

RASPBERRY
GROWING
in MICHIGAN

By R. E. Loree

MICHIGAN STATE COLLEGE
EXTENSION SERVICE
EAST LANSING

CONTENTS

	PAGE
Cost of establishing the plantation	3
Production costs	4
Yields and profits	4
Selection of the site	4
Soil preparation	6
Plants and planting	7
Propagation	7
Obtaining and handling the plants	8
Time of planting	9
Systems and distance of planting	9
Contour planting	11
Setting the plants	11
Care of the plantation	12
Cultivation	13
Cover crops	14
Intercrops	14
Mulching	14
Maintaining soil fertility	15
Manures	15
Commercial fertilizer	15
Pruning and training	16
Harvesting	22
Life of the plantation	23
Insects infesting raspberries	24
Diseases of the raspberry	27
Bacterial and fungous diseases	27
Virus diseases	32
Programs for disease control	34
Notes on varieties	36

Issued as Circular Bulletin 152 of the Michigan Agricultural Experiment Station, October 1934

Second Printing, February 1936

First Revision, October 1941

Second Printing of First Revision, April 1944

Second Revision, May 1946

Re-issued (and Revised) as Extension Bulletin 287 of the Michigan State College

Extension Service, February 1948

Raspberry Growing In Michigan

By R. E. LOREE

The raspberry is one of the more important fruits in Michigan. Both red and black raspberries are commonly found growing wild, and the standard domesticated varieties are well adapted for cultivation in most sections of the state.

The success or failure of a commercial plantation will depend largely upon the choice of soil and location, securing disease-free plants, methods employed in establishing and maintaining the plantation, and the grower's ability to manage the harvesting and marketing of the crop.

The acreage planted should be governed by the type of market which one intends to supply. Usually the most profitable plantations are those located near the larger towns and cities where the fruit can be marketed quickly and economically and where pickers can be secured readily. In many towns and cities, the demand for good raspberries far exceeds the supply. Such markets furnish excellent opportunities for those who have nearby locations and sufficient labor to harvest and care for the crop. The grower should consider the possibilities of these markets and make sure that they are well supplied with berries before consigning fruit to more distant or general markets.

Another outlet for the crop is the commercial cannery. Although the prices paid by canneries are usually somewhat lower than those in the fresh fruit markets, the difference is not large when the cost of crates and baskets and the convenience of disposing of the crop are taken into consideration. Growers in the vicinity of commercial canneries should find raspberry growing fairly profitable, provided good management methods are used in the plantations and relatively large yields are obtained.

COST OF ESTABLISHING THE PLANTATION

No figures are available on the cost of establishing a plantation under present economic conditions. If all the labor of planting and care is given by the owner, the cash outlay will be reduced. The net cost may be further reduced by growing cultivated crops between the rows the first season.

PRODUCTION COSTS

Cost studies on 70 Michigan farms having both red and black raspberries show that the average total pre-harvest cost in 1943 was \$122.31 per acre. The cost for labor, power, and materials amounted to \$61.96 and overhead costs, including depreciation on plantation, interest and management, were \$60.35.*

YIELDS AND PROFITS

Profit or loss in raspberry production depends primarily on yield per acre. High yields can be realized only by a judicious selection of soil and site and by skillful management in establishing and maintaining the plantation.

Average yields in Michigan raspberry plantations are relatively low. The average yield from 70 Michigan farms for the 3-year period 1941-43, was 1,077 pounds or about 715 quarts per acre. The yield is far below that of some of the other leading raspberry states and much lower than that obtained by the better growers in Michigan. Yields of 1,200 to 1,400 quarts per acre are not uncommon, and in well-managed plantations on good soils it should not be unreasonable to expect yields as high as 2,000 quarts or even 3,000 quarts or more per acre.

SELECTION OF THE SITE

The site or location upon which the planting is made is probably the most important factor in determining the success or failure of the raspberry plantation. In seasons most favorable for raspberry production, large yields are sometimes obtained in poor locations, but a good site is necessary if high yields are to be obtained regularly throughout the life of the plantation.

The Soil—Raspberries can be grown on almost any type of soil, provided it is retentive of moisture and well drained. They succeed best on soils ranging from a sandy loam to a light clay loam. They seldom do well on heavy clay. Some varieties prefer the heavier types of soil, but a fine, deep, sandy loam well supplied with humus usually will be best suited to the varieties which are commonly grown in this state. Light sands should be avoided. They usually lack fertility and tend to dry out quickly. The acidity of those soils that would ordi-

*Data from Department of Farm Management, Michigan State College.

narily be selected for raspberry culture is seldom a limiting factor in the growth and productiveness of raspberry plants.

The successful growth of raspberries may depend on the character of the subsoil even more than that of the surface soil. Variations in the subsoil type are more or less common and these differences are often responsible for poor stands and weak or uneven growth of plants in many fields. For this reason, a careful examination of the subsoil at several points in a field intended for raspberries is very important. The most suitable subsoil is one that is sufficiently open or porous to permit good under drainage and yet will retain considerable water. Soils with a high water table or a hard pan close to the surface should be avoided.

The Moisture Supply — Whenever possible, a soil that will furnish an ample supply of water at all times should be selected. Good drainage, however, is very important and often contributes much to the success and longevity of the plantation. The soil should be moist and very retentive but never soggy and wet. The root system of the raspberry plant in good soil usually extends to a depth of about 3 feet, with the bulk of the roots in the upper 2 feet. Hence, the water level at no time should be within 2 or 3 feet of the surface for a very long period. A careful study of soil and subsoil conditions with special reference to drainage should be made before selecting a site for a raspberry plantation.

Air Drainage — Whenever possible, a gently sloping site somewhat higher than surrounding land should be chosen. Low lands or valleys which have no natural outlet for the heavy cold air which settles in from higher levels should be avoided. Soil conditions are often more favorable on such lands but the plants are more subject to injury from late spring frosts and winter freezing than those grown on the higher and more favorable situations. Mildew and other fungous diseases are likely to be more serious where the air drainage is poor. Hilltops or steep slopes are undesirable because much fertility may be lost and the plants injured as a result of excessive washing of the soil.

Protection from high winds should also be taken into consideration when selecting the site. The black raspberry in particular is characteristically weak at the crown and both the new shoots and the fruiting canes are easily broken over by winds. Protection from winds prevents much of this breakage of the canes, and loss of fruit from whipping. Also, there is less evaporation from the soil and the canes, and consequently less winter injury.



Fig. 1. Root development and penetration are closely related to the height of the water table. This plant was grown in a location in which the water level was high—9 inches from the surface at two different times in the spring. The working level of the roots was only 7 inches and the maximum penetration 10 inches. The plants produced an average of only one-half ounce of berries each.

If there is a choice of slopes, the northern exposures are to be preferred. They are cooler and more moist than the other exposures, and these conditions are more favorable for the production of large fancy berries. Raspberries should not be planted on the site of an old plantation within at least 4 or 5 years after the old patch has been destroyed. It is not advisable to plant black raspberries on fields which have recently been cropped with potatoes or tomatoes because certain wilt-producing fungi are often present in the soil following these crops and may attack the raspberries.

SOIL PREPARATION

The plants should not be set on newly plowed sod land. All weeds and grass should be thoroughly subdued. It is advisable to grow a hoed or cultivated crop on the land for at least one year immediately preceding the planting of raspberries. If the soil is deficient in humus, a liberal amount of organic matter in the form of stable manure or green manure crops should be plowed under and well incorporated with the soil. Clover is one of the best crops to use for this purpose.

This will improve the texture of the soil and increase its water holding capacity. In the final preparation, the soil should be plowed deeply and disked and harrowed until it is in a fine mellow condition. Plants which are set in well-prepared soil become established more quickly and less hand-work is necessary in caring for them during the first and succeeding seasons.

PLANTS AND PLANTING

Propagation—The red raspberry is commonly propagated by transplanting the suckers or shoots which grow up from the underground stems. These may be dug and set directly in the field or they may be grown a year in the nursery row, when they are known as transplants. The higher cost of one-year transplants which are offered by nurserymen is not warranted for commercial planting. For the home garden, however, these transplants may be desirable, because they need not be pruned as severely as the sucker plants and, consequently, bear some fruit the first year.

