RASPBERRY CULTURE in Oregon

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Agricultural Experiment Station
Oregon State College
Corvallis, Oregon

Station Bulletin 443
February 1947
Cover illustration—
A raspberry planting in western Oregon.
FOREWORD

During the latter part of the war and especially during the postwar period thus far, there has been an increasing demand on the part of Oregon growers or prospective growers for information on the production of small fruits. This demand has stemmed from the present high prices being paid for these fruits, and the fact that parts of western Oregon are exceptionally well suited for their production.

The peak production of small fruits in Oregon was reached in 1941, when over 25,000 acres were in plantings, and a production of approximately 83,000,000 pounds was obtained. The acreage and production fell rapidly during the next three years, however, dropping to about 16,500 acres and 48,000,000 pounds production in 1944. Production of these crops is definitely on the increase again, with many former producers re-establishing their old plantings and many new ones entering the industry.

In order to help answer the many questions which will confront these growers, this bulletin and two others, Station Bulletin 441, Culture of Trailing Berries in Oregon, and Station Bulletin 442, Strawberry Production in Oregon, have been prepared.

Wm. A. Schomfeld
Dean and Director
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Raspberry Culture in Oregon*

by

GEORGE F. WALDO and HENRY HARTMAN†

The raspberry has been an important horticultural crop in Oregon for many years, being grown in both the home garden and in commercial plantings. The climate and soil conditions of western Oregon, as well as such economic factors as availability of labor, have been largely responsible for continued raspberry production in the area. The past decade has seen a decrease in red raspberry production and acreage, but a compensating increase in black raspberries or "blackcaps" in the state. The total acreage for both types has varied between 4,500 and 5,000 acres.

The early development of the red raspberry industry in Oregon was to a large extent due to the introduction of the Cuthbert variety. Since its introduction here, this variety has been the standard of quality in the Pacific Northwest and other areas. In recent years, however, the depletion of soil fertility and advent of diseases and pests have reduced yields and longevity of plantings of this and other varieties. This bulletin furnishes information on the methods of raspberry culture resulting in high yields and maintenance of the soil fertility.

The cultural practices described apply to the red, black, and purple raspberries. Although the purple raspberries are not commonly grown in Oregon, the cultural practices described for the black varieties apply to them also.

RASPBERRY PRODUCING AREAS

Over 90 per cent of the red raspberries produced in the state come from the Willamette Valley, and nearly 100 per cent of the black raspberry production is in that valley. The leading counties with their acreages in 1944‡ are listed in Table 1.

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* This publication is based largely on the results of investigations conducted jointly by the Division of Fruit and Vegetable Crops, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture and the Oregon Agricultural Experiment Station.

† George F. Waldo, Pomologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture; and Henry Hartman, Horticulturist and Head, Department of Horticulture, Oregon Agricultural Experiment Station.

‡ Source: Oregon State Extension Bulletin 656, Oregon's Small Fruit Crops.
Outside of the Willamette Valley, raspberries are of commercial importance in only Klamath, Umatilla, and Jackson counties.

**FACTORS IN LOCATING RASPBERRY PLANTINGS**

Great care must be taken in selecting a location for growing raspberries on a commercial basis. Markets, climate, and soils are but some of the important factors to be considered. Oversight of any one of these may result in high cost production, low yields, or short life of plantings. The cost of establishing raspberry plantings is usually greater than with other small fruit, also.

Poor choice of site or suitable soil often results in low yielding plantings. Yields of less than 2 tons per acre generally cannot be considered profitable. Black raspberries have a lower cost of production than the red varieties, as a rule, so they can be grown profitably at lower yields. Yields of 3 to 4 tons per acre are usually regarded as very good for either type, but red raspberry yields may go as high as 8 tons per acre.

**Market outlets**

The primary consideration in locating a commercial raspberry planting is the availability of a market outlet for the crop. The early development of the industry in the state was largely for fresh berry shipment. Refrigeration in shipping made it possible for Oregon-grown raspberries to be marketed fresh in eastern states. The increase of population in the western states in recent years has created a greater demand for fresh berries in this area, also.

Since the establishment of canning and freezing plants, however, most red raspberries are now processed. Much of the black raspberry crop is also handled in this way. In the earlier years of the industry, most black raspberries were dehydrated. Some are still processed by this method. A high percentage of the black raspberry production is marketed ultimately in eastern states.
Since processing is now the chief outlet for the raspberry crop, the needs and requirements of processors must definitely be considered. Certain varieties are more suited to the various types of processing than are others. Consumer habits are another important factor. In general, processors cannot use new types or varieties with which retailers or consumers are not acquainted.

The distance the plantings will be from the processing plants or other market outlets must be regarded also. Excessive distances will increase costs as well as damage the quality of the fruit unless extreme care is taken. The importance of this factor, however, has been lessened in recent years by improved roads and hauling equipment.

**Climatic requirements**

Climatic conditions are very important in raspberry production. These berries are not adapted to as wide a range of conditions as are other small fruits. The most favorable climate for raspberries should have a relatively cool summer, a rain-free harvest season, and a mild winter. Hot, dry, windy weather during the summer months retards cane growth and causes the berries to be soft and seedy. Rain during the harvest season results in soft berries which spoil quickly after being picked. Excessive heat prior to harvest will cause berries to soften before they become properly matured. Cold winter weather, especially if it is windy, often results in winter injury. The exposure of plantings to cold northeast winds has been known to produce winter injury, a typical example being the plantings along the Columbia River in Multnomah County. In extremely windy areas, canes are often badly damaged and plants, especially black raspberries, often are uprooted. Windbreaks built along the northeast of the planting may offer some protection from this type of winter injury. Another possibility is to make plantings on the southwest side of a timber belt or hill.

In areas where winters are quite cold, but where home garden plantings are desired, the best policy is to select one of the more hardy varieties.

**Soil requirements**

The most desirable soil for growing raspberries should have depth, good drainage, adequate fertility, and a high water holding capacity. In addition, steep slopes subject to erosion should be avoided.

The depth of the soil is especially important with raspberries, as they are deep rooted plants. A root system adequate enough to produce and support a vigorous, high yielding plant can develop only
in a deep soil. For this reason, the subsoil, as well as the top soil, must be considered. Subsoils that are tight or sticky prevent root development, besides being water-logged during much of the rainy season. These soil types that have tight and poorly drained subsoils, such as the Dayton, Amity, and Wapato series, should be avoided.

Proper drainage is necessary as raspberries cannot stand a water-logged soil for more than a few days at a time. Heavy clay soils that are low and level fall into this poorly drained, undesirable group. Gentle slopes are more favorable, but even here underlying rocks or hard layers may retard proper drainage. If this is the case, these soils should be avoided.

Naturally fertile soils are essential also. Soils that lose their fertility quickly should never be planted to raspberries. The shallow, coarse textured types of the red soils and the gravelly river bottom soils are in this undesirable class. Naturally fertile soils that have become depleted of plant nutrients and organic matter should be restored before raspberry plantings are made. Use of manure, commercial fertilizers, and cover crops are the methods used to restore fertility and organic matter to the soil and are thoroughly covered in a later section. (See pages 12-14.)

**Raspberries should not follow certain crops**

Raspberries are susceptible to certain root diseases, such as crown gall* and Verticillium wilt.† Crown gall may be present on the roots of orchard trees and cane fruits. Several years should intervene, therefore, before making a raspberry planting on soil where affected plants of these fruits have grown. Verticillium wilt organisms often remain in the soil after the growing of such crops as potatoes, tomatoes, or eggplants. For this reason, raspberry plantings should not immediately follow these crops.

Raspberry plants are sometimes attacked by the strawberry crown moth (borer) when raspberries immediately follow an old strawberry planting. Also, it is not known whether the little-understood organisms causing black root in strawberries attack raspberries. Until more knowledge is available, growers are advised against planting raspberries on soils where strawberries infested with this root disease have been grown.

**Raspberries as intercrops**

Raspberries may be grown profitably in young orchards in order to obtain a return from the land while the orchard is coming into production. This practice should be restricted, however, to the

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*Agrobacterium tumefaciens (E. F. SM & Towns) Conn.
†*Verticillium dahliae* R & B.
most fertile soils that are well supplied with moisture. This practice is most successful where trees are not planted close and are varieties that do not come into bearing quickly, such as walnuts or apples. Planting of raspberries as intercrops should be considered as relatively temporary. As soon as trees become large, they compete with the raspberries for soil nutrients and moisture. Orchard trees may be seriously checked in growth if raspberries are left too long as an intercrop.

SELECTING VARIETIES FOR PLANTING

Varieties must be selected that are adapted both to the existing climatic and soil conditions and to the needs and requirements of the market outlets. In areas of low winter temperatures, hardiness is a major consideration, while in commercial areas such as western Oregon, the requirements of the processing plants are of chief importance.

New varieties are being introduced from time to time after they have been developed and rigorously tested. The United States Department of Agriculture and the Oregon Agricultural Experiment Station are cooperating in a breeding and testing program to develop new varieties that will better meet Oregon's needs.

The varieties described here are those known to succeed in Oregon or that are believed to have possibilities in parts of Oregon.

Red raspberry varieties

CHIEF. Minnesota origin. Fruit is of medium size, light red, medium acid to acid, and early with a long season. This is one of the hardiest varieties and is recommended for the high-altitude sections of the state.

CUTHBERT. New York origin. Fruit is of medium size, dark red, mild subacid, excellent quality, and midseason. The principal variety grown in the Willamette Valley, it is adapted to local and distant markets, canning, and freezing. It was originally vigorous and productive, but in recent years, perhaps as a result of "decline" virus disease, has become less productive and hardy, as well as shorter lived.

LATHAM. Minnesota origin. Fruit is of medium size, bright light red, medium acid to acid, and midseason to late. This hardy variety is recommended for high-altitude sections of eastern Oregon.

LLOYD GEORGE. English origin. Fruit is large, dark red, rather soft, medium acid to acid, and of fine quality. The variety lacks vigor except when grown in the coastal section. The fruit is too
soft for commercial uses, but excellent for home use. A fall crop
is usually produced. It is susceptible to virus diseases and much of
the available stock is diseased.

**Milton.** New York origin. Fruit is medium to large, dark
red, medium acid, and of good quality. It is a newly introduced
variety, and its adaptation to Oregon conditions is not well known.
The variety has been hardy and productive at Corvallis, Oregon.

**Newburgh.** New York origin. Fruit is large, firm, medium
light red, mild, good quality, and midseason to late. This variety is
well-adapted to most sections of Oregon. It is hardy in the lower
valleys of eastern Oregon as well as in the Willamette Valley and
coastal region. Its large size, bright red color, and firmness have
made it popular in local markets. It is quite attractive frozen, but is
too light in color for canning.

**Ranere (St. Regis).** New Jersey origin. Fruit is small to
medium size, dark red, rather soft, good quality, and very early,
producing a full crop also. This variety is grown largely in home
gardens for early berries and for the second crop produced in late
summer. It is also quite hardy and is grown in sections of eastern
Oregon.

**Tahoma.** Washington origin. Fruit is of medium size, light
bright red, medium acid to acid, and early. This is a new variety,
and its adaptation and uses are not definitely known. It is grown in
Washington for early shipping.

**Taylor.** New York origin. Fruit is large, medium firm,
medium red, mild acid, good quality, and midseason. This variety is
quite hardy in the lower valleys of eastern Oregon. Vigor and pro-
duction in this variety have sometimes been disappointing. It is
quite attractive frozen, but is too light in color for canning.

**Washington.** Washington origin. Fruit is of medium size,
dark red, medium firm, mild acid, excellent quality, and midseason
to late. This variety is of recent introduction and its adaptation is
not fully known. Fruit is excellent for all purposes. It has proved
to be much more hardy than Cuthbert in the Willamette Valley. It
has a very productive fruiting habit and high yields are obtained on
moist, fertile soils. The plants, however, have been less vigorous
than Cuthbert on poor soils, and berries have been small.

**Willamette.** Oregon origin. Fruit is large, very firm, dark
red, medium acid to acid, and midseason. This is another newly
introduced variety, and its adaptation is not known fully. For sev-
eral years it has been hardy and productive at Corvallis. The fruit
is very large and very firm and because of this is well-adapted to
Figure 1. The fruit of the Willamette red raspberry, a new Oregon-introduced variety, is large, firm, and of a dark red color.

local markets and shipping. The frozen and canned products are attractive also but more acid than Cuthbert or Washington.

Black raspberry varieties

**Bristol.** New York origin. This is a new variety that has been tested in eastern Washington. In that locality it has been very productive and hardy. In New York it has been early, hardy, and very productive.

**Cumberland.** Pennsylvania origin. This variety has been more widely grown than any other. It has not been popular in Oregon although occasional plantings of it have been made. It has not been considered as productive as Plum Farmer or Munger.

**Dundee.** New York origin. This is a new variety which has shown promise in trials at Corvallis. Plants are very vigorous, and excellent yields of good dessert-quality fruit have been obtained. Dundee is being grown to some extent in Washington.

**Evans.** New York origin. This is another new variety that has yielded well at Corvallis but is not quite as vigorous as Dundee.
LOGAN (New Logan). Ohio origin. This variety is also relatively new in Oregon. It has been quite popular in certain eastern states where it is desired because of its earliness. It has been vigorous and productive in trials at Corvallis. A few plantings have also been made elsewhere in the state.

Morrison. Ohio origin. A new late variety widely advertised in eastern states as very large, firm, and very productive. Plantings are now on trial in Oregon.

Munger. Ohio origin. Munger has long been a popular variety in Oregon and probably occupies the largest acreage of any variety in the state. Plants are usually vigorous and very productive. The fruit is of good quality. Occasionally, objection to this variety has been made because of its susceptibility to mildew.

Plum Farmer. Ohio origin. This variety, like Munger, is very popular. It seems to be widely adapted and good yields are usually obtained. It is not susceptible to mildew.

SOIL PREPARATION FOR PLANTING

A program of soil improvement is generally necessary before setting a new plantation of raspberries. After a planting has been made, soil fertility may be maintained by use of the established practices. It is difficult, however, to improve the soil conditions when a planting is in full production. Soils long in cultivation are often in poor physical condition and usually low in organic matter.

Addition of organic matter

Organic matter is a most essential constituent of a fertile soil. Ample organic matter makes a soil loose and easy to cultivate, prevents stickiness or cloddiness, as well as increasing its moisture-holding capacity. Major plant food elements are made more available and minor elements usually become available when sufficient organic matter has been incorporated into the soil. These minor element deficiencies are often very difficult to correct through the use of commercial inorganic fertilizers.

Farm manure is the best source of organic matter, but it is now seldom available in sufficient quantities. Heavy applications of 20 to 30 tons per acre before planting in soil of average fertility are usually sufficient. Poultry manure should be applied at about half the rate of ordinary manure or at about 10 to 15 tons per acre. Soils known to be very deficient in organic matter may require a combination program of manure and cover cropping for a period of one or two years.
Cover crops are usually the principal source of organic matter (Figure 2). Crops most generally grown are vetches or Austrian winter peas in combination with winter oats, barley, or rye. Willamette vetch is suitable for western Oregon, and hairy vetch is best for eastern Oregon. Austrian winter peas may be grown in either eastern or western Oregon. Rye is preferred to barley or oats when a larger quantity of organic matter is desired. Rosen rye is hardy in both eastern and western Oregon. Abruzzi rye is faster growing in early spring than most other cereals and is suitable for western Oregon. These cover crops are seeded in the fall and plowed under in the spring.

When time permits, additional material may be incorporated by using the following system. The above-mentioned crops are allowed to mature, and the seed shatters out. This seed starts growing following the autumn rains. This new and thick growth, in addition to the dead growth from the previous crop, makes possible the addition of a much greater quantity of organic matter. As an alternative method of turning under more material, Sudan grass may be sown in late spring and plowed under in time for seeding the fall-sown cover crop.

Figure 2. Incorporating a cover crop into the soil before raspberries are planted will pay big dividends.
Land that has been in hay or pasture for a few years is usually very desirable for raspberry plantings. Legumes, such as alfalfa and the various clovers, increase the available nitrogen content of the soil as well as the organic matter content. Land that has been in grass for seed or pasture purposes will be higher in organic matter content and will have a better physical structure. A year, however, should intervene between plowing up sod land and the planting of raspberries.

Crop refuse, such as straw, spoiled hay, vegetable tops, and similar materials may be used. Weed growth on some soils is often very heavy and may be plowed under also. Some of these materials may be slow in decomposing, but the addition of nitrogen fertilizers, such as ammonium sulphate or ammonium nitrate at the rate of 300 to 400 pounds per acre, will increase the rate of decomposition. A large cover crop disk is usually necessary to mix the material thoroughly into the soil.

Tillage requirements

The preparation of soil for planting is usually done just prior to the time the plants are set in fall or early spring. Fall plowing for spring planting is advantageous as the soil will be in shape for planting much earlier. This practice, however, is unwise if there is danger of soil erosion or washing. Red raspberries can be planted in late fall or during the winter months. Preparation for planting at this time may not be so thorough as for spring planting. Large air spaces, however, should not remain in the soil, but the surface may be left rough to check erosion or run off.

For spring planting of raspberries, the soil should be prepared as for any other cultivated crop. Deep plowing and thorough disking to break up lumps and eliminate large air spaces are always necessary. Some leveling of the surface with a harrow is usually needed. It may be necessary to use a float, drag, or roller if the soil is very rough or lumpy; the surface, however, should generally be left loose.

RASPBERRY PLANTING OPERATIONS

Selecting the planting stock

The profitable life of a planting may be cut short at the very beginning if superior planting stock is not obtained. This cannot be overemphasized. Plants should be secured from vigorous, young plantings, which are known to be free from injurious insects and diseases. If possible, the prospective grower or dealer handling the plants should inspect the mother planting during the previous growing season. When a grower has plants shipped to him, he
should look them over carefully. Should galls be found on the roots, it is best to reject all the plants since crown gall organisms may be present on even the healthy appearing plants.

Only large plants with a well-developed root system should be set (Figure 3). Such plants start with vigorous growth and can withstand adverse growing conditions better. Small plants may develop into good vigorous ones under favorable growing conditions, but often die under adverse conditions.

Red raspberry planting stock consists of shoots sent up from the roots. Those most generally used for fall, winter, and early spring planting are shoots sent up the previous summer that have reached a height of from one to three feet. Shoots having a portion of the original root together with the new roots make the best planting stock. Such plants should be dug rather than pulled, since the new tender roots may become detached by pulling.

Spring shoots are often used in spring plantings. Shoots 6 to 10 inches in height should be dug carefully so they are not broken from the attached root.
Tip plants are used almost entirely for black raspberry plantings and are set in the early spring. The tip plants are the result of the rooting of the ends or terminals of the canes during the previous autumn.

The number of plants required per acre can be easily determined by the following method. Multiply the distance the rows are to be apart by the distance plants are to be set apart in the rows. Divide this figure into 43,560, the number of square feet in an acre. The answer will be the number of plants needed for an acre.

Table 2. Number of Plants per Acre

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Table 2 gives the number of plants per acre needed for some of the planting distances in common use.

Handling the plants

Dormant raspberry plants may be held for a considerable time if it is not possible to set them out when they are first obtained. Plants are "heeled-in" in a trench dug deep enough to receive the roots. The bundles are broken open and the plants placed side by side in the trench and covered with soil pressed tightly against the roots. Plants may be held also in cold storage in the packing bundle or box, if the temperature remains constant at about 31° to 33° F. Plants cannot be held for long periods, however, after growth has started in the spring.

Care must be taken to keep the roots from drying out. If roots begin to dry, they should be placed in water. While being transported or held in drying weather, the roots should be covered with damp burlap or packed in damp moss, sawdust, or similar packing material.

Careless handling of the black raspberry plants may cause breakage of the tip or small shoot. Growth is delayed when the shoot is broken. If unfavorable growing conditions exist, the plant may die.
Time of planting

Red raspberries may be planted from late fall to spring. Late fall or winter planting is often advantageous where winters are relatively mild, since root growth can continue during these months. If conditions are favorable when late fall or winter plantings are made, the plants will start growing immediately. The major disadvantage to fall planting is that the soil is often too wet. Most plantings are, therefore, made in the early spring. Plantings should not be made too late in the spring, however, as they generally will not get a proper start before the hot dry season arrives.

Figure 4. In the linear system of planting red raspberries, it’s a “row of hills” with the plants held in place by a 2- or 4-wire trellis. The plants in this illustration have been pruned, but not tied, to the trellis.
Black raspberry plants are usually set in the spring. The ends of the canes take root in late September or October and continue root growth throughout the winter. A stronger plant with a large root system can, therefore, be obtained in the spring. As with the red raspberries, the soil is usually too wet for proper planting in winter.

**Planting systems**

The system under which raspberries are to be grown should be definitely determined before setting the plants. Various systems are used and growers often modify them to suit their particular needs or desires.

Red raspberries are most commonly grown in a row of hills called the "linear system" (Figure 4). The plants are usually set in the row 2 1/2 or 3 feet apart. Some plantings have been made, however, with as much as 4 to 5 feet between plants. As only the shoots that start close to the original plant are allowed to remain and grow, the canes are kept grouped together in the so-called hill. All other shoots which come up between the plants are hoed out as they appear.

The hedge system used in eastern states is seldom found in commercial plantings in Oregon, but is often seen in home gardens. In this system new shoots are allowed to remain between the original plants. Eventually a solid row is developed which has the appearance of a hedge.

Black and red raspberries are sometimes planted so that they can be cultivated in two directions. The distance apart is determined by the width necessary for cultivation implements to pass without injury to the canes.

Black raspberries are generally planted in rows of hills as in the linear system for red raspberries. The plants, however, are set in the row 4 to 6 feet apart.

The width between the rows should be determined by the kind and type of cultivating implements that will be used. Very small tractors, such as the garden tractor, or single-horse cultivators may require rows no farther apart than 5 to 6 feet. Most small tractors, however, require rows at least 8 feet apart. Many growers prefer rows 9 to 10 feet apart with some going as high as 12. The wider spaced rows are essential where a cover crop program is to be used after planting. The rows should always be far enough apart to allow cultivation without injury to the canes or plants.

Some definite system of marking out rows is usually used in order to give the planting an orderly appearance and make cultivation practices easier. Rows are often laid out with a line of cord or wire. Hand or tractor-drawn markers or a corn planter may also
be used. Small stakes are sometimes put in where each plant is to be set, especially if cultivation is to be in two directions.

Although straight rows are ordinarily desirable, contour planting may be advisable on sloping ground to prevent erosion. It may be necessary also to vary the width of the rows with such plantings. Where erosion is not a factor, rows should ordinarily run north and south.

**Setting the plants**

Plants should be set so they will start growth as quickly as possible after planting. Particular emphasis should be placed on pressing the soil tightly against the roots so that no air spaces remain to dry them out. The root system should be spread out so that the soil is in contact with each of the individual roots. When roots are folded or in a ball, air spaces remain and only part of the roots is in contact with the soil.

Most raspberries are planted by hand. A spade or shovel is used to make the hole. The plant should be set down into the soil a little below the original depth at which it grew, with sufficient space allowed for spreading the roots. Loose soil is then returned and pressed firmly against the roots. When planting is done in loose soil and plants are not oversized, satisfactory planting may be done by plunging the spade well down and moving it forward or backward. The plant is then set down into the opening and as the spade is drawn out, the soil falls against the roots and is made firm by packing with the feet.

Some growers plow a deep furrow and place the plants along one side of it. The soil is then returned by plowing another furrow. This method is satisfactory only if care is taken to see that the soil is always pressed tightly against the roots and the plants are set at the proper depth.

Black raspberry tip plants should be set so that the tip or growing point is at the surface of the soil. Dormant plants may be set with the tip not more than an inch beneath the surface. If leaves are beginning to appear, they should not be covered.

Great care should be taken in setting the spring-shoot plants of red raspberries. These plants are best set in cool, cloudy, or even rainy weather. If warm, drying weather should occur immediately following planting, removal of some of the large leaves is recommended to help prevent wilting. This may be done at planting time, if dry weather is expected.

After planting it is usually best to cut back the cane of the red raspberry plant to about 6 inches. The so-called “handle” or attached cane of the black raspberry plant may be cut back to the sur-
face of the soil. Such cutting back reduces leaf surface and transpiration, which often delays plants in making new growth. The possible spread of some diseases may be checked also.

**CARE OF THE PLANTATION**

**Cultivation**

Cultivation should be primarily for the control of weeds. Weeds compete with the raspberry plant for moisture and plant food and should not be allowed to develop during the growing season.

Deep cultivation, or that in excess of 1 to 2 inches in depth, should never be practiced. Raspberry roots are found in great abundance just beneath the surface and deep cultivation destroys many of these roots. Raspberry plantings have been permanently injured by deep cultivation. Slightly deeper than ordinary cultivation may be necessary in early spring in order to work the cover crop or weeds and grass into the soil. Following the early spring working, cultivation should be done only to control weeds and prevent the formation of a crust following irrigation or rain.

The early spring cultivation is important because if the cover crop, grass, or weeds are allowed to remain too long, they may seriously compete with the raspberry plant for moisture. Disking down a cover crop is usually preferable to plowing, though the latter method may sometimes be necessary. A grape hoe is often very useful in clearing grass and weeds from between the plants in the row. Various implements may be used for summer cultivation, such as cultivator attachments to the tractor, spring-tooth harrow, and weeder of various kinds. Very little, if any, cultivation is necessary during the harvest season.

Some hand hoeing is usually necessary to get the weeds and grass close to the plant. Shoots or suckers of red raspberries must also be controlled between the plants. Several hoeings may be necessary during the summer.

**Caution:** All implements used in raspberry cultivation must be adjusted so they do not disturb the roots that are more than an inch or two beneath the surface.

**Irrigation**

Irrigation is usually necessary in most parts of southern and eastern Oregon. The surface method of application is most practical in these areas. Water is usually applied whenever soil moisture becomes low enough to check vigorous growth. The period when vigorous growth is desired is prior to the harvest season. The soil type and climatic conditions of each location determine the amount
and frequency of application. Water is usually conducted to the plants in furrows along each side of the row.

Experiments have shown that irrigation is of benefit to raspberries in the Willamette Valley, but few plantings are being irrigated at the present time. Many growers are equipped with sprinkler systems used for other crops, however, which might profitably be used with raspberries. Since very little experimental work has been done with this type of irrigation on raspberries, it is not definitely known whether injury to the berries will result.

**Mulching**

Mulches of straw or hay have not been generally used with raspberry plantings, but higher yields have been obtained when they have been used. Some growers object to their use because of the fire hazard. Mulches to be effective must be deep. Those observed have been about 12 inches deep after settling. When the depth becomes less than this, new straw is applied to the entire surface. If the distance between the rows is 9 or 10 feet, an unmulched strip of 3 or 4 feet may be left between the rows.

Experiments in eastern states have shown that higher yields can be obtained from straw mulches. The mulches used in that area are generally shallower than the ones used in the West. Growers in Oregon who have used mulches are convinced also that higher yields can be obtained through their use. Mulches prevent the loss of moisture and make plant food elements more available.

**Intercrops in young raspberry plantings**

Intercrops may be grown the year a raspberry planting is set out. This practice is satisfactory if the soil is fertile and retentive of moisture. Cultivated crops are satisfactory, but grain and hay crops are not suitable. Crops that are heavy users of water may check raspberry growth in unirrigated plantings. Generally, intercrops are most satisfactory where irrigation is provided. Crops that might spread raspberry root diseases, such as potatoes and tomatoes, should be avoided.

Intercrops should not be planted the second year following the planting of the raspberries. This is the year when a very vigorous cane growth is desired for producing the first crop of fruit the following year. During the second year, too, the roots spread rapidly to occupy nearly all the soil area between the plants.

Many growers in western Oregon do not grow intercrops because of the danger of slowing down raspberry plant growth in case the summer months should be especially dry. The cover crop program for maintaining soil organic matter can be started the first year, also.
MAINTAINING SOIL FERTILITY

The life of a raspberry planting may be greatly prolonged if plans for maintenance of soil fertility are made at the time of planting. Growers should not wait until yields begin to decrease before taking steps to stop a further decrease in fertility. All plans may fail, however, if the planting is in a poor location and on poor soil.

Use of manure

The annual application of manure is probably the best insurance against depletion of soil fertility. Applications of 10 to 15 tons of animal manure per acre, or about one half that amount of poultry manure, have given good returns. Larger amounts applied in alternate years may be satisfactory also. Manures may be supplemented with commercial fertilizers, using particularly those elements known to be most deficient in the soil.

Manure applied in early autumn may be disked in and a cover crop sown in order to increase further the organic matter content. Manure may be applied at any time during the winter or early spring. Where there may be run-off during the winter, it is best not to apply manure until it can be immediately disked into the soil.

Cover crops

In general cover crops must be depended upon to maintain the organic-matter content of the soil (Figure 7), since manure is seldom available in sufficient quantities. Legume cover crops add nitrogen as well as organic matter to the soil. Vetches, particularly the Willamette variety, and Austrian winter peas are the principal legumes used. Crimson clover may be grown successfully in some locations. A cereal, either winter oats, barley, or rye, is usually grown in combination with the legume.

The best method of sowing a cover crop is with a drill in about the middle of September. Earlier seeding would be necessary in black raspberries, however, since the cane growth in the middle of September is too dense for a drill to pass through without damaging the canes. Earlier seeding, however, may not be satisfactory, since light rains may cause the seed to germinate only to die later because of lack of moisture. For this reason broadcasting by hand may have to be resorted to when planting a cover crop with black raspberries.

The application of fertilizers to increase the growth of the cover crop may be necessary when a large amount of organic matter is desired. The most effective fertilizers seem to be those containing phosphorus and nitrogen. These are best applied in early winter or spring.
Disking is the best method of incorporating a cover crop into the soil. Shallow plowing may be satisfactory, but heavy cover crops usually cannot be properly incorporated into the soil without deep plowing which injures the root system. It is not essential that all cover crop growth be completely covered. A trashy surface is not objectionable as long as it does not interfere with weed control. The cover crop should not be allowed to grow after drying weather occurs, since it will compete with the raspberry plant for moisture.

Commercial fertilizers

Experimental evidence is inconclusive regarding the benefits of commercial fertilizers on raspberries. Many growers, however, report better plant growth and increased yields from their use. Various fertilizers are used, but complete fertilizers are most common. Applications are usually made in early spring with rates varying with the grades used. Because of the wide variation of fertilizer requirements on different soil types, growers are advised to follow local recommendations.

Fertilizers used to stimulate cover crop growth may also have a direct influence on raspberry cane growth. Cover crops usually respond to nitrogen and phosphorus applications and on some soils to sulphur. The application of lime to acid soils is beneficial to the growth of leguminous cover crops.

PRUNING AND TRAINING

Fruit bearing habits

Fruit bud formation takes place in raspberries after most of the cane growth has stopped. This period begins in July and continues to the end of the growing season. Cane elongation ceases in midsummer with the fall-bearing red raspberries. Immediately after cane growth has stopped, fruit buds develop rapidly in the terminal portions of the canes and soon develop into flowers and fruit. The first fruit bud development is at the top of the cane and goes downward at a progressively slower rate. The lower buds, therefore, do not flower and fruit until the following spring. The same process takes place in the single-crop raspberries, but cane growth continues later into the autumn, so that the time when the terminal buds differentiate, or start to form fruit buds, is much later.

Varieties like the Cuthbert, which continue growth late into the autumn or early winter, sometimes flower and even ripen fruit. Black raspberries also differentiate fruit buds in the autumn, but the rate of development is slow until growth starts the following spring.
Fruit buds develop rapidly in spring into fruiting laterals which bloom and fruit. The buds from the upper portions of the canes develop into fruiting laterals first and those in the basal portion of the cane last. The fruiting laterals from the upper buds are shorter and have fewer berries than the laterals from the lower buds. The range in lateral length and in number of berries, as well as the average length and number, vary between the different varieties and according to the vigor of the plants.

Pruning principles

It must be remembered that any pruning reduces yield, since nearly all buds, unless injured, develop into flowers and fruit. Any removal of canes or portions of canes, therefore, reduces the number of berries that can be produced. It is common knowledge, however, that if all canes are permitted to fruit, the berries are small and the current season's cane vigor is reduced. Unpruned raspberry plantings usually deteriorate rapidly and soon become unprofitable excepting those growing under very favorable conditions.

The objective in pruning raspberries, therefore, is to obtain the highest yield of marketable fruit without in any way reducing the future productiveness of the planting. Definite rules cannot be laid down. Each grower must determine the amount of pruning to be done according to conditions existing in his own planting. Experiments have shown that canes of large diameter produce the greatest quantity of marketable fruit. It is, therefore, the common practice to remove all canes of small diameter. The tip portions of long canes are also of small diameter, so these are generally removed. The grower, however, must determine for himself, according to his local conditions, just what canes to leave and what portions to cut off.

Pruning red raspberries

The pruning of red raspberries involves both fall and winter operations. Besides the regular pruning, there is also the problem of controlling the shoots or suckers that are constantly coming up from the roots. In most plantings, the regular cultivation and hoeing is sufficient to control those coming up between the rows and between the hills in the row. The shoots which come up right in the hill are left, with the exception of weak or excess ones, as the former will be the next year's fruiting canes.

The regular late summer or fall pruning of red raspberries consists of removing the canes which fruited that year. This is usually done shortly after the harvest season is over. At this same time the weak or excess new shoots are cut out also. It is not essential that old canes be removed in the fall, but it does have the advantage of lessening the chances of diseases spreading from the old to the new canes.
The winter or early spring pruning is done after the danger of severe freezing weather has passed. This is usually February or early March in western Oregon, but later in eastern Oregon. At this time the old canes are removed if this was not done the summer before. Weak canes are also removed. The number of canes to leave per hill is a relative question when a large number of canes per hill are produced. Unless the canes are of very large diameter and tall, it is usually best not to leave more than 12 canes per hill. Good yields may be expected when hills average 7 to 10 canes per hill.

When the hedge-row system is used, the grower should leave approximately the same number of canes per row as in the hill system. In this system canes would be spaced about 4 to 6 inches apart when the row is about 12 to 15 inches wide.

The height at which to cut off the canes is determined by their diameter and length (Figure 4). Tall canes are usually of large diameter and, if much of the cane is cut off, yield of good fruit is greatly reduced. For the sake of general appearance, growers

Figure 5. When red raspberry canes are left long, they should be bent down and twisted along the wires so that the fruit can be picked.
usually determine a height that will give the best returns and maintain it throughout the whole planting. Tall-growing varieties, like Cuthbert, are often cut back to 5½ or 6 feet. Occasionally longer canes are left, which in order to be picked must be bent down and twisted along the wires (Figure 5). Low growing varieties, like Newburgh, may be cut back to 4 feet without seriously reducing the probable yield.

With fall-bearing raspberries the upper portions of the canes that fruited the autumn before are cut off. These are usually low-growing varieties, and canes do not ordinarily need to be shortened much more.

**Pruning black raspberries**

As the growing habit of the black raspberry is much different from that of the red varieties, so, also, are the pruning operations. Black, as well as most purple raspberries, normally produce canes that make a rapid growth upward to about 4 or 5 feet and then arch over and finally trail along the ground to the end of the growing season (Figure 6). Only a few side canes are produced naturally. Many side branches or canes are produced, however, if the terminal of the cane is cut off. The pruning involves the trimming of these canes.

The system under which black raspberries are grown determines to some extent the height at which the cane should be cut or headed. The greatest number of strong branch canes of the largest diameter results when the canes are cut or headed while they are still short. Black raspberries grown without any support must be headed low, 18 to 24
Figure 7. Higher yields, as well as longer life of plantings, can be expected of black raspberries when they are properly pruned and the soil maintained by cover cropping.

inches, in order to prevent them from being uprooted (Figure 7). Higher heading without support causes the plant to become top heavy and thus to be easily blown over.

When canes are supported by a wire trellis or tied to a stake, higher heading, leaving a 2- to 3-foot cane, is usually practiced. Sometimes heading is not done at all when canes are supported, but yields are generally much lower when this is the practice. Higher heading results in weaker branch canes. Very weak branch canes result when heading is delayed and then a considerable portion of the cane removed. The strongest branch canes are obtained when only 3 to 6 inches of the terminal end is removed when the cane is about 2 feet high. This operation can be done by pinching off with the fingers or cutting with a knife or pruning shears.

Canes usually reach the desired height for heading in May or June. For greatest uniformity the grower must go over the planting 3 or 4 times. Some growers delay heading so that the branch canes do not interfere with the picking operations. This practice results in weak branch canes.

Winter pruning of black raspberries consists of cutting out the old fruiting canes and cutting back the branch canes or laterals. Ordinarily there is no advantage in pruning out the old fruiting wood in the fall. It is more economical to do it with the winter
pruning. Winter pruning is usually done during January, February, and early March.

Pruning at this time consists in thinning out the weak canes and cutting back the branch canes or laterals to a length that will give the greatest quantity of marketable fruit. The length to leave is determined by the general vigor of the plant and diameter of the canes. Branches 10 to 15 inches long may be left if plants are very vigorous, but lateral branches should be cut back to 3 or 4 inches if the plants are very weak (Figure 6). Canes that have not been headed are usually cut back to 3 or 4 feet and tied to supports of wire or stakes.

Disposal of pruning wood

Pruning wood is generally disposed of by gathering, removing it from the planting, and burning. In recent years prunings have often been left in the rows and broken up with a disk. Growers feel that this is advantageous, since the broken and decaying pruning wood improves the physical properties of the soil.

Trellises and supports

The wire trellis is the most common support used for both red and black raspberries. The wires usually extend from well-anchored end posts to intervening posts set 16 to 20 feet apart. Practically all posts used are split cedar fence posts, as fir or other types of wood posts rot too quickly. Wood preservatives, however, may make their use practical.

The 2-wire trellis is most commonly used. For red raspberries the wires are placed on each side of the post and held to the post with large staples or nails. The wires are usually placed about one foot below the height at which the canes have been pruned. Many growers also use a third wire placed just above and between the 2 wires. The canes are then tied to the third wire. Canes are also often tied to each of the 2 wires. A second set of wires may sometimes be placed 18 to 24 inches below the top wires (Figure 4). The 2-wire trellis is sometimes used for black raspberries. When low heading is practiced, however, trellises or other supports are not used. Sometimes cross pieces are nailed to the posts so that the 2 wires may be 12 to 15 inches apart.

Stakes are used to some extent for both red and black raspberries, but this system is usually confined to plantings where cultivation is in two directions. Small cedar stakes extending about 5 feet above ground are generally used. Ordinary binder twine is usually employed to tie the canes to the stake, and from one to three ties are made. Black raspberry canes are sometimes tied together where no support is used.
HARVESTING

The harvest season for raspberries usually begins in the latter part of June and continues to the end of July. The fruiting habit of the variety and local conditions greatly influence the length of the season. The harvest season for red raspberries averages about one month in length. It is usually somewhat shorter for black raspberries.

Picking crews should be secured before the season begins. The number of pickers needed will depend on the probable yield, size of the berries, and speed of the pickers. Usually about 5 pickers are needed per acre. Picking crews are made up largely of women and children from nearby towns and cities.

Raspberries must be picked at the proper stage of maturity. Red raspberries in particular become overripe very quickly in warm weather. Ordinarily they should be picked every other day; not more than two days should ever intervene between pickings. Black raspberries do not deteriorate so quickly and pickings can be made at greater intervals. Care should be taken, however, to see that all fully ripened berries are picked each time. Pickers should be properly instructed regarding the degree of maturity desired. A responsible person should be in charge of large crews to see that berries are picked correctly.

Careful handling of berries must be emphasized. This is especially important with red raspberries as they are soft and easily

Figure 8. To obtain maximum returns from raspberry plantings, efficient harvest operations are essential.
crushed. Most ripe red raspberries can be picked by a gentle pull or slight twist without crushing or squeezing the berry. Berries should be gently placed in the berry boxes or hallocks. These are usually carried in a box-like container holding two boxes and tied or strapped around the waist of the picker. Carriers are taken along by the pickers so the boxes or hallocks can be put in them after they have been filled. The usual carrier will hold 8 to 12 boxes. It is often constructed with legs so it will be 1 to 2 feet off the ground.

The firmer black raspberries require less care in picking. A half-gallon or gallon pail can even be used to put the berries in as they are picked.

Raspberries soften quickly in warm weather and should be removed from the field as quickly as possible. As soon as a carrier is filled, it should be taken to a conveniently located packing or assembly shed. In the assembly shed the boxes are taken from the carriers and placed in crates or in the lug boxes provided by packing plants. Berries should be transported to market or the packing plant as quickly as possible.

PLANT PROPAGATION

There should be more attention given to the propagation of good raspberry planting stock. Conditions in Oregon are almost ideal for growing nursery stock of all types. The presence of certain diseases and insect pests makes it unwise to use plants from regular commercial plantings. Anyone interested in nursery stock propagation should be familiar with the problems of raspberry production, particularly diseases and insect pests, as well as propagation techniques.

Suitable soil for the nursery must be a primary consideration. The best soil management practices for raspberry fruit production must be observed in a naturally good propagating soil. This type is generally a fertile sandy soil or one that is loose. Such soils allow the maximum root development and make it possible to dig plants without excessive injury to the root system. Propagating soil should be retentive of moisture, and if possible, irrigation should be provided.

The parent planting stock should be carefully selected for freedom from diseases and insect pests. It is always necessary to examine plants frequently and rogue out those suspected of having a disease. The virus diseases can be controlled only by rogueing. Some fungus diseases and insect pests can be controlled by spraying.

Plants should be kept growing vigorously throughout the season in order to get the greatest number of vigorous plants. Early plant-
The addition of fertilizers may be helpful, as well as irrigation in dry weather.

No control of shoots or suckers is needed in red raspberries grown for plant production. The number of black raspberry plants can be increased by early pinching out of the terminals of the first canes that appear. Some of the vigorous early branch canes may be pinched, thus inducing more canes which form new plants.

Rapid propagation of red raspberries may be obtained by using root cuttings. The main roots of a raspberry plant may be cut into 3- or 4-inch pieces in the autumn and placed in moist sand in a cool place. After 2 or 3 months a callus forms over the cut ends, after which they can be lined out in a furrow and covered with 3 or 4 inches of soil. Good results may be obtained by lining out in winter without being placed in sand. Black raspberries may be similarly propagated by leaf-bud cuttings taken before August 1 and set in a cold frame or greenhouse.

DISEASES AND INSECT PESTS

Raspberries are susceptible to certain troublesome diseases and insect pests. Growers cannot succeed in raspberry growing without taking precautions for their control. These are discussed in Oregon Agricultural Experiment Station Bulletin 418, *Diseases and Insect Pests of Cane Fruits in Oregon*, by S. M. Zeller and Joe Schuh.