

BRAMBLE PRODUCTION SYSTEMS

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Plant growth can be manipulated by growers to achieve long-term increases in production of quality fruit. Pruning and trellising affect plant growth rate, fruit quantity and size, soluble solids (sugars), disease susceptibility, ease of harvest, and spraying efficiency. Brambles respond significantly to pruning and trellising, but these practices are usually the most expensive and time-consuming part of an operation. Growers must use care when choosing pruning and trellising strategies.

The following discussion presents different types of pruning and trellising methods for primocane-fruiting and florican-fruiting brambles. Each different type of bramble will be discussed in relation to the specific pruning and trellising methods that best promote high yields of high quality fruit.

Primocane-Fruiting (Fall-Bearing) Raspberries

Primocane-fruiting raspberries produce fruit at the top of first-year canes in late summer. If allowed to overwinter, these same canes will produce fruit again in early summer of the second year. However, the quality of this early summer fruit is inferior to both the late summer primocane crop and summer crops of florican-fruiting types. Also, harvesting the early summer second-year crop is difficult because of interference from new primocanes. Likewise, harvesting the late summer primocane crop is difficult because the primocanes are thinner and taller when the second-year canes are allowed to grow, too. Most growers sacrifice the early summer second-year crop in favor of a smaller, but higher quality late summer primocane crop.

Pruning

The smaller yield of a single late summer primocane crop is offset by the ease of management. To prune primocane-fruiting raspberries for a single late season crop, the canes need only be cut to the ground in early spring. New canes will grow each year and fruit in late summer, the canes will be cut early the following spring, and the cycle continues.

It is important to cut old canes as close to the ground as possible so that buds will break from below the soil surface. If canes are not cut low enough, fruiting laterals may form on any remaining cane portion. These fruiting laterals are not healthy; they are entry sites for insects and disease pathogens. Also, any fruits that form will most likely rot, attracting pathogens and creating a source of inoculum (disease-conducting material) for the late summer crop. All canes that

are cut from the planting should be removed from the area and destroyed. In warm climates, the primocane crop can be delayed by mowing the young primocanes a second time when they are approximately 1 foot tall. Pinching the primocanes (removing the growing tip) in July to stimulate growth of laterals will also delay fruiting. This is sometimes done to delay harvest until after the intense heat of July.

The timing of cane cutting is also important. Carbohydrates move from plant leaves into the crown in autumn, and from the crown to the buds in early spring. If canes are cut before all the carbohydrates reach the crown in autumn, the new canes may not be as vigorous the following year. Canes can also be cut too late, after carbohydrates have moved into the buds. From December through February, most carbohydrates are in the crown, so this is the ideal time to cut canes.

Yield of primocane-fruiting types is influenced mainly by (1) the number of canes per unit area and (2) the number of berries per lateral. Growers can influence the number of canes produced by plants. Since large numbers of canes do not seem to decrease fruit size in the fall crop of primocane-fruiting raspberries, growers should try to produce as many canes per area as possible. This can be done by planting narrow rows and more rows per acre. Row widths of 12-18 inches are considered ideal for harvesting. The distance between rows should be wide enough to allow available equipment to pass. The other factor influencing yield, the number of berries per lateral, generally depends on the particular cultivar being grown. The grower has little control except to choose productive cultivars.

Trellising

Primocane-fruiting raspberries are top heavy and tend to lean, since all the fruit is produced on the tops of long canes. Most growers find that a temporary trellis is necessary during harvest season to allow easy movement between plant rows. The T-trellis has worked well and consists of T-shaped wooden or metal posts, approximately 7 feet long, with a 3-foot cross arm. The ends of the cross arms have a screw eye or other hardware to hold a length of baling twine. The baling twine is cheap and disposable, yet strong enough to temporarily hold canes upright. Each T-shaped post is set into a hole in the center of each row; holes are placed 25-30 feet apart within rows. The holes should be 3 feet deep and slightly wider than the diameter of the base of the posts. A 3-foot section of plastic PVC pipe can be set into the holes immediately after they are dug to prevent them from collapsing.

