Raspberry Production in Colorado

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Raspberry Production in Colorado

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One of the most valuable small fruits adapted to Colorado conditions is the raspberry. It can be grown on a variety of soils, and it can be produced at high altitudes. With reasonable care it will produce satisfactory crops over long periods of time.

Yields of 2,500 to 3,000 quarts per acre have been obtained in Colorado. Raspberry acreage has remained about the same in the State but production per acre has decreased. According to United States Census figures the 1929 production in Colorado averaged 1,050 quarts per acre; by 1940 this had dropped to about 820 quarts per acre. Either of these yields is much below those which should be obtained on good locations with good care. Undoubtedly some of the low yields are due to losses from cold injury, but these losses are not great enough to account for yields as low as 820 quarts per acre. Diseases and insect pests are responsible for much of the decrease in production. Through proper management, yields can be greatly increased.

Fruiting Habits of Raspberries

Raspberries, one of the brambles, differ from most other fruit plants in that they have biennial canes or tops and perennial root systems. That is, they produce their fruit on the 1-year-old wood or canes. The canes develop during one summer, produce a crop of fruit the following summer, and then die shortly after harvest. New canes are produced each season to replace the ones that have completed their growth. Certain varieties, called everbearing, produce a fall crop on the current season's growth; these same canes then produce a crop the following season.

Varieties to Grow

Many varieties of raspberries have been tried in Colorado, but only a few are adapted to conditions in this State. It is better to use varieties of known value rather than un-tested sorts, even though these latter may be highly advertised.

Red Raspberry Varieties

Latham.—Latham is probably the most widely planted in Colorado. The plants are hardy, vigorous, productive and quite mosaic resistant. The berries are large, bright red, and of fair quality.

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Chief.—Chief is similar to Latham, but the fruit is smaller, lighter in color, and less attractive. It may ripen from a few days to a week ahead of Latham, but the plants are less productive.

Newburgh.—Newburgh matures a few days before Latham. The fruit is large, the color is good, and the flesh is firm. It is said to be quite disease resistant. It has been productive in nearly every area in Colorado where it has been planted.

June.—June has been a profitable variety in northern Colorado. It matures its fruit early and the berries are large and well-colored. It is reported to be quite susceptible to mosaic diseases, but in the vicinity of Fort Collins it has been no more so than has Latham.

Indian Summer.—Indian Summer is the best of the “everbearing” raspberries. It is much larger and more prolific than St. Regis (Ranere). The fruit is dark red, large, and of good quality. The spring crop ripens ahead of Latham, and a second crop is produced in the fall on the tips of the maturing canes. It has been grown extensively in Jefferson County, Colorado, but the season in that area often is too short to allow maturing of the entire fall crop.

Other Varieties.—Several other varieties of red raspberries have been grown in the State. Cuthbert long has been the standard for quality, but because of extreme susceptibility to disease and poor yields it has been discarded for more profitable sorts. Otah (Flaming Giant) is productive, but the berries are soft and of poor quality. Marlboro and Taylor like Cuthbert have shown too great susceptibility to disease.

Black Raspberry Varieties

There is no dependable hardy variety of black raspberry as yet available for Colorado conditions. Of those now in use, Cumberland is as satisfactory as any. Under good cultural conditions it produces heavy yields of good-quality fruit which matures in midseason. Other varieties such as Logan, Dundee and Quillen have proved to be no more adapted than Cumberland and in some locations have been less productive.

Purple Raspberry Varieties

Purple raspberries, although of good quality, have not shown sufficient hardiness for general use in the State. Columbian, Potomac and Sodus have all been planted on a limited basis.
Selection of Planting Site

The site for a raspberry planting should be carefully selected, since it is often the determining factor in the success or failure of a planting. The two important factors to be considered in the selection of a site are soil and exposure.

Soil

The soil is more important in determining the site than is the exposure. Raspberries do best on fairly fertile loam, well drained and containing sufficient organic matter to provide for the retention of moisture and to make the soil easy to handle. Such soil will produce the strong, vigorous canes essential for high yields. The organic matter can be supplied, if lacking, by turning under barnyard manure or cover crops.

The red raspberry prefers the lighter soils such as sandy to clay loams. The purple raspberry prefers a silty loam. Although the black raspberry will grow satisfactorily on a wider range of soil types than the other raspberries it does best on a rich silt loam to clay loam having a subsoil which contains somewhat more clay than does the topsoil. Such a soil is well drained, yet it retains enough moisture for satisfactory growth.