The best plants for starting a new plantation are the suckers which come up in the fall after cultivation has ceased. Those that reach a height of 12 to 18 inches make excellent plants. They should not be pulled from the soil, but should be carefully lifted with a spade, care being taken to obtain as much of the root system as possible.

Red raspberries also may be propagated by means of the young green sucker plants which come up in the spring. These may be dug and transplanted in early June or as soon as they are a few inches high. Better results, however, will be obtained if the suckers are allowed to grow until they are somewhat hard or woody at the base. The young sucker should be dug with a piece of the old root attached and the top should be cut back to good, firm tissue when it is planted. When moisture conditions are favorable a good stand of plants may be obtained by this method. Its chief advantage is that it permits the selection of healthy plants, as mosaic and curl may be readily detected in the foliage of the young shoot.

The black and the purple raspberries are propagated by tip layering. Late in the summer, usually about the end of August, the ends of the canes bend to the ground and the tips lengthen rapidly and bear small curved leaves. These tips develop roots readily when in contact with moist soil, and many of them root naturally if not disturbed by cultivation.

When a large number of plants is desired the rooting of the tips is facilitated by bending the longer branches of canes to the ground and covering them with soil. This is commonly done by opening a hole in the soil with a spade, inserting the tip to a depth of about 3 inches and pressing the soil firmly against it so that it will not be whipped out by winds. Larger quantities of tips may be obtained from a plant by pinching back the main shoots in early summer to induce the formation of laterals. These laterals usually will grow enough by early fall to permit their use for tip production. The new plants may be dug in the fall, but it is best to leave them until the time of transplanting in the spring. They are then removed by cutting off the parent cane or lateral a short distance above the ground and carefully lifting them with a spade to avoid damaging the roots.

Obtaining and Handling the Plants—Only the best plants obtainable should be used for starting a new raspberry plantation. Those which are healthy and vigorous and with good root systems will give the best results. The most desirable plants are those from young vigorous plantations. They are usually more thrifty and freer from insects and diseases than those from old neglected plantations. It is an advantage to have good home-grown plants or to obtain them from nearby plantations as these may be set out soon after they are dug.

Every possible precaution should be taken to prevent the introduction of any of the serious raspberry diseases into the new plantation. It is unwise to dig or accept plants from any field which has not been inspected and rogued for diseased plants. The plants should be obtained only from carefully inspected and certified nurseries or plantations. If the plants are propagated at home, only the strongest plants should be selected. Plants with galls on their roots or those which otherwise show evidence of disease should not be set.

Raspberry plants require careful handling between the time of digging and the time of setting in the field. They are easily injured by heat or by dry atmospheric conditions. They should always be kept cool and moist. The plants should be set in the field as soon as they are received from the nursery, and, if for any reason they cannot be set immediately they should be heeled in. This is done by digging a trench, placing the roots of the plants in it, and covering them with moist soil. It is best to open the bundles and arrange the plants in a single row along the trench in order that the soil may be brought in close contact with all of the roots. Sometimes it is desirable to wet

the roots, or, if they are very dry, to soak them for a few hours before the plants are heeled in.

Time of Planting—Red raspberries may be planted either in late fall or early spring. Generally, good results have been obtained with fall planting but some growers seem to be more successful when the work of transplanting is done early in the spring. When the plants are purchased from a nurseryman, fall planting may be more successful because the plants received in the fall are freshly dug, while those purchased in the spring may have been held throughout the winter under unfavorable storage conditions. Fall planting is advantageous because it permits the work to be done at a time when other work is comparatively light and the plants can become established during the winter, thus enabling them to take advantage of the first growing weather in the spring. It has the disadvantage that the plants may be seriously damaged by winter injury or by heaving of the soil. This may be prevented by plowing a furrow up to the rows of plants or by mulching them with coarse straw or strawy manure.

The black and the purple varieties, which propagate by tip layering, should always be planted in the spring. Spring planting of raspberries should be done as early as the soil can be prepared to receive the plants. Early setting enables the plant to become well established before the hot, dry weather of summer. Furthermore, the raspberry plant starts growing early and there is always danger of breaking the growing tips or shoots when the planting is done late. Late spring planting often results in poor stands of plants and unsatisfactory growth the first season.

Systems and Distance of Planting—Raspberries are grown according to several systems of culture. The plants may be grown in hills so that cultivation may be practiced in both directions in the plantation or they may be kept in rows and cultivated in only one direction. Under the row system, the growth may be restricted to the original plants or crowns to form what is known as the linear system, or the sucker plants of the red raspberry may be left to form a more or less solid row, in which case the method is referred to as the hedge system or the hedgerow method of culture.

The distance between the rows and between the plants in the row are determined by the planting system used, the type and vigor of



Fig. 2. Black raspberries grown according to the linear system. The young shoots are pinched back when they are about two feet high.

the variety, the fertility of the soil, and the moisture supply. When grown according to the hill system, the plants are usually set 5 feet apart each way, though the distance varies from 4 by 6 to 8 by 8, according to the preference of the grower. The latter distance permits the use of two-horse tillage implements. This system has the advantage of requiring less handwork in controlling grass and weeds as the cultivator can be run in both directions. Also, the berries are more easily picked. The chief disadvantage of the hill system is the low acre-yield which is obtained, especially when the wider planting distances are used.

Red raspberries are most commonly grown according to the hedge-row system. This system has some disadvantages but usually these are more than compensated for by the large yields made possible because of the greater number of canes. The plants are usually set about 3 feet apart in rows spaced from 6 to 12 feet apart, the distance depending on the method of cultivation to be employed. The rows are commonly spaced 8 or 9 feet apart for team cultivation and 10 feet or more if a tractor is to be used in the plantation. The red varieties are also grown

successfully under the linear system. In this system, the plants are set 4 feet apart in rows 8 feet apart. A minimum of work is necessary with this system but generally it will not be found as satisfactory as the hedgerow system.

The black and the purple raspberries are usually set 3 or 4 feet apart in rows 7 or 8 feet apart. Because of the necessity of spraying these varieties, the wider spacing of the rows is recommended. Closer planting in the row will tend to reduce the amount of breakage of the new shoots and of the bearing canes in the plantation.

When the plants are to be set according to either the hedge or the linear system, it is advisable to check the rows in both directions. Cross cultivation may then be practiced for the first season or perhaps longer. This will eliminate considerable handwork and reduce the first year's expense.

Contour Planting—On sloping sites which may be subject to erosion, the rows should be arranged to run across the slope according to the contour and all cultivation should be in line with the rows in only one direction. This will help check water run-off and loss of valuable topsoil. When contour plantings are properly laid out, the results will be satisfactory provided the slope is regular and not too long or too steep. If the slopes are irregular or the topography such that serious soil and water losses are likely to occur, the grower is advised to obtain information regarding the proper methods of laying out the plantation and soil management practices which will be most effective in erosion control. Assistance in soil conservation and contour planting may be secured locally through the County Agricultural Agent and the Soil Conservation Service.

Setting the Plants—The tops of the plants should be cut back to a height of 6 inches or less either before or immediately after planting. Red raspberries will start better if not more than 4 to 6 inches of the cane are left above ground. When setting the black or the purple varieties, all of the old cane or "handle" should be removed or entirely covered with soil to prevent the spread of the anthracnose disease which may be present.

The plants should be set a little deeper than they previously grew in the soil. Red raspberry plants may be set as much as 3 or 4 inches deeper, but care should be taken not to cover plants of the black varieties too deeply or the tips may be smothered. They should be set so that the tips are not covered with more than 1 or 2 inches of soil.

The operation of setting the plants is usually done with a shovel or a spade. They are also set by what is known as the furrow method. Spade setting is most easily and quickly done by two men. One makes an opening in the soil with a spade, the other inserts the plant in the space which is opened, after which the spade is removed and the soil pressed firmly against the roots. In the furrow method, the row is furrowed out with a plow, the plants set against the straight side of the furrow and covered with soil. Later, the furrow is filled with a plow or by subsequent cultivation. This method is especially adapted for setting plants of the black and the purple varieties, as it permits deeper planting without danger of smothering the tips. It is best to cover the plants lightly at first and, as the new shoots develop to fill in the furrow by cultivation. The crowns of plants set in this manner are well below the surface of the soil so that they are less likely to suffer from drouth or breakage of canes by winds than those with shallow crowns.

During the planting operations, some precautions are necessary to prevent the plants from drying out. When carried to the field, they may be protected by wrapping in damp burlap or by covering with wet moss, and when setting is being done only a few should be dropped ahead of those who are doing the planting. Sometimes, it is an advantage to dip the roots in rather thick muddy water just before the plants are set. This will form a coating on the roots which will partially protect them from the sun and wind. When setting plants of the black and the purple varieties, particular care should be taken in firming the soil about the roots to avoid injuring the young growing tips which are tender and easily broken.

CARE OF THE PLANTATION

Although considerable emphasis has been placed upon the importance of a good site and healthy planting stock, these do not insure success in raspberry production. Healthy plants in an ideal location will not yield profitable crops if neglected. Good care and management are necessary to maintain the plantation in a productive condition. Profits depend primarily on yield and good care is one of the factors which make it possible to obtain large yields in the raspberry plantation. Economy of labor is often necessary to reduce production costs; nevertheless enough time should be given to insure care and thoroughness in cultivating, pruning and other field operations.

CULTIVATION

Cultivation should begin soon after the plants are set and in established plantations as early in the spring as conditions permit. Thorough and regular cultivation is necessary to destroy grass and weeds and thus to conserve moisture. These should not be permitted to grow in the plantation as they not only take needed moisture from the soil but are difficult to eradicate when they become established in the rows, and interfere with the development of the canes. Spring tillage in the established plantation consists of shallow plowing or disking, after which the soil is kept in fine mellow condition by frequent stirring with a cultivator or harrow.

Frequency of Cultivation—The amount or frequency of cultivation will depend on seasonal conditions, the soil type, and the prevalence of weeds. Some growers find it necessary to cultivate as often as once a week in order to control weeds and to conserve moisture in dry seasons. The soil should be stirred as soon as possible after each rain to prevent a crust from forming and frequently thereafter to maintain a loose surface mulch which will permit light rains to penetrate comparatively deep.

Depth of Cultivation—Cultivation should be relatively shallow, especially near the plants. A depth of 3 or 4 inches is usually sufficient. Deeper cultivation will result in much injury to the roots which will cause the plants to suffer from lack of moisture and in the red varieties excessive suckering is likely to occur. It is a good practice to shorten the cultivator or harrow teeth which run close to the plants in order to disturb the young roots as little as possible.

When to Discontinue Cultivation—Usually cultivation is discontinued at the beginning of the harvesting season. Some growers make it a practice to cultivate between the rows after each picking. The practice may be profitable especially in a dry season. However, the berries often become dirty and dusty during cultivation and, unless the plants are staked or trellised, it is difficult to use a cultivator without knocking off many berries or injuring the canes.

After harvest, one or more thorough cultivations are necessary to loosen the soil which has been packed by the tramping of the pickers and restore it to good condition. Cultivation should not be continued long after the harvesting season as the late tillage tends to induce new growth which may not fully mature and hence is subject to winter injury.

Cover Crops—A cover crop should be sown in the plantation at the time of the last cultivation which is usually about the middle of August. Although cover crops are used by many raspberry growers they are not employed as much as they should be in Michigan plantations. They afford one of the best sources of organic matter which is very essential for maintaining the physical condition of the soil and they aid in ripening the canes by competing with them for moisture and plant nutrients thus preventing a late fall growth and consequently winter injury.

The most suitable cover crop plants are those which die during the winter. Oats are probably as satisfactory as any crop for the purpose. The seed is usually cheap and readily obtained, and oats make an abundant fall growth which is not killed by the first frosts. They may be drilled or broadcast at the rate of 2 bushels per acre. Barley, buckwheat, and millet are also fairly satisfactory cover crop plants. Crops which live over winter such as clover and vetch and rye are usually unsatisfactory. If used, these crops are drilled or sown carefully between the rows where the growth is accessible for turning under very early in the spring. Otherwise, they will become established in the rows and considerable handwork may be necessary to eradicate them.

Intercrops—During the first season, a hoed or cultivated crop may be grown between the rows. Those which need cultivation during early spring and summer such as beans, peas, cabbage, and cauliflower are best suited for this purpose. Tomatoes and potatoes should not be interplanted with raspberries because of the susceptibility of the raspberry to wilt diseases which may be brought into the plantation by the tomatoes or potatoes. No intercrop should be grown with the raspberries after the first season.

Mulching—On small areas, a mulch of straw, hay, leaves, or similar material may be used to advantage. A mulch of this sort checks evaporation and smothers weeds and thus takes the place of cultivation. On account of its cost and the frequent difficulty of obtaining suitable mulching material, the practice is not recommended for large commercial plantations. Once the mulch is applied, it should be replenished each season as the roots are brought close to the surface and some injury may result if the mulch is allowed to disappear entirely.

MAINTAINING SOIL FERTILITY

On fertile well-drained soils which are well supplied with humus there is little to be gained from the use of fertilizers. Such soils apparently furnish the plants with an ample supply of the necessary plant nutrients and additional amounts in the form of fertilizer are seldom necessary. However, there are undoubtedly many lighter, less fertile soils which would be benefited by applications of stable manure and perhaps some commercial fertilizer. Deficiencies in moisture, poor drainage, poor culture, and the prevalence of disease limit growth and production more often than the lack of mineral nutrients in the soil. Moreover, it has been demonstrated that in fields where such conditions prevail the plants will not respond profitably to fertilizer treatments even though the soil may be deficient. When cane growth and yields are unsatisfactory, the grower should make every possible effort to correct unfavorable soil conditions and eliminate diseases before attempting to increase yields by the use of fertilizers.

Manures—Stable manure usually gives the best results and where it is obtainable it probably furnishes the best means of enriching the soil in the raspberry plantation as it not only supplies large amounts of organic matter but also some mineral plant nutrients. If available, it should be used liberally when preparing the soil for planting and also in the bearing plantation. An annual application of about 10 tons per acre is usually recommended. This amount should maintain a good supply of humus and should keep the soil in productive condition. The manure should be applied during late fall and winter or very early in the spring before growth starts. Poultry manure may also be used advantageously. It contains considerable amounts of nitrogen as well as small amounts of other mineral nutrients and adds some organic matter to the soil. It should be applied at the rate of about 2 tons per acre.

Commercial Fertilizer — When manures are not available, the humus content of the soil should be maintained by the annual growth of cover crops and in fields where cane growth is unsatisfactory some commercial fertilizer may be used. The results of field experiments with fertilizers on raspberries indicate that the nitrogenous fertilizers such as nitrate of soda and sulphate of ammonia are most likely to be beneficial. There is no evidence that either phosphorus or potash can be used profitably in the raspberry plantation. On some soil, an appli-

cation of 300 to 400 pounds of superphosphate per acre may be useful in promoting a better growth of cover crop, but its use in the plantation is not recommended otherwise.

When nitrogenous fertilizers are used, sulphate of ammonia applied at the rate of 200 to 250 pounds per acre will be found satisfactory. Nitrate of soda and other quickly available forms of nitrogen give equally good results if the rate of application is such as to provide an equivalent amount of nitrogen. The best time to apply the fertilizer is in early spring about the time growth starts. It should be evenly distributed fairly close to the rows and not applied directly on the hills or crowns of the plants.

PRUNING AND TRAINING

Manner of Fruit Bearing—The manner of fruit bearing is essentially the same in all types of raspberries. Each season new shoots are developed from buds at the base of the old canes or from buds which are formed on the roots. These shoots develop into canes which complete their terminal growth the first year. Fruit buds are formed during the summer and in the spring of the second year these develop into short side branches or laterals upon which the fruit is borne. Soon after the berries ripen the canes die. The canes are therefore biennial, that is, living for a part of two years; and the roots are perennial, living for many years and producing new shoots each season. A few varieties of the red raspberries such as Ranere (St. Regis) bear fruit on the tips of the new canes in the fall and the part of the cane which has not borne fruit bears the following summer.

Removal of Old Canes—Each year, the old canes which have borne fruit should be removed from the plantation. Most growers remove them soon after harvest, but they are often left until winter or until the time of pruning in the spring. By removing them immediately after harvest some insects and diseases which may be harbored in them may be destroyed and it is thought that the new shoots having more room will make a better growth. There is also an opportunity to thin out the weaker shoots at this time, thus throwing all of the energy of the plant into the development of those which are left.

In plantations which are exposed to winds or where deep snow is likely to cause breaking of the canes during the winter, it is undoubtedly an advantage to leave the old canes in the field until spring. However, the problem of disease and insect control is likely to be

serious in the average plantation, and as a sanitary measure it is probably best to prune out the old canes and burn them as soon as possible after harvest.

Thinning New Shoots and Canes—In addition to the new shoots which are developed from buds at the base of the old canes, the red raspberries produce shoots called suckers from their roots. Some varieties produce suckers rather sparingly, while others produce them in such large numbers that unless some are removed, the field soon becomes a dense thicket of canes of little value for fruit production. When the proper tillage implements are used, the suckers which grow between the rows are readily destroyed by cultivation, but those in the rows or near the plants must be thinned when the hoeing is done in early summer or by cutting them out later during the pruning operations.

Usually, some thinning of new canes should be done at the time the old canes are removed. If this is done immediately after harvest, it is advisable to leave more than are actually required for fruit bearing the next year, as a reserve against accident or winter injury. These surplus canes may be removed in the spring when those which are left are headed back.

When the plants are grown in hills or according to the linear system of culture, all suckers and weak canes should be removed and only the plants originally set kept for fruiting. Ordinarily seven to nine strong vigorous canes of the red raspberry are left in each hill or crown.

Where the hedgerow system of training is used, only the suckers between the original plants should be allowed to grow and with vigorous growing varieties these should be thinned so that there are not more than three or four strong canes to each lineal foot of row.

The black and the purple raspberries do not produce shoots or suckers from their roots and very little cane thinning in the hill is necessary. All of the large canes over one-third inch in diameter at the base should be retained for fruit bearing. Investigations at the Michigan Station indicate that the average black raspberry plant can support all of the canes over one-third inch in diameter which it will produce, provided the laterals are severely cut back at the time of the spring pruning. Thinning of canes reduces total yield greatly without any material increase in the size of berries. Hence, the practice is not recommended except for the removal of weak, slender and diseased canes.

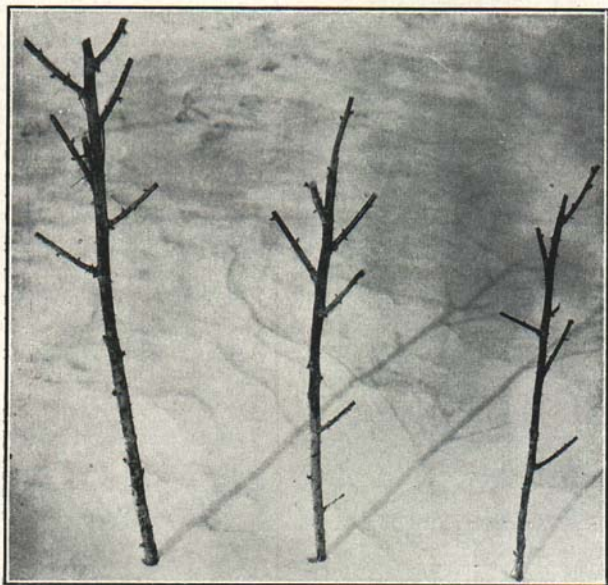


Fig. 3. Good, medium and poor fruiting canes of Cumberland black raspberry.

Heading Young Shoots—During the summer, usually in June, the terminal growth of the black and the purple raspberries is checked by pinching off the tips. When allowed to grow naturally, the shoots develop into long sprawling canes which will not stand erect when bearing a crop of fruit and some support will be necessary. In order to prevent this, the ends of the shoots are pinched off. This tends to force the lower buds to develop strong side branches, thus making a low stocky self-supporting cane. The height of heading the shoots varies with the type and the vigor of the variety. With most varieties of black raspberries, the height should be about 24 inches. Purple raspberries are more vigorous and the shoots should be headed a little higher, about 30 to 36 inches. The shoots should not be headed much higher else the canes will be top-heavy and hence easily blown or broken over when loaded with fruit. The tips should be pinched off soon after the shoots have reached the desired height. In order to

accomplish this, it is necessary to go over the patch several times during the season as all of the shoots do not attain the desired height at the same time. Weaker branching results if the heading is delayed until the shoots have grown much beyond the desired height and severe cutting back is necessary. If the work is done at the proper time, the tips of the shoots may easily be pinched or broken off with the thumb and fingers and no pruning shears or knife are needed.

Pinching the tips of the young shoots of the red raspberry to force branching is not recommended. The branches formed are often very susceptible to winter injury. This injury may be so severe as to result in a marked reduction in yield.

Spring Pruning—Spring pruning is largely a fruit thinning process intended to concentrate the moisture and nutrient supply of the plant in the development of fewer clusters and thus fewer berries of large size and better grade. This may be accomplished by thinning the canes in the hill or row and by heading back either the canes or the laterals or perhaps both, depending on the growth of the variety.

Spring pruning should be done during March or later when all danger of injury by freezing is past. Usually, some cane thinning is required, especially if the shoots were not thinned at the time of re-

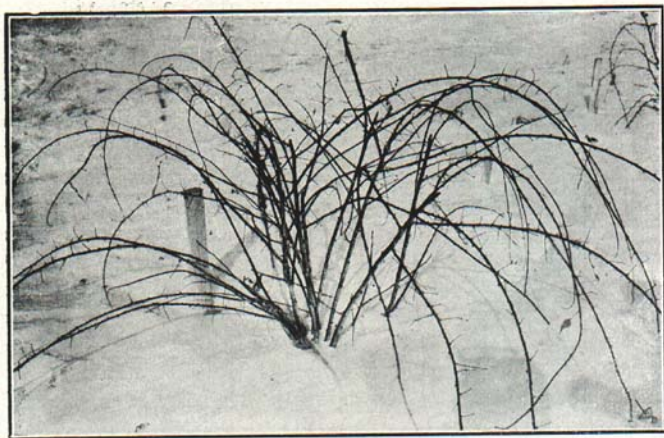


Fig. 4. A vigorous black raspberry plant before pruning. Compare with Fig. 5 on page 20.

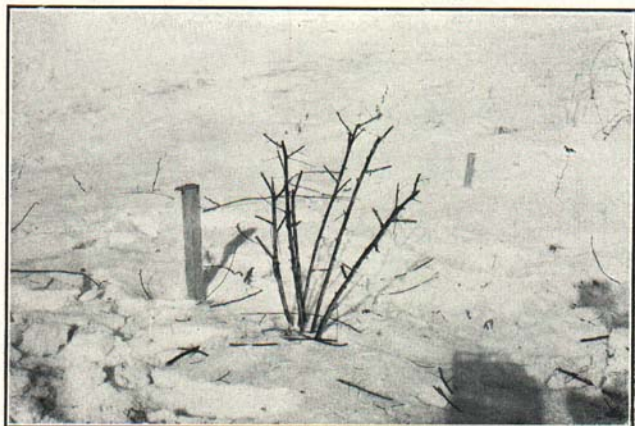


Fig. 5. The same plant shown in Fig. 4 after being properly pruned. The laterals have been shortened to four to six buds each.

moving old canes after harvest. The number which should be left in the hill or row has been discussed under the heading of cane thinning. Only the largest and most vigorous canes should be retained for fruit bearing.

The severity of heading canes and laterals will depend on the size and vigor of the individual canes, the method of training, and the moisture supply. Obviously, if the black and the purple varieties have been properly summer-pruned, very little heading of the main canes will be required. The pruning will consist chiefly of heading back the laterals or side branches. However, if the tips of the shoots have not been pruned off during the preceding summer a rather severe heading back of the canes will be necessary, unless some support is provided for them. The best results will be obtained by reducing the length of the laterals to four to eight buds, depending on the size of the canes. Canes one-half inch in diameter or less should have their laterals cut back to four buds in length while those of larger size can carry laterals six to eight buds in length. The laterals of the purple varieties may be pruned somewhat longer than those of the black raspberries. However, a relatively short pruning of the laterals gives best results.

Relatively fewer buds are produced by the red raspberry than by the other types, and in many cases the number of buds that eventually produce fruiting laterals is not many more than is required for a full crop. In fields where such conditions exist, the heading back or topping of the canes of the red raspberry consists in cutting off only that portion which has been injured during the winter. In more vigorous plantations, some reduction in the number of buds by thinning and heading of the canes may be necessary if a maximum yield of high grade fruit is to be obtained.

The best results are likely to be obtained from a light or moderate pruning. Canes receiving a light heading back are the easiest to pick, and they blossom and produce ripe berries several days earlier than canes pruned more severely. Unpruned canes are likely to be top-heavy and bend over into the rows where much of the fruit becomes dirty or is knocked off by the pickers or by cultivation.

Vigorous unbranched canes which are headed at 4 to 5 feet usually give the most satisfactory yields. When the canes are headed much lower than 4 feet, the number of berries harvested is less and there is no appreciable increase in their size. Very vigorous branched canes should have the main stem headed back to 4 or 5 feet in height and the branches shortened to about one foot in length. A more severe pruning is suggested where the moisture supply is likely to be a limiting factor.

Trellises and Supports—Raspberries are usually pruned and trained so that no support for the canes is necessary. There are, however, some advantages if the canes are provided with some means of support. The canes are kept from bending and breaking over, thus making cultivation easier, the fruit is more easily picked, and there is less loss of fruit from becoming covered with soil or splashed with dirt by rains. When red raspberries are grown in hills, a strong stake is often set in the center of each hill and the year old canes tied to it. When grown in rows the bearing canes may be tied to a single wire stretched about three or four feet high on posts set about 20 to 30 feet apart in the rows. Two wires, one at 3 feet and one at 5 feet may also be used in making this kind of a trellis and the canes tied to both the upper and lower wires. A very simple and satisfactory form of trellis may be made by nailing cross pieces about 15 inches in length to posts. Wires are stretched from the ends of the cross pieces one on each side. The

plants grow up between the wires and are supported by them. When the black and the purple varieties are planted closely and properly summer-pruned, no trellis or supports are necessary. If desired, the plants may be trained to stakes or the two-wire trellis just described will be found very satisfactory.

HARVESTING

Raspberries are ready for picking whenever they can be easily removed from the core or receptacle without breaking or crumbling. In the home garden when the fruit is to be eaten fresh or used for canning, the berries may be left on the bushes until very ripe to develop the highest flavor and quality. If the berries are to be shipped or placed on the market, they should be picked when firm, but well colored, in order to reach the consumer in good condition.

The fruit should be picked directly into the boxes in which it is to be sold. It should be picked and handled carefully to avoid bruising. Special care should be taken to remove the berries without breaking or crumbling them, and only a few berries should be held in the hand at a time, to avoid mashing. The bushes should be picked over often. During the height of the season picking at least on alternate days is necessary. The berries should not be picked when wet unless for immediate use, as they mold quickly, especially in very warm weather. Soft or injured berries should be placed in a separate receptacle or



Fig. 6. Harvesting the crop in Cheboygan county. Note the type of carrier used.

discarded. They should never be placed in the same box with firm berries. Soft berries quickly break down and are attacked by molds which often spread from one or two berries throughout an entire basket. Clean picking is important. Ripe berries left on the bushes become soft and are certain to cause trouble in later pickings.

The berries should be kept from the heat of the sun after they have been picked. It is best to keep them temporarily in the shade of the bushes and remove them as soon as possible to a cool, well-ventilated place until ready to market them. A small packing shed is desirable for larger plantings which are not located near farm buildings. This will not only provide shade for the fruit but will serve as basket storage and shelter for pickers in case of rain.

In picking, waist carriers are more convenient than the common hand carriers. The waist carriers are supported by a strap or strong cord tied around the waist and usually hold two baskets. As soon as the baskets are filled, they should be transferred to the hand carriers or to crates and carried in them to the packing shed. Usually, six or eight pickers per acre are needed for harvesting the crop.

Both the red and the black raspberries are commonly sold on local markets in quart baskets which are packed in the standard 16-quart crate. Pint baskets are to be preferred, especially for the red raspberries, and should always be used for berries to be shipped to distant markets. There is less crushing of the berries in pints and they are almost necessary for soft varieties. Crates holding 24 pints are commonly used for shipping.

LIFE OF THE PLANTATION

The average life of a red raspberry plantation is probably about 8 to 10 years and that of the black and the purple raspberries 5 to 7 years. However, under favorable soil conditions and with good care and management, it should be possible to lengthen the period of profitable bearing considerably beyond that of the average plantation. Decline in productivity in many older plantations is more often due to a reduction in vigor and the premature dying out of plants because of the attacks of disease, injuries by wind or by cultivation or the effects of unfavorable soil conditions, rather than to old age or over-bearing. Of these factors, soil conditions and the prevalence of disease are the most important, although the care in cultivation, pruning and the maintenance of the humus supply in the soil often determines

to a considerable extent the longevity of the plantation. A good location, especially with reference to soil and subsoil conditions, and disease-free planting stock are necessary for the establishment of a profitable long-lived raspberry plantation.

When diseases are likely to become a serious limiting factor in production, it is probably best to keep the plantation in a high state of productivity during the first three or four crop years or until it begins to decline in production, then discard it. This will necessitate setting out new plantations more often but the younger plantations usually are more vigorous and productive than the older, and the difference in yield may more than offset the cost of establishing new plantations.

INSECTS INFESTING RASPBERRIES

*Prepared Under the Direction of Ray Hutson,
Department of Entomology*

The danger of residue from DDT is such and there are so many other efficient insecticides that it is better to refrain from using DDT on raspberries.

American Raspberry Beetle—The raspberry fruit worm which is found in the ripe fruit of both wild and cultivated raspberries is the larva of a small brown beetle about one-eighth inch in length. The beetles appear early in the spring about the time the flower buds are forming and feed for a time on the buds and opening leaves. Eggs are laid on the stems and the bases of the blossom buds, and the larvae on hatching work their way into the base of the developing berry where they feed until the berry is ripe. By this time, the larvae are full grown and they soon drop to the ground where they pupate either in the soil or under rubbish until the following spring.

The best control for these insects is the use of dust consisting of about 1 part calcium arsenate and 19 parts of hydrated lime. Good results also have been obtained with a mixture of 1 part lead arsenate and 9 parts of hydrated lime. Either material should be dusted upon the plants at the first appearance of the beetles and the plants subsequently kept covered by dusting at intervals until blossoms appear. The addition of lead arsenate to early sprays for anthracnose is also an effective treatment. After bloom, a 1-percent rotenone dust (15 to 25 pounds per acre) is the best treatment.

Cane Borers—Two pests of the raspberry known as cane borers are commonly found in Michigan plantations. These are the rednecked cane borer and the raspberry cane borer. The rednecked cane borer causes the enlargements or swellings known as gouty galls found on the canes of raspberries and blackberries. These swollen areas are from 1 to 2 inches in length and the bark over them is ruptured in several places. The part above the swelling either dies or becomes much weakened and often is broken over. The most characteristic injury caused by the raspberry cane borer are the girdles which are found about 6 inches from the tips of the canes. The girdling occurs during the latter part of the picking season or later. The female beetle before depositing an egg makes two rows of punctures around the cane about $\frac{1}{2}$ inch apart. The egg is then laid in the cane between the two rows of punctures or girdles. The part above the girdles usually wilts and later dies. After the egg hatches the larva bores downward in the cane where it remains until the second spring after the laying of the egg. It then comes out as an adult beetle.

The most practical means of control is the cutting out and burning in late fall, winter or spring of all infested canes. In the case of the raspberry cane borer, the new canes should be cut off several inches to a foot below the place where the eggs were laid. Whenever the wilted tips are seen, they should be cut or pinched off about 2 inches below the injured area. Wild raspberries in the vicinity of the plantation should also be destroyed as far as possible, as they provide breeding places for these pests.

A spray of lead arsenate 3 pounds per 100 gallons applied just before bloom will help cut down the infestation and aid in control since the adult insects feed sparingly on the leaves.

Cutworms sometimes cause serious damage by destroying young raspberry shoots. The greatest damage usually occurs in new plantings of the black raspberry, although they often do considerable damage to newly set reds. Often, the original stand of plants is greatly reduced by the attacks of these pests. The damage may be avoided by the use of poison bran-bait. This should be scattered thinly about the plants soon after they are set. In older plantations, the poison bait may be scattered on the ground underneath the plants whenever serious injury by cutworms is likely to occur. The bran-bait is made according to the following formula:

- 20 pounds wheat bran
- 1 pound white arsenic
- $\frac{1}{2}$ gallon molasses
- 2 ounces amyl acetate of good grade (banana oil)
- Water to moisten

Add molasses and poison to 5 or 6 gallons of water and stir all ingredients together and add enough water to moisten thoroughly. Success depends largely on the thoroughness of the stirring.

Raspberry Mites—The common greenhouse red spider and other species of mites often attack the raspberry. These mites live and feed on the under sides of the leaves which as a result of their attacks become pale and unhealthy in appearance. When the mites are very numerous, the damage may be so severe that the leaves fall off and at times the fruit may be covered with the pests. Plants infested with mites are weakened and the fruit does not ripen normally. The damage from mites is usually most severe in dry seasons. They seem to occur less frequently on soils with a good water holding capacity.

Summer oil emulsions made from oils having a viscosity of 75-85 (Saybolt at 100° F.) and an unsulphonated residue of at least 92 percent used at 1-percent strength are most satisfactory for the control of the mites. Three thorough sprayings, about 1 gallon to each rod of row, with these materials at intervals of 5 days will give good mite control without injury to the raspberry plants. In mite-infested plantations, a series of three sprays should be applied as soon as the plants show green. Old canes should be cut out immediately after harvesting and burned while green to prevent the migration of the mites to the young canes. Clean cultivation to keep down weeds which may act as host plants for the mites is also essential. A spray treatment as outlined, after cutting out and burning old canes, will reduce the number of mites going into the winter and will help to produce vigorous young canes for the next year's crop.

Raspberry Sawfly—The larva of the sawfly often causes serious damage on the raspberry. When full grown, the larvae are about one-half inch long and are nearly the same color as the leaves. They feed on the foliage, first eating out irregular holes and finally all the soft tissues of the leaf. When very abundant, they may strip the plants bare, leaving only the midribs and coarse veins.

When the larvae appear early, before the fruit is formed, they may be controlled by spraying the plants with lead arsenate at the

rate of 3 pounds to 100 gallons of water or bordeaux or by dusting a mixture of either calcium or lead arsenate and lime as recommended for the raspberry fruit worm. For later infestations, coming after the fruit is set, use derris or pyrethrum sprays according to the manufacturer's recommendations for caterpillars. A second application should be made a week after the first if all the larvae are not killed by the first spray. Derris sprays act rather slowly upon raspberry sawfly slugs, but the insects do not feed after they have received a killing dose. Thorough spraying with these materials is necessary.

Tree Cricket — The presence of this insect is known by the rows of punctures or scars caused by the female when laying eggs in the cane. These scars are often so close together that they make an almost continuous slit often 2 or 3 inches long, running lengthwise of the cane. The scars may be found on almost any portion of the cane, but most of them are about 18 inches below the tip. The injury tends either to kill the upper part of the cane or weaken it so as to prevent the proper development of the fruit. This insect can be controlled by the removal and burning of all infested canes when pruning the plants in the spring.

DISEASES OF THE RASPBERRY

*Prepared Under the Direction of Donald Cation,
Department of Botany*

Bacterial and Fungous Diseases

Anthracnose — This is one of the most common fungous diseases of the raspberry. It is found to some extent in nearly all raspberry plantations but is usually most injurious on the black varieties. The disease is easily recognized by the characteristic spots or lesions on the canes. The spots are more or less round and have a white slightly sunken center surrounded by a red ring. When the spots are numerous, they may run into one another forming irregular blotches which sometimes cover a considerable portion of the cane. In some severe cases, the canes present a rough warted or knotted appearance. Lesions may also occur on the leaf stalks and on the leaf blades. The fruit is also attacked but this is seldom important except under dry summer conditions. The chief damage from anthracnose arises from the weakening of canes and from the cracking of canes which occurs in cases of severe attack.

Raspberry anthracnose can be controlled most satisfactorily by a combination of sanitation and spraying. The fungus lives over winter on the canes and the piece of old cane which is usually left attached to black raspberry tip plants may become a source of new infection. For this reason, the part remaining above ground after planting should be removed and burned. If the old canes are removed and the tips buried completely at planting time, the new shoots will grow up relatively free from anthracnose and the disease will be more easily controlled in succeeding years by sprays. To secure the best results, planting should be done early, only vigorous tips should be used, and the tips should be removed directly from the mother plants to the new planting. If planting is too much delayed, new shoots develop and become infected before transplanting takes place. In most seasons, anthracnose can be controlled in the bearing plantation by spraying as recommended on page 36.

Recently there has been recognized a disease of the red raspberry known as "gray bark". This disease is a form of anthracnose of the black raspberry and it should be treated accordingly.

Cane Blight—Cane blight attacks all varieties of raspberries. The most characteristic symptoms of the disease make their appearance sometime between blossoming and the period of fruit ripening. The disease usually attacks one or more of the fruiting canes in a hill or crown but seldom kills the entire plant. The affected canes suddenly begin to wilt, the leaves turn brown, the berries become dry, and part or all of the cane dies. If the affected canes are examined, slightly faded areas varying from one to several inches in length will be found. These are likely to be covered by a smoky colored growth and numerous small black dots, the fruiting bodies of the fungus, may be seen.

The cane blight fungus is carried over from season to season in the affected canes. The fungus enters the bark through wounds made either by insects or mechanical injury. Warm wet seasons favor the growth of the fungus, but the loss in fruit may not show until the next year as the new canes are not usually killed the first season. The disease cannot be satisfactorily controlled by spraying. The general sanitary measure of prompt removal of canes following harvest and the removal of blighted canes as fast as they appear are all that can be recommended.

Crown Gall—Crown gall is one of the most common and destructive diseases of the raspberry in Michigan. It occurs in the form of



Fig. 7. Raspberry cane blight. The prompt removal of old canes after harvesting will aid in controlling the disease.

galls or knots found near the crown of the plant, on the canes some distance above the ground, or on the roots. For this reason, it is variously known as crown gall, root gall, or stem gall, according to the part of the plant affected. The young galls are white and inclined to be soft but the older ones become dark and more woody and the surface is rather rough, warty, or irregular. On red raspberries, the galls are found more commonly on the roots, while on the black and the purple varieties they are found mostly at the crowns and sometimes on the canes. The disease is caused by bacteria which live in the galls and are liberated in the soil when the galls break up or disintegrate. New infections take place through wounds made by insects or by mechanical injuries such as the whipping of canes against each other or by bruising or cutting of parts with tillage implements.

After the plants are started in the field, there is no practical way of preventing gall development. Control measures are, therefore, confined largely to the planting of nursery stock as free of the disease as possible. Close inspection of stock that is being set out should be

made, and all plants which show any signs of galls on the roots or other parts rejected. New plants should not be set on land that has recently been used for raspberries, blackberries or dewberries. Several years should intervene between raspberry plantings on the same site.

Leaf Spot—Raspberries are often attacked by a fungous disease known as leaf spot. The spots are round and usually are bordered with a purple margin. Sometimes the central portions of the spots drop out, thus giving a shot riddled appearance. When the spots become very numerous, whole leaflets may be killed but the attack more frequently is heavier on one edge or one-half than on the other and only a portion of the leaflet is destroyed. The disease may also attack the stems but it seldom causes any damage to the canes. The chief damage consists of a general weakening of the plant through the loss of leaf surface. The disease is seldom serious in Michigan raspberry plantations and will be kept in check where the plants are sprayed regularly for anthracnose.

Orange Rust—The black and the purple raspberries are subject to a fungous disease called orange rust. The disease is not known to occur on red raspberries. It is very common on wild blackberries and dewberries and from these sources it often spreads into commercial plantations and is capable of doing serious injury. The rusted plants are easily recognized in the spring soon after the leaves start to expand. The fungus produces very conspicuous orange-colored blisters on the under sides of the leaflets and during the greater part of June the rusted plants may be seen for a considerable distance. When the rust matures, a great quantity of orange powder, the spores, is scattered about. These spores carry the rust to healthy plants.

A plant which is once infected with the orange rust fungus never recovers but may continue to live and produce a new crop of spores each season for several years. Control measures consist of digging and burning plants affected with the rust as soon as they are recognized. It is important that the rusted plants be removed before the leaves begin to shed the orange spores. Otherwise, there is danger of considerable summer infection which may lead to more rusted plants the following season. Since the rust may be carried on nursery stock, young plantings should be watched carefully and rusted plants removed if they appear. Rusted wild blackberries, dewberries and raspberries growing in the vicinity of the planting should be destroyed if possible in order to prevent infection from outside sources.

Powdery Mildew—This disease occurs rather frequently on raspberry, particularly in plantings of Latham. The fungus is most commonly found on the leaves, but it also attacks the more succulent parts of the cane. Slight attacks of mildew cause irregular yellowish blotches on the upper sides of the leaves. Just opposite, on the under side of the leaf, the surface is covered with a white powdery fungus or in some cases it may show a water soaked appearance. In more severe cases, the tip leaves may be entirely covered with the fungus; in this case, the leaflets are usually small and often are distorted and curled at the edges. Tips having such leaves are usually much dwarfed and, although the canes may continue to grow, only a few small leaves are formed, giving rise to a short spike-like or "rat tail" growth.

Control measures for mildew on raspberries have not been well worked out. With the exception of Latham, the varieties which are commonly grown in the state are fairly resistant and control measures are not considered necessary. Powdery mildews in general are controlled by the application of sulphur dusts and it is probable that these materials may be effective if the mildew becomes serious enough on the more susceptible varieties to justify attempts at control.

Spur Blight—Red varieties sometimes are affected by this blight. The disease may be recognized on the young canes by a brown or purplish brown discoloration which develops at the base of the leaves and around the buds in the axils of the leaves. This develops by the middle of July and is found only in the lower part of the cane. During the remainder of the season, the disease spreads in the bark around the buds so that a discoloration occurs for an inch or two above and below the bud and extending completely around the cane. Fruiting laterals often fail to develop from the buds in the diseased areas and as a result the yield may be materially decreased. The spread of the fungus seems to be favored by a dense stand of canes which prevents rapid drying of the canes after rains. Spur blight can be controlled by sprays, but, unless it becomes more serious than it is now known to be in the state, the application of sprays will seldom be necessary.

Wilt—This is a fungous disease which is known to attack nearly all varieties of raspberries. Injury seems to be more severe on the black varieties. The disease works slowly and usually takes from one to three years to kill a plant. The most characteristic symptoms appear during the second season. The lower leaves turn yellow or brown and droop or fall from the canes. The tips of the canes wilt and the

cane turns dark blue. Often the canes are more severely affected on one side than on the other and the severely injured side is marked by a broad blue stripe and wilted leaves.

Wilt is caused by a fungus which lives on decaying organic matter in the soil. Refuse of such crops as potatoes, tomatoes and egg plant often infest the soil with the wilt fungus. Therefore, it is unsafe to plant raspberries following these crops which have had this type of wilt. If wilt becomes established in the field, removing diseased plants as soon as they are recognized may help to check its spread.

Virus Diseases

Some of the most serious diseases of the raspberry belong to the virus group. The cause of these diseases is believed to be something in the juice of the affected plant called a "virus" which remains active as long as the plant is alive, and is capable of producing the symptoms of the disease when transferred to healthy plants. The viruses of the diseases are carried from plant to plant by aphids or plant lice. They are not spread directly by pruning or other cultural operations.

Three general types of virus diseases are found in Michigan raspberry plantations. They are the mosaics, curl, and streak. Although these diseases produce distinctly different symptoms in the plant, they have certain characteristics in common. They are infectious, systemic diseases which when present in a plant render it worthless. Plants affected with these diseases usually become stunted, make but poor growth and produce only a small amount of abortive, insipid fruit. An infected plant never recovers. The disease is present in all parts of the plant and although only one part of a plant may show symptoms the whole plant, roots, stems, and leaves, will eventually suffer. All stock propagated from diseased plants, whether by cuttings or suckers from the roots or by the rooting of tips, will carry the disease. The disease, first seen only here and there in the field, soon becomes distributed throughout the field and makes the crop unprofitable.

The Mosaics—These are the most common of the virus diseases of the raspberry. They are found to some extent in all varieties. There are several types of mosaic on raspberries and the symptoms vary considerably with the variety affected. The most common characteristic is a mottling of the leaves which varies from small yellowish spots to a condition in which the leaves have a few elevated green blisters surrounded by larger yellow areas. Yellowing of the foliage,

extreme stunting of the plants, and death of the tips of the canes are symptoms more or less characteristic of individual forms of these troubles. The symptoms of mosaic are most easily seen just before the beginning of hot weather in summer.

Curl—All types of raspberries are affected by curl. The Cuthbert red raspberry is extremely susceptible to this disease. Latham and Viking are also rather susceptible. Of the black varieties, Cumberland and Gregg are most susceptible. In general, the purple varieties are comparatively resistant. The disease is easily identified by the deep green color of the affected plants. The leaves are distinctly curled or rolled downward and inward at the edges. The symptoms are distinct from the time of the first growth in the spring until the leaves are off in the fall. The disease is spread by a small plant louse which is very sluggish and, except in the winged stages, does little moving from one plant to another unless disturbed. Hence, the curl usually spreads rather slowly in most seasons.

Streak—Black raspberries are severely injured by streak but it is not known to occur on the reds. It is found in some fields but is not common in Michigan. It is also known as blue-stem and rosette. The diseased plants are most readily detected in the middle of the summer



Fig. 8. Raspberry curl. Easily recognized by the deep green color and the distinct curling of the leaves.



Fig. 9. Raspberry mosaic. The mottling of the leaves is one of the most characteristic symptoms of the disease.

or later. The leaves of affected plants are a darker green than normal. They tend to curl slightly at the edges and the leaflets twist in such a manner as to bring the lower side of the tips uppermost. In most cases, the new canes are striped with dark reddish streaks varying from a sixteenth to an eighth of an inch in width. Sometimes the stripes run together producing a more or less solid bluish-red cane. Diseased plants are stunted and usually die after four or five years.

The control for this and other virus diseases is outlined in the following program for the care of raspberry plantations. In general, it may be said that the culture of the more susceptible varieties can be made profitable if an isolated patch is developed to serve as a nursery which by frequent inspection must be kept free from disease of the virus type. Then, by close roguing of fields and by replanting with healthy stock, it should be possible to maintain plantations capable of high production.

PROGRAM FOR DISEASE CONTROL

Healthy Planting Stock—Only vigorous disease-free plants from plantings which have been inspected and rogued for mosaic, curl, orange rust, streak, and other diseases should be used for starting new

plantations. The best plants are usually those secured from young fields. Whenever possible, the plants should be taken directly from the mother plants to the new field.

Culture—Raspberry disease control should start with the proper culture of the plant. Proper attention should be given to fertilizing and to cultivation. Many fields have run out and should be replaced by new plantings on new ground. In many cases over-bearing, lack of care, or other conditions affect plants so that few vigorous canes are produced.

Sanitary Measures—When planting black raspberries, the piece of old cane which is attached to the rooted tip should be removed and burned. Anthracnose is carried to the new field on these "tails". The removal of these and the covering of all parts of the tips with soil greatly reduces anthracnose in the new planting.

Black raspberries should be planted at least 50 yards from any of the red varieties. Red varieties, especially King and Latham, carry the mosaic viruses which do little harm to reds but which cause severe stunting of the blacks. Wild red raspberries are also a source of infection and for this reason those in the immediate vicinity of plantings of black raspberries should be destroyed.

After harvest, old canes which have fruited should be removed. In addition, all canes that are badly diseased with anthracnose and those girdled with cane blight should be taken out, leaving only healthy canes for the next year's crop.