Just before harvest, T-posts are slid into the plastic-lined holes. The baling twine is strung from pole to pole and pulled tight to lift canes upright. After harvest, the twine can be cut and the posts removed and stored for another year. Since the plastic pipe is buried, it can remain in the ground where it will not interfere with cane cutting operations.

The advantages of a single cropping system are that (1) cane thinning and detailed pruning and tying are eliminated, (2) cold injury of buds is eliminated, (3) winter damage from rabbits or voles is eliminated, (4) spur blight, anthracnose, cane blight, and several other diseases are reduced, (5) sap beetle problems are reduced and other insect problems are eliminated, and (6) applications of fertilizers and pesticides are made easier.

Season Extension of Primocane-Fruiting Raspberries

Fall-bearing raspberries often ripen too late for growers to pick all the fruit before the first frost. Also, a gap exists between the time when the last summer-bearers ripen and the first fall-bearers start. Therefore, it is desirable to close this gap as much as possible.

We have successfully used a lightweight rowcover to accelerate cane growth in spring, leading to earlier flowering and fruiting. Rowcover is applied over the rows of fall-bearing raspberries after they canes have been cut at ground level, early in spring (i.e. late March). Slack is left in the covers to accommodate cane growth. Canes will grow under the covers, but then covers should be removed when canes are about 18 inches tall (mid-May). (Temperatures will get too warm if covers are left on longer.) These taller canes will flower and fruit as much as 2 weeks early, depending on weather.

Late-Fall Production With High Plastic Tunnels (Courtesy of Kathy Demchek, Penn State Univ.)

High tunnel production of primocane-bearing raspberries offers potential increases in yield and fruit quality as compared to field production. Until more research is conducted and experience is gained, this growing system should be tried on a limited basis. High tunnel production may be of particular value where a premium market exists for high quality fruit produced with little or no pesticide use, and is also advantageous where a longer growing season is needed to allow more complete harvest of the fall-bearing raspberry crop. This lengthening the growing season appears to be the main advantage, more than advancement of the harvest season. Yield obtained per linear foot of row during the planting year can be nearly equal to that from a mature 3-year-old field planting.

Plants are planted in spring. If tissue-cultured plants are used, they should be planted when it is expected that temperatures will no longer drop below freezing in the high tunnel. Plants may be grown either in the ground with trickle irrigation, or in containers using media as for greenhouse production. If plants are grown in the ground, the high tunnel will need to be dedicated to raspberry production, unless the tunnel is moveable. Containers offer the advantage that a different crop can be grown within the high tunnel early in the year, after which the raspberry plants can be moved into the tunnel. The raspberry plants should be in the tunnel for protection from rainfall during the time from bloom through

harvest to obtain the advantage of increased gray mold control without fungicides.

To delay harvest until October, primocane tips can be pinched in July and about 4 inches of growth removed. This will cause a couple of lateral buds to grow, but their growth and eventual fruiting will be delayed. This is an advantage if the intention is to extend the harvest as late as possible into autumn. Bees may have to be introduced into the high tunnel if flowering is delayed into the fall. While extensive evaluation of cultivar suitability has not been done, characteristics desired may be somewhat different than for field production. For example, if a market that commands a choice price is to be targeted, size and flavor may be of more importance than resistance to foliar diseases because plant foliage is kept dry. Both Autumn Britten and Heritage have performed well in research in Pennsylvania, with Autumn Britten fruiting about a month earlier than Heritage.

Generally, pesticides that are labeled for greenhouse raspberry production can be used in high tunnels, though individual state recommendations should be consulted and followed. However, no pesticides may be necessary at all, and again, a higher price may be obtained for pesticide-free fruit. Differences in pest complexes should be expected from those encountered in field production. By keeping the foliage, flowers, and fruit of the crop protected from rain, disease incidence can be minimized. In research plantings in Pennsylvania, 97-100% of fruit harvested was marketable and shelf-life was more than doubled with no fungicides used when compared to that from field plantings under a standard fungicide spray program.

