GROWING RASPBERRIES IN NORTH CAROLINA

North Carolina Cooperative Extension Service

North Carolina State University

GROWING RASPBERRIES

IN NORTH CAROLINA

While there is limited commercial raspberry production in North Carolina, interest in raspberries continues to grow as more consumers demand a local supply of fresh, high quality fruit. Many "ready-buyers" for red raspberries have moved to North Carolina from other regions, such as the Northeast and Midwest, where this fruit is highly treasured.

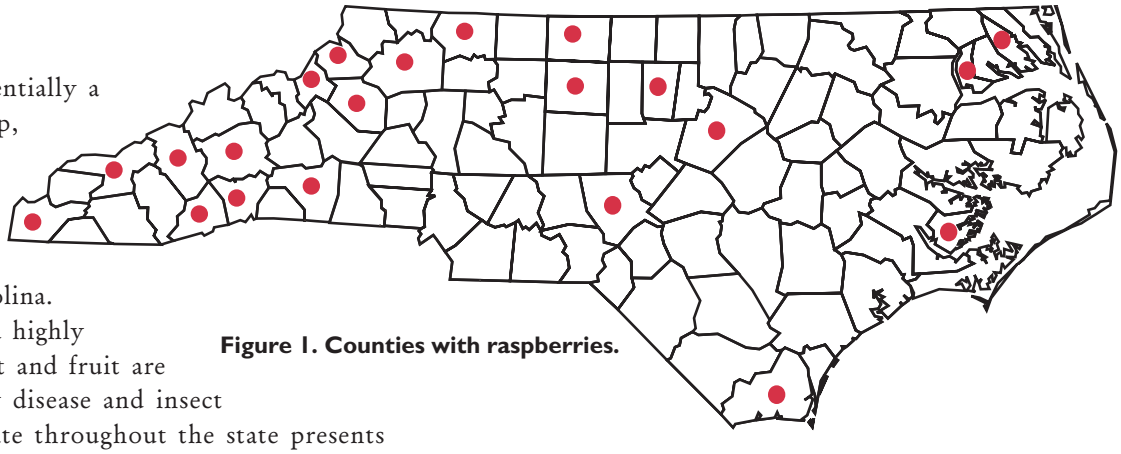

Figure 1. Counties with raspberries.

Raspberries are potentially a very high-value crop, but they are also one of the most difficult small fruit crops to grow in North Carolina. The fruit is soft and highly perishable, the plant and fruit are susceptible to many disease and insect pests, and the climate throughout the state presents physiological demands in terms of high and low temperatures that make production a challenge. Furthermore, raspberries are a very labor-intensive crop that can easily require more than over 80 hours per acre annually just for pruning, training, and trellis management. The harvest of fresh raspberries is extremely labor intensive; an average picker will only harvest and field pack about 11 to 12 pounds of fruit per hour.

Commercial raspberry production is more common in western North Carolina's mountains and foothills, although there are many small U-pick raspberry plantings in populous areas in the piedmont region as well (Figure 1). Raspberries are not commonly grown in the piedmont and coastal plain areas, because most raspberry varieties are poorly suited to the warm temperatures in these areas.

Raspberries belong to the genus *Rubus*, which also includes blackberries. They differ from blackberries in that the receptacle tissue stays attached to the plant when raspberries are picked, leaving a hole or hollow core in the fruit. Cultivated raspberries are classified as red, black, purple, or yellow.

- **Red raspberries** are by far the most common type grown in the United States. Red raspberry varieties, which are the most widely adaptable, are the primary focus of this bulletin. However, other types have merit and should be evaluated in local trials.
- **Purple raspberries** are fairly disease- and insect-resistant, and show some promise for the mountain and piedmont regions of North Carolina. These types can be quite vigorous, the fruit is tart and makes good preserves.
- **Black raspberries** have firm fruit with a distinct flavor that may or may not limit market potential, depending on how familiar people are with "blackcaps," as they are commonly called in more northern regions. Black raspberries are not as hardy as red raspberries and are quite susceptible to insects and diseases.
- **Yellow raspberries** are more suitable for backyards or local specialty markets. Their fruit is very soft, and the plants have lower yields than other types of raspberries.

Varieties and Their Importance by Region

Success of a commercial raspberry planting will depend largely upon selection of the proper varieties for your region. Trials conducted by Dr. James R. Ballington show that yields from a single variety can vary significantly depending on location (Tables 1 and 2). This section provides information on some raspberries that have shown promise in the mountains, piedmont, and coastal plain regions of North Carolina. Readers should note that Dr. Ballington's raspberry breeding program is developing new raspberry varieties better adapted to the warmer growing conditions in the piedmont and coastal plains. In addition, several new and untested varieties from other regions that are not mentioned in this publication are worthy of trial, especially in the mountains and foothills.

Mountains and Foothills. On-farm research and varietal testing efforts over the last 10 to 15 years have determined the raspberry varieties that perform the best in western North Carolina. Growers in this region have the most varieties that perform the best. This is because summer temperatures in the mountains and foothills are cooler, and the winter temperatures are also consistently cool and stay cool long enough to satisfy the chilling requirement of most raspberry varieties. In the mountains of North Carolina, it is possible to select varieties and use growing techniques that would allow almost a continuous harvest of raspberries from late June until early October.

Table 1. Primocane Fruiting Raspberry Selection Trials, 1992.

Cultivars	Location	Yield (pounds per acre)
Autumn Bliss	Fletcher	9,900
	Reidsville	1,200
	Salisbury	3,250
Red Wing	Fletcher	8,050
	Reidsville	1,100
	Salisbury	4,200
Heritage	Fletcher	9,400
	Reidsville	3,000
	Salisbury	4,600
Ruby	Fletcher	11,950
	Reidsville	1,000
	Salisbury	3,900
Cherokee	Fletcher	5,650
	Reidsville	4,550
	Salisbury	6,850

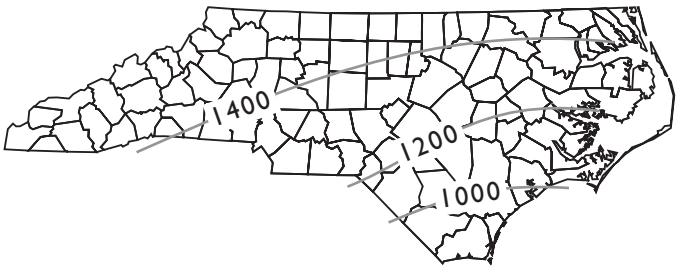

Figure 2. Average chilling units in North Carolina. (Adapted from: Swartz, H.J. And S.E. Gray. 1982. "Annual Chill Accumulations in the U.S." *Fruit Var. J.* 36:80-83).

Table 2. Floricane Fruiting Raspberry Selection Trials, 1992.

Cultivars	Location	Yield (pounds per acre)
Mandarin	Fletcher	8,350
	Reidsville	3,500
Latham	Fletcher	6,050
	Reidsville	4,350
Royalty	Fletcher	2,300
	Reidsville	2,700

Late June and July:

Floricane fruiting: Reveille, Latham, Citadel, Mandarin

Primocane fruiting: Autumn Bliss, Cherokee, Summit, Red Wing, Heritage, Ruby

August and September:

Primocane fruiting: Heritage, