruit as well as pollinating ability. Where this is true, arranging the orchards so as to have no one variety planted in large blocks is sufficient


to provide for pollination. Blocks of four rows are convenient units for spraying and picking; no tree should be more than two trees away from a pollinator.

In other cases, as with sweet cherries, varieties of lower commercial value must be used for pollination. In this event a minimum number of pollinizers is needed. A pollinizing variety for every fourth tree in each fourth row is considered sufficient.

**Apples.**—Grimes Golden, Duchess of Oldenburg, Early Harvest, and Yellow Transparent are considered self-fruitful (do not require pollinizers). Jonathan, Rome Beauty, Gano, Grimes Golden, Wealthy, Oldenburg, Transparent and Red Astrachan are partially self-fruitful and will sometimes crop well by themselves; however, they should have cross-pollination to be safe. Delicious, McIntosh, White Winter Pearmain, Winter Banana, Rhode Island Greening, Winesap, Black Twig (Arkansas), Arkansas Black, Wolf River, Golden Delicious, and Stayman are self-unfruitful and should always be planted with a view to cross-pollination.

There is little difficulty with inter-unfruitfulness (failure to set fruit when varieties are crossed) in apples. Winesap, Arkansas Black, Stayman, and Black Twig will not pollinize each other and are poor producers of pollen. Where one of these varieties is used, two other varieties should be planted for pollination so as to insure fruitfulness of the pollinizing varieties. Delicious, Jonathan, McIntosh, Winter Banana, Grimes Golden, Wealthy, Golden Delicious, and Transparent are abundant producers of viable pollen.

**Pears.**—The principal varieties grown in the intermountain region, Bartlett and Anjou and Bartlett Anjou, are both partially or wholly self-unfruitful, and require cross-pollination. Fortunately, they are inter-fruitful and fruit well when planted together. Other good pollinizers for Bartlett are Winter Nelis, Duchesse de Angouleme, and Seckel. Winter Nelis is considered particularly good.

Other varieties requiring cross-pollination are Keiffer, Clairgeau, Clapp Favorite, Lawrence, Sheldon, and Winter Nelis. Flemish Beauty, Duchesse de Angouleme, Seckel, and Tyson are considered self-fruitful.

**Peaches.**—All peach varieties except J. H. Hale, June Elberta (Mikado), and Late Crawford, are self-fruitful and may be planted in any quantity alone. The All Peaches Except J. H. Hale does not produce sufficient viable pollen and should be planted with the Elberta, South Haven, or the Planted Alone Early Elberta.

**Apricots.**—Apricots are considered self-fruitful.

**Plums and Prunes.**—Nearly all Japanese varieties are self-unfruitful. Burbank, Formosa, Duarte, Gaviota, Kelsey, Satsuma, and Wickson require cross-pollination, while Beauty, Climax, and Santa Rosa are self-fruitful. Formosa and Gaviota are cross-incompatible. Apex, El Dorado, Formosa, Gaviota, Satsuma, and Kelsey produce little pollen and hence are poor pollinizers. Beauty, Burbank, Santa Rosa, and Wickson are desirable pollinizers.

**Plums Usually Require Mixed Planting:** Of the European or Domestica plums (which include the prunes), Italian Prune (Fellenberg), French Prune (Agen), Giant, Reine Claude (Green Gage), Sugar Prune, and Yellow Egg set heavy enough crops without mixed planting. On the other hand, Grand Duke, Pond
Seedling, Tragedy Prune, German Prune, Golden Drop (Silver Prune), Jefferson, Washington, President, and Standard require cross-pollination. So far as is known these varieties are compatible.

The native plum varieties cross readily with each other, with the Japanese varieties, and with the new hardy hybrids between the native species and the Japanese. Any combination of these varieties with a number of varieties should be fruitful. The European plum with few exceptions, will neither pollinize nor be pollinized by either the Japanese or the native varieties.

**Cherries.**—Sour cherries are usually considered self-fruitful, although there are a few exceptions. The Duke cherries (hybrids between sweet and sour cherries) may be considered self-unfruitful for practical purposes.

All sweet cherry varieties have been found to be self-sterile. In addition, Bing, Lambert, and Napoleon, the three most valuable commercial varieties, have been found to be inter-sterile, thus requiring a fourth variety to set good crops. In tests conducted by the Utah Station² Black Tartarian, Windsor, Black Orb, and Centennial have been found to be satisfactory pollinizers of Bing, Lambert, and Napoleon. A pollinizer should be placed as every fourth tree in each fourth row. Since some known strains are poor pollinizers, particularly in Black Tartarian and in Napoleon, it is suggested that these varieties be propagated from tested sources.

**LAYING OUT THE ORCHARD**

**Soil Separation**

THE SOIL should be thoroughly prepared and in good condition in advance of planting time. Soil intended for planting should be deeply plowed the previous fall and disked or spring-toothed as soon as it can be worked in the spring. Orchards should not be planted on newly-broken sod where this can be avoided. It is better to grow a cultivated crop a year before planting trees. Heavy alfalfa sod especially is difficult to kill and should be subdued before the trees are planted.

Land low in fertility or organic matter may be built up by planting two years previously to sweet clover and by plowing-under a heavy green-manure crop of sweet clover the summer preceding the planting of the orchard. This crop must be plowed-under before the trees are planted, because of treehopper damage to the trees which clover occupying the ground for more than one season invites.

**Staking Out the Orchard**

Having settled upon the planting plan, planting distances, and amount of space at ends, the varieties, fillers, arrangement, etc., the next step is marking where the trees are to be set. Trees should be lined up accurately in all directions, not only for appearance but for convenience in cultivation. Probably the most convenient way is to lay out the orchard with lath stakes placed where each tree is to go. The method of staking a square orchard is as follows:

**Methods of Laying Out and Staking Orchards**

Using a straight fence or road markers as a base line, measure out the distance

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Planning, Planting, and Caring for the Young Orchard

to be allowed at the margin (usually somewhat more than half the distance apart of the trees) and establish a base line, setting stakes at each point on this line where a tree is to go (Fig. 5).