Powdery mildew is a disease which requires dry foliage and high humidity for the highest incidence. Both of these conditions exist in high tunnels. This is not typically a problem with brambles, but growers should be aware that the potential for this disease to occur exists. Keeping air flowing through the tunnel when possible will minimize the likelihood of disease development.

Floricanes-Fruiting (Summer-bearing) Raspberries and Blackberries

Floricanes-fruiting brambles produce fruit only from buds on second-year canes. Unlike primocane-fruiting raspberries, these canes must remain intact throughout the winter and following growing season, until the completion of harvest. Also, during second-year flowering and fruiting on floricanes, new first-year primocanes are growing. These primocanes interfere with spraying and harvesting, shade the leaves and laterals of floricanes, and compete for water since they share a single root system. This interference must be minimized to obtain a high yield of fruit each year.

Pruning

Five general methods of pruning floricanes-fruiting brambles are described below. Each method will produce different results in the growth of primocanes and

floricanes of floricane-fruiting crops. Also, with the following methods, row widths should be maintained at no greater than 18 inches.

Conventional: No Mowing or Suppression of Primocanes

This training system is traditionally used by bramble growers in the Northeast. Primocanes emerge and are permitted to grow throughout the season. The following year, they become floricanes, flowering and fruiting as new primocanes. Immediately after fruiting, however, the floricanes are cut at ground level and destroyed. Some carbohydrates are lost by cutting canes in summer. However, this loss is offset by the advantages of reduced disease inoculum and a reduction in dormant season pruning. In early spring, all remaining canes are topped (headed back) to a convenient height for picking, since little vegetative growth occurs in the second season. Canes are thinned to a desired number, usually 3-4 canes per square foot. When thinning, the most vigorous canes should be selected to produce the next crop -- those with good height, a large diameter, and no visible symptoms of disease, insect damage, or winter injury.

Alternate Year Mowing

Primocane interference among floricanes is reduced by alternately mowing half of the planting to the ground each year during the dormant season. In the spring after mowing, primocanes will emerge and grow without interference from fruiting canes. The following year, the floricanes will flower and fruit. Although primocanes will also grow in the fruiting year, all canes will be cut to the ground during the next dormant season. Advantages of this method are that no detailed cane thinning or pruning is required, and spray material costs are reduced approximately 50%. Disadvantages include a reduction in fruit quality, berry size, and yield of approximately 30% for most cultivars, since only half the planting is fruiting in any one year.

Mowing with Primocane Suppression

The reduction in yield caused by alternate year mowing can be recovered over the short-term by removing all primocanes from the plant row during the fruiting year. The elimination of primocanes after they begin growth is called "suppression." After the first few flushes of growth are removed, primocanes eventually will be allowed to grow.

A system that involves mowing in one year, followed by primocane suppression in the second year, is truly biennial -- primocanes grow without interference from floricanes, and floricanes grow without interference from primocanes. Removing primocanes, however, is not easy. Dinitrophenol products can no longer be used, so growers must find other ways to remove primocanes until new products are developed. Some growers have reported success with Gramoxone, Scythe and Goal.

The advantages of this method are the ease of pruning when done in early spring, and a reduction in spray materials cost. Disadvantages are a reduction in yield over the long-term, since only half the planting is fruiting in any one year, and the cost of primocane suppression (labor, materials).

Primocane Suppression without Mowing

The highest long-term yields and largest berry sizes have resulted from a combination of selective floricanes thinning and suppression of primocanes in late. If primocanes are suppressed when 6-8 inches tall, shading on the lower portions of floricanes is reduced. Harvesting is easier because smaller primocanes cause less interference. Primocane suppression has also been reported to increase hardiness.

Since there is less shading and fewer demands for water, fruit size and productivity of lower laterals are increased. Primocanes of vigorous cultivars can still grow to a sufficient height for adequate fruiting the following year. Primocanes should not be suppressed until the planting is at least three years old. Primocanes contribute large amounts of carbohydrates to the bramble plant, and repeated suppression will reduce carbohydrate levels. Therefore, suppression should be skipped every third or fourth year to allow the planting to recover from the general reduction in vigor. Weak hills or sections of rows should not be suppressed at all.

There are conditions under which suppression of primocanes is not recommended. If a fruit crop load is particularly heavy, primocane growth may decrease naturally as developing fruit demands all the plant resources. Also, if primocanes are suppressed in regions with short growing seasons, they may be too short at the end of the growing season. Suppression is not recommended under the above conditions, or whenever the plant is stressed, such as from a lack of moisture or a nutritional imbalance.

Advantages of primocane suppression are: (1) increases in fruit size and quality, (2) increases in production, and (3) reduced cane numbers. Disadvantages are: (1) long-term reductions in stand vigor and (2) expenses involved with primocane suppression or elimination.

Partial Primocane Suppression

Yield and quality may be increased without suppressing all the primocanes in a planting. Removing all but 4 or 5 primocanes per linear foot of row will increase yield and fruit quality in floricanes of some cultivars.

For this method, growers select the primocanes in late spring which will be carried into the following year for fruiting. Rejected primocanes are cut to ground level when 8 inches tall. The raspberry plant uses resources for the current fruiting canes and the remaining primocanes, rather than for many primocanes which would eventually be removed.

Primocane regrowth is ignored until the dormant season when these short canes are removed. Advantages of this system are: (1) selected primocanes grow for an entire season instead of the partial season permitted in complete primocane suppression, (2) rejected primocanes are removed when small, succulent, and easy to handle, as opposed to large and thorny, and (3) fruit size and quantity of

current season is increased. The major disadvantages are: (1) primocane selection is difficult when leaves are on the plant, and (2) suppression of undesirable canes requires much labor.

Trellising

Proper trellising can reduce primocane interference and improve light interception to increase production. Without trellising, fruiting canes must be cut short (topped) in the dormant season to prevent canes from breaking or tipping over. Since many of the fruit buds are on the top half of the cane, topping a plant too low can greatly reduce the productivity of a planting. As a general rule, no more than 25% of the total cane length should be removed.

One method of trellising that is occasionally used is to stake brambles in a hill. Advantages are reduced cost, ease of harvest, and ability for two-way cultivation. Disadvantages are poor light interception by the plant, increased disease development in the leaf canopy, and low yields per unit area.

I-trellising

Another method is to tie plants to a single wire 3-4 feet above the ground. The I-trellis prevents cane breakage, but allows little light to reach the lower portions of canes. Also, primocane growth is forced toward the aisles where it can greatly interfere with spraying and harvesting operations.

V-trellising

Cane interference and competition can be reduced and yields increased by using a trellis which separates the fruiting canes from vegetative canes. One such system is the V-trellis, in which wires are strung along posts placed at a 20-30° angle along the outer margins of each plant row, forming a V-shaped structure. Fruiting canes are tied to wires on the outside of the V, and primocanes are permitted to grow in the center of the V. Spraying, harvesting, and pruning operations are made easier since floricanes are outside and accessible, and primocane interference is minimized. Also, the presence of primocanes in the center of the row forces fruiting laterals to grow outward. Yields of several cultivars of raspberries have increased when plants are V-trellised, primarily due to increased light interception by the plant canopy.

Several types of V-trellises are used throughout the world. In some places, half of the floricanes are tied to each side of the V. Elsewhere, growers tie floricanes to one side of the V and train primocanes to the other side. Some growers use a V-trellis and mow alternate halves of the row lengthwise every year. In these cases, fruiting canes are tied to only one wall of the V.

T-trellising

Trellis systems also can be constructed with a T-post. Generally, a T-post will require an additional crossbar between the ground and upper arm to support the fruiting canes. The disadvantage of the T-trellis is that adjustments for annual variations in cane height are difficult. Also, during trellis construction, growers

must estimate future cane height on a given site. The V-trellis allows adjustments in wire heights to be easily made at any time.

