SMALL FRUITS

RASPBERRIES, BLACKBERRIES, DâuBERRIES, LOGANBERRIES, CURRANTS AND GOOSEBERRIES

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THE BRAMBLES

The term "brambles" is used in horticultural literature to designate the raspberries, blackberries, dewberries and loganberries. Nearly all species of these fruits have biennial stems and perennial roots. All can be grown successfully in the irrigated portions of Colorado, but are not successful in the unirrigated portions because the annual rainfall is not sufficient to produce a profitable crop.

In Colorado, the raspberries are the most important of the brambles from a commercial standpoint. The red raspberry is more important commercially than the black raspberry. There are only a few commercial plantings of blackberries in Colorado. This is due to the fact that they do not seem to be well adapted to Colorado conditions, they are more difficult to cover for winter protection, and the markets seem to prefer raspberries. Dewberries and loganberries are not planted much commercially because of the difficulty of handling plants of their trailing type and of the limited market demand for them.

The latest available statistics show that there are only 613 acres of raspberries grown in Colorado, producing only 643,678 quarts with an average yield of 1058 quarts per acre, and selling at an average price of 24 cents per quart. The average yield of 1058 quarts per acre is much lower than should be secured under good cultural practices. A yield of 3,000 quarts per acre can be easily secured on good soil with cultural operations that promote vigorous growing conditions throughout the plantation. Part of the low yield is due to losses from late freezes, but these losses are not enough to cause a yield as low as 1,058 quarts per acre. The successful growers are those who secure the larger yields because all operations, except harvesting and marketing, cost just as much for a low yield as for a high yield. Therefore rather than increase the acreage to secure more fruit the successful grower increases his yield per acre thru more attention to his operations. Furthermore, high quality is usually associated with high yields and it is always the fruit of high quality which brings the best market price.

Undoubtedly there are some areas in Colorado where raspberries are not grown now, that would produce profitable crops. Many of the mountain valleys at elevations up to 8,000 feet will grow raspberries. Berries grown at this altitude are of high quality, are practically free from insects and disease, except mosaic; and mature
during the latter part of July, a time when there are no other raspberries on the market. It seems then that raspberries grown at high altitudes would be profitable. But many localities could not produce enough berries to ship in carload lots and express shipments are too expensive to permit large-scale shipments to distant points. Furthermore the demand is always limited at that time of the year due to competition from other fruits. But for the grower who is fairly sure of his market, brambles offer an additional source of income.

Anyone contemplating the commercial culture of brambles in any locality must realize that they are special crops requiring special care if profitable crops are to be secured. The berries of brambles are soft and perishable; they mold or sour easily, especially if allowed to stand in the sun after picking, if packed with dew or rain on them, or when improperly cooled in the cars on the way to market. They must, therefore, be marketed as soon as possible after picking. The fruit of brambles ripens rapidly and for best results should be picked during the cool morning hours. This requires large picking crews.

Bramble growing has advantages as well as disadvantages. A profitable crop can be secured in 2 or 3 years. The ease of all cultural operations and the large returns per acre make it possible for one man to handle the whole plantation except during harvest. If the canes need to be laid down for winter protection an extra man will be needed for a few days at this time. The large returns per acre make it possible to grow brambles on high-priced land near the large city markets. However, modern refrigeration methods make it possible to ship berries to markets which are 24 to 36 hours distant, thus enabling growers to make use of cheap land for bramble growing.

The prospective grower of brambles must realize that they do not offer a source of easy wealth but that they must be regarded like any other farm crop and incorporated in a farming plan based on sound business principles, rather than upon speculation. The successful bramble growers are those who grow them as only one of several sources of farm income, and so regulate their cultural operations that a maximum yield is secured. Such growers are seldom injured by periods of agricultural depressions, but are able to accumulate enough in more favorable times to carry them thru periods of depression and to show a profit in the long run. It is the speculators and the inefficient, unskilled growers who make failures when all conditions are not favorable.

The brambles are all desirable for the home garden. A few
dozen plants are sufficient to provide an abundance of fresh fruit during the summer and plenty more for canning and preserving. The most desirable of the brambles for home gardens in Colorado are the raspberries because they always do well where brambles can be grown and they are easier cared for than the blackberries and dewberries. Where the plants must be covered for winter protection the red raspberry is more desirable than the black because it can be more easily covered and uncovered due to the fact that it produces unbranched canes, and longer and more pliable canes.

Bramble Types

Three types of raspberries are grown commercially in Colorado. The red raspberry is of the greatest commercial importance, the black raspberry is second and the purple raspberry ranks third. The purple raspberry is a hybrid or cross of the red and the black raspberry. The yellow raspberry is grown to a limited extent but is not suited to commercial culture because the only good yellow variety is subject to disease and produces fruit that is too soft for shipping. It is a variety of red raspberry.

Our cultivated blackberries have all been derived from native species. The blackberry family embraces a wide variety of forms and our cultivated varieties have come from an intermingling of nearly all of these types. Therefore any classification of varieties according to the species from which they have descended is almost impossible and certainly not practicable. It is even difficult to separate the blackberries from the dewberries on account of their natural crossing and it is not difficult to find many forms with the characteristics of both blackberries and dewberries. Several of these blackberry-dewberry hybrids are found among our cultivated varieties of brambles. The cultivated dewberries have originated from native species, and, on account of the natural crossing of species in the wild, the parentage of our present-day varieties is difficult to determine.

Characteristics of the Brambles

The red raspberry produces erect to slightly arched canes which are of a reddish color when young, changing to light brown in their second year of growth. It does not usually produce laterals in Colorado. Small spur-like thorns are borne on the canes. Some varieties are almost void of thorns. The red raspberry grows to form a solid mat in the row. The new canes come from buds at the base of the old plant and from adventitious buds on the roots. The red raspberry is vigorous under good growing conditions and is very productive. The fruit is usually red but occasionally is yellow.
The black raspberry differs radically in habit of growth from the red. The canes are blackish purple, form several laterals each, are covered with a great deal of gray bloom and are much arched, the tips of the shoots usually touching the ground before the growing season is over. The black raspberry has heavy recurved thorns in decided contrast to the small, rather inconspicuous thorns of the reds. It grows in clumps, the new canes coming from buds at the crown of the plant and from buds near the base of the previous year's canes. Under good growing conditions the blacks are as productive as the reds. The fruit is a glistening purplish black color.

The purple raspberry, being a cross of the red and the black, has characteristics of both parents. The canes are reddish purple with a moderate amount of grayish bloom. They have the arched canes, heavy recurved thorns and the habit of growing in clumps of the blacks. Under the same growing conditions the purple varieties are more vigorous and productive than either of their parents. The fruit is reddish purple in color.

The blackberry canes grow upright and are much branched. The branches do not droop like those of the black raspberry, and the bark color is dark reddish brown. The canes are often much furrowed or grooved. Large recurved thorns are produced on the canes and in some varieties small thorns are also produced on the underside of the leaf along the ribs. The new canes grow in the same manner as do those of the red raspberry. On account of the sucker-producing habit of the blackberry it is often difficult to eradicate the plantation, for a new plant will come from every piece of root left in the ground. The fruit varies from medium to large and is of a glistening black color.

The dewberry is a low-growing plant, the reddish-brown canes trailing along the ground. The canes bear thorns very similar to those of the blackberry. The fruit is large, oblong and of an attractive black color. On account of the trailing habit of the canes the fruit is rather difficult to pick unless the canes are trained on a trellis or tied to stakes. The leaves tend to hide the fruit when the canes are left on the ground.

There are a number of blackberry-dewberry hybrids which have a semi-trailing growth habit. Some are rather upright while others, such as the McDonald, are only slightly upright.

The brambles bear their fruit on one-year-old canes. The buds on the laterals and on the main cane send out leafy shoots on which the fruit is borne. After the fruit ripens the cane dies. At the same time new canes are growing to replace the old canes. These new canes produce the crop the following year.
Fig. 1.—A tip-layered black-raspberry shoot.

Propagation

The black raspberry and most of the purple varieties reproduce themselves naturally by tip-layering, that is, by the tips of the canes taking root as shown in Fig. 1. In order to secure new plants it is only necessary to cover the tips with soil early in August so the new plants will be well rooted before frost. A great many of the tips will be covered by cultivation but for best results they should be covered by hand. The rooted tips should be severed from the parent plant and dug in the fall before heavy freezes, after they have become dormant, and stored over winter in bundles of 25 or 50 in a box of green hardwood sawdust kept at a temperature of about 40 degrees F. If the temperature gets much higher the plants are apt to start growth. They should be kept just damp enough to prevent drying out. The plants can then be set out in the spring. The young plants can be heeled in out of doors instead of storing in sawdust. Fig. 2 shows how the young cane grows from a tip-rooted plant.

Those varieties of red raspberries and blackberries that sucker freely are propagated by means of the suckers which come from the adventitious buds on the roots. See Fig. 3. The young suckers are dug in the fall and handled in the same way as the young black
Fig. 2.—A vigorous 1-year-old tip-rooted black-raspberry plant showing the young cane (2) arising from a bud on the crown of the plant.
raspberry plants. Where covering is not necessary to protect the brambles over winter, the young plants of both the reds and blacks can be left until spring and then dug up and set out. Fig. 4 shows the new canes growing from sucker plants.

Fig. 3.—At the left a young blackberry cane growing from the base of a bearing cane and at the right a sucker plant growing from an adventitious bud on the root of the old plant. The red raspberry produces its young canes in the same way. (Courtesy Missouri Experiment Station.)
Fig. 4.—Young canes growing from buds on the roots of 1-year-old sucker plants; on the left a red raspberry and on the right a blackberry plant. The dark line indicates the position of the ground line.
When it is desired to propagate new plants rapidly or when a variety does not lend itself easily to propagation by the methods outlined above, propagation by root cuttings can be practiced. Roots the size of a lead pencil should be selected in the fall, cut in lengths of 3 to 5 inches and stored over winter in damp sawdust at 40 degrees F., as described above for tip-layers and suckers. In the spring the cuttings are dropped 5 to 6 inches apart in a furrow about 3 inches deep and covered with loose sandy soil. They should be given ordinary garden cultivation during the summer. They should be dug in the fall and stored the same as suckers and tip-layers. They can be set out permanently the following spring.

The dewberry is propagated most satisfactorily by tip-layering in the same way that black raspberry plants are propagated. Tip-rooted dewberry plants have a better-developed root system than is secured by any other method and tip-layering is therefore preferred.

Site

The site is that portion of the farm on which the bramble plantation is planted. The site should be carefully selected because it is often the determining factor in the success or failure of the plantation. Therefore, anyone contemplating the planting of a bramble plantation should first of all determine whether the farm contains a suitable site and which of several possible sites is the best for the production of brambles. The two important factors to be considered in selecting a site are soils and exposure.

Soils.—The soil is more important in determining the site than is the exposure. Brambles do best on fairly fertile loam, well drained and containing enough humus for retention of moisture and to make the soil easily cultivated. Such a soil will produce the strong vigorous canes which are essential to high fruit production. Humus can be supplied, if lacking, by plowing under cover crops or by the addition of barnyard manure.

The black raspberry will grow on a wider range of soils than any of the others but does best on a rich clay loam with a subsoil which contains more clay than does the top soil. This type of soil is well drained and yet retains enough moisture for best growth.

The red raspberry does best on the lighter soils; a sandy to a clayey loam is preferred. The purple raspberry, since it is a cross of the black and red, naturally does best on an intermediate type of soil, which in this case is a silt loam.

The blackberry requires a clay loam but of less fertility than that required by the black raspberry. On a too fertile soil the blackberry becomes vegetative in growth and bears very little fruit.
The blackberry must have a soil that is retentive of moisture or the
crop will be dried up from lack of water during the ripening sea­
son, when the maturing fruit uses up large quantities of water.
Blackberries cannot be grown successfully on gravelly and sandy
soils unless they are underlain with a heavy, porous, clay subsoil.

The dewberry grows wild upon sandy to gravelly well-drained
soils and it grows best under cultivation upon such soils.

Exposure.—All of the brambles except the dewberry are found
growing wild in the cool damp recesses of the woods, and they thrive
best under cultivation on sites that approximate their natural grow­
ing conditions. Therefore a north or northeast slope is always pre­
ferred, where there is any choice of slope, because north and north­
east exposures do not get the full force of the sun's rays and are
therefore cooler and more like the natural wild home of the brambles.
However, if berries are desired for an early market a south slope
is preferred because it warms up sooner in the spring and growth
starts earlier.

The site should be on well-drained soil since brambles will not
thrive in wet, poorly drained soil. Air drainage is not very impor­
tant in Colorado, except in those localities where berries do not have
to be covered over winter. Under these conditions the danger of
winter injury is greatly increased if the berries are planted where
there is poor air drainage since the cold air will settle in the lower
parts of the plantation and often materially injure the canes.
Brambles usually bloom late enough to escape late spring frosts.
Due to the fact that irrigation must be practiced in Colorado to
raise brambles successfully, very little attention is usually paid to
the direction of the slope.

Varieties

Many varieties of small fruits have been grown in Colorado and
also in the other commercial small-fruit-producing states. The farm
papers, nursery catalogs and horticultural magazines frequently
have advertisements of some new and, according to the advertise­
ments, especially noteworthy variety of small fruit. It is advisable
to steer clear of these highly lauded novelties and wait until the
experiment station has tried them out sufficiently to make definite
recommendations in regard to their value under local conditions.

When starting a raspberry plantation, plant only recommended
varieties and order the plants from a reliable nursery. The horti­
cultural department of the Colorado Agricultural College is now
conducting a trial of all the more desirable new varieties of small
fruits and will be able to make definite recommendations in regard
to varieties for Colorado conditions as soon as these trials are com­
pleted. At the present time the varieties listed below seem to be the most desirable.

**Red Raspberries.**—Cuthbert.—One of the most widely grown of all varieties. Grows well in all raspberry regions, hardy, usually healthy and productive, but susceptible to leaf curl and mosaic. The fruit is dark red, attractive, fairly firm and of good quality when not over-ripe. A good home-garden sort on account of high quality but should not be planted extensively commercially on account of low productivity, susceptibility to mosaic and because the fruit is too soft for shipping long distances.

Herbert.—One of the best red raspberries. Very vigorous, hardy, productive and resists mosaic better than most red varieties. It is much more productive than Cuthbert. The berries are slightly larger than Cuthbert, of high quality but not quite as firm. An excellent home garden and nearby market berry, but not firm enough for long shipment.

June.—One of the earliest of all raspberries. The plants are hardy, vigorous and productive. The yield is well distributed over a long season; fruit a large handsome red, of good quality and a good shipper. Does better on heavy soils than on light. Well worthy of commercial planting.

Latham.—(Also known as Redpath and Minnesota No. 4). This is the variety introduced by the Minnesota State Fruit Breeding Farm that has become popular wherever it has been tried. The plants are extremely hardy, vigorous and disease resistant. Berries large, bright red, attractive, of moderate flavor. It very probably will become, before long, one of the most widely grown varieties throughout the country. It is probably the most desirable variety for commercial planting in Colorado.

Marlboro.—This variety has been more widely planted in Colorado than any other. Its popularity has been due to its hardiness, productiveness, attractive appearance and excellent shipping qualities. Its defects are its rather exacting soil requirements, a lack of vigor, susceptibility to spur blight and mosaic and severe injury from mosaic when it is contracted. It should be replaced by Latham, June or Herbert which have the advantages of Marlboro but not its disadvantages.

Golden Queen.—This is the only variety of the yellow fruited raspberry worthy of cultivation. It is said to be a sport of Cuthbert and is like it in all respects except the fruit, which is light yellow, larger, more delicately flavored and softer. The plants are very susceptible to mosaic. The Golden Queen should not be planted com-
commercially because of the softness of the fruit, but is well worthy of trial in the home garden on account of its high quality.

**Everbearing Raspberries.**—Everbearing varieties of the red raspberry have been grown for a number of years. In Colorado they bear from mid-summer until frost. They bear both on one-year-old wood and on the current season’s growth. Where winter protection is necessary the old canes can be left unprotected, then cut off in early spring, and a crop of fruit will be produced on the shoots that grow during the following summer.

Everbearing red raspberries are not suited to commercial planting due to the high harvesting cost caused by the necessity for making a number of pickings, and on account of the added fact that all the varieties now grown produce small fruit of poor flavor and lacking in uniformity of both size and color. Their culture should be restricted to the home garden where their only possible advantages are the production of fruit over a long season, and the fact that winter protection is not necessary.

**Erskine Park.**—This is usually considered to be the best of the everbearing red raspberries. The plants are very vigorous, hardy, variable in yield, and only moderately injured by mosaic. The fruit begins to ripen in early-midseason and a fair crop is borne until frost. It is of medium size but variable, dark red, inclined to crumble and of fair to good quality. This variety is apparently identical with the variety La France altho there seems little doubt that they originated from two entirely different sources.

**Ranere.**—Also called St. Regis. This is the only other everbearing red variety that has attained any prominence. The plants are only moderate in vigor and productiveness but hardy and resistant to mosaic. The fruit ripens from early in the season until frost. The berries are small and variable in size, tend to crumble, and are of poor quality.

**Black Raspberries.**—Black Pearl.—Hardy, productive; berries large, glossy black, juicy, firm, good quality, ripen early, ship well. Usually considered to be the best black raspberry for cold climates.

**Honeysweet.**—Vigorous, hardy, productive, moderately susceptible to diseases. The fruit, as the name suggests, has a honey-like aroma. The berries are large, glossy black, attractive and ripen in early midseason. The fruit can be left on the canes so long that the entire crop can be harvested in two pickings. The berries are excellent for cooking and require less sugar than most other black raspberries. Desirable either for commercial or home-garden berry.

**Plum Farmer.**—Usually considered to be a very desirable variety; vigorous, hardy, very productive. The fruit ripens in early
midseason, is large, attractive, ships fairly well, and is of good quality. More desirable for local markets and home gardens than for large commercial plantings which necessitate shipment over long distances.

**Purple Raspberries.**—Columbian.—This is the best liked of the common varieties of purple raspberries. Other varieties are also grown very successfully in some sections but the Columbian is more universally successful than any other purple sort. The plants are vigorous, hardy, very productive, and contract mosaic slowly. The fruit ripens rather late, is large, firm, juicy, of handsome appearance and high quality. Excellent for either home use or commercial production. However, the purple raspberry is not well known on the markets of this region and commercial plantings should not be made until there is some certainty of the market. They are excellent for canning.

**Blackberries.**—The blackberry is little grown in Colorado, hence a long list of varieties is not desirable. Some of the best are:

Early Harvest.—This variety, while not as desirable as several of the later season sorts, is still considered the standard early variety. The plants are of only moderate vigor and hardiness and moderately productive. The fruit is smaller than that of other sorts, but is uniform in size, attractive, ships well and is of good quality. It is the best very early blackberry.

Eldorado.—This is usually the first main-crop variety to ripen. The plants are vigorous, productive, hardy and healthy. The fruit is large, attractive, firm and of very high quality. Good for home garden or for commercial planting. Ripens over a long season.

Mersereau.—A popular variety wherever grown. It is a seedling of Snyder which it surpasses in vigor and in size and quality of fruit. The plants are vigorous, hardy and productive. The fruit is late midseason, ripens over a long period, is large, and attractive glossy black, firm, and of high quality. Desirable both for home and commercial planting.

Snyder.—This has been a standard commercial variety for many years. Its popularity has been due to its vigor, good health, productivity, and extreme hardiness, but it cannot withstand drought. The fruit ripens in late midseason, is inferior in size, has a poor appearance, turning brownish or red after picking and the quality is only average, even when well grown. It is a good shipper which accounts in part for its popularity. It should never be grown for a home-garden berry on account of its poor flavor, but because of its vigor and productivity, it is still a desirable commercial sort.
Dewberries.—Lucretia.—This was one of the first varieties to attain prominence and is today the best known of all dewberry varieties. Its popularity has been due to the fact that it grows satisfactorily on a wide range of soil types and in regions of widely different climate. However the plants are susceptible to anthracnose and produce many double blossoms which are sterile. The fruit ripens early, is variable in size, an attractive jet black color, firm and of good quality when the berries are allowed to become fully ripe before picking.

Young.—This variety, which is a cross of the dewberry and loganberry, was distributed in 1924. It is usually called the Youngberry. It is grown extensively in California and probably should replace Lucretia in most sections. The plants are vigorous, trailing, moderately hardy, very productive. The fruit is larger than Lucretia, glossy dark wine color, juicy, firm, of good quality; ripening the same time as Lucretia but with a longer picking season. Suitable for home garden or commercial growing.

Planting Preparations

Brambles usually do best on land that has been cultivated at least one year after being broken out of sod, and following some intensively cultivated or hoed crop. This helps to destroy weeds and also gets the soil in good tilth. The land should be plowed 8 inches deep the fall before the plantation is to be set. At this time, it is advisable, if possible, to plow under a heavy cover crop. This adds humus that is so essential to the success of the plantation in the years to come. If the cover crop is thoroly disked before it is turned under it will decay more quickly. The land should be disked again in the spring and worked into good condition as soon as weather permits, in order that the plants can be set out early in the season. If a cover crop is not plowed under in the fall it is very advisable to add 10 to 15 tons of well-rotted manure to the acre and to thoroly incorporate it into the soil by disking and plowing.

The average bramble planting is a long time investment and during its life requires rather large quantities of humus. It is much easier to start the plantation off with a liberal supply of humus in the soil than to try to add it after planting.

Planting

Source of Plants.—For commercial plantings it is always ad­visable to purchase the young plants from a reliable nursery. Young plants can be secured from a previous planting or from a neighbor’s plantation. Such plants are quite satisfactory if they are taken from disease-free plantings, but old plantations are very liable to be dis-
eased and especial care must be taken to get disease-free young plants. Nurseries must sell disease-free plants to keep in the business and most states require inspection of all nursery stock.

All plants affected with crown gall, mosaic, or any other disease should be discarded. Diseased plants are always weakened and therefore do not grow as vigorously or produce as much fruit as healthy plants. First-class nurseries always discard such plants and sell only vigorous, disease-free plants.

**Handling Plants Before Setting.**—The grower should order his plants early in the winter and instruct the nurseryman to ship them at about the time they are to be set out in the spring. By ordering early the grower gets the best plants and avoids the risk of substitutions which are usually made if the supply of the desired variety is exhausted.

If the plants arrive before they can be set out they should be unpacked and heeled in to prevent them from drying out or rotting. To heel plants in, a trench should be dug with the back side sloping at an angle of 45 to 60 degrees and deep enough for the plants to be covered a few inches deeper than they stood in the nursery. The bundles should be untied, the plants spread out along the slanting side of the trench and then covered with loose moist soil which should be firmly tramped about the roots. If the plants have dried out in shipping they should be stood in water for a few hours before heeling in.

**Setting the Plants.**—All of the brambles do best in Colorado when set in the spring. There seems to be no advantage in setting in the fall and there is the disadvantage that the plants have to be covered over winter and, even with the best of care, quite a few are liable to be lost. The plants should be set early in the spring before growth has begun because in late plantings the tender young shoots are liable to be broken off in setting and many of the new roots that have been formed will be broken off. The plants are then slower in becoming established than they are when planted in the dormant state.

The ground should be harrowed or stirred in some similar fashion just before planting. It should then be marked, and cross-marked if the field is large. Setting the plants at the cross mark allows the plants to be cross cultivated the first year, which eliminates hoeing in the rows.

After the ground is ready for setting the plants should be taken out of the trench where they have been heeled in, but only as fast as they are needed. The roots should be dipped in muddy water before setting and kept shaded to prevent drying out.
The plants should always be set with the roots in contact with moist soil. They are commonly set by pushing a spade into the ground, then pushing it forward and dropping the plants into place, removing the spade and tamping the soil firmly about the plant. This method is very satisfactory if the plants have not been allowed to dry out and if the ground is in good condition. It is by far the fastest method that can be used. Holes may be dug for the plants or a furrow plowed and the spade used to finish the hole at the point where the plant is to set.

The old canes of tip-rooted black raspberry plants should be cut back to 4 to 6 inches since their main function is only to mark the rows until the new shoots begin growth. If there is any anthracnose or other disease present on the old canes they should be entirely cut off to prevent the spread of the disease.

The shoots of red raspberry and blackberry plants should also be cut back to 4 to 6 inches when they are set out. Red raspberries and blackberries are usually set 3 to 4 inches deeper than they stood in the nursery, but the black and purple raspberries should not be set more than 2 inches deeper, because their shoots are very tender and sometimes are not able to push thru to the surface if set too deeply on a heavy soil.

On well-drained land a good system is to set the plants in the bottom of a trench 6 or 8 inches deep, cover them with only about 2 inches of soil and gradually fill the trench in by cultivation during the summer. This gives deeply rooted plants and the canes come from far enough below ground that they are not easily broken off with winds. This also delays the tendency of the crowns to rise above the surface.

If possible the rows should run north and south in order to get the maximum amount of sunlight along the row.

**Planting Distances.**—Red raspberries and blackberries are commonly set 3 to 4 feet apart in rows 6 to 8 feet apart when they are to be trained to either the unsupported-hill or hedge-row system. If the staked-hill system of training is to be used they should be set 5 to 6 feet apart each way. When they are to be trained to the hedge-row system they can be set closer than 3 feet apart if plants can be secured at a low price, for the solid hedge row will form sooner if the plants are set closer together.

The black and purple raspberries should be set 3½ to 4 feet apart in rows 6 to 8 feet apart. Closer planting in the row will hinder the proper development of the clumps. When dewberries are grown in rows they should be set 3 to 3½ feet apart in rows 6 to 8 feet apart. When they are grown in hills they should be set 5 to 6
feet apart each way. Youngberry plants should be planted 7 to 9 feet apart in rows 7 to 8 feet apart. Planting any of the brambles in rows closer than 6 feet causes crowding, while planting more than 8 feet apart is a waste of land. This does not apply to the checked-hill system of planting.

**Cultivation**

**Culture The First Year.**—Cultivation is as essential to successful production of brambles as it is with other crops. Cultivation should start immediately after the plants are set and should be continued throughout the summer at intervals frequent enough to keep the ground in good physical condition, to keep weeds killed, and to remove red raspberry and blackberry suckers that come up between the rows. Cultivation should not be over 3 inches deep after the first two cultivations, which may be an inch or two deeper in order to get the ground thoroughly stirred. For cultivation an ordinary 5 or 7-shovel cultivator is very satisfactory. In cultivating red raspberries and blackberries it is well to use shovels with square points to cut off suckers. With thorough and careful cultivation the suckers can be kept out of the middles between the rows.

Cultivation should be discontinued by August 15, except after irrigations, in order to allow the wood to ripen before winter. The canes have usually made sufficient growth by this time and further cultivation would only prolong the growing season and the canes would go into the winter in an immature condition, resulting in considerable winter injury in those localities where winter covering is not practiced. After cultivation is discontinued in midsummer the food that is manufactured in the leaves is stored for fruit-bud formation and for the production of the next year's crop. If cultivation is continued until fall there is very little food stored but nearly all that is manufactured in the leaves is used for cane growth, and the crop is very light the following summer. It will usually be necessary to hoe the plantation once or twice during the summer in order to remove the weeds in the row.

Intercrops may be grown between the rows the first season, but they should never be grown afterward. The returns secured from intercrops more than make up for any check in growth that they may cause to the plants the first year. Crops should be used that require thorough cultivation and that are harvested before September the first. Beans, cabbage, beets and similar crops are best adapted for this purpose. A crop that is started fairly late must be used since they can't be started until after the plants are set out. Only one row should be planted between each two rows of brambles.

**Culture After The First Year.**—Cultivation should start as
soon as the canes are uncovered in the spring, or at this time if covering is not necessary. The first cultivation should be 3 to 4 inches deep in order to thoroughly pulverize the soil. This is very valuable if a cover crop or application of manure is on the ground. After this the cultivation is the same as for the first year. Cultivation should be discontinued during picking except following irrigations, which are necessary to supply the large amount of water used by the ripening berries.

Mulching.—Mulching is practicable only for small plantings such as the home garden where it is difficult to give adequate cultivation. Straw, hay or leaves are the best mulching materials. The mulch should be applied to a depth of 4 to 6 inches. The mulch conserves moisture, since there is little chance for evaporation from the soil thru the mulch; it keeps down weeds and suckers, adds humus to the soil, and affords some protection to the roots over winter. It is well to remove most of the mulch each spring and plow the soil before again applying a mulch. This adds organic matter to the soil and keeps the soil in good physical condition. The disadvantages of a mulch are the cost of application, the danger of plants growing too late in the season with a consequent loss from winter injury in plantations that are not covered over winter, and the increased difficulty of providing winter protection in those sections where it is needed.

Fertilization

Whether brambles should be fertilized is as yet an unsettled question. There are not enough reliable data to give any definite recommendations in regard to bramble fertilization. Most soils on which brambles are grown in Colorado are fertile enough to produce good crops without fertilization. It is only necessary to maintain the humus content of the soil and to keep the soil in good physical condition.

To maintain the humus supply an application of barnyard manure is the best material. It can be mixed in the soil when uncovering the canes in the spring or applied evenly over the whole plantation. It is then incorporated into the soil by the spring plowing and summer cultivations. The manure should be applied at the rate of 10 to 15 tons per acre on the average soil suited to bramble culture. Manure that is fairly well rotted and that contains considerable litter is best for this purpose. Most of our Colorado soils are high in nitrogen content and if very fresh manure or commercial fertilizers containing much readily available nitrogen are applied there is danger of causing excessive vegetative development at the expense of fruit production. That is, excessively vegetative
plants form relatively few fruit buds since most of the food manufactured by the leaves is used up in wood growth rather than being stored for the production of fruit buds.

**Irrigation**

The frequency with which bramble plantations should be irrigated is governed by the seasonal climatic conditions and by the physical character of the soil. In seasons of much rainfall the plantation will naturally require less irrigation. Showers seldom wet the ground deeply enough to provide any water to the root system and should therefore not be depended on to take the place of irrigation. The heavier types of soil, such as silt and clay loams, are more retentive of moisture than the lighter types, such as sandy loam, and therefore do not require as frequent irrigations. Likewise, a soil that contains large quantities of humus does not require irrigation as often as a soil that is lacking in humus, because a soil well supplied with humus is retentive of moisture. It is often difficult to properly irrigate a soil that is lacking in humus because it does not readily absorb moisture. The furrow system of irrigation should always be practiced.

Soon after the plantation is set out a shallow furrow should be made a few inches to one side of the row and a small, slow stream of water run thru it until the soil is thoroly moistened about the roots of the young plants. From this time the grower must rely upon his judgment concerning the frequency of irrigations. In any case a thorø irrigation should be given every two weeks and some soils will require it more often.

During the picking season large quantities of water are used by the ripening fruits. Two thorø irrigations a week should be sufficient except on very light soils. The fruit should be picked in the morning of every other day and on irrigation days the water should be started as soon as the day’s picking is over. This allows the surface to dry off the following day and it is not so muddy when the plantation is again picked. When pickers are obliged to work in a muddy field the soil becomes hard and packed and is difficult to efficiently cultivate.

After about August 15, irrigations should be only frequent enough to prevent the plants from suffering from water. This, combined with the lessened frequency of cultivations, causes the plants to grow less rapidly thereby maturing their wood growth before winter and storing food for the production of the following year’s fruit crop.

In the fall, just before the plants are covered for winter protection, the plantation should be thoroly irrigated in order that there
will be plenty of water in the soil to maintain the plants during the winter. This irrigation also makes the soil easier to handle in covering the canes. If winter protection is not necessary it is advisable to give this irrigation because the soil may dry out during the winter and many plants be lost from the death of the roots in the dry soil.

Whenever the plantation is irrigated the water should be left to run long enough to wet all the soil in the row to a depth of at least one foot. The more thorough the irrigation the less frequent becomes the need for its application. Some growers irrigate frequently yet their plantations suffer from a lack of water because they do not irrigate thoroughly enough. After every irrigation the soil should be cultivated as soon as it is dry enough. This prevents the formation of a surface crust.

Winter Protection

In many sections of Colorado all types of raspberries and blackberries need winter protection of some sort to prevent the canes from dying. Death is attributed not to the cold but to the loss of moisture from the canes, caused by the high winds, intense sunlight, and wide fluctuation between the day and night temperatures in Colorado. The canes freeze at night and thaw during the day. The intense sunlight of midday warms the canes to a temperature higher than that of the surrounding air. Under these conditions the vapor pressure of the canes is higher than that of the air, and water vapor passes out of the canes thus drying them out. Sudden drops in temperature leave the temperature of the canes higher than that of the air and consequently water vapor passes out of the canes due to the higher vapor pressure of the canes. That death is not due to the degree of cold is indicated by the fact that canes left uncovered at the Colorado Agricultural Experiment Station during the winter of 1927-28 were still alive after being subjected on two successive nights to a temperature of 17.5 degrees F. below zero, but nearly all dried out and died before April. The temperature did not go below 10 degrees F. at any time after the 17.5 degrees F. below zero mentioned above. If any assurance of a crop is desired it is advisable to provide winter protection for all of the brambles except in those sections of the state where experience has shown that protection is not necessary.

The best way to protect canes from winter killing is to completely cover them with soil to a depth of 2 to 4 inches. Straw, cornstalks, etc., are sometimes used but none of these materials is as satisfactory as soil. The wind also tends to blow the covering away, and there is always danger of the straw, etc., harboring mice which often do considerable damage to the canes. Deep snow does not pro-
vide ample protection because the part of the cane above the snow line is usually killed and this killed portion often includes the best producing part of the cane.

The canes should be covered between October 15 and November 15. The fall pruning as described on page 28 should be done before covering. Some growers do not cut the tips of the canes off until they are uncovered in the spring, but generally they are cut off in the fall at the regular pruning.

Fig. 5.—Red raspberry canes bent down and partially covered by the plow.

After the plantation is pruned the canes are covered in three operations. First, the canes are bent down as nearly flat as is possible without breaking and the tips weighted down on the right side of the row with a shovelful of earth. By placing the canes to the right of the row the ends are not plowed into in uncovering as they would be if they were placed on the left side. After the cane tips are weighted down, 1 or 2 furrows about 6 inches deep are plowed on both sides of the row, with an ordinary landside turning plow, in order to throw the dirt up on the canes. See Fig. 5. The plowing never completely covers the canes and it is therefore necessary to finish covering them with shovels. The canes should be covered 4 to 6 inches deep at their highest point. In Fig. 6 the covering has been completed. Of course the tips will often be covered several inches deep, when the basal one-half or one-third of the cane is only adequately covered, but this does no harm. Canes should never be covered when they are frozen because they are then so brittle that it is almost impossible to bend them down without breaking a large percentage of them. Even under the most favorable conditions, it
is impossible to prevent some breakage of canes. It is often advisable to remove a spadeful of dirt from in front of the hill before bending the canes down. This is especially advantageous in the case of old plantations where the hills are usually rather root bound. Don't under any circumstances leave any of the cane exposed. Careless growers often do not completely cover the canes but merely cover what they can with the plow. This usually leaves a foot or

Fig. 6.—A row of raspberries properly covered for winter protection.
two of the middle of the cane exposed, with the result that the canes dry out and die during the winter, and the labor of covering the canes is lost, to say nothing of the far more important loss of the canes and the crop of fruit that they would have borne.

The canes should be uncovered before the buds begin to swell much, and in all cases, should be uncovered before the leaves begin to push out. This is usually about April 1 in northern Colorado and will vary in other parts of the state as their season of growth varies from that of northern Colorado. If the canes are left covered until the leaves begin to push out there is a great deal of danger that they will be killed if there are any frosts after uncovering. The leaves that grow before uncovering are tender and succulent and are unable to withstand even moderately cold weather. On the other hand if the canes are lifted before any growth starts the leaves will come out gradually and will become hardened to the prevailing temperatures. There is relatively little danger of any damage resulting from early uncovering of the canes. Canes of the red raspberry at the Colorado Agricultural Experiment Station uncovered when the buds had begun to swell but before the leaves had started to push out were subjected to a temperature of 4.8 degrees F. without injury of any sort.

The canes are partially uncovered by plowing down both sides of the row throwing the dirt away from them. They are then usually lifted by thrusting a 4 or 6 tine fork under them and lifting upward. This pulls the tips from under the dirt. All of the dirt should then be raked out from between the canes until the row is perfectly level. If the dirt is not all removed from between the canes a ridge forms in a few years making it difficult to adequately irrigate, and consequently the plants often suffer from drought. Some growers do not completely uncover the canes at once but plow away the sides of the ridge and wait a few days before lifting them. This is done in order to allow the canes to become gradually accustomed to the air temperature. However, it is doubtful that there is any advantage in this practice.

**Fruiting Habits**

All of the brambles bear their fruit on one-year-old wood, commonly called canes. The canes grow during the summer of one year, produce a crop of fruit the following year, and then die after the fruit is harvested. The first year of the life of a plantation there is no fruit borne. One or two canes grow from the crown of the new plant which was set out. Figs. 2 and 3 show how these young canes grow from the plants that are set in the field. The second year several new canes grow from each hill and the canes that grew the
previous year produce a little fruit and then die. The third year the canes that grew the second year produce a crop of fruit and die. New canes grow up at the same time to replace them. The amount of fruit produced the third year depends upon the vigor of the plants. Normally one-half to two-thirds of a full crop can be expected the third year and a full crop the fourth and following years. After the third year the plantation each year has canes bearing a full crop of fruit and new canes growing to produce the crop of the following year. If, for example, a plantation was set out in the spring of 1929, its life history would be as follows:

Spring 1929—Plants set in field.
Summer 1929—One or two canes produced per hill.
Summer 1930—Canes grown in 1929 produce a little fruit and die. Several new canes grow to produce 1931 crop.
Summer 1931—Canes grown in 1930 produce 1-2 to 2-3 of a crop and die. Several new canes grow to produce 1932 crop.
Summer 1932—Canes grown in 1931 produce a full crop and die. Several new canes grow to produce 1933 crop.
After 1932—Each year same as summer of 1932.

All of the buds on the canes of any of the brambles are potential fruit buds, that is, they are capable of producing fruit. In the spring a leafy shoot several inches long grows from the bud and the fruit is borne on this shoot. If every bud on a cane produced a vigorous fruiting shoot the food demanded by the developing fruit could not be supplied by the plant, the fruit would be small and the plant would be so weakened that it would grow no vigorous young canes to bear the next year’s fruit crop. Therefore it is necessary to prune brambles in order to keep a balance between the vegetative and fruiting activities of the plant. Bramble pruning is merely a method of fruit thinning.

Training

The common methods of training red raspberries are the hill and the hedge or matted-row systems. The black and purple raspberries on account of the fact that they do not send up suckers, necessarily are always trained to the hill system. Blackberries are trained like red raspberries. Dewberries are usually kept in hills.

The Hill System.—The method of red-raspberry training most commonly used in Colorado is the unsupported hill system. By this system the plants are kept in hills the same distance apart that
they are set in the field. From five to eight canes are left per hill for fruiting. No support is usually needed but some growers use a trellis. If no support is used the canes must be more severely pruned in order to hold up the load of fruit. The advantages of this system are: (1) Easier picking; (2) covering is said to be less difficult; (3) less difficult to keep weeds out of row; (4) can be cross cultivated the first 2 years, thus giving more thorough tillage; (5) diseased plants can be more easily rogued out.

Another system of hill training is the supported-hill system in which a stout stake is driven into the center of the hill and the canes tied to it. The plants are set an equal distance each way and cross cultivation practiced throughout the life of the plantation. The only added advantages of this system are: (1) More thorough tillage, and (2) less hand labor in cultivation. The disadvantages of this system are: (1) The cost of stakes, (2) the necessity of removing stakes where winter protection is essential, (3) lack of adaptation to long narrow fields, and (4) less plants per acre, with the consequent probability of a smaller yield.

The Hedge or Matted-Row System.—In this system the suckers are allowed to grow in the row between the hills. In this way a row 18 to 24 inches wide is formed with the canes scattered uniformly along the row. A trellis support for the canes is not necessary unless the plantation is exposed to heavy winds. The advantages of this system are: (1) Larger yield, (2) distributes plants evenly along row, and (3) roots don't tend to form a clump that grows out of the ground as they do in the hill system.

The disadvantages are: (1) The tendency to leave too many canes; (2) more hand labor needed to keep weeds out of the row; (3) slightly more difficult to pick; and (4) covering is said to be more difficult.

The results of Johnston and Loree at the Michigan Agricultural Experiment Station indicate that yields of a fourth to a third more are possible by the hedge-row system than by the hill system. This difference in yield should much more than compensate for any of the advantages of the hill system.

Blackberries can be trained by either of the methods described for red raspberries. Here again the yield will undoubtedly be greater when they are trained to the hedge-row system, due to the greater number of canes per acre and the more even distribution of the canes. Blackberries should be supported by a trellis when they are grown in regions in which high winds are prevalent.
Pruning

The actual operations of bramble pruning vary with the crop to be pruned. This variance is caused by the differences in the growth characteristics of the various brambles. Altho the method of pruning differs, the result obtained is the same, namely, the equalization of the vegetative and fruit-developing tendencies. This equalization is secured thru the fruit thinning accomplished by pruning.

Fig. 7.—A hill of red raspberries before pruning.
Red Raspberries.—The red raspberry in Colorado nearly always produces unbranched canes. Canes with laterals are very uncommon. Every bud on the cane is capable of producing fruit, but the desirability of removing some of the buds by pruning has been pointed out. Johnston and Loree 3 at the Michigan Agricultural Experiment Station found that under Michigan conditions the most productive portion of red-raspberry canes was from the fifth to the twentieth bud counting upward from the ground. Beyond the twentieth the yield for each bud decreased rapidly. Their investigations indicated that a moderate heading back was the most desirable method of pruning red-raspberry canes.

Moderate heading back (removing from one-fourth to one-third of the canes) removes the region of lowest productivity and at the same time removes enough fruit to give the desired balance between vegetativeness and fruitfulness. The berries tend to be larger on canes which are moderately headed back than on canes which are not headed back. Picking is also easier when heading back is practiced because there is a shorter cane length to be picked.

Severe heading back should not be practiced because it removes some of the heaviest producing part of the cane. Colorado red-raspberry plantations should have the canes headed back one-fourth to one-third, depending on the vigor of the canes. The more vigorous a cane the less severe the pruning should be. If none of the cane tip is removed the weight of the berries and leaves causes the canes to bend over, making cultivating and picking more difficult. The canes of some varieties bend badly even when cut back, and need a temporary trellis of some sort to support them. A permanent trellis can be provided where winter protection is not necessary.

In Colorado the first pruning of the red raspberry done during the season is the removal of the old fruiting canes soon after harvest. The remainder of the pruning is done in the fall a short time before covering for the winter. Some growers do all of the pruning in the fall. The only objection that can be raised to this practice is the danger of spread of disease or insects from the old to the young canes.

In those sections of the state where winter covering is not necessary the old canes are pruned out after harvest and the remainder of the pruning done in the early spring before growth starts. If the pruning is not done until spring all the weak and winter-killed shoots can be removed and the winter-injured tips can be removed. If the pruning is done in the fall many canes that are left will be winter killed or the tips killed back and it is necessary to prune again in the spring to remove this dead wood. In fact, it is probably a good
system to leave the old fruiting canes until spring also, unless they are diseased or infested with insects. In such cases they should be removed and burned immediately after harvest. If the old fruiting canes can be left until spring there is the advantage of having to do only one pruning; they help to protect the young canes from blowing about by the wind; and to catch and hold the snow, which is an advantage in the semi-arid climate of Colorado.

Red raspberries in Colorado are most commonly grown according to the hill system of training as described on page 214. At the time of the fall pruning the old fruiting canes are removed if they have not been removed immediately after harvest and the weak, diseased, and broken canes removed, leaving all of the vigorous young canes. Some growers never leave over 5 canes per hill for fruiting while others leave 7 or 8. Johnston and Loree at the Michigan Agricultural Experiment Station found that under Michigan conditions the amount of fruit borne by the red raspberry depended not so much upon the number of canes per hill as upon the size of the individual canes, and that for greatest returns 7 or 8 canes per hill should be left. They found that canes 1-2 inch in diameter yielded more than twice as much as canes 9-32 inch in diameter and a third more than canes 3-8 inch in diameter. This indicates that it is more important to leave good-sized fruiting canes than it is to leave any definite number. Under Colorado conditions, where plenty of water can always be supplied thru irrigation, it appears quite logical that all of the canes 3-8 inch in diameter or over should be left for fruiting, regardless of the number per hill. Fig. 7 shows a hill of red raspberries before pruning and Fig. 8 the same hill after it has been correctly pruned.

Fig. 8.—The same hill of red raspberries showing in Fig. 7 after properly thinning out and heading back.
If the hedge-row sytem of training is practiced the same prun­ing schedule is followed as in the hill sytem. Johnston and Loree found that under Michigan conditions, with the hedge-row system of training, the greatest net returns were secured when the canes were left to stand 2 1/2 to the foot. Vigorous canes could very probably be left to stand 3 or 4 to the foot under the more favorable growing conditions of Colorado.

**Black and Purple Raspberries.**—The young canes of the black and purple raspberries usually do not branch freely but grow into long slender canes which are easily bent and broken under the weight of fruit the next year. They are also easily injured by wind. In order to induce branching and the consequent development of sturdier canes, the tips of the young shoots of the black raspberry should be pinched out when they have reached a height of 20 to 24 inches and the tips of the purple raspberry should be pinched out when they are 24 to 30 inches tall. The purple-raspberry shoots, on account of their naturally more vigorous growth, are allowed to grow taller than black-raspberry shoots before pinching. If the shoots are not pinched until they are taller than the heights indicated above, the resulting laterals are weak and unable to bear a normal crop of fruit.

The next pruning given the black and purple raspberries is the removal of the old bearing canes immediately after the fruiting season is over. Many growers leave the old canes until the fall pruning in order to reduce labor.

If the black or purple raspberries are grown in a section of the state in which covering is necessary for winter protection, the canes must be pruned in the fall before covering. The old bearing canes should be removed, if they were not removed soon after harvest, and the young canes thinned to 5 to 8 vigorous canes per hill. The laterals can be shortened at this time or left until spring when the canes are lifted. Some growers prefer to leave them until spring, believing that the canes can be handled more easily if the laterals are not cut back before covering. This is largely a matter of personal opinion and preference. Regardless of whether the laterals are pruned in the fall or spring, the weak laterals should be thinned out and only the vigorous ones left. The laterals that are left should be shortened to 8 to 10 buds on the black raspberry and 12 to 15 buds on the purple raspberry. More buds are left on the purple raspberry because the first few buds at the base of the lateral often bear little or no fruit. See Fig. 9.

When the canes are uncovered in the spring the broken ones should be removed and the laterals pruned as described above, unless
they are pruned in the fall before they were covered. The canes should be thinned to 5 or 6 vigorous canes per hill. Johnston at the Michigan Agricultural Experiment Station, found that under Michigan conditions the yield depended not so much on the number of canes per hill as upon the size of the cane. He found that canes 19-32 of an inch in diameter produced 3 times as much fruit as canes 12-32 of an inch in diameter and the berries on the larger cane were materially larger. Therefore, it seems that the question is not one of number of canes per hill but of the number of vigorous canes per hill. It is probably wise to leave all canes 1-2 inch or more in diameter, rather than try to restrict the hill to any definite number. Under average Colorado conditions there should be 5 to 7 vigorous canes per hill. At the end of the first and second years of the plantation all of the vigorous canes that grow during the summer should be left.

If conditions do not necessitate covering raspberries for winter protection, it is advisable to let the plantation go until March before doing any pruning except of course the summer pinching of the young shoots. By waiting until March the grower can tell which canes are winter killed, if any, and can cut back the winter-injured tips of the laterals, whereas if fall pruning were practiced it would
be necessary to go over the plantation again in the spring to remove winter-injured wood. The old bearing canes can also be left until spring unless they are diseased or infested with insects. In such cases they should be removed and burned immediately after harvest. Leaving the old canes until March, where possible, reduces the labor of pruning since it can all be done at one operation and the old canes help to protect the young ones from wind injury and also are a valuable aid in holding snow.

![Image of blackberry canes](image)

**Fig. 10.—Well-developed canes of the black raspberry (left) and blackberry (right) produced by pinching at the proper height. Pinching stops length growth, thickens and strengthens the main canes, and causes the production of vigorous laterals. (Courtesy Missouri Experiment Station).**

**Blackberries.—**The blackberry, like the red raspberry, produces young canes both from buds on the crown of the old plant and from adventitious buds on the roots. These new canes branch naturally but, as is the case with the purple and the black raspberry, it is necessary to pinch out the tips of the young shoots in order to induce the formation of vigorous laterals as shown in Fig. 10. The tips of the young shoots should be pinched out when they have reached a height of 24 to 30 inches, depending upon the vigor of the variety. The more vigorous varieties should be allowed to reach the greater height. If winter protection is needed the blackberry is pruned in the same fashion as the black raspberry except that 10 to 15 canes are left per hill if the hill system of training is used. If the hedge-row system of training is used the canes should be thinned to stand on the average 3 or 4 to the foot. The laterals can be pruned before covering or left until the canes are uncovered in the spring. The canes should be thinned to 8 to 10 per hill when they are uncovered in the spring.

If winter covering is not necessary the plantation can be left until March before pruning. At that time the weak canes should
be removed leaving 8 to 10 vigorous canes per hill where the hill system of training is used, or an average of 3 or 4 canes per foot where the linear system of training is used. The old bearing canes should, of course, be removed if disease infestation did not necessitate their removal soon after harvest. All the weak laterals should be removed, leaving only vigorous ones for fruit production. Healthy canes produce 5 to 7 vigorous laterals. The laterals should be shortened according to the fruiting habit of the variety. Some varieties such as Early Harvest and Robinson produce their buds close together on the laterals; varieties of this type should have their laterals shortened to 12 to 15 inches. Other varieties, such as Snyder and Eldorado, produce their buds somewhat further apart than those of the first group and should have their laterals shortened to 18 to 24 inches. See Fig. 11. The lateral pruning is the same whether the canes are covered during the winter or left uncovered.

Fig. 11.—Fruiting habits of different varieties of blackberries. Varieties like Early Harvest (1) and Robinson (2) which produce their fruit buds close together and close to the bases of the laterals like Snyder (3) and El Dorado (4) which produce their fruit buds far apart and some distance from the bases of the laterals, should be pruned long. No. 3 shows the removal of buds and consequent crop reduction caused by the close pruning of varieties that should be long pruned. (Courtesy Missouri Experiment Station).
Dewberries.—The most common and simplest method of training dewberries is to let the canes trail along the ground. This is cheaper than tying to stakes or any other system of trellising. When stakes are used for support the young canes are allowed to grow on the ground and lie there over winter and are gathered up in spring and tied to stakes 5 or 6 feet long, and the ends of the canes cut off a few feet above the posts. In any system of training, the fruiting canes should be cut off after bearing.

Harvesting

Raspberries are ready to pick as soon as the berry can be easily removed without injury. Fruit picked at this stage will keep and ship much better than when it is picked fully ripe. Raspberries should never be allowed to become dead ripe unless they are to be picked for home use or for a local market where only a short haul is necessary.

For shipping purposes blackberries should be picked as soon as they separate fairly easily from the cluster, in order that they will hold up in shipping. But for home use or for a local market they should not be picked until fully ripe, because they do not attain their best flavor until they are well ripened. A blackberry is still unripe when it first turns black. In general the principles followed in blackberry picking apply to the picking of dewberries.

Three fingers should be used in picking and only a few berries should be held in the hand at a time. The fruit should be placed and not dropped into the container. Pickers are supplied with carriers holding 4 to 6 boxes and the fruit should be placed carefully in these. The fruit as picked should be placed in the boxes in which it is to be marketed since additional handling of these soft fruits usually results in broken skins which afford a ready means of entrance for rots, etc. The carriers should be taken to the packing shed as soon as filled and never allowed to sit in the sun out in the field. Exposure to the sun heats the berries and causes them to start deteriorating sooner. Blackberries turn red and acquire a bitter taste if exposed to the sun for very long.

The best time for picking berries is early in the morning. When there is little or no dew the pickers can start at daylight. If the dew is very heavy it is best to wait an hour or two until it has partially dried off. The berries are firmer in the early morning and can be handled with less damage. Pickers also work better in the cooler morning hours. Berries that are picked during the middle of the day are difficult to cool readily and are easily damaged in handling.
Packages

The factors that should determine the kind of package in which any bramble fruit is marketed are:

1.—Convenience in handling. Crates holding more than 24 boxes are rather difficult to handle and should be used only for local markets.

2.—Carrying quality of the fruit. Soft fruits such as raspberries should be marketed in boxes holding not over 1 pint because the fruit in the bottom of the box will be mashed if a larger size is used. The longer the haul the greater is the damage. Blackberries and dewberries can be marketed in quart boxes.

3.—Market demands. The market demand is of minor importance because the consumer buys more on quality than on the style of package. However, when buying in crate lots the consumer usually prefers a crate containing 24 boxes of fruit and the 24 box crate is used more than any other throughout the country.

4.—Cost of materials. The total cost of marketing any given lot of fruit is less when large crates are used because less material is needed. But the crate can become so large that it is unwieldy. The size of the individual box influences the marketing cost because more crates are needed when small boxes are used.

The grower should select the crate of most convenient size, which is usually one containing 24 boxes, and choose the largest size of individual box that can be used without damaging the fruit.

Fig. 12.—Different kinds of boxes for berries. From left to right the 1-pint Leslie style box, the 1-quart American style box, the 1-pint paraffined cardboard box, the method of ventilation of the 1-pint cardboard box, and the half-pint non-ventilated paraffined cardboard box.
The packages most commonly used in Colorado for the marketing of raspberries are the Leslie style 24 one-half pint crate, and the Universal folding 24-pint crate. The Colorado raspberry sections are practically the only ones in the United States which use the Leslie style box. In most other sections they have been replaced by the American crate and the Universal folding crate. The advantage of these two packages is that the individual boxes come made up and there is not the trouble nor loss in making that there is with the Leslie style box. Another advantage is that most markets are more familiar with the American style box than they are with the Leslie style. Another probable advantage, the importance of which has not been determined experimentally, is that the American box is ventilated while the Leslie box is not. The American style box is also capable of standing more rough handling.

The use of the half-pint box for marketing raspberries is a doubtful practice and is used only in certain sections of Colorado. In all other sections of the country the pint box is used. The cost of packages is greatly increased by the use of the half-pint box. For example the current catalog of a box and basket company offers the Leslie style 24-pint crate made up completely for 24 cents each, while the cost of the 24 one-half-pint crate is 20 cents each. On a yield of 3,000 quarts per acre, which can be easily obtained with correct cultural practices, the saving from the use of the pint box would be 16 cents per 24 pints or $4.00 per acre. The greatest advantage of the half-pint box is the possibility of securing more money from a pint of berries when it is packed in 2 boxes instead of 1. This assumed advantage depends entirely upon the ignorance of the consumer as to the contents of the box. The wise purchaser of raspberries should prefer the pint box because per pint of berries there is less surface exposed to sunlight, flies and all the other sources of damage to the surface layer of berries; there are fewer berries in contact with the sides of the box per pint of berries; and there are scarcely enough berries in a one-half-pint box to serve two people. Therefore, it seems desirable to market raspberries in pint boxes, either the Leslie style or the American style. The American style should be preferred on account of its greater durability.

Blackberries and dewberries can be marketed successfully in quart boxes, and the cost of package is much less than when pint boxes are used. The Leslie style 24-quart crate costs only 4 cents more per crate than the 24-pint size or a saving of nearly one-half on package materials. On a yield of 3,000 quarts per acre the saving from the use of 24-quart crates would be $25.00 if the Leslie style boxes were used and a saving of at least $37.50 per acre if the American style were used. The American style crate costs usually 7 cents
a crate more than the Leslie style crate. However, the growers of most commercial districts feel that the greater durability and the ventilation afforded by the American style crate is worth this difference. Fig. 12 shows different styles of containers.

Packages can be secured in which the individual boxes are made of paraffined cardboard. These boxes are durable and well ventilated. Being smooth and paraffin coated, there is not as much tendency for the skin of the fruit to be broken and the juice of the berry cannot be absorbed as it is by wooden boxes. These boxes can be lithographed with the trademark of the grower and have his name stamped on them or any other information that the grower desires. They are the most attractive of all berry boxes and should be well adapted to the selling of high-grade fruit. The trademark also gives the grower an opportunity to get the public acquainted with his product. However, these cardboard containers have not been tried out by the experiment station and cannot be recommended, but are worthy of trial.

**Paying The Pickers**

The pickers may be paid by one of two methods, by the hour or by the box. There are drawbacks to each method, but the piece-work method is now used almost entirely. When pickers are paid by the hour they seldom exert their best efforts and consequently picking is more expensive than by the piece-work method. The greatest disadvantage of the piece-work method is the tendency of the pickers to fill their boxes as rapidly as possible with little regard to the quality of the fruit picked, and their habit of picking in those areas where the berries are thickest, thus leaving scattered berries. However, the employment of a good field boss is the best insurance against the drawbacks of the piece-work system.

There are various ways of keeping an account of the amount of berries gathered by each picker. The first of these is the day-book method where the foreman records each picker's name, the date and the amount picked. This method is not satisfactory on a very large scale and is very little used in commercial districts. It leads to disputes between the picker and grower as to the amount picked and is also liable to error.

The check system is used in some districts. By this system the picker is given a check usually made of aluminum and about the size of a 25-cent piece, with the design of the fruit and the number of boxes stamped on it. Checks are in denominations of 1 pint, 1 quart or 1 tray. These checks are kept by the picker until pay day and then turned in for cash. Sometimes the grower has an agreement with the local merchants whereby the picker can exchange the checks
for merchandise and the grower redeems them from the merchants. The disadvantage of this system is that the pickers may lose the checks and there is no way for them to get a second check.

The best method of keeping accounts is the double punch-card system. In this system the picker is given a tag about the size of a shipping tag which has his name and number on it, and the rate paid per box. Numbers are around the edge of the card to designate the number of boxes picked. When the picker brings a tray to the packing shed, a number on the card is punched to designate the number of boxes picked. The picker usually is given a daily card and a weekly card and paid at the end of the week. To keep pickers from punching their own cards a duplicate card is kept by the foreman and the two cards punched together. The double punch card is by far the most satisfactory system.

Pickers are usually paid once a week in big commercial districts or oftener in small districts. The grower redeems their checks or punch cards with cash. In order to get pickers to remain all season, a part of the price paid per box, usually 1-4 cent, can be kept by the grower until the final pay day of the season. Perhaps a better method is to offer a similar bonus for those who stay through the season.

The price paid for picking in Colorado varies. Raspberry growers pay 40 to 50 cents per crate. Strawberry and blackberry pickers are usually paid 2 or 3 cents a box.

**Grading and Packing**

Many raspberry growers do not do any grading other than that done by the pickers in the field. If the pickers are careful to leave out unripe, over-ripe, injured and very small berries, there is really no need for any grading at the packing shed. Due to the fact that raspberries are easily injured by handling, it is much more desirable that the pickers do the grading as the berries are picked than that they be rehandled and graded at the packing shed. Blackberries also should be graded as picked, observing the same precautions as in the picking of raspberries. Blackberries are not as perishable as raspberries and can usually be graded at the packing shed without appreciable damage but they can be more cheaply graded when picked. Dewberries should also be graded as they are picked.

After the grading is done the boxes are filled up with berries of the same quality so they won't arrive at the market looking half-full, due to jarring in transit. In the well-established commercial centers, especially where marketing is done thru an association, it is customary to market all of the berries of the district under some
specific brand name, and lithographed labels bearing the brand name and the name of the association are pasted on one or both ends of the crate. The number of boxes and their individual size must also be stamped on the crate in compliance with the Net Weight amendment to the Food and Drug Act which states that in interstate shipments the shipper must stamp plainly on the outside of the package the contents and number of open packages contained in the terms of the largest unit therein. Thus a 24 one-half-pint crate would be labeled "Contents 24 dry one-half pints." It is a good business practice for the grower to stamp his own name and address on the crate also. This is a means of establishing his product on the market since the consumers are always anxious to obtain good fruit and will try to get fruit from a grower whose product they know is dependable.

A packing shed is a very desirable part of the small-fruit plantation. It is absolutely essential for plantings of one acre or more and is very desirable for any size commercial planting. The packing shed provides a central point from which to direct the harvesting operations, protects the fruit from sun and rain, provides storage room for empty crates and boxes, and furnishes comfortable surroundings for grading and packing. The simplest type of packing shed consists only of a cheap framework roofed and usually with only 3 sides boarded up, the other side being left open. All types of sheds are used from this type to the substantially constructed shed which is practically weather proof and has a loft for permanent storage of packing material.

**Life of the Plantation**

The length of life of a bramble plantation should be determined entirely by the returns secured from it. Whenever a bramble plantation, whether raspberry, blackberry or dewberry, reaches that stage in life when it is returning less profit than a young plantation would, it is time to remove it and start a new plantation. There are many red-raspberry plantations in Colorado 20 or more years of age. It is very probable that these plantings have long since passed their age of maximum profit and should be replaced by newer plantings. The length of profitable production of a plantation depends upon a number of factors, chief of which are soil, diseases and general care. A normal plantation of any of the brambles should remain profitable for 10 or 12 years. When they have reached that age the soil is usually so full of old roots that it is difficult to properly irrigate and cultivate the plantation. The old roots lack the vitality to produce vigorous fruiting canes and if any disease has been allowed to remain in the plantation there will
usually be a number of hills missing and many more so weakened that they can no longer produce much fruit. Usually the general vigor of a plantation declines after the tenth or twelfth year.

A simple method of removing the old planting is to cut off all the canes close to the ground after the fruiting season. Plow deeply to turn up all the old clumps and then haul them off the field. It is not advisable to replant the field to brambles at once, but it should be planted to some cultivated crop for at least 2 years in order to get all the old roots out of the soil and to get the land in a good state of tilth. The land can then be seeded to alfalfa or sweet clover and the alfalfa plowed under in the fall of the third year or the sweet clover in the fall of the second year. The following spring the field can again be planted to brambles. Leave the last crop of hay and plow it under for green manure. Brambles occupy the ground for a long time and need all the humus and plant food that can be incorporated into the soil before the young plants are set.

Yields

The latest available statistics report that the average yield of raspberries in Colorado is only 1,058 quarts per acre or a little over 176 twenty-four one-half-pint crates per acre. Raspberries cannot be raised profitably on such low yields. However the yields secured from raspberry plantations in Colorado need not be this low. The red-raspberry field shown on the front cover of this bulletin produced in 1928 on its 2 1/4 acres, 1,200 crates, each containing 24 one-half-pint boxes, or an average of 533 1/3 crates per acre. This is equivalent to 3,200 quarts per acre. This yield is not phenomenal but is what a grower should expect if the plantation is operated efficiently. It is necessary for Colorado raspberry growers to obtain yields of 2,500 to 3,000 quarts per acre of any bramble crop if he hopes to secure much return on his investment. Maintaining the soil fertility, keeping the soil in a high state of tilth, applying the correct amount of irrigation water, planting only the higher-yielding varieties, strict roguing of plants affected with mosaic, the use of sprays for spur blight, if present, and plowing out plantations more than 10 to 12 years of age should make it easily possible to secure yields of 3,000 quarts or more per acre of any of the bramble fruits.

The work of Johnston and Loree shows that yields may be materially increased by maintaining the plantation in a vigorously growing condition for the larger canes produced much more and larger fruit than the smaller ones and canes with abundant foliage were more productive than those of scanty foliage. Their results
also indicate that yields one-fourth to one-third larger can be ex­
pected from the matted or hedge-row system of training than from  
the hill system. All this shows that it is possible to secure large  
yields if the correct cultural practices are used.

Insects

Raspberry Cane-borer.—This insect is often found in Colorado  
raspberry plantations. It seldom does a great deal of damage, but  
may become serious if control measures are not practiced when it  
appears. The adult of this pest is a black beetle about half an inch  
long. The body segment just back of the head is yellow. The larva,  
which damages the canes of both the blackberry and raspberry, is  
a yellownish white grub 1-2 to 3-4 of an inch long and about 1-16 of  
an inch wide or slightly wider.

The adult beetles lay their eggs usually in early June in north­
ern Colorado. The beetle commonly makes two rows of punctures  
around the cane about half an inch apart and deposits the egg in  
a small hole between them. The double row of punctures is thought  
to be for the purpose of slowing down the circulation of sap to  
prevent the crushing of the egg by the rapidly growing tip. The  
first indication of the damage is the withering and drooping of the  
tips of young canes. Examination shows that the center of the cane  
has been hollowed out by the young larva which hatches and bur­
rows its way downward in the cane. The larva reaches the root  
of the plant by autumn and then transforms to a pupa and passes  
the winter. An examination of the cane during the dormant season  
shows that the larva has burrowed the entire length of the cane and  
holes about 1-16 of an inch in diameter are found at irregular in­
tervals along the cane. These holes are made by the larva to en­
able it to deposit its excrement outside the burrow.

Control.—The most efficient method of controlling this insect  
is to break off and burn the tips of the injured canes as soon as  
they show the characteristic wilting. The tips should be broken off  
3 or 4 inches below the wilted portion of the canes. If the tips are  
broken off below this point the larvae are left in the cane tips which  
are destroyed. This breaking off of the young cane tips does not  
injure the canes since it usually amounts to about the length of cane  
that would be removed in pruning an uninjured cane. If the tips  
are not removed when they show wilting, the larvae burrow down  
to the roots and the first indication of damage is the shriveling  
of the leaves on the canes when growth starts the following season.  
When this occurs the whole plant should be dug up and destroyed  
since the insect is in the roots and cannot be reached.
Red Spider.—This insect may become quite troublesome in any section of Colorado. It is about 1-50 of an inch long and varies from pale greenish-yellow to crimson red. It is usually noticed as little red dots about the size of a pin point. On closer inspection, either with the naked eye or with a magnifying glass, they can be recognized as insects. They hibernate in the ground or in rubbish and emerge in the spring.

Red spiders usually spin a delicate silken web on the under side of the leaves and use it as a protective covering while they suck the juice from the leaves. They lay their eggs and the young develop under this web. The yellowing of the foliage is usually the first indication of their presence.

Control.—Various methods of control have been tried, none of which have been successful under all conditions. The red spider thrives under dry, hot conditions and is therefore more likely to be prevalent in seasons of little rainfall. Dusting with sulfur is effective under moist conditions. Commercial liquid lime-sulfur at the rate of 1 gallon to 49 gallons of water is usually effective. Volck or other miscible oils, applied according to the directions of the manufacturers, are also very good. These oil compounds make an emulsion when mixed with water. They can be purchased from any dealer in spraying materials.

Control measures are more effective when employed before the spiders spin their web, since they are then easier to reach and kill. Close observation will reveal their presence before the webs are spun.

Diseases

If healthy plants are used to start the plantation and ordinary field sanitation is practiced, there usually is little trouble from diseases in Colorado. Disease control depends upon the use of preventive measures first and control methods afterward. The most important method of prevention is the purchase of plants from a reliable nursery that sells only healthy plants. Next comes the question of sanitation which means the removal of weeds, old canes, diseased plants and all rubbish which might provide a harboring place for germs. But diseases will occasionally become serious even in the best-cared-for plantations. The most likely to be found in Colorado bramble plantings are discussed below.

Crown Gall.—This is a disease which is sometimes found on brambles especially raspberries. The affected plants have the gall-like swelling on the roots or cane or both, shown in Fig. 13. The plants gradually become weaker and eventually die.
Control.—The control for crown gall is simple: Plant disease-free stock. A careful examination of plants in the nursery will show the trouble if any is present. Infected plants should be destroyed. The soil should be sterilized after their removal, either by saturating it with 40 percent formalin or by burning brush over

Fig. 13.—Crown-gall development on a young Cuthbert raspberry plant. It showed no infection when planted but came from a bundle of nursery stock containing crown gall. (Courtesy Michigan Agr. Exp. Station. Spec. Bul. 178).
Fig. 14.—Plate on Spur Blight. (Colo. Exp. Sta. Bul. 206). 1. Petiole infection; 2. infection at node; 3. dead stem of a leaf that died from lack of nourishment caused by petiole infection; 4. cortex cracked and exposing the tissue beneath.
it. New plants can then usually be set without danger of infection.

**Spur Blight.**—This disease is often destructive in Colorado red-raspberry fields. It does more damage in the state than any other disease except mosaic. Spur blight appears on the young shoots usually in late June or early July. Its presence is shown by chocolate brown spots at the nodes, along the internode or on the leaf petiole. In severe cases infection is apparent at all of these places. See Fig. 14. The infection at the node causes the weakening or death of the bud. If the bud lives until the next spring it is later than normal in coming into leaf, the fruiting shoot arising from the bud is weak and seldom bears fruit, the leaves seldom develop, but remain small and sickly and eventually die.

The disease is usually worst on the lower part of the cane, if the whole cane is not infected. When the leaf petiole is infected it gradually dries up and the leaf droops and dies. Infection often starts on the petiole and spreads to the node. It usually spreads from the node to the adjacent internodes and in severe cases the lesions may coalesce to surround and entirely cover the whole lower one-fourth or one-third of the cane. In such cases the bark commonly splits and exposes the cortex beneath, causing the canes to dry out and become very brittle. They break easily in

![Fig. 15.—Four diseased canes at left and three normal canes at right showing by the dark areas the distribution and extent of spur-blight infection in September. (From Colorado bulletin 206.)](image-url)
handling, such as that required by covering and uncovering.

In September, grayish white patches appear in the center of the brown areas. Later the little black spore cases, about the size of pin points, appear. These spore cases remain on the canes over winter and mature early in the spring. They burst and liberate the spores contained within them. The spores settle on the young shoots and cause the injury described above.

Control. — After a thorough study of a spur blight, Dr. Sackett of this station found that the best method of controlling it was to spray thoroly with Bordeaux mixture, 3-2-50, to which 2 pounds of rosin fish oil soap was added as a sticker. In order for a spray to be effective it must be applied before the spore cases burst and liberate the spores. Therefore the first application of Bordeaux should be made when the young canes are 8 to 12 inches tall. Since all of the spore cases do not mature at the same time it is necessary to apply later sprays to combat those liberated later in the season. Two more sprays should be applied at intervals of 2 weeks. The third has to be omitted sometimes because it comes too close to the ripening season. Bordeaux mixture discolors the fruit, making it unattractive for sale. Therefore it should never be applied later than one week before the first fruit ripens.

It is advisable to remove the old bearing canes as soon as the fruiting season is over and apply a fourth spray to destroy any late-maturing spores. The fourth spray should usually be applied about August 15. In all spraying for the control of spur blight
only the young canes should be sprayed since it is the damage to them which reduces the next year’s fruit crop. Figs. 16 and 17 show the effect of bordeaux sprays in spur-blight control.

Mosaic.—Mosaic is perhaps the most destructive of all raspberry diseases. It can be found wherever raspberries are grown. It attacks the red, purple and black raspberries. It is sometimes found on the blackberry and the dewberry, but seldom becomes serious. This disease is the cause of the so-called running-out of raspberries. It usually is worst on the red raspberry and some otherwise very desirable varieties have had to be abandoned in some sections due to their susceptibility to mosaic.

Symptoms.—The most common and easiest-recognized form of mosaic is one in which the leaves are mottled with yellow and cupped at the edges. See Fig. 18. The plant is yellowish in general appearance and stunted; the berries are small, of poor flavor and crumble easily. Due to the dwarfing effect and the poor fruit produced, the yield and consequent profits are greatly reduced. The infected plants eventually die, the time elapsing between primary infection and death depending upon the resistance of the variety. The important point, however, is that the diseased plant never bears profitably after it becomes infected.

Mosaic also attacks black and purple raspberries. It is very destructive to the individual plants of the black raspberry but does
Fig. 18.—At the left, a healthy red-raspberry leaf. At the right, one badly infected with mosaic.

Fig. 19.—Illustrating the effect of mosaic on red-raspberry plants. The plants in the rows to the left are healthy; 95 percent of the plants in the rows to the right are infected with mosaic. (Courtesy Mich. Agr. Exp. Station. Spec. Bul. 178).
Fig. 20.—Tip of black-raspberry cane infected with mild mosaic. The growth is checked and dark brown spots appear at the cane tip and on the leaf petiole. (Courtesy Mich. Agr. Exp. Station. Spec. Bul. 178).
not spread readily to the other plants, hence the ultimate loss is not usually as great as it is with red varieties. On the black raspberry the disease is first noticed as a slight browning and bending of the tips of the new canes. Fig. 20. The tips usually cease growth and may die. The following year the bearing canes are usually not over 2 feet tall, the leaves are mottled and come out in whorls close together, giving them a rosetted look. The diseased plants usually die during the following winter. The infection is not always as severe as here described but can always be readily identified. In Fig. 22 is seen the severe damage that mosaic causes on black raspberry plants.

A less severe type of mosaic does not show the characteristic mottling of the type described above, but shows only a mild mottling and that only when the temperature is very low. The leaves grown at relatively high temperatures do not show any mottling. This type of mosaic is common on black raspberries. The affected plants are usually considerably stunted but they may live for several years. This kind of mosaic does not materially reduce the yield of red-raspberry varieties, but on account of its dwarfing effect does reduce the yields of blackberry varieties.

Yellow mosaic is a third type of mosaic. It gets its name from the

Fig. 21.—A black-raspberry plant the first year it is infected with mosaic. Note the stunted condition of the plant and the wrinkling and mottling of the leaves. Behind it to the left is a healthy plant.
yellow appearance of infected black-raspberry plants. This yellowing is caused by the fading from green to yellow of the leaf tissue along the leaf veins. The infected plants usually die in 2 or 3 years but may live longer. The plants are usually stunted and the yield consequently decreased. Yellow mosaic is also found on red raspberries, purple raspberries and dewberries. The disease may not be severe on the reds and purple the first year or two of infection, but the plants are usually stunted and the leaves are mottled.

Dissemination of Mosaic.

Mosaic, according to Bennett 1, is spread chiefly by a large plant louse which is usually found on the lower side of very young leaves and occasionally on the stems and older leaves. Winged forms may be produced at any time during the season. No definite evidence has been found of spread by pruning, harvesting or cultural operations.

The rapidity with which mosaic spreads depends to a considerable extent on the variety, some varieties being much more resistant than others. Rankin's 4 observations show that Latham is highly resistant, June, Idaho and King fairly resistant; Columbian, Cuthbert and Marlboro moderately to slightly resistant; and Herbert has practically no resistance. Rankin 4 also classified varieties according to their klendusity or ability to escape mosaic infection. Latham, Idaho, Herbert and King were found to be highly klendusie; Cuthbert, June and Cardinal slightly klendusie; and Marlboro not klendusie.
This shows that if we are to prevent loss from mosaic it is desirable to grow varieties that are either highly klendusic or that are fairly resistant to mosaic, or both. Fortunately we have productive, high-quality varieties that are either highly klendusic or resistant. Herbert is highly klendusic but slightly resistant; but the losses are light on account of its ability to escape the disease. King is highly klendusic and also highly resistant, giving us a desirable early variety. June is only slightly klendusic, but also very resistant; therefore mosaic losses from it are not heavy. June is another desirable early variety. Cuthbert is only slightly klendusic and also tends to low resistance and losses from mosaic may therefore be very heavy. However, on account of the high quality of the Cuthbert it should be retained as a home-garden variety. Columbian is in the same class with Cuthbert but is still the most desirable of the common purple raspberries. Marlboro is not klendusic and tends toward low resistance. Therefore its use for commercial planting is questionable now that we have such desirable varieties as Latham and Herbert to take its place.

Most varieties of the black raspberry contract mosaic from the reds rather readily but the disease does not spread within the variety very rapidly; in other words they are only slightly klendusic but very resistant. The planting of black-raspberry varieties at a distance of 50 to 100 yards from red-raspberry plantings will materially reduce mosaic losses. Plum Farmer is more highly klendusic than any of the common varieties of black raspberry.

Control of Mosaic.—Sprays are not effective in the control of mosaic. Since mosaic is a disease of the internal structure of the plant, sprays could not possibly have any direct effect. The only possible effect that sprays can have is in destroying the aphids that carry the disease. But even sprays especially designed to destroy the aphids have not proved successful. Furthermore, spraying is an expensive operation.

The cheapest and most effective method of controlling mosaic is the removal and destruction of the diseased plants. Merely removing the canes is not enough because the root system also becomes diseased. The plants should be dug out. The removal of diseased plants is known as roguing. In newly set plantings roguing should be begun the first year. The plantation should be gone over several times and the plants pulled up and burned. Pulling young plants removes the root system. If left another year or two the root system must be dug out which requires much more labor than the pulling up of young plants. The aphids that carry mosaic are not usually numerous in a young plantation and careful roguing the first year will eliminate a great deal of it in later years. In old plantations
Roguing is often a considerable task but it is the only means of getting rid of mosaic. If old plantations contain a very large percentage of mosaic-infected plants it is usually advisable to remove the planting and start a new plantation elsewhere.

When diseased plants are being removed the aphids on them commonly fall to the ground and crawl to other plants and infect them. To prevent the spread of aphids the foliage of the diseased plant can be burned before the plant is removed. This can be done with a torch or by sprinkling the plants with gasoline.

Roguing should be begun early in the season. There are two reasons for this; first, diseased plants can be more readily detected in the early part of the season and second, most infection takes place after the middle of June. Delay in roguing may result in leaving plants that are diseased but have not had time to develop symptoms. These plants will be a source of infection all summer and greatly increase the number of diseased plants.

Anyone wishing to learn more about mosaic and similar bramble diseases should write to: Director, Michigan Agricultural Experiment Station, East Lansing, Michigan, for Technical Bulletin No. 80, 'Virus Diseases of Raspberries,' by C. W. Bennett; and Director, New York State Agricultural Experiment Station, Geneva, New York, for Bulletin 543, 'Mosaic of Raspberries,' by W. Howard Rankin. The publications give a thorough and authentic discussion of these diseases.

Anthracnose.—Black raspberries suffer most from this disease. Dewberries are also severely attacked. It is found on red and purple raspberries and on blackberries but seldom becomes severe. All of the commercial varieties of black raspberries are susceptible to anthracnose.

Symptoms.—This disease first appears as brownish spots when the young canes are 6 to 8 inches tall. As the canes grow the spots increase in size. On the mature cane they are elliptical in shape and one-eighth inch or more across their shortest diameter. They are then grayish white with a purple border. In severe cases the spots may coalesce to form large areas on the cane. Fig. 23. In these areas the wood is usually exposed and cracks and dries out, greatly weakening the cane. Dry weather is unfavorable to the spread of the disease and therefore it seldom becomes serious in Colorado. Spores are liberated from the lesions all during the summer. Anthracnose is also found on the leaves and fruit but its worst damage is that done to the canes.

Control.—The best methods of controlling anthracnose are sanitation and spraying. The piece of the old cane left on tip-rooted
Fig. 23.—Anthracnose on a black-raspberry cane, showing individual lesions and lesions coalesced to form large areas. (Courtesy Michigan Agr. Exp. Station, Spec. Bul. 178).
Fig. 24.—Anthracnose spots on the old stub of a tip-rooted black-raspberry plant. To prevent infection of the new shoots, this old stub should be removed below the ground line at planting time. (Courtesy Michigan Agr. Exp. Station. Spec. Bul. 178).
plants may be diseased. Fig. 24. Therefore, if any anthracnose
lesions are found on the old stub at planting time they should be re­
moved and the plant set deep enough to cover the tip completely.

Either lime-sulfur or bordeaux mixture is effective in reduc­
ing losses from anthracnose. The following spray schedule should
be followed: First spray.—Just before growth starts—lime-sulphur,
7 gallons to 43 gallons of water.

Second spray.—When new shoots are 8 to 10 inches tall. Lime­
sulfur, 1 1-4 gallons in 48 3-4 gallons of water or bordeaux mix­
ture 3-4-50.

Third spray.—Just before blossoming—same as second spray.
Fourth spray.—Soon after harvest—same as second and third
sprays.

The removal of the old canes as soon as harvest is over is also
advisable as this practice removes a possible source of infection.

**BUSH FRUITS**

The commonest bush fruits are the gooseberries and currants.
They are not grown commercially on a very large scale in Colorado.
They are not usually very profitable unless a special market is avail­
able. However, they are very desirable for a home-garden fruit in
the irrigated sections of the state. They are both extremely hardy and
require no special culture. They must have water and are not
usually very successful in the dryland portions of the state.

**Characteristics.**—Gooseberries and currants have perennial tops
and roots and the individual branches bear for a number of years.
However, the branches soon pass their age of maximum production
and are then usually removed in pruning in order that younger and
heavier-yielding branches can take their place. The young shoots
are unbranched and are of a grayish color. In the second year of
their growth the shoots turn to a brownish color and send out lateral
branches. As the age of the cane increases the color deepens and
the branches become more numerous.

**Sites**

**Soils.**—Gooseberries and currants make the most satisfactory
growth when planted in a deep, cool, fertile, well-drained soil, con­
taining plenty of humus. |Silt and clay-loam soils are more suited
to their culture than soils containing considerable sand. Good drain­
age is essential for they will not grow in a water-logged soil even
the they require plenty of water.

**Exposure.**—If there is any choice of exposure a northern slope
should be chosen. Both the gooseberry and the currant grow wild
in shady situations or on northern slopes where the hot sun does not directly strike them, and the best results are secured when these conditions are approximated. Good air drainage is essential since both of these fruits bloom early in the season, and if there are any air pockets in which the cold air can settle, the flowers are liable to be injured by late spring frosts.

Varieties

Gooseberries.—On account of ease of growing, the Downing and Houghton varieties have long been the most extensively planted of the American varieties of gooseberries. But they both produce small fruit and the Houghton is susceptible to mildew. The Downing is mildew resistant and bears slightly larger fruit. They should be replaced by the newer and better varieties.

Champion.—Also called Oregon Champion. This variety is grown in several parts of Colorado. It is vigorous, productive, bears early, the fruit is of medium size and of good quality.

Poorman.—This is the best of the American varieties. The plants are large, very vigorous, productive and healthy. The fruit is larger than that of the above-named varieties, ripens in early midseason with a long ripening period and the quality is equal or better than that of all other American varieties. It is easily propagated from cuttings.

Chautauqua.—This is the best of the European varieties of gooseberry. The plants are large, vigorous, very productive and healthy. The fruit ripens in midseason, is large, silvery green, juicy and firm, and of high quality. It is much superior to Downing and Houghton.

Currants.—Fay.—Also called Fay’s Prolific. This is one of the most popular red varieties. The plants are of medium size and are moderately productive. The clusters and berries are very large and uniform, making a very attractive fruit. The cluster stems are long, which makes picking easy. The berries, which ripen in early midseason, are dark red, juicy and thin skinned so that the fruits are excellent for canning and for jelly.

Perfection.—This is a very desirable variety. The plants are medium in size, vigorous, hardy, healthy and very productive. The fruit ripens in early midseason, is large, dark red, easily picked, ships well, has a desirable flavor and high quality.

White Grape is usually considered to be the best of the white currants on account of vigor, hardiness, healthiness and productive-
ness. It has the largest clusters and berries of any of the white sorts. The fruit ripens in midseason, is a clear yellowish white, tender, firm, juicy and of good quality.

Wilder.—Wilder is one of the best red varieties of currants. The plants are large, vigorous, productive and free from insect and disease damage. The fruit ripens in late midseason, the clusters are long and compact, the berries medium to large, attractive, dark red and of good quality.

Boskoop Giant.—For those who desire a black currant this variety is worthy of trial. The plants are large, vigorous and productive. The fruit ripens in midseason; the berries are large, sweet, pleasantly flavored and of good quality. The color is dull black. Black currants are generally not nearly as satisfactory as the red varieties.

Propagation

The common method of propagating gooseberries and currants is by the use of hardwood cuttings. The cuttings are made in the fall at any time after the plants become dormant. Vigorous shoots that grew during the preceding summer are used for cuttings. The cuttings are made 8 to 10 inches long with the lower cut made just below a bud and the upper cut an inch above the bud. This facilitates the formation of the callus over the lower end and makes it easy to distinguish the top from the bottom before the cutting is calloused over.

The cuttings are tied in bunches of 25 and stored over winter in sawdust or sand at approximately 40 degrees F. and with just enough moisture to prevent any tendency toward drying out. In the spring the cuttings are planted out in the nursery rows. They are set 6 to 8 inches apart in the row in order to allow cultivation between them, and with only the two top buds above the surface to induce deep rooting. The following spring they should be big enough to set out permanently. Those plants that have not grown vigorously should be left in the nursery another year.

Instead of storing the cuttings in sawdust the bundles may be buried upside down in a warm, well-drained soil and covered 3 inches deep. This allows the cuttings to callus the same as if stored in sawdust. The following spring they are set out in the nursery and handled in the manner described above. The cuttings should always be planted in the nursery as early as possible in the spring because they start into growth at low temperatures. Fig. 25 shows how the shoots grow from a cutting of gooseberry or currant.
The Downing and some other varieties do not root readily from cuttings. In such cases new plants are secured by mound layering. By this method the old plants are pruned back severely in the fall or winter in order to induce a heavy growth of new shoots the following summer. There should be a number of vigorous new shoots present by midsummer. At this time soil is mounded up about halfway to the tops of the plants and worked down between the shoots. The shoots send out roots in the covered portion and in the fall the dirt can be removed and the stronger shoots severed from the parent plant. They are then stored over the winter in the same way as cuttings. In the early spring they should be set out in the nursery rows and grown for one year before planting permanently in the field. shoots lacking in vigor or not well rooted should be left on the parent plant to grow another year.

Soil Preparation

If the soil does not contain liberal quantities of organic matter it should be added before the plants are set. Gooseberries and currants last for a long time once they are planted and it is a great deal easier to add the much needed humus before planting than afterward. Humus can be added either by plowing under a cover crop or by applying 10 to 15 tons of manure to the acre. The cover crop should be plowed under in the fall if possible and when manure is used it also should be worked into the soil in the fall.
Planting

The soil should be prepared as early in the spring as possible and the plants set at once. Fall planting is not advisable in Colorado on account of the severe winters.

Source of Plants.—It is advisable to purchase plants from a reliable nursery rather than try to propagate them unless one desires to propagate some plants from a special plant which he owns. Good nurseries sell only first-class stock which is usually more satisfactory than home-propagated plants. One-year-old plants are satisfactory and cheaper, but when the grower desires bearing plants in a short time he should purchase 2-year-old plants.

When the plants arrive from the nursery they should be unpacked at once and if the ground is not ready to set them out they should be heeled in until planting time. If the plants are dry when they arrive from the nursery they should be watered before heeling in.

Setting the Plants.—Before the plants are set the dead diseased and injured roots should be cut off and long roots shortened. To balance the pruning of the root system the top should be cut back about one-third. The plants should be set 4 to 5 feet apart in rows 7 feet apart. If cross cultivation is to be practiced the plants should be set 6 feet apart each way. The plants should be set deep enough for the lower branches to be partially covered. This facilitates the training of the plant to the bush form.

In setting, the field is marked and then the holes dug as the plants are set. The holes should be large enough to receive the root system without crowding. After the root system is spread out the hole is filled, taking care to carefully firm the soil about the roots.

Cultivation

The gooseberry or currant plantation should be cultivated in much the same manner as the bramble plantation. Cultivate often enough to keep down weeds and to prevent the formation of a crust on the surface. Surface crusts are particularly liable to form after irrigations if the plantation is not cultivated as soon as the soil is dry enough to work.

The frequency of cultivations should decrease after the middle of August in order to allow the bushes to ripen up their wood before winter. From this time on cultivation should be practiced only after irrigations. It may be necessary to go over the field once during the season with hoes in order to remove weeds around the plants. Deep cultivation is advisable the first 2 years in order to keep the soil loose and friable. After the second year the roots are too close to the surface for deep cultivation to be practiced.
Irrigation

Both the gooseberry and the currant require plenty of water for good growth and fruit production. The furrow system of irrigation should be practiced, using a shallow furrow on each side of the row. The water should be left to run in the irrigation ditches until the soil is soaked down to a depth of at least one foot. The next irrigation should not be given until the soil begins to dry out, which will usually be a period of 10 days to 2 weeks. This system is much better than that of applying frequent shallow irrigations, when the plant is never adequately watered and often suffers because the root system does not receive plenty of water.

Winter Protection

The gooseberry and currant are both hardy in Colorado and do not need to be buried for winter protection. However it is advisable to mulch around the crown of the plant with strawy manure to a depth of 3 or 4 inches. This prevents any winter injury that may occur to the crown. The mulch should be put on in the fall after one or two freezes. The freezes rid the field of mice and there is then no danger of them living in the mulch and damaging the bushes. In the spring the mulch can be scattered between the rows and worked into the soil by the first cultivation.

Training

Commercial plantings of gooseberries and currants are trained to the bush form. The plants are set deep enough to cover the lower branches with dirt at their junction with the main stem. The new shoots then rise from underground buds, thus securing a bushy plant. In the tree form of training the central stem is allowed to grow to a height of about a foot before any side shoots are left. The main disadvantage of this type of training is that if the currant borer attacks the stem the whole plant is destroyed, whereas in the bush form of training only one of the several stems would be lost. Furthermore, the damage from winds is liable to be greater where the tree form of training is used.

Pruning

To intelligently prune any fruiting plant a knowledge of the manner in which it bears its fruit is essential. The gooseberry and currant bear most of their fruit (1) on 1-year-old canes that grew from the crown of the plant, (2) on 1-year-old shoots that arise laterally or terminally on older wood, (3) on 1-year-old spurs on 2-year or older canes, and (4) on 2-year-old spurs on canes 3 or more years old. Thus it is seen that most of the fruit is borne on
young wood, from which it readily follows that an abundance of vigorous new growth each year is essential to maintain the plant in a high state of production. The fruit which older wood produces is far inferior to that produced from the young wood. Most gooseberry and currant plantations are not pruned severely enough and it is a common sight to find bushes in which there are canes 6 or 7 years old, bearing very little marketable fruit, with only a few spindling new shoots growing from the crown.

**Pruning Young Plants.**—To secure the correct amount of vigorous fruiting wood the following pruning schedule should be followed, always doing the pruning in the late winter or early spring before growth has started and changing the dates to suit the date of individual plantings.

**Spring 1929**—Young plants pruned back to 3 or 4 branches 10 to 12 inches high at the time of planting.

**Spring 1930**—Remove injured and weak shoots and then remainder to 4 to 6 vigorous shoots. A little fruit will be borne during the summer.

**Spring 1931**—Remove all of the shoots that grew from the crown during the summer of 1930 except 3 or 4 vigorous ones. The bush after pruning has 4 to 6 two-year-old branches and 3 or 4 one-year-old branches. The plant should bear about one-half of a full crop during the summer of 1931.

**Spring 1932**—Remove all of the shoots that grew from the crown of the plant during the summer of 1931 except 3 or 4 vigorous ones. Also thin the shoots left in the spring of 1930 to 3 or 4. The bush now consists of 3 or 4 three-year-old canes, 3 or 4 two-year-old canes and 3 or 4 one-year-old canes and should bear a full crop during the summer of 1932.

**Spring 1933**—Remove the 3 or 4 canes which were left in the Spring of 1930 since they are the oldest ones on the plant and have already produced their best crops. Leave 3 or 4 vigorous young shoots that grew from the crown of the plant during the summer of 1932. These replace the old canes which are removed. From this time on the annual pruning consists of removing the oldest canes and leaving a like number of young shoots to take their places. In this way the bush will al-
ways contain the correct number of canes to produce a heavy crop of fruit and at the same time the plant will be able to send up a vigorous crop of new shoots from the crown.

Pruning Old Plants.—When old bushes have been carefully pruned all of their lives they should be pruned in the same way as young bushes just beginning to bear full crops. However, old bushes are quite common which have never been pruned. In such cases there is a preponderance of old wood and very little young wood present. Consequently the fruit that is produced is small and inferior in quality. Since young wood is essential to the production of desirable fruit the old bushes must be pruned severely in order to stimulate the production of vigorous young canes. For best results it is advisable to remove all wood over 3 years old and thin what is left to 3 vigorous canes of each year’s growth. The following year the oldest canes should be removed and enough vigorous young canes left to replace them. After this time the pruning each year should be that outlined above for a bearing young bush.

Fertilizers

Very few experiments have ever been conducted in any part of the United States with fertilizers for currants and gooseberries. Therefore no definite recommendations can be made in regard to the use of commercial fertilizers. The only fertilizer practice that can be recommended is the use of barnyard manure in those cases where the plantation seems to be lacking vigor or where the soil seems to need humus. An application of 10 to 15 tons per acre of well-rotted barnyard manure should be sufficient under Colorado conditions. The frequency of application will depend entirely upon the condition of the soil.

Harvesting

Gooseberries are usually harvested green. Therefore the common practice is to wait until most of the berries are full grown and then pick all of them at once.

When currants are to be used for making jelly they should be picked before all of them are ripe. But when they are to be used for making preserves, jams, etc., they should not be picked until they are well ripened. Currants are picked by removing the entire cluster and not by removing the individual berries, which would require too much labor.

Picking receptacles similar to those used for harvesting the bramble fruits are satisfactory for harvesting gooseberries and cur-
rants. The fruit should not be exposed to the sun’s rays any longer than is necessary after picking. Gooseberries and currants are marketed in the same sort of containers as the bramble fruits, using the crate containing 24 boxes, either pint or quart size.

Insects

**Imported Currant Worm.**—The larva of this insect is a small greenish-yellow worm which is covered with small black spots when young. It is about 3-4 of an inch long when full grown. It is equally destructive to gooseberries and currants, in severe cases eating all the leaves on the plant. It feeds very rapidly and often does considerable damage before noticed. There are usually two broods during the summer, the first appearing soon after the leaves come out and the second about the time the fruit is ready to harvest.

Control.—The imported currant worm can be controlled by spraying thoroly with arsenate of lead, 1 pound to 50 gallons of water, as soon as the caterpillars appear. Thoro and timely spraying to control the first brood greatly reduces the damage from the second. If it is necessary to spray near picking time, white hellebore at the rate of 3 pounds in 50 gallons of water should be used instead of the arsenate of lead. Hellebore is not so poisonous to man and is safer to use near picking time than is arsenate of lead. Fresh hellebore in air-tight cans should be used because it soon loses its poisonous properties when exposed to the air.

**Currant Borer.**—The larva of the currant borer moth is a yellowish grub about 1-2 inch long which burrows into the canes of currants and occasionally gooseberries. The canes are weakened and eventually die. The infested canes should be cut out and burned early in the summer before the insect leaves them.

**Currant Aphid.**—The currant aphid is a small green plant louse. The aphids gather on the under side of the leaves and suck the juice from them. The leaf edges consequently curl under and the upper surface takes on a swollen or blistered appearance. Bright red spots are often present on the upper surface of infested leaves.

Control.—The most effective control measure is 40 percent nicotine sulfate diluted at the rate of 3-4 pint to 100 gallons of water or spray material, and applied before the leaves become distinctly curled, since it is necessary to actually wet the insects with the spray in order to kill them. Nicotine sulfate can be combined with any other spray material.

Diseases

**Powdery Mildew.**—This is a disease that affects gooseberries most commonly but is also occasionally found on currants. The
disease attack the leaves, canes and berries. It usually appears first as a whitish powdery-looking growth on the under side of the leaves and progresses to the other parts of the plant if the infection is severe. As it becomes older the color changes to brownish. It is always worse under damp conditions.

Control.—This disease can be controlled by a dormant spray of lime-sulfur, 6 1-4 gallons to 43 3-4 gallons of water; followed by 3 or 4 summer sprays of lime-sulfur, 1 1-4 gallons to 48 3-4 gallons of water, applied first when the buds start opening and repeated every 10 to 14 days. This spray cannot, however, be used after the berries begin to form, if they are to be sold for canning, because it produces "hydrogen swell" in the canned product.

Leaf Spot.—Leaf spot is a fungous disease found on both the gooseberry and the currant. It seldom does much damage in Colorado. The disease appears as yellowish-brown spots on the upper surface of the leaves. In severe cases the diseased leaves fall prematurely. This weakens the plant and cuts down the crop of the following season. A dormant spray of lime-sulphur, 6 3-4 gallons to 43 3-4 gallons of water, followed by summer sprays as needed of lime-sulfur, 1 1-4 gallons to 48 3-4 gallons of water, or bordeaux mixture 3-4-50, will control leaf spot.

SUMMARY

Brambles

The red raspberry is the most important of the brambles in Colorado. The black raspberry ranks second. Brambles can be grown at altitudes up to 8,000 feet.

Brambles are desirable crops to include in the farm plan but should not be grown in a speculative way.

Red raspberries and blackberries are propagated by suckers or by root cuttings. Black and purple raspberries and dewberries are propagated by tip layering.

Select a site that has rich, well-drained soil, and that is protected from winds.

Use high-yielding, disease-resistant varieties that produce berries firm enough for shipping if the market is distant. Do not grow everbearing varieties commercially.

Plant brambles after an intensively cultivated crop, order plants from a reliable nursery, heel them in when they arrive, never let them dry out, and plant 2 to 3 inches deeper than they stood in the nursery. Plant 3 to 4 feet apart in rows 6 to 8 feet apart.
Cultivate thoroughly to keep down weeds and suckers and to prevent the formation of a surface crust.

Keep the soil well supplied with humus by applications of 10 to 15 tons of barnyard manure per acre every few years.

Soak up the soil to a depth of 1 foot when irrigating and irrigate as frequently as is necessary to keep the plantation in a vigorously growing condition. Decrease the frequency of irrigations after midsummer so that the plants can mature their wood before winter.

Winter protection is necessary for brambles in many parts of the state. The best kind of winter protection is a fall covering of soil to a depth of 4 to 6 inches. Uncover the canes in the spring before the leaves start to push out.

The brambles all produce their fruit on 1-year-old canes which die after bearing. The plantation will produce a full crop when 3 years old.

Use either the hill or hedge-row system of training. A larger yield is probable when the hedge-row system is used.

Brambles must be pruned to equalize their vegetative and fruit-producing tendencies. Bramble pruning is fruit thinning.

Harvest brambles for shipping as soon as the berries can be removed without injury, but for home use or local markets do not harvest the berries until they are fully ripe.

Use the largest sized package that can be handled easily and the largest sized individual box in which the berries can be shipped without damage to them. This effects a saving in cost of package materials.

Pay the pickers on the piece-work basis and use the double punch-card system of keeping accounts with them.

Grade the berries as they are picked to avoid the damage resulting from handling again. Provide a centrally located packing shed. Harvesting operations can be directed from it, the fruit is protected from the sun and rain, and empty packing material can be stored in it.

Remove the plantation after the tenth to twelfth year. After this time it is usually not as profitable as a young plantation would be.

Yields of 3,000 quarts per acre can be expected in normal years if the plantation is well cared for.
Control cane borers by breaking off and burning the infested part of the cane. Spray with lime-sulfur or Volek to control red spider.

Purchase only disease-free nursery stock and practice farm sanitation as aids in disease control.

Plant disease-free stock and dig up and burn all infected plants for crown-gall control.

Spray with bordeaux mixture for the control of spur blight; apply it thoroly, at the correct concentration and at the right time.

For mosaic control buy disease-free plants, use resistant varieties of high quality and productiveness, and rogue out the diseased plants early in the season.

To reduce mosaic losses in black raspberries, plant them 50 to 100 yards from red raspberries.

**Bush Fruits**

Plant gooseberries and currants in deep, cool, fertile, well-drained soil, containing plenty of humus, and on a northern slope with good air drainage if there is any choice of slope.

Plant vigorous, productive varieties which bear large berries of high quality.

Propagate most varieties by hardwood cuttings. Varieties that do not root readily from cuttings are propagated by mound layering.

Supply humus before planting either thru a cover crop or an application of 10 to 15 tons of barnyard manure per acre.

Purchase plants from a reliable nursery, unpack and heel them in when they arrive, and plant 4 to 5 feet apart in rows 7 feet apart.

Cultivate and irrigate the same as brambles.

Scatter manure over the crowns to a depth of 3 to 4 inches for winter protection.

Training to the bush form causes less damage from wind and borers than training to the tree form.

Remove wood over 3 years old because the best fruit is borne on young canes and removing old wood stimulates the production of vigorous young canes.

Gooseberries are usually harvested green and as soon as they are full grown. Harvest currants for jelly before they are all ripe, but for other purposes leave them until well ripened.
Spray with arsenate of lead or white hellebore to control currant worms.

Cut out and burn canes infested with currant borer. Spray with nicotine sulfate to control currant aphis.

Powdery mildew can be controlled by sprays of lime-sulfur.

Leaf spot, if present, can be controlled by lime-sulfur sprays.

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