Exposure

Raspberries are found growing wild in the cool, damp recesses of the woods. They thrive best under cultivation on sites that approximate their natural growing conditions. Therefore, a north or northeast slope is preferable, where there is a choice of slope, because north and northeast exposures do not get the full force of the sun’s rays. Such a site is cooler and more like the natural home of the wild raspberries. However, if early berries are desired, a south slope is preferable because it warms up earlier in the spring and growth starts earlier.

Air drainage is of minor importance in Colorado except in locations where the plants do not require winter protection by covering. Under these conditions the danger of winter injury to the canes is increased if the planting is located where air drainage is poor. Raspberries usually bloom late enough to escape late spring frosts.

Because irrigation is essential in Colorado, if raspberries are to be grown successfully, the slope should not be so steep as to make irrigation difficult or soil erosion a problem.

Preparations for Planting

Raspberries usually do best on land that has been under cultivation at least 1 year after being broken out of sod, and
following some intensively cultivated crop. This cultivation helps to destroy weeds and get the soil in good tilth. The land should be plowed at least 8 inches deep the fall before planting. If possible, it is desirable to plow under a heavy cover crop or coating of manure at this time. The land should be disked in the spring and worked into good condition as soon as weather permits, so that the plants can be set out early in the season. If a cover crop or manure was not plowed under in the fall, it may be desirable to apply from 5 to 15 tons of well-rotted manure per acre before working the ground in the spring.

Raspberry plantings are long-time investments and during their life require large quantities of humus. It is much easier to provide a liberal amount of humus before planting than to try to add it after planting.

**Planting**

**Source of Plants**

For most plantings it is desirable to purchase the plants from a reliable nursery. Plants can be obtained from a previous planting, and such plants should be satisfactory if they are disease-free. Unfortunately, old plantings are usually badly diseased so extreme care must be taken to get only disease-free, young plants.

All plants showing crown gall, mosaic, or any other disease or any insect injury should be discarded. Diseased plants are always weakened and therefore cannot be expected to grow vigorously or produce as much fruit as healthy plants. First-class nurseries discard such plants and sell only the vigorous, clean plants.

**Handling the Plants Before Setting**

Plants should be ordered early, and the nurseryman should be instructed 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 substitution, which may occur 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 the plants in, a trench is dug with one side sloping at an angle of 45 to 60 degrees and deep enough to allow the plants to be covered a few inches deeper than they stood in the nursery. The bundles should be un-tied and the plants spread out along the sloping side of the trench and then covered with
loose, moist soil which should be firmly tramped around the roots. If the plants have dried out in shipping, they should be soaked in water for a few hours before heeling-in.

**Setting the Plants**

Raspberries 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 to protect them over winter. Even with the best of care quite a few plants may be lost during the winter. The plants should be set early in the spring. Setting after growth starts will cause many of the tender, young shoots to be broken off and many of the new roots will be damaged. Such injured plants establish themselves more slowly than do those in the dormant state.

The ground should be worked down well just before planting. Then it should be marked off and crossmarked if the field is large. Setting the plants at the crossmarks spaces the plants and allows for cross-cultivation the first year. This eliminates much of the hoeing that would be needed otherwise.

After the ground is ready for setting, the plants should be taken out of the trench where they have been heeled-in only as fast as needed. The roots must be protected at all times against drying out. The plants should be set with the roots in contact with moist soil. They may be set by pushing a spade into the ground, then pushing it forward and setting the plants in place in the opening made by the spade. The spade is then removed and the soil tramped firmly around the roots. The plants are set just a little deeper than they were previously. This method of setting is by far the fastest and is satisfactory if the plants are in good condition and the ground has been well worked. Other methods of setting are planting in a furrow or in holes dug for each plant.

The canes of red-raspberry plants should be cut back to 6 to 12 inches from the ground when set. Black and purple raspberries should be pruned severely immediately after the plants are set, with old stems or “handles” being removed and taken from the field.

**Planting Distances**

Red raspberries are commonly set 2 to 4 feet apart in rows 6 to 9 feet apart when they are to be trained to the hedgerow system. If the staked-hill system is used, the roots should be set 5 to 6 feet apart each way.
Black and purple raspberries should be set 3 to 5 feet apart in rows 6 to 9 feet apart. Closer planting will hinder the proper development of the plants.

**Cultivation**

**Culture the First Year**  
Cultivation is as essential to successful raspberry production as it is with other crops. It should start immediately after the plants are set and should be continued through the summer frequently enough to keep the ground in good physical condition, to control weeds, and to remove red-raspberry suckers that come up between the rows. The first 2 cultivations may be 4 or 5 inches deep to stir the ground thoroughly, but later cultivation should not be more than 3 inches deep.