Modifications of the Gjerde system developed in Norway can be used with a T-trellis. Two wires are strung across the top of a trellis arm. From early spring till the beginning of flowering, floricanes are held vertically in an I-trellis. When flowering begins, the wires and the attached floricanes are moved to outer row positions, while primocanes take the center position. A swinging crossbar can be used to easily make the change from an I-trellis to a V-trellis. Additional wires on a lower crossbar may be needed to support the fruiting canes.

Care must be taken not to damage the fruiting laterals when spreading the floricanes. The outward direction of the fruiting laterals, which results from spreading the floricanes during flowering, makes harvest easy and efficient. After harvest, the outer wires are removed and the dying fruiting canes are bent out at right angles to the row and cut, while middle wires hold the primocanes erect. A swinging arm trellis has been developed in Virginia that allows floricanes to grow on one side of the trellis in a nearly horizontal position until petal fall. Then the canes are shifted to the other side so that the fruiting laterals are hanging to the outside of the trellis. This greatly reduces harvest costs.

Materials

Monofilament plastic wire is the preferred material for trellis construction. It is as strong as metal wire, but much lighter and easier to handle. Inexpensive devices hold the monofilament taut at the anchoring posts and can rejoin lines that have accidentally been cut. Monofilament does not conduct electricity, so plants are less susceptible to lightning damage.

Trellis posts and anchors should be made from readily available materials. Also, growers must plan a trellis for the potential 15-year life of a planting.

Pruning Details for Floricane-Fruiting Raspberries

Red Raspberries

Productivity in summer-fruiting red raspberries is most closely related to the number of canes. Unlike the situation with primocane-fruiting raspberries, however, fruit size decreases as cane numbers increase. Growers must maintain a high number of canes, but not high enough to greatly reduce fruit quality. In general, 3-5 large canes per linear foot of row is the optimal range with a plant row width of 12-18 inches.

On summer-fruiting raspberries, buds at the top of a cane often winter kill because they are less mature and less hardy than buds lower on the cane. Spring pruning should be delayed until winter injury on canes can be identified, usually by mid-March. Canes should be topped as high as the trellis and harvest operations will permit, but below the point of winter injury. Severe topping will

increase fruit size but will greatly reduce yield. To prevent a loss in yield, no more than the top one-fourth of a cane should be removed.

Growers may choose any of the five general pruning methods described for summer-fruiting raspberries. Each method will produce different effects on yield and productivity. After pruning, canes are tied loosely to the trellis wire to prevent wind damage of laterals after bud break. Canes should be spaced evenly along the trellis wire, or equally divided and spread between sides of a V-trellis.

Tipping (pinching off the tips) of red raspberry primocanes during the growing season to promote lateral growth is not recommended in the Northeast. This procedure slows cane development, does not stimulate much branching, and makes the plant susceptible to winter injury.

Black Raspberries

In contrast to red raspberries, black raspberries respond well to primocane tipping. Many more fruiting buds are produced on black raspberry lateral branches than on the main cane, so primocanes are pinched back at a height of 28 inches to stimulate lateral branching from the main cane. At least 4 inches of tip should be removed during pinching. Several passes through the field may be required since canes grow at different rates. Ideally, primocanes should be tipped just above a bud so very little dead wood is left between the pruning wound and the bud. Dead wood can be a site for cane blight infection, especially if wet weather follows tipping.

Some growers tip black raspberries mechanically by shortening fruiting canes to a height of 22 inches in early spring. Later in the spring, several passes are made with a sickle bar mower at 24 inches. Although this method is less labor intensive than tipping, primocanes will be more susceptible to cane blight infection since there is little control over wound size or the amount of dead wood between the cut and first bud.

At the end of the first year, black raspberry primocanes are branched with long laterals. These lateral branches should be supported by trellis wires before October since wet snow tends to break them off the main cane. Also, canes are more flexible in early autumn than in late autumn and are less prone to breaking from the crown during trellising.