Rogueing—The fields should be inspected closely for plants which show symptoms of any of the serious raspberry diseases, more particularly orange rust, curl, mosaic, and streak. When these diseases are found, the plant should be dug, removed carefully from the plantation, and burned, care being taken to remove all parts of the plant including all the suckers of the red raspberry. Curl can be seen best shortly after the leaves come out in the spring, and patches should be inspected at that time for this disease. Mosaic can be best identified about a month later just before the beginning of hot weather, and inspection at this time is necessary to eliminate this disease. Throughout the summer, plants affected with diseases of this type should be removed when seen.

Spraying is recommended chiefly as a control measure for anthracnose or "gray bark". The plants should be sprayed regularly each spring when the buds show green for the control of this disease.

Spraying for the control of other diseases or insects usually is not necessary unless infestations of red mite, sawfly or fruit worm become serious in the plantation. Special measures for the control of these insects are given on pages 24-27. Spraying is not effective in the control of the virus or bacterial diseases (mosaics, streaks, curls, and crown gall).

Only one spray application, the delayed dormant, is recommended for the control of anthracnose. No material is known that may be used after the leaves have become fully expanded which will control anthracnose and not result in foliage injury. For the delayed dormant application use lime sulfur 10 to 12 gallons and water to make 100 gallons of mixture when the green tips are showing in the buds. This spray eradicates the fungus in all lesions which are covered, hence thorough coverage of all parts of the canes is essential. Lack of thoroughness in the application will result in failure. Proper timing of the application is also important. There is about a 10-day period after the leaf tips are exposed and before the leaves are fully expanded when the spray is most effective.

NOTES ON VARIETIES

When selecting varieties the purpose for which the fruit is to be grown should be kept in mind. The dessert quality of the fruit should be the chief basis for the choice of varieties for home use or for a discriminating local market trade. The suitability of the fruit for canning and quick freezing also should be considered. When producing for distant markets the firmness, shipping and keeping qualities of the fruit are more important. The plants should be hardy, resistant to disease and productive on the soil type where they are grown. Two or more varieties ripening in succession are desirable especially for the home garden or for local or roadside marketing.

Red Raspberries

Latham is the leading commercial red raspberry. The plants are hardy, vigorous, productive and resistant to virus diseases. However, it often mildews badly and it seems to be quite susceptible to spur blight and "gray bark". The berry is large, rather coarse, often crumbles, and is poor in quality. The fruit, however, is firm, bright red in color and, when properly handled, arrives on distant markets in good

condition. It sells well largely because of its fine appearance. When grown for the general fresh fruit market Latham probably will be more profitable than most other varieties, but when the fruit is grown primarily for canning, home use or for local markets where a high quality product is desired, other varieties are to be preferred. The crop ripens about midseason and picking continues for about three weeks.

Chief—The plants of this variety are moderately vigorous, very hardy and productive and resistant to disease. The berries are not as large as those of the Latham but better in quality. Small size of berry is the chief defect of this variety. However, the fruit ripens early and can be recommended where an early red variety is desired.

Cuthbert—For many years Cuthbert was the most commonly grown red raspberry in Michigan, but because of its susceptibility to winter injury, virus diseases and the poor handling qualities of the fruit, it has been almost entirely replaced by other varieties. When well grown on good soils the plants are large, vigorous and productive and the dark red, conical berries are desirable for canning and dessert use. It is one of the best varieties for home use. The variety is seldom offered for sale by nurserymen and plants are difficult to obtain.

Indian Summer—A fall-bearing variety which produces a crop during late September and in October, as well as a crop during the regular season. Berries are large, dark red, soft and inclined to crumble. Very good in quality. Plants hardy, moderately vigorous, and productive. Recommended only for planting in the home garden or for very special markets where a variety of this type is desired. Not dependable as a fall bearer. Often blossoms profusely but fails to mature a satisfactory crop. Bears a good summer crop which ripens very early.

Marcy—A promising variety which seems to be increasing in favor with some growers. Plants are hardy, vigorous, productive. Berries very large, conical in shape, with a thick, firm flesh. Quality good, mild in flavor, medium to late in season. Trial plantings recommended for home and market use.

Milton—A new raspberry originated at the New York State Experiment Station at Geneva from a cross between Lloyd George and Newburgh. The plants are very vigorous with canes of medium height, hardy and resistant to mosaic. Berries large, conical, bright red in color, mild in flavor and of good quality. Ripens a few days later than Latham. Trial plantings recommended for home and commercial use.

Newburgh—The berries of this variety are large, firm, rather coarse and similar in appearance to Latham, but better in quality. The color is a bright attractive red and it possesses good shipping and keeping qualities. Plants of only medium height, rather dense, hardy and productive. It seems to be resistant to mosaic. Generally, the variety has not become popular with Michigan growers, and trial plantings only are recommended.

Ranere (St. Regis)—An old fall-bearing variety which is still grown to some extent in the state. Plants very hardy and productive but rather susceptible to the mosaic disease. The berries are usually small and decidedly inferior in quality. Not recommended.

Sunrise—An early variety reported to be a cross between Ranere and Latham. Plants healthy and vigorous with canes of medium height. Very productive. Berries small to medium in size, bright red and very attractive, but as grown on the Station grounds are very inferior in quality. Not recommended.

Taylor—One of the best of the new red varieties. On good soils the plants are tall, vigorous, hardy and very productive. Somewhat susceptible to virus diseases, and especially curl, but this can be kept under control by careful roguing. The berries are large, conical, with a thick, firm flesh and small cavity. Quality good. One of the best for canning and freezing. A good variety either for the home garden or commercial planting. Thrives better on clay soils than on sand.

Washington—A new variety introduced by the Washington State Experiment Station and recommended as a commercial variety for that section. As grown at the Michigan Station the plants are below medium in height, generally lacking in vigor and somewhat susceptible to leaf spot diseases. Productive. The berries are large, excellent in flavor and quality and suitable for dessert, canning or freezing purposes. Generally the variety does not make satisfactory cane growth.

Black Raspberries

Bristol—A comparatively new variety introduced by the New York (Geneva) State Experiment Station where it is rated one of the best. The berries are large, attractive and very good in quality. Ripens about the same time as Cumberland. Plants vigorous, very productive and quite resistant to disease. Trial plantings recommended for home and market use.

Cumberland is the leading black raspberry in the state. The plants usually are vigorous, and produce large crops of jet black berries of excellent quality, somewhat susceptible to mosaic and anthracnose, hence careful roguing and spraying are required for the control of these diseases. The berries are very firm, attractive in appearance and ship well. Ripens in mid-season.

Logan (New Logan)—An excellent early variety which ripens about a week earlier than Cumberland. Plants vigorous, healthy, and very productive. Berries nearly as large as those of Cumberland, firm and very good in quality. Especially recommended for planting in either the home garden or the commercial plantation where an early black variety is desired.

Morrison—A new variety which originated in Ohio. Plants large, vigorous, healthy and productive. Berries very large, firm, attractive and high in quality. Ships and keeps well. Ripens a little later than Cumberland and holds its size well to the end of the season. Trial plantings recommended for home and commercial use.

Purple Raspberries

The purple raspberries are hybrids between the black and the red varieties. The habit of growth, method of propagation, and culture are very similar to that of the black raspberry. The plants are usually larger and more vigorous and should be planted a little farther apart in the row than is commonly recommended for the black raspberry. The purple raspberries are popular with some people for canning and other culinary uses, but generally they are not as profitable commercially as either the red or the black varieties.

Sodus is the best purple variety. The berries are large, firm and good in quality. The plants are strong vigorous growers, very productive and drouth resistant. Rather susceptible to mosaic but superior to Columbian in this respect. Recommended for planting where a variety of this type is desired.

Marion—A very large purple raspberry of good quality which ripens about a week later than Sodus. Not as desirable as Sodus but may be used to prolong the season for berries of this type.



SERVING MICHIGAN

WKAR (870) - WKAR - FM (90.5)

Cooperative Extension Work in Agriculture and Home Economics. Michigan State College and U. S. Department of Agriculture cooperating. R. J. BALDWIN, DIRECTOR EXTENSION SERVICE, Michigan State College, East Lansing. Printed and distributed under acts of Congress, May 8 and June 30, 1914.

5M