Cultivation should stop about August 15, except after irrigations, in order to allow the wood to ripen before cold weather. The canes usually have made sufficient growth by this time, and further cultivation would only prolong the growing period. If this occurs, the canes would go into the winter in an immature condition and might suffer considerable winter injury, especially where winter covering is not practiced. It is usually necessary to hoe a raspberry planting once or twice during the summer to keep weeds out of the rows.

Inter-crops may be grown between the rows the first season, but they should not be used later. The returns from inter-crops may more than make up for any check in growth to the plants the first year. Crops used should be those that are given thorough cultivation and that are harvested by the first of September. Beets, beans, cabbage, and similar crops are best adapted for this use. Only one row of an inter-crop should be planted between each two rows of raspberries.

**Culture After the First Year**  
Cultivation should start as soon as the canes are uncovered in the spring or as early as the ground can be worked if covering is not necessary. The first cultivation should be 4 or 5 inches deep, especially if a cover crop or an application of manure is on the ground. After this, cultivation is the same as for the first year. Cultivation should be discontinued during the picking season except following the irrigations which are necessary to supply the large amount of water required to mature the fruit properly.

**Mulching**  
Mulching of raspberry plants, which has been recommended in some eastern areas, is practical under Colorado conditions only
for small plantings such as the home garden where it is difficult to give adequate cultivation. When used, the mulch should be applied to a depth of 4 to 6 inches. Straw, hay, and strawy manure are satisfactory materials. Mulch conserves moisture because there is little chance for evaporation from the soil through the mulch. It also keeps down weeds and suckers, adds humus to the soil, and affords some protection to the roots over winter. It is desirable to remove most of the mulch each spring and work the soil before mulching again. Mulch material usually is applied only in the row, although some growers mulch the entire field.

The disadvantages of a mulch are the cost of application, the danger of forcing late fall growth with a consequent loss from winter injury in plantings that are not covered for the winter, the increased difficulty of providing winter protection in those areas where protection is needed, and the danger from fire.

**Fertilizers**

Whether raspberries can profitably be fertilized is as yet an unsettled question. There is little reliable evidence showing which fertilizer materials can be expected to give results. Most soils in which raspberries are grown in Colorado are fertile enough to produce good crops without fertilization. It is mainly necessary to maintain the humus content of the soil and to keep the soil in good physical condition.

The most satisfactory method of maintaining the humus supply is by applying manure either by spreading it broadcast over the entire planting or by mixing it with the soil as the plants are uncovered in the spring. It is then incorporated into the soil by the cultivations during the spring and summer. Manure that is fairly well-rotted and that contains considerable litter is best for this purpose.

**Irrigation**

The frequency with which raspberries should be irrigated is governed by seasonal climatic conditions and the physical character of the soil. In seasons of much rainfall, plantings naturally will require less irrigation. Showers seldom wet the ground deeply enough to provide water for the root systems and cannot be depended on to take the place of irrigation. Heavier types of soil, such as silt and clay loams, are more retentive of moisture than lighter types, such as sandy loams, and do not require as frequent irrigations. Likewise, soils containing large amounts of organic material are more retentive of moisture and do not require as many irrigations as do those lacking in organic matter.
Those which lack organic matter do not take up water readily and are difficult to irrigate. The furrow system of irrigation should always be used with raspberries.

Soon after the plants are set, shallow furrows should be made a few inches from one side of each row and a small stream of water run through them until the soil is thoroughly wet around the roots of the young plants. From this time on, the grower must rely on his own judgment as to when to irrigate. In any case, a thorough irrigation should be applied at least every 2 weeks; some soils will require water more frequently.

During the picking season, large amounts of water are needed to mature the fruits. Two thorough irrigations a week during harvest should be sufficient except on very light soils. The fruit should be picked in the morning of every other day. On irrigation days, the water should be turned in as soon as picking is over for the day. This allows the surface of the soil to dry off somewhat before the next picking. When pickers are obliged to work in a muddy field, the soil becomes packed and hard and is difficult to cultivate.

From about August 15 on, irrigation should be only frequent enough to keep the plants from suffering from lack of water. This, combined with the lessened frequency of cultivations, will check the rapid growth of the plants and cause them to mature their wood before winter and to store food for the production of the fruit crop for the following year.