A large portion of the lateral branches may be killed during the winter since black raspberries generally are not as hardy as red raspberries. Black raspberries could be pinched higher, but shorter laterals would result and the winter damage would be greater. If the whole lateral is permitted to fruit, smaller berry size will result. Laterals are shortened (headed back) in early spring to remove winter damaged wood and to maintain berry size. Some growers shorten laterals to less than 10 inches. The choice of lateral length depends on cultivar vigor and the relationship between crop size and fruit size. The relationships among productivity, fruit size, and lateral length are not well known.

Whatever general pruning method is chosen, leaving 4-6 canes per crown should give most growers acceptable yields of large fruit. Black raspberries will respond well to partial primocane suppression. Full suppression is not recommended because black raspberries produce few primocanes.

Purple Raspberries

Purple raspberries perform best if pruned similarly to red raspberries. Purple raspberry primocanes may be tipped, like black raspberries, but wounds are often an entry site for cane diseases which kill part of the cane.

If a grower chooses not to tip purple raspberries, the canes will grow very tall, and the trellis should be able to support such vigorous growth. Primocane suppression can be used to control this vigor with good results. Some natural branching will occur near the base of primocanes when growing conditions are favorable. These canes may be removed or allowed to fruit.

If primocanes are tipped to keep the plant short and compact, it should be done when primocanes reach a height of 32 inches. At least 4 inches of tip must be removed. Many lateral buds will break near the the top of the cane, and fewer near the base. Lateral branches should be shortened below any winter damage in early spring.

Tipped plantings without cane diseases will generally produce higher yields, but berries on the long laterals are more difficult to harvest. Also, long lateral branch or cane length generally results in smaller fruit size. Larger fruit can be obtained by shortening canes or lateral branches in early spring, but at the expense of yield.

Pruning methods that leave 3-4 fruiting canes per linear foot of row produce acceptable yield and quality of fruit. Purple raspberries respond favorably to primocane suppression but do not respond well to mowing.

Thorny Blackberries

Thorny blackberry primocanes are tipped when 3-4 feet high to stiffen canes and cause lateral branching. The laterals are shortened to 12-16 inches in early spring, and canes are thinned to two per linear foot of row. Longer lateral branches will produce more but smaller fruit than will shortened laterals. Growers may choose alternate year mowing methods to avoid the difficult task of pruning the thorny canes.

Thornless Blackberries

For two years after planting, thornless blackberry primocanes tend to grow along the ground, like a vine. Growers may have to move trailing canes in the direction of the row to allow room for cultivation. After two years, however, canes become more erect and are naturally branched. Thornless blackberry canes are thicker and more flexible than raspberry canes.

Because of the poor hardiness of thornless blackberries, northern growers must take special precautions to protect canes during winter. Although canes are somewhat flexible, they will not bend to the ground after the third year to be covered with mulch or straw. Some growers tip thornless blackberry primocanes when they reach a height of 24 inches so that low growing laterals are more easily protected during winter.

In spring, the canes should be tied at least 3 feet above the ground to trellis wires. Fruiting canes are either shortened to the top trellis wire or woven around the wire. Woven canes should overlap no more than two or three feet with an adjacent plant. Lateral branches are shortened to approximately 18 inches, and laterals on the lower two feet of cane are removed. Thinning canes to 6-8 per hill will maintain acceptable production. Partial primocane suppression is recommended for thornless blackberries.

Thornless blackberries have been grown successfully using a variety of trellising systems which are required to hold canes above the ground. The double curtain V-trellis has been very successful. Fruiting canes are tied to one side of the V and primocanes to the other. Primocanes and floricanes alternate sides of rows across the field, so each row middle is bordered by canes of the same age. This pattern makes spraying and harvesting easier.

Season Extension of Summer-Fruiting Raspberries

Summer-bearing raspberries can be "forced" to fruit in late winter and early spring. Once plants have been exposed to chilling temperatures for a sufficiently long period of time, they will flower and fruit when exposed to spring-like temperatures in a greenhouse. Using summer-bearing raspberries to produce fruit in winter months has great potential for extending the season in cold climates.