Fig. 5. LAYING-OUT THE ORCHARD.—Base and side boundary lines are laid off and stakes set at desired distances for trees. Method of laying out corner by use of 3-4-5 triangle shown at lower left. Inside guide lines of stakes enable one man to set remaining tree stakes by sighting each way on 2 stakes in line.

The next step is to lay out square corners and close in the field with similar staked lines on all four sides of the field. A handy method of obtaining a square corner is to use a triangle whose sides bear the relation to each other of the numbers 3, 4, and 5. Such a triangle always forms a right angle. Measure, say 80 feet along the baseline from the corner, setting a temporary stake at that point. Now measure out 60 feet on what appears to be a right angle from the corner, using a light wire fastened securely to the corner stake to form one side of the triangle. Next measure across the corner from the 60-foot mark to the 80-foot mark on the baseline. Holding the steel tape on the 80-foot mark, adjust the position of the 60-foot wire and the 100-foot tape, establishing the corner stake exactly where the 60-foot and 100-foot marks coincide. Now extend the sideline by sighting carefully on the 60-foot stake and the corner stake.

Lay off the other two corners in the same fashion. In closing the fourth corner, check the distance between the two sidelines along the distant boundary to see that it is the right distance. If it is not the same length as the original baseline the corners are not true right angles and must be adjusted. Then finish staking for the trees in the boundary rows.

Having completed staking the outside rows, the inside stakes can be set by sighting, using three men, one on each side of the field to sight in each direction with the third to set the stakes. Lines of stakes may be set by sighting in guide rows the center of the field running in each direction. This gives two stakes to line on in each direction from any point in the field, enabling the stakes to be set by one or two men. Again, where the inside guide stakes have been set, the trees can be placed directly without setting stakes, sighting for the holes and again for
Part of the labor of digging holes for the trees can be saved by plowing deep furrows in the rows where the trees are to stand. When this is done, outside guide rows of stakes should be set 10 to 15 feet outside the last row of trees to prevent plowing them out and losing the measurements, and inside rows at intervals of 100 feet or less to sight on while plowing the furrows. A double row of stakes around the outside helps to sight accurately. Several turns, the last ones weighted to secure depth, are needed to make the furrow deep enough. Holes can then be sighted in the usual manner by resetting the inside guide stakes after plowing; or individual stakes can be set and the planting board used.

Care should be used in sighting to always have at least two guide stakes in view, one of which is on the distant end of the row. Sighting from tree to tree back along the row as one plants often leads to disastrous results. Each inch of variation is magnified as the planting proceeds.

The Planting Wire

Quincunx, hexagonal, or triangular systems are easily and accurately laid out by means of the planting wire (Fig. 6). Two wires heavy enough not to stretch (twisted, multiple-strand wire is pliable and convenient) are fastened to three 4-inch harness rings, so as to form a triangle. The wires are cut to the same length as the distance between the trees (in the hexagonal or equilateral triangle method) or to the distance between trees on the diagonal in the quincunx plan. Allowance should be made for the distance from the inside of the ring opposite where the wire is fastened to the point of fastening. In using the planting wire, the base line and sides are laid out as usual, the baseline being staked at the correct tree distance. The rings attached to the single wire ends are set over the corner stake and the second stake on the baseline, stretched tight and a stake set in
the third ring at the apex of the triangle thus formed. The wire is then shifted to the second and third stakes along the baseline, the second stake in the second row set, and so on until the second row is completely staked. The wire is then moved up and the third row staked in similar matter. The end stakes in the rows can be set by sighting or measuring along the side line. Three men are required with a fourth man or boy to carry stakes. Staking is rapid by this method, but the wire must be accurately measured and stretched tightly each time or cumulative errors will cause the rows to bend.

To determine the proper length of wire for a quincunx plan, square (multiply by itself) half the distance between trees in the row, add the sum together, and extract the square root of the total (based on the rule that the squares of the hypotenuse of a right-angled triangle is equal to the sum of the squares of both sides).

**SELECTION OF TREES**

**Rootstock Requirements**

THE ROOT SYSTEMS of fruit trees, although less well-understood, are fully as important as are the scion varieties. Since a choice of rootstocks is possible in some cases it is well for the prospective grower to be acquainted with the factors governing such a choice.

An ideal rootstock would be one which is vigorous, hardy, uniform, congenial, adaptable, resistant to insects and diseases, easily transplanted, and low in cost. Unfortunately, none of our commercial seedling rootstocks meets all of these requirements.

APPLE TREES are propagated on French Crab seedling apple stocks, which are fairly satisfactory except in extremely cold parts of those regions where heavy soil freezing occurs, in which case selected seedlings of hardy varieties are best. Budded and grafted trees, whether piece or whole root grafts, are equally satisfactory if they are of equal size and possess desirable root systems.

PEAR TREES are propagated usually on either French pear seedlings (*Pyrus communis*) or on Japanese pear seedlings (*Pyrus serotina*). The Japanese stocks are somewhat more blight-resistant and more vigorous than the French, but because of their particular soil requirements and the possibility of damage from "black end" (a hardening of the fruit now causing widespread loss in California), the use of this stock is inadvisable. Other oriental blight-resistant seedling stocks either cause black end or are of questionable congeniality and adaptation.

Dwarf trees for home orchards and gardens are propagated on quince stocks. Because of their slower growth, they come into bearing earlier and are less susceptible to fire blight.

New blight-resistant body stocks belonging to the French pear species (*Pyrus communis*), such as Old Home, which are planted and later topworked to the more susceptible varieties, as Bartlett, Flemish Beauty, etc., thus building a tree with blight-resistant trunk and main branches, are well worthy of trial by pear growers.

PEACH TREES are usually propagated on peach seedlings. Tennessee and Carolina naturals and certain cultivated varieties are considered to give superior seedlings.

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APRICOT TREES are propagated on both peach and apricot seedlings, with peach stocks most common in Utah. Nurserymen prefer peach stocks because of the greater ease of securing a stand of buds on this stock. Apricot on peach is reported as a weak, short-lived union by some horticulturists. Trees on peach stocks are attacked by the peach borer to a greater extent than those on apricot stocks. Definite information as to comparative vigor and longevity of the two stocks is lacking.

Choice of Peach or Apricot Stocks

PLUM AND PRUNE TREES are commonly propagated on myrobolan plum and peach seedling rootstocks. Myrobolan is considered superior in heavy, compact soils, with peach roots adapted to drier, lighter soils. Peach stocks are reported to give more rapid growth and earlier bearing of most European varieties in California as compared with myrobolan stocks. Peach is commonly used for the Japanese varieties. Peach stocks have the disadvantage of being susceptible to peach-borer attack. Native varieties and the new hardy hybrids are propagated on native Prunus Americana seedlings where winters are too cold for peach stocks.

CHERRY TREES are propagated on either mahaleb (Prunus mahaleb) or mazzard (P. avium) seedling stocks. Sour cherries are practically always worked on mahaleb, while opinion differs as to the best stock for the sweet varieties. Mazzard has long been held to make larger, longer-lived, and more productive trees than mahaleb; this opinion has been substantiated by experimental results of the New York Experiment Station\(^7\) for eastern conditions.

Mahaleb Considered Best Stock for Utah

In California, however, doubt is expressed as to the correctness of the mazzard tradition. Howard\(^8\) reports that on gravelly soil trees on mahaleb are more regularly productive than are those on mazzard. The trees on mahaleb are smaller but more easily harvested and more profitable.

In Utah, nurserymen emphatically prefer mahaleb as being longer-lived, hardier, and better adapted to soil and climatic conditions in the mountain states. In the absence of local experimental results to the contrary and in spite of the difficulty of transplanting and getting a good stand of trees on this stock, mahaleb is the logical choice.

Ages, Sizes, and Grades of Trees

One-year-old budded trees (2-year-old roots) are standard in the intermountain region. Since 1-year-old western-grown budded trees are as large as is convenient to plant, there is no apparent advantage in planting 2-year-old trees.

Medium to large sizes are preferred to the small trees. Many of the latter will make full-sized trees, but many are dwarfed by weak-growing seedling rootstocks or by poor unions. Such trees grow more slowly and do not reach heavy bearing size as quickly as do the larger trees.

Medium and Large Size; 1-Year-Old Trees Preferred

As a rule yearling trees are sold by height, while 2-year-old trees are sold on the caliper basis. Grades are based entirely on size. Common grades are 2 to 3 feet, 3 to 4 feet, 4 to 6 feet, and 5 to 7 feet with a small


\(^8\)Howard, W.L. Head, Division of Pomology, California Agricultural Experiment Station. Correspondence with writer, 1929.
price differential between each grade. Corresponding caliper grades are 5-16, 7-16, 9-16, and 11-16 inch, respectively. With peach trees the medium size is preferred to the large trees since lower buds on the latter have usually formed shoots which have been broken in handling necessitating their removal, thus making it difficult to secure branches low down on the trunk.

**Insect Pests and Diseases of Nursery Stock to be Avoided**

Several pests commonly borne on nursery stock injure the small trees. **Crown Gall** forms knots and galls on the roots, and, while not usually serious, is undesirable. **Woolly aphid** is a form of plant lice infesting the roots as well as the tops. It forms swellings on the roots. This pest is particularly common on apples and is difficult to control. **Peach borer** frequently injures nursery trees of peaches, apricots, and plums on peach stocks and weakens them. **Fire blight** occasionally forms cankers on nursery pear and apple trees, giving this serious disease a foothold in the new orchard which may ultimately cause its destruction.

(Note: It is only fair to state that most nurserymen grade their trees so carefully that the purchasers usually will not find any of these pests present on the trees he buys. However, instances are known where such cull trees escape the bonfire and are peddled out by irresponsible peddlers who label each tree to suit the demand and sell at "bargain" prices. A knowledge of these troubles by the grower is a protection to the legitimate nurseryman as much as to the purchaser himself.)

**Securing True-to-Name Trees; Certified Trees**

**TRUENESS TO VARIETY** is something on which the purchaser of trees must take the nurseryman's word. The only reliable method is to purchase trees from responsible concerns which have a record for extreme carefulness and integrity. "Bargain" trees offered by irresponsible agents who themselves do not grow trees, who do not represent reliable concerns, and who have no reputation for long and honorable fair-dealing should be looked upon with suspicion.

CERTIFIED TREES are those propagated from selected trees, presumably superior in size, color, quality, or yields. In most cases such variations have not
bred true. With many fruits in which bud-sports are known to occur rather frequently, or in which different strains have been recognized (as, for example, in prunes and sweet cherries), this practice of propagating from selecting trees should be of value. In any case, the extra care thus exercised should insure trueness to name and should merit consideration.

HANDLING TREES AND PLANTING

Handling in Transit

TREES should have a plump “live” look when received for planting. The roots should likewise be plump and fresh. Trees with withered stems, and dry or dead roots should be rejected at the express office. Trees but slightly dry may be revived by submerging completely for a day or two in a tank. Where the roots are shrivelled and dry, the tree is injured and probably will not start normally. Trees frozen in transit should be regarded with suspicion, since roots are easily damaged by freezing. In case of doubt, conditional acceptance or rejection is the policy of caution. Trees should be dormant when received unless ordered late, in which event heavier mortality and a poorer start is to be expected.

Nursery stock must be handled with extreme care after being dug to prevent drying of the roots. Growers taking their trees directly from the nursery should see that the roots are well-packed with wet straw or shingletow and covered suitably to prevent the drying action of wind and sun in transit. Immediately upon arrival, the trees should be heeled-in, i.e., the bundles cut and the roots spread out in a trench and covered with moist soil. It is good practice to add a few buckets of water to settle the soil and to fill up air pockets. When received, bundles must be spread out, or the trees in the center will dry out.

To keep the trees dormant, the “heeling-in” trench is located preferably in the shade of a building. If the soil is frozen, the trees can be kept for a short time in a cold, moist cellar by packing the roots down and keeping them moist. In no case should the trees be kept in bundles unnecessarily long in a warm, dry place.

Time of Planting

In those sections of the intermountain region with rather severe winters, early spring planting is recommended. In more sheltered localities, where the ground is well-protected by snow and does not freeze to the level of the roots, thehardier fruits—apples, pears, and sour cherries—can be fall-planted to advantage.

Fall vs. Spring Planting

Roots grow at low temperatures, giving late fall-planted trees an opportunity to form an absorbing system of fine rootlets with their root-hairs, with a better start in the spring. Except in low-altitude sections with relatively warm, open winters, sweet cherries, peaches, apricots, and plums should not be planted in the fall.

SPRING PLANTING should be done as early as possible. A week’s difference in time of planting may mean a difference of a foot of growth the first year. Trees stunted at transplanting are slow to recover and to reach heavy bearing size. Cherries are transplanted with difficulty and require early planting. Trees of all kinds should be ordered early and heeled-in ready for early planting.
Planning Methods

After staking out the orchard and securing the trees the first step in planting is to dig the holes. These should be ample in size to accommodate all the roots of the tree without bending or constricting them. Little root pruning should be done—not more than freshening the cut ends and removing broken and injured roots. If fibrous roots are dry and dead, their removal will help place the soil in contact with the roots. If these roots are alive, they should be retained and given special care in planting, as new rootlets grow from fine roots more readily than from large stubs.

In digging the hole, the richer surface soil should be put to one side and placed about the roots first.

To place the trees in the exact place where the stake was set, the planting board illustrated in Figure 7 is recommended. This handy device is set with the pegs in the soft earth extended with the notch about the stake. The stake is then removed, the planting board folded back and the hole dug. The tree is then set in the hole, the board extended, and the trees held in the notch while moist soil is filled in about the roots.

![Planting Board Diagram](image)

**Fig. 8.** PLANTING BOARD.—A handy device to locate tree in exact place where stake was set after hole is dug. Hinged end of board folds back out of way while hole is dug. Tree fits in notch at “A” located by stake “B”.

Trees should be set only slightly deeper than when grown in the nursery. Deep planting, particularly in heavy soil types, should be avoided. Where strong
prevailing winds occur, the trees should be leaned toward the prevailing winds. To prevent sunscald, branched trees should be placed with a good low branch to the southwest.

Special care in filling-in the holes will be well repaid in trees saved and better growth. If the subsoil is rocky, gravelly, or poor, making the holes deeper than needed, placing a shovel or two of good rich loam in the bottom is a good practice. After the tree is placed, a shovel or two of fine, moist topsoil should be added and settled down through the roots by shaking the tree somewhat. Where roots are bunched or matted, soil should be pushed up with the hand so as to leave no hole to dry out the roots. Close contact between soil and roots is the ideal to keep in mind.

No fertilizer or foreign matter should be placed in the hole. The soil is best tramped when the hole is half full and again when nearly full, after which loose, moist soil may be added for a mulch. A basin should be left about the base of each tree to catch rain and to provide for irrigation. Wherever possible, irrigation water should be run immediately into the basins to settle the soil and fill in any air spaces left in the soil about the roots.

MANAGING THE YOUNG ORCHARD

Pruning the Newly-Set Orchard

NEWLY-SET TREES are pruned for two reasons: (1) To balance the top with the root and (2) to start the tree's training.

In digging nursery trees, a considerable portion of the roots is cut off and lost to the tree, while the tops are intact. In addition, the moisture-absorbing mechanism of the tree—the root-hairs—have been destroyed. New root growth must replace these before moisture will be available for top growth. Because of this disturbance of the water-absorbing organs, there is not enough moisture for all the buds in the top. Pruning off some of the buds helps to restore the balance and to secure a more normal growth of those remaining.

Heading, and possibly disbudding, is the only pruning operation necessary where trees are whips. With the advent of the modified-leader system of training, higher heading than formerly used is the rule. Where fairly large trees are planted, 30 to 36 inches is customary. The purpose of this higher heading is to secure a longer main trunk along which the scaffold branches are distributed, giving stronger crotches which will bear heavy loads of fruit without bracing or without breakage.

One system now recommended is to trim branched trees, such as peaches, apricots, Japanese plums, and sour cherries, to a whip, stubbing the branches to leave buds. After growth starts, commencing with the topmost shoot, a selection is made of three or four new shoots properly placed around the tree, showing a wide angle with the trunk and 5 or 6 inches apart on opposite sides of the tree; the others are removed. This will throw all of the moisture and nutrients into the useful scaffold branches which remain. This treatment diminishes growth for the first season; however, this effect is offset in the lighter pruning needed during the first winter.
With sweet cherries, apples, pears, and European plums, in order to force dormant buds out below, it is suggested that the growing points of the new shoots be pinched off when about a quarter of an inch in length.

With branched trees, such as peaches, Japanese plums, some apricots and Training by apples, another system, which has been followed with success by the writer, is to leave two or three scaffold Leaving Selected branches and a leader, shortening them in and removing the remainder. Strong branches, with wide-angled crotches well-distributed around the trunk and 6 inches or more apart are chosen. With peaches, apricots, sour cherries, and Japanese plums, the leader, or topmost branch, should be left relatively longer.

Trees which may make a long growth without branching the first season should be clipped back in June. By the use of this method two years' branching can be secured in one season with vigorous trees.

Soil Management in the Young Orchard

CULTIVATION is essential in young orchards. Without thorough cultivation growth is slow because of lack of food and moisture occasioned by competition with weeds or intercrops. Cultivation aerates and loosens the soil, thus promoting formation of plant nutrients and conserving moisture.

With the soil well-worked before planting, all that is necessary will be disk- ing, spring-toothing, or cultivating. Cultivation after each irrigation will prevent baking of the soil and will make irrigation necessary less often.

IRRIGATION should have as its object the maintenance of the proper amount of moisture in the soil about the developing roots. This can best be done the first year by using one or two furrows connected to a wide basin about each tree. The second year one furrow on each side is usually sufficient, after which two furrows on each side of each row should be used. Irrigations should be frequent enough and long enough to saturate and store as much moisture as possible in all of the soil from which the roots draw moisture. The soil should never be allowed to become dry. In general, coarse gravelly soils will require more frequent irrigations, shorter furrows closer together, and a shorter time of watering to saturate the soil without loss from deep percolation than will heavier, more compact soils.

INTERCROPS should be chosen primarily with the effect on tree growth and welfare in mind, with the possible returns, labor requirement, and utilization of the crop as secondary considerations. Intercrops, to be ideal, should (1) be legumes which increase fertility, (2) permit the orchard to be thoroughly worked in the spring, (3) require cultivation, and (4) removed in time to permit fall-sown cover crops for green-manure. Few crops meet all these requirements, in addition to the important one of bringing a high return. Such crops as early peas, beans, melons, squash, corn, potatoes, onions, tomatoes, cabbage, and cauliflower, and other vegetables can be grown without injury to the trees, provided (1) fertility is maintained, (2) the crops are not planted close to the trees, and (3) weeds are suppressed until about August first.
Strawberries are less desirable, unless the common tendency to form a dense, weedy mat is prevented by annual renovation, with cultivation and hoeing after the crop is removed. The berries should be kept 3 or 4 feet away from the trees to permit cultivation of the latter. Bush and cane fruits are even less desirable because of the delay in bearing and the difficulty of later removal.

Grain crops are not advisable because spring cultivation is not possible where they are used, and their greatest use of plant-food and moisture comes at the same time that the trees require the greatest amounts for their growth. For very evident reasons **legume or grass sod crops are not permissible**: (1) Nitrate formation is depressed under sod, and sod plants consume large quantities of this element as well as water, thereby reducing the amount of these materials so necessary to growth; hence, the amount of growth and the size of the first fruit crops; (2) the prevalence of insects which feed on legumes and grasses and lay eggs in the twigs and branches of young trees, severely injuring them in many cases.

**COVER-CROPS**, annual crops planted at the last cultivation in late July or August and plowed-under the following spring, are helpful in building up the organic matter of the soil, thus increasing its water-holding capacity and fertility. They should be used whenever the ground between the trees is not occupied in the fall by intercrops.

**Fall-Planted Cover Crops Beneficial**

Winter vetch alone or in combination with rye is probably the best cover crop, as it is a legume, fixing nitrogen in the soil; it is winter-hardy and makes some growth in the spring. The large seed makes it easy to get a stand, seeding it after the last cultivation. Oats are often used but make less growth as they are killed by hard freezes late in the fall.

**FERTILIZERS**, especially organic materials like barnyard manure, are particularly valuable not only for the fertility they provide but for the organic matter they add to the soil. Particularly in open soils which have been cropped for some time, manure helps to give that vigorous growth so much to be desired in young trees. Where cover crops cannot be grown because of intercrops occupying the ground, it is particularly important that fertility be maintained and built up and the organic content of the soil increased by the liberal use of manure. Poultry litter is likewise valuable as a mulch or manure.

Chemical fertilizers have not been tested as to their benefit to young fruit trees on Utah soils. Where soil is known to be low in fertility and trees are not making sufficient growth in spite of good cultivation and irrigation, and where manure is not obtainable in sufficient quantity, applications of nitrogen fertilizer, particularly ammonium sulfate, may be advisable. The cost is small compared to the value of increased growth, resulting in heavier early bearing, which usually follows fertilization under these conditions. It should be emphasized that nitrogen fertilizer will give increased results only when the supply of nitrogen is less than can be utilized by the tree, i.e., when available nitrogen is the limiting growth factor. This is true only when plenty of moisture is available through clean cultivation and irrigation, when the leaves are green and in a healthy con-
dition, and when the roots are well-established. The amounts of ammonium sulfate suggested are as follows:

- Newly-set trees ........................................... ¼ lb.
- 2 to 3-year-old trees .................................... ½ lb.
- 4 to 5-year-old trees .................................... 1 to 1½ lbs.

Phosphorus is sometimes indirectly beneficial by stimulating growth of the cover crop, thus increasing the amount of green manure turned under. In most sections of Utah, phosphorus is reported to have given marked increases in growth of alfalfa. It is possible that this same response may be obtained with other leguminous cover crops.

APPLY FERTILIZERS such as manure preferably during the winter or early spring, spreading lightly in a circle about each tree and enlarging the circle as the tree grows to about twice the distance to which the branches extend. Where sufficient manure is to be had and intercrops are to be benefitted, broadcasting with a spreader is advisable. Manure should not be piled up around the tree but should be placed at least 6 inches from the trunk. Ammonium sulfate is best applied in early spring, spreading lightly about the trees and cultivating in. A second application in June is sometimes beneficial.

Protecting the Young Orchard

CERTAIN INSECTS AND DISEASES often damage young trees, which are particularly susceptible to them; therefore, if the full measure of success is to be obtained the grower must be on constant guard against their depredations.

Young fruit trees should be sprayed annually with arsenate of lead (2 pounds to 50 gallons of water); or if growth is rapid, semi-annually, to protect the foliage from various leaf-feeding insects. Pear and cherry trees especially should be sprayed to control the pear and cherry slug, which skeletonizes the leaves, defoliates the trees, and greatly reduces growth. All chewing insects are controlled by this arsenical spray, which should be applied in late May.

Aphids, or plant lice, are another source of injury to young trees. Curling of the leaves, particularly the tender new leaves at the tip of the expanding shoot, indicates their presence. They should be controlled before curling reaches an advanced stage, as it is difficult to reach the aphids with spray after the leaves are curled. The Black Cherry Aphid is a particularly common offender on sweet cherry trees. Where aphids are present, nicotine sulfate is applied at the rate of one-half pint to 50 gallons of water; or, if desired, the nicotine can be added to the arsenate spray. Where aphids have been injurious the year before, it is advisable to spray early enough to kill the young aphids immediately after hatching. Since aphids are sucking insects, they must be thoroughly wet with the spray.

OTHER INSECT OFFENDERS commonly troublesome are San Jose Scale and the Peach Tree Borer. The former can be identified by the tiny grayish scales on leaf or twig, surrounded by a reddish discoloration. Lime-sulphur (one

10Collaboration of the following members of the Station Staff in the preparation of this section is hereby acknowledged: Dr. B. L. Richards, Plant Pathologist; Dr. F.B. Wann, Associated Plant Physiologist; C.J. Sorenson, Assistant Entomologist.

11For complete information on pest control and copy of spray-schedule consult local crop pest inspector or send inquiry to Horticultural Department, Utah Agricultural Experiment Station.
gallon concentrated liquid or 4 pounds of the dry-powdered form to 8 gallons water) or oil emulsion (1 gallon to 12 gallons water) is applied in early spring while the trees are dormant; or summer oil emulsion (1 to 1.5 per cent solution) may be applied during the growing season.

**Peach Tree Borer** attacks the trunks of young peach, apricot, and plum trees just below the soil line, chewing the bark and young sapwood and often girdling the tree. Eggs are laid in late summer by the adult, a clear-winged, wasplike moth; these eggs are hatched in early fall. Hand-worming, digging away the soil from the trees, and digging out and destroying the borer larvae with a knife wherever frass and gum indicate their work is necessary with young trees. Paradichlorobenzene, the chemical so successfully used on older trees, is not safe to use on trees under 4 years of age. Worming is best done during September and October before the borers are large enough to seriously damage the trees.

**Borers Require Hand-Worming**

**FEW DISEASES** affect young trees in the intermountain region. Three of them, however, should be guarded against by the grower: (1) **Fire Blight** of apples and pears, (2) **Chlorosis**, a physiological yellowing of the leaves, which affects all kinds of fruit plants under certain conditions, and (3) **Wood Decay**, or **Heart Rot**, as it is more commonly called.

**Fire Blight** is a contagious bacterial disease which over-winters in cankers or diseased areas on the trunks, roots, or larger branches. In the spring the bacteria exude a sticky liquid which is spread by insects, principally aphids and plant bugs. Control entails cleaning out all over-wintering cankers in the neighborhood, trimming them back to the live wood, and disinfecting tools and cuts with a special disinfectant made of 4 grams of mercuric chloride (corrosive sublimate) and equal amounts of mercuric cyanide dissolved in a pint of hot water and mixed with 3 pints of glycerine. During the growing season, close watch must be kept, and new blight infections removed about a foot below where the infections show; the branches or twigs removed are burned and the cuts disinfected. Cankers on branches over 3 inches in diameter may be treated with Day's Blight Solution.

**Chlorosis** in most cases appears to be due to difficulty which the plants have in getting sufficient iron from soils high in calcium or under alkaline conditions. Successful treatment has been attained in most cases by inserting capsules of powdered citrate of iron or phosphate of iron, after removing the caps, into holes bored with an auger in two or three places around the lower trunk. In larger trees, more holes will be necessary. The holes should be just deep enough to hold the capsules and permit covering with grafting wax. Soils in which chlorosis is severe should be avoided for commercial orcharding.

**Wood Decay, or Heart Rot**, is an insidious disease caused by a group of wood-decaying fungi universally distributed and well-known as the cause of rotting off of fence posts, wooden foundations, logs, and any untreated wood containing moisture and air. **In the trees**, the fungus rots out the heartwood upon which
the tree depends for strength to hold its fruit, making it spongy and worthless for mechanical support. Most breakage in bearing trees is due to wood decay.

These fungi enter the tree through germination of spores in wounds left in pruning, breakage of branches, or mechanical injury. They cannot enter through live bark. Wounds over an inch in diameter (such as will not heal in the current season) should be treated with a fungicidal wound dressing. One of the best of these is Bordeaux paint, made at home by mixing dry-powdered Bordeaux mixture, a common and easily obtained spray material, with linseed oil to form a thick paint. This should be renewed annually until the wound heals.

Mechanical Injury can be prevented by using proper safeguards and care in working around the trees. Harness chains and singletree ends are frequent offenders in the matter of "barking" trees. A section of old inner tube tacked to the singletree so as to cover the chain will prevent much injury. Protruding parts of disks, harrows, springtooths, cultivators, etc. used in the orchard should be similarly protected. Tractor wheels with lugs should be covered with guards. Horses having a taste for fruit tree leaves should be muzzled. Under no circumstance should stock be pastured in the young orchard. Sheep are particularly deadly to trees, often stripping the bark from large branches.

Protecting the Young Orchard in Winter

ALMOST EVERY SPRING losses of valuable young fruit trees are reported by orchardists. Sometimes it is jackrabbits, sometimes field mice, and occasionally, as in the winter 1924-25, it is winter injury which plays havoc with the young orchards. Such losses are in most cases preventable. Even winter injury, against which most growers feel helpless, can be reduced to a minimum by certain precautions. Since mice often girdle trees over a foot in diameter, even bearing orchards are not safe from rodent depredations.

Winter Injury. A properly matured tree will stand cold much better than one which has made a late, succulent growth. Such forms of winter injury as black heart, twig-killing, crotch injury, and collar rot are associated with immaturity. These occur most frequently in young, vigorously growing trees. To bring about proper maturity of such trees, there should be no cultivation after August 15 and only enough water given to keep the trees from wilting. The late growth of weeds or fall cover-crop of vetch or oats will aid in checking late growth by drying the soil and using up available nitrates.

After cold, fall weather sets in, however, the orchard should be irrigated if fall rains have not been sufficient to thoroughly saturate the soil. The widespread injury during the winter of 1924-25 showed the danger of allowing trees to go into the winter with dry soil about the roots. Such orchards, with others of low vigor from neglect, suffered the greatest injury. Nearby, others, in good vigor and with moist soil, came through with much less damage.

Jackrabbits are a serious problem nearly every winter, particularly on the lands nearest the hills. Under ordinary conditions permanent protectors made of galvanized netting wire or hardware cloth are effective. The inch-mesh netting
Tree Protectors

Prevent Rabbit Injury

is much less expensive than the hardware cloth, but protectors, made from the latter closely woven and more durable material, are also effective against mice. Eighteen-inch wire netting purchased in rolls should be cut into 18-inch lengths, bent around the trees with the stiff selvedges together in a vertical position and fastened together with wire. Such protectors will serve for five years or more, but must be watched and loosened when they become tight to prevent girdling of the trees.

Hardware cloth comes in rolls 36 inches wide. The roll may be cut in two at the center, the strips cut into 18-inch lengths, bent around the trunk with the edges overlapping, and fastened about the center with a small wire. The base should be set below the soil.

When snows drift deeply so the rabbits can reach over the protectors and gnaw the branches, poisoned hay or baits should be used. A formula with poisoned oats, recommended by the U. S. Department of Agriculture\textsuperscript{3}, is made as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats</td>
<td>12 qts.</td>
</tr>
<tr>
<td>Powdered strychnine alkaloid</td>
<td>1 oz.</td>
</tr>
<tr>
<td>Laundry starch</td>
<td>1 tbsp.</td>
</tr>
<tr>
<td>Saccharine</td>
<td>$\frac{1}{8}$ oz.</td>
</tr>
<tr>
<td>Water</td>
<td>1 qt.</td>
</tr>
<tr>
<td>Bicarbonate of soda</td>
<td>1 oz.</td>
</tr>
</tbody>
</table>

Mix the starch with 2 pints of cold water. Pour this into 1.5 pints of boiling water and boil for a minute or two until starch is clear. Mix the strychnine and soda in a small pan and sift it over the hot starch, stirring thoroughly to form a smooth paste. Add the saccharine and stir again. Pour the mixture of oats in a metal tub, mixing until all the grain is wet. Allow the oats to dry before distributing. Scatter the oats along runways in small piles. Alfalfa hay in small quantities helps to attract the rabbits. Twigs of apple trees and prunings dipped in the starch-strychnine mixture are effective against both mice and rabbits and are less dangerous to domestic animals.

Poisoned Alfalfa Leaves\textsuperscript{4}.—Dissolve one ounce of strychnine sulfate in $\frac{1}{2}$ gallon of hot water and sprinkle over 10 pounds of clean alfalfa leaves. These may be procured by placing a few forkfuls of leafy alfalfa hay on a tarpaulin or wagon cover, threshing it with a pitchfork and removing the stems and dirt. Mix the poisoned leaves thoroughly until all moisture is absorbed. Should strychnine alkaloid be used $\frac{1}{2}$ quart of vinegar should be substituted for $\frac{1}{2}$ quart of water in preparing the solution, and equally good results will be obtained. Bait may be exposed in small piles along runways within areas fenced away from livestock.

Repellent Paints or washes are helpful but are not always sufficient and need to be renewed frequently. A repellent which has worked well in Weber County is as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosin</td>
<td>7 lbs.</td>
</tr>
<tr>
<td>Beeswax</td>
<td>1 lb.</td>
</tr>
<tr>
<td>Yellow ocher</td>
<td>2 oz.</td>
</tr>
<tr>
<td>Asafetida</td>
<td>1 oz.</td>
</tr>
<tr>
<td>Strychnine</td>
<td>1 oz.</td>
</tr>
</tbody>
</table>

Melt ingredients together and apply with a brush.

\textsuperscript{3}Lantz, D.W. "Cottontail Rabbits in Relation to Field and Farm Crops". U.S.D.A. Farmers' Bul, 702 (1916; revised 1924).

\textsuperscript{4}Recommendations of R. Scott Zimmerman, Rodent Control Leader, U.S. Biological Survey, Salt Lake City.
Field Mice appear to be well distributed in our fruit sections. While orchards in sod or other vegetation are most liable to damage, the presence of trash, weeds, or cover crop about the base of trees in a cultivated orchard is a source of danger, since such protection is sought by mice under the snow.

Methods of Controlling Field Mice

Danger from this source can be minimized by cleaning away trash, grass, and cover-crop from the trees, by mounding the soil up firmly about the tree and by tramping the snow down about the trunks after storms.

Where orchards are clean-cultivated and not adjacent to pastures or hayfields, these precautions should be sufficient.

In other cases, however, either small mesh-wire protectors or poison will be needed for safety. Growers should not wait for injury from mice before taking steps to control them. Permanent control can be obtained by keeping poison bait always available in the orchard. When this is done, outbreaks are unknown.

The following formula is recommended for a durable bait in poisoning meadow or field mice:

- Powdered strychnine alkaloid ........ ½ oz.
- Baking soda .................................. ½ oz.
- Steam-rolled oats or oat flakes ....... 1 qt.
- Tallow ...................................... 6 tbsp.
- Paraffin .................................... 2 tbsp.

Sift and mix the strychnine and soda and mix well with the oats. Heat the mixture and stir into it the melted tallow and paraffin, until each grain of oats is well coated. When cooled, bait will be water-proof but inviting to mice. Or, if more convenient, the steam-rolled ground squirrel bait, being used so widely in Utah and adjacent states, may be supplemented with excellent results.

“Starch-coated grain bait: Mix 1 tablespoonful of gloss starch in ½ teacup of cold water and stir into ¾ pint of boiling water to make a thin clear paste. Mix 1 ounce of powdered strychnine alkaloid with 1 ounce baking soda and stir into the starch to a smooth creamy mass, free of lumps. Stir in ¾ pint of heavy corn sirup and 1 tablespoonful of glycerine. Apply to 12 quarts of wheat or to 20 quarts of steam-crushed whole oats and mix thoroughly to coat each kernel. The crushed oats ground squirrel bait now being used in most of the counties works out nicely.” (See footnote 14)

The stations should be placed about the orchard in containers accessible to mice but protected from birds. Tin cans with partly opened tops, glass bottles, tiles, or wooden stations will answer.

“A simple wooden poison grain station for field mice may be made of 1-inch material, the top 8 inches and the bottom 6 inches square, and the side strips 1½ inches high. An important feature of this station is the one-half inch depression or groove to hold the poisoned bait. This is made with two ½ inch cleats at right angles to side opening. Grain is placed in the station. Fruit or vegetable cans may be used for bait stations.” (See footnote 14)

The stations should be placed against the tree trunk and covered with grass, brush, or prunings to hold the snow and make an inviting retreat.

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Silver, James "'Mouse Control in Field and Orchard'». U.S. Dep't Agr. Farmers' Bul. 1397 (1924)
SUMMARY

1. MORE FAILURES IN ORCHARDING ARE DUE TO MISTAKES MADE IN PLANNING AND PLANTING than at any other time. Careful planning, including location, variety selection, spacing and arrangement, is essential to success.

2. Before planting an orchard, the FUTURE MARKET OUTLOOK for the fruits to be grown and the MARKET REQUIREMENTS should be considered.

3. FREEDOM FROM FROST is the most important factor in locating an orchard. This is secured by elevation above surrounding country and by canyon breezes.

4. A DEEP, WELL-DRAINED SOIL well-adapted to the fruits to be grown should be selected. MOISTURE-HOLDING CAPACITY is more important than fertility.

5. Fillers of early-bearing fruits give increased early yields in orchards of fruits requiring wide spacing. DELAY IN THEIR REMOVAL IS EXTREMELY HARMFUL. Intercrops of vegetables are often more profitable. Both may be used.

6. The SQUARE PLAN is recommended for permanent plantings. Where fillers are desired, either square, rectangular, or quincunx plans may be used.

7. TREES SHOULD BE SPACED FARTHER APART than has been done in the past. Higher yields, quality, longevity and lower cost of production are the advantages of proper spacing.

8. Consider pollination requirements in planting the orchard. MOST APPLES, PEARs, PLUMS, AND ALL SWEET CHERRIES REQUIRE CROSS-POLLINATION. Apricots and peaches, except J. H. Hale, and sour cherries are self-fertile. BING, LAMBERT, AND NAPOLEON ARE INTER-STERILE and require other pollinizers.

9. ROOTSTOCKS SHOULD BE SELECTED CAREFULLY. French seedlings or Old Home bodystocks for pear trees, peach seedlings for peach trees, apricot seedlings for apricot trees, myrobolan seedlings and peach stocks for plums, and mahaleb stock for cherry trees are considered best under Utah conditions.

10. EARLY SPRING PLANTING is preferred over fall planting except in special cases. Careful handling pays.

11. MODERATE HEADING, with disbudding, selection of shoots, or pinching, is recommended where whips are planted, to secure proper branch distribution over a long head and avoid weak crotches. Two or three scaffold branches and a leader on branched trees may be chosen at planting time and headed back, leaving the leader longer.

12. ALL YOUNG ORCHARDS SHOULD BE CULTIVATED to provide plenty of plant food and moisture and prevent damage from tree hoppers. ALFALFA, CLOVER, OR GRASS SOD IS NEVER ADVISABLE IN YOUNG ORCHARDS.

13. Annual cover crops planted in August and turned under in May are advised to maintain fertility and increase water-holding capacity.
14. Only CLEAN CULTIVATED INTERCROPS ARE ADVISABLE. When intercrops are used, liberal applications of manure are necessary.

15. Young orchards should be sprayed with lead arsenate once or twice a year to kill leaf-feeding insects. Other insects and diseases require special treatment. Winter injury, and injury by rabbits and mice must be guarded against. Suggestions are given on these points.
Other Publications of the Utah Agricultural Experiment Station of Interest to Fruit Growers

Bulletins

128. Blooming Periods and Yields of Fruit in Relation to Minimum Temperature.
141. Variation in Minimum Temperatures Due to Topography of a Mountain Valley in Relation to Fruit-Growing.
143. Fruit Tree Root Systems—Spread and Depth.
196. Fruit Tree Leaf Roller.
197. The Pear Leaf Blister Mite as an Apple Pest.
206. Treehopper Injury in Utah Orchards.

Circulars

12. Thinning Apples.
63. Tomato Culture in Utah.
64. Onion Growing in Utah.
77. Measurement of Irrigation Water.
83. Planning, Planting, and Caring for the Young Orchard.
84. Building Young Deciduous Fruit Trees.

Mimeograph Sheets (Limited in Number)

20. One Hundred Selected Bulletins on Fruit Culture (List Only)
26. Fruit Thinning Pays Dividends.
27. Bigger and Better Fruit Through Improved Soil Management.
29. Pruning the Concord Grape.
30. Apple and Pear Packing.
31. Pointers for Picking Pears.
37. Apple Varieties for Utah.
38. Pear Varieties for Utah.
40. Peach Varieties for Utah.
41. Plum Varieties for Utah.
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