In the fall just before the plants are covered for winter protection, the plantings should be irrigated thoroughly so 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 when covering the plants. Even if winter protection is not necessary, it is desirable to apply this irrigation to keep the soil from drying out during the winter since many plants may be lost by the roots dying in dry soil.

Whenever the planting is irrigated, the water should be run long enough to wet the soil down to a depth of at least 1 foot. The more thorough the irrigation the less frequent becomes the need for its application. Some growers irrigate frequently, yet their plants suffer from a lack of water simply because they do not irrigate thoroughly enough.

**Winter Protection**

In many sections of Colorado all types of raspberries need winter protection of some sort to keep the canes from dying.
Death in these areas is attributed not to low temperatures but to the loss of moisture from the canes at a rate faster than it can be replaced. This is largely due to high winds, intense sunlight, and wide fluctuations between day and night temperatures. To assure a crop, it is advisable to supply winter protection for all raspberries except in those areas where experience has shown that protection is not necessary.

The best way to protect canes from winter-killing is to cover them completely with soil to a minimum depth of 4 to 6 inches. Straw, cornstalks, manure, and similar materials are sometimes used, but none of these materials is as satisfactory as soil. Winds tend to blow coverings of these materials away, and there is always danger that they may harbor mice which sometimes cause considerable damage to canes. Deep snow does not always provide sufficient protection because the canes often are not entirely covered and the part above the snow is usually injured. This top portion often includes the most productive part of the canes.

Raspberry canes should be covered between October 15 and November 15. Fall pruning should be completed before the covering is done, and all 2-year-old wood should be removed close to the ground level. It is better not to tip the canes in the fall but to wait until they are uncovered in the spring. After the plants have been pruned, the canes are covered in three operations. First, the canes are bent down as nearly flat as possible without breaking and are weighted down at the right side of the row (fig. 1). When the canes are placed at the right side 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 canes are weighted down, one or two furrows about 6 inches deep are plowed on both sides of the row with an ordinary turning plow to throw dirt up onto the canes (fig. 2). The plowing will not completely cover the canes, so it is necessary to finish covering with shovels. The canes should be covered to a depth of 4 to 6 inches at their highest point. Often the tips of the canes will be covered several inches deep while the basal half or third of the cane may be only adequately covered. This does no harm. Canes should never be covered when they are frozen, because then they are so brittle that it is almost impossi-

![Image](image.png)

**Fig. 2.—A row of raspberries properly covered for winter protection.**

ble to bend them down to the ground without breaking a large percentage of them. Even under the most favorable conditions, it is impossible not to break some canes. It often helps to remove a shovelful of dirt from in front of the hill before the canes are bent down. This is especially desirable in old plantings where the hills may be rather root-bound. **Do not under any circumstances leave any of the cane exposed.**

The canes should be uncovered in the spring before the buds swell much and in all cases should be uncovered before the leaves begin to push out. This is usually about the first of April in northern Colorado and will vary in other parts of the State as the growing season differs from that of northern Colorado. If the canes are left covered until the leaves push out, there is great danger that they will be killed if frosts occur after uncovering. Leaves that grow before uncovering are tender and succulent
and are unable to withstand even moderately cold weather. However, if the canes are lifted before growth starts, the leaves will come out gradually and will become hardened to the prevailing temperatures. There is relatively little danger of damage resulting from early uncovering of the canes. Canes uncovered early, when the buds were swelling but before the leaves had started to push out, withstood a temperature of 4.8 degrees Fahrenheit without injury at the Colorado Experiment Station planting.

The canes are partially uncovered by plowing down both sides of the row, throwing the dirt away from the plants. Then the canes are usually lifted by thrusting a 4- or 6-tine fork under them and lifting upward with a shaking movement. This pulls the tips from under the dirt. All the dirt should then be raked out from between the canes and the row left level. If all the dirt is not removed from between the canes, a ridge will form in a few years and make adequate irrigation difficult. Some growers do not uncover the canes completely at one time but plow away the sides of the ridge and then wait a few days before completely uncovering them, thus allowing the canes gradually to become acclimated to air temperature. However, there does not seem to be any advantage to this practice.

In small plantings where plows are not available, covering may be done entirely by hand. While considerable labor is involved, it is not too difficult to be considered practical under home-garden conditions.

Pruning

The actual operations in pruning raspberries will vary with the type grown. Although the methods may vary somewhat the purpose is always the same: the equalization of vegetative growth and fruit production. This is accomplished by the fruit thinning which occurs in the removal of extra canes during pruning.

Pruning Red Raspberries

The first pruning done during the season is the removal of the old, fruiting canes some time after harvest has been finished. The time when this is done is dependent largely on the desires of the grower. Some growers remove these old canes soon after harvest, while others in areas where winter covering is not practiced may wait as late as early spring. If the plants are to be covered for winter protection, these old canes should be cut out before the covering is done. There is no need for saving these old canes since they have already produced their
entire amount of fruit and since leaving them in place makes covering more difficult. Weak, broken, and straggling canes also are removed before covering.

In Colorado, red raspberries are usually grown according to the hedgerow system of training where the sucker plants are allowed to grow at random between the old plants and out into the space between the rows. In the early spring, these sucker canes should be thinned out so as to space them from 4 to 8 inches apart each way, and the width of the row should be kept at from 12 inches to not over 18 inches. This should leave from 3 to 4 plants per running foot of row. All surplus canes should be cut off close to the ground.

In the hill system, which is sometimes used, the canes are kept in hills spaced the same distance apart as the original plants were set in the field. From 5 to 8 canes per hill should be left for fruiting (fig. 3), all others being cut out. In hill-system plantings, cultivating, spraying, harvesting, and covering are easier, but yields are usually less than those obtained from well-managed hedgerow plantings.

Moderate heading-back of canes (removing \(\frac{1}{4}\) to \(\frac{1}{3}\) of the upper parts of the canes) removes the part producing the least fruit and, at the same time, thins the crop enough to provide the proper balance between vegetative growth and fruit production (fig. 4). Severe heading-back should not be practiced since it removes part of the central or most productive part of the cane. Heading-back of canes in Colorado should be delayed until the most severe part of the winter has passed or until after
the canes are uncovered. All winter-injured wood should be removed at this time.

**Pruning Black and Purple Raspberries**

The young canes of both black and purple raspberries naturally produce long, sprawling canes which are difficult to handle. Such canes are easily bent or broken under the weight of the fruit they bear. To induce branching and development of sturdier canes, the tips of young black-raspberry canes should be headed-back at a height of 20 to 24 inches (fig. 5), and those of purple raspberries at a height of 24 to 30 inches. The purple raspberries, because of their more vigorous growth habit, are allowed to grow about 6 inches taller before heading-back than are the black-raspberry shoots. If the canes are headed-back at a much higher level, the plants become top-heavy with the weight of the fruit crop. If the canes are permitted to grow taller and then are cut back, the upper growth is cut off and wasted. Since all canes do not reach the proper height for heading at the same time, it will be necessary to go over the planting several times during the summer. Pinching or heading-back may be done with the fingers, pruning shears, or a knife.

After the canes have fruited they should be removed some time before the next season. As with red raspberries, they may be cut away soon after harvest or at a later date.

If black or purple raspberries are grown where covering for winter protection is necessary, some pruning should be done in the fall before covering. The old, bearing canes should be re-
moved if they were not taken out before, and the young canes should be thinned to 8 to 10 buds for black raspberries and 12 to 15 buds for the purple sorts. More buds are left on the purple varieties because the first few buds at the base of the laterals often bear little or no fruit.

When the canes are uncovered in the spring, the broken ones should be removed and the laterals cut back as just described unless this was done at the time of covering. The number of vigorous canes left should be reduced to about 5 to 7 per hill. It is probably better to leave all canes one-half inch or more in diameter than to try to restrict the hill to any set number. Under average Colorado conditions, the plants can mature all fruit set on such canes.

If winter covering is not necessary, the planting may be left until March before any pruning other than summer heading-back is done. By waiting until about this time the grower can tell which canes have been killed during the winter and can cut back winter-injured tips of the laterals. If this work is done the previous fall, it still will be necessary to go over the planting again in the spring to remove any injured wood. The old, bearing canes also can be left until spring unless they are diseased or infested with insects. In such cases, they should be removed and burned immediately after harvest. Where it can be done, leaving the old canes in place until spring often reduces the amount of labor needed in pruning, since then all the work may be done at one time. The old canes will also help protect the young canes from wind injury and will help hold snow.

**Harvesting**

Raspberries are ready to pick as soon as the berries can be removed easily and without injury. Fruit picked at this stage will keep and ship much better than that picked fully ripe. Raspberries should never be allowed to become dead ripe unless they are to be used at home or for strictly local markets.
The best time for picking berries is early in the morning; when there is little or no dew, pickers can start at daylight. If the dew is very heavy, it is best to wait until it has dried off somewhat. The berries are firmer in the early morning and can be handled with less damage, and pickers work better in the cooler, morning hours. Berries picked during the middle of the day are difficult to cool properly and are damaged more easily in handling.

Many growers do no grading with raspberries other than that done by the pickers in the field. If the pickers are careful to leave out unripe, over-ripe, injured, or very small berries, there is little need for further grading at the packing shed. Since raspberries are so easily injured in handling, it is much better to have the pickers do the grading in the field as the berries are picked than to rehandle them in shed grading.

**Life of Raspberry Plantations**

The economic length of life of a raspberry planting should be determined entirely by the returns obtained from it. Whenever a planting reaches the stage where it will return less profit than a young planting, it should be removed and a new one started. There are many red-raspberry plantings in Colorado which are 20 or more years old. It is very probable that their maximum productive age passed years before and that they should have been replaced at an earlier date. The length of profitable production depends on a number of factors, chief of which are soil, disease incidence, and general care. A normal plantation should be profitable for 10 to 12 years.

**Raspberry Diseases**

There are only a few serious raspberry diseases in Colorado. Fortunately certain practices, if carried out from year to year, will prevent undue losses.

A prospective grower should (1) buy clean stock from an inspected nursery, (2) set his plants out in a field which has not been used for brambles or nursery stock, (3) remove and burn any abnormal-appearing raspberry plant after the young plants have become established, and (4) consistently follow a seasonal spraying plan. In general, a program such as this will go far in the prevention of disease losses.

**Mosaic and Related Troubles**

**General.**—There are four recognized virus diseases of raspberries: streak, mosaic, yellow mosaic, and leaf curl. The average grower would have difficulty in distinguishing each of these dis-
eases. However, there are certain simple rules which if followed will aid in checking the development and spread of any of these virus diseases. Any plant which shows (1) stunted shoot growth (fig. 6) and short laterals, and (2) either curled leaves, wrinkled leaves, yellowed leaves, mottled leaves (fig. 7), or leaves showing downward cupping at the margins, should be regarded with suspicion. Stock should not be obtained from nurseries where any plants show such symptoms. Further, plants showing such symptoms should be removed and burned promptly.

Since mosaic is the most serious of these virus diseases in Colorado, it will be given detailed consideration.

**Red Raspberry Mosaic.**

Mosaic is probably the most serious raspberry disease in the State. It affects most varieties of raspberries, including reds, blacks, and purples. On red raspberries the symptoms of the disease appear when the leaflets first unfold in the spring. The affected leaflets show a “mosaic” or mottled pattern, usually consisting of irregular, green and yellow areas. The green areas, as a rule, are raised or elevated in a blister-like fashion. The stems of diseased plants tend to be short and spindly with shortened lateral shoots. Infected plants generally are stunted, producing less fruit and fruit of inferior quality. The leaf symptoms of mosaic may disappear or become “masked” during hot weather. One of the few varieties of red raspberries which does not appear to be ser-
triously affected by mosaic is Latham. It is considered to be resistant to the disease, but it actually becomes infected and may act as a "symptomless carrier" of the virus of mosaic. Where mosaic is very serious, the planting of the Latham variety exclusively may be the most practical way to control the disease.

![Image of healthy and infected raspberry leaves]

**Fig. 7.—At the left, a healthy red-raspberry leaf; at the right, a leaf badly infected with mosaic.**

Mosaic is even more destructive on black raspberries. New shoot growths are usually stunted and show brownish, discolored streaks developing from the tips downward; eventually they may become brittle and die. The leaves on affected shoots often turn yellow, showing reddish-brown to black spots or elongated blotches on the leaf stems (petioles). In general, the leaves of mosaic-infected black raspberries show less mottling than infected red varieties.

**CONTROL.—**Mosaic can usually be controlled by the following practices: (1) Planting healthy stock obtained from inspected nurseries, (2) where red raspberries alone are desired, plant the variety Latham exclusively, (3) separating black- and red-raspberry plantings by at least 300 feet, and (4) removing and burning diseased plants as soon as they are detected. It is advisable to kill lice on an affected plant by flaming the leaves with old newspapers or a torch before the plant is disturbed, because the mosaic virus is carried from diseased to healthy plants by
the plant louse (*Amphorophora rubi*). After the plant has been thoroughly flamed, it should be removed and burned with roots intact.

**Crown Gall**

Crown gall is a fairly serious disease in Colorado. It is characterized by the appearance of rough, spongy, gall-like growths on the roots (fig. 8) and frequently on the canes, espe-

![Crown-gall development on a young raspberry plant.](image-url)
cially near the ground line. All varieties of raspberries, black-caps, reds, and to a lesser extent purples, are susceptible to crown gall.

Crown gall is caused by soil-borne bacteria (*Phytomonas tumefaciens*). The crown-gall bacteria escape from decaying galls and are thus freed into the soil. They may then enter unaffected plants through wounds, attack the plant tissue, and bring about the development of galls.

CONTROL.—Since the causal agent of crown gall lives over in the soil from year to year, it is best to plant raspberries on ground not previously planted to bramble crops, orchard crops, or woody nursery stock. The best soil to use, where crown gall is a problem, is land previously planted to grain since the crown-gall organism apparently does not attack cereals or grasses.

Of equal importance is the care in the selection of nursery stock. Any plant showing galls on the roots or canes should be discarded. A plant which develops crown gall after planting should be immediately removed, with roots intact, and burned.

**Spur Blight**

Spur blight is of common occurrence in the State although it has not caused serious losses. The disease is characterized by the presence of chocolate-brown to purple-brown discolorations on the young canes just below the leaf stems (fig. 9). The disease usually first appears on the lower portions of the canes and spreads upwards. The buds on canes may shrivel and die and frequently the leaves may fall off, leaving bare portions of the cane. The affected parts of the canes eventually become brownish-gray and often split. In the fall of the year, minute black pimple-like bodies usually appear on the margins of some of the lesions. These bodies contain the over-wintering spores of the causal fungus.

Spur blight is caused by a fungus (*Mycosphaerella rubina*). The spores found in the black bodies on over-wintering canes are discharged in the spring, infecting young shoots. Later in the spring and in early summer, other spores are produced which continue to bring about infection.

CONTROL.—Where spur blight is a problem, strict sanitation together with a spray program should be followed. Old canes showing indications of infection the previous year should be pruned and burned. It is a good practice to prune all old canes and burn them soon after the berries are picked. A spray pro-
Fig. 9.—Spur blight on raspberry. 1. Petiole infection; 2, infection at node; 3, dead stem of a leaf that died from lack of nourishment; 4, cortex cracked and exposing the tissue beneath.
gram consisting of three sprays is advisable. This program is outlined as follows:

1. Delayed dormant spray

Apply in the spring after growth has started (leaf and shoot growth just noticeable). Use 4-4-50 bordeaux mixture or liquid lime-sulfur (10 gallons of concentrated liquid lime-sulfur per 100 gallons of water).

2. First summer spray

When the new canes are 3 to 4 inches high apply 4-4-50 bordeaux or liquid lime-sulfur (2 gallons concentrated liquid lime-sulfur to 100 gallons of water).

3. Second summer spray

Apply just before bloom. Be sure to cover new canes thoroughly. Use the same materials recommended for the first spray of the season.

Cane Blight

Cane blight is a disease which is apparently of minor importance in Colorado. This is fortunate since it is difficult to control. The first obvious symptom of the disease is that of wilting of the leaves of a cane. If this occurs the entire length of the cane should be examined for light-colored diseased areas. These are the lesions caused by the cane-blight fungus, *Leptosphaeria coniothyrium*. The wood under such lesions is usually dry and brown. Above and below the diseased area the bark and wood may be normal and healthy. Later in the spring and early summer small, black, pimple-like bodies appear on the lesions surrounded by darkened smudged areas. The smudged areas consist of the summer spores of the fungus which are capable of entering wounds such as insect punctures or those caused by pruning. Cane blight usually starts at a pruning wound and works downward, killing the branches as it advances.

The causal fungus of cane blight forms over-wintering bodies in the affected canes. In the spring spores are produced from these over-wintering bodies and are carried by rain, insects or tools to wounds and thus initiate new season infection. The cane-blight fungus may live in dead canes for several years.

CONTROL.—The only successful measures in controlling cane blight are: (1) Setting out plants free from infection, (2) pruning and burning old canes as soon as the fruit is harvested, and (3) where possible, avoiding undue wounding of canes.
Raspberry Pests

A number of insect pests frequent raspberries. The more important ones are briefly described with suggestions on identity and control. Timely control of insect pests is most important.

**Common Red Spider, Tetranychus telarius L.**

The healthy green plantation assumes a faded, dull, yellowish or brownish cast when the common red spider is present. The injured plants assume a rusty appearance, and the underside of the leaf is usually covered with a fine silken webbing. On the upperside of the leaf fine, pin-point, light spots may occur especially along the larger veins. With a severe infestation leaves may turn brown on the edges and drop. Plants infested with mites are weakened and the fruit does not ripen normally.

The nearly microscopic adults over-winter under rubbish and emerge in early spring to multiply rapidly. The young nymphs and adults suck plant juices. There are several generations a year and rainy weather is unfavorable for their development.

Control must be started early in the spring. At least two sprays or dusts, with a 10-day to 2-week interval, are required. The spray or dust must be applied with sufficient force to reach all parts of the plant, especially the underside of the leaf. Sulfur is used widely but should not be used on berries as they approach market size or when the temperature is high. Use a 300-mesh dusting sulfur, 1 pound to 5 pounds of talc; or liquid lime-sulfur, 1 gallon to 40 gallons of water; or 1 pound of wettable sulfur to 20 gallons of water. Oil sprays, 1 to 2 percent (3 to 4 quarts summer oil emulsion to 100 gallons of water) give good control and are less likely to cause burning than is sulfur.

**Four-spotted Tree Cricket, Oecanthus 4-punctatus Bent**

Tips may wilt or canes may split or break, particularly when being bent over for winter covering, if this insect is present. Splitting or breaking is due to rows of punctures 2 or 3 inches in length running lengthwise of cane and extending into pith. In each puncture will be found an egg which hatches in the spring.

Nymphs upon hatching do very little damage during the season and mature in the fall to become pale-green adults, somewhat like a cricket and with an antennae sometimes longer than the slender body.

Cutting out and burning all infested canes in the fall or early spring may control the pest. Where the tree crickets are
abundant, spray the shoots early in the summer before the fruit is set, with lead arsenate (4 pounds to 100 gallons of water).

**Raspberry Root Borer, *Bembecia marginata* (Har.)**

Canes infested with the raspberry root borer show a sudden wilting particularly lateral growth starting in the spring. An examination of the crown and the cane near the crown will disclose tunnels in the wood that have been made by yellowish-white larvae.

Two years are required for a generation. The adults are clear-wing moths with a wing expanse of 1 inch. The body is marked with four yellow bands. They emerge in late summer and eggs are deposited on the leaves and stems. Upon hatching the young worms burrow into the canes near the ground line; they feed a short time and then construct a cell in which they spend the winter. The following growing season is spent in the canes and the second winter is passed in the crown. Growth is continued the second spring, then pupation and the moths emerge in late summer, thus completing a 2-year cycle.

Control consists of removing the infested canes as close to the ground as possible. If this is done, root borers seldom become numerous.

**Raspberry Fruitworm, *Byturus unicolor* Say**

Berries affected with the raspberry fruitworm ripen earlier, are often smaller, may be distorted and crumbly, and are unfit for market.

Small light-brown beetles deposit eggs on the blossoms and young fruits. The eggs hatch into slender white worms which feed and develop inside of the berry. They become full grown about the time the berry ripens and fall to the ground and pupate in the soil. The beetle, after spending the winter in the soil, emerges about the time the plants bloom.

Shallow cultivation will destroy some of the insects. Where the infestation is serious, control may be secured by three applications of derris or cube spray containing .012 percent rotenone (2 pounds of ground cube or derris root containing 5 percent rotenone in 100 gallons of water), or dust containing 1/2 percent rotenone in talc, applied at weekly intervals beginning about 10 days after the blossoms appear.
Raspberry Cane Maggot

Canes infested with raspberry cane maggot show a sudden wilting or dying of the terminal leaves with purple discoloration at the point where the maggot is girdling the cane.

Removing and burning the wilted canes as soon as they are observed is the only means of control.

Rose Leafhopper, *Typhlocyba rosae* L.

The rose leafhopper adults are light colored and about one-eighth inch long. The nymphs are a light green color and found on the undersides of leaves.

Nicotine dusts or sprays applied on the nymphs before they reach the adult stage usually give control. Pyrethrum dusts containing 0.2 percent pyrethrins are effective.

Aphids, *Aphis rubicola* Oest. and *Amphorophora rubi* Kalt

Aphis control is important to prevent transmission of raspberry leaf-curl virus and red-raspberry mosaic. If the aphis are present in numbers, they may be controlled by the use of nicotine dusts or sprays.

Grasshoppers

Grasshoppers may become so numerous that they will defoliate raspberries. They also will feed on the ripening fruit.

Thorough cultivation to expose the eggs aids in keeping down the numbers of this insect. Where cultural practices fail to control, poison baits have been the most efficient and economical means of control. Most counties, under the leadership of the county extension agent, operate poison bait mixing plants. This bait, scattered along ditch banks and fence rows when the hoppers are small, gives the best control. Two or three baitings a week may be necessary when adult hoppers are migrating to the raspberry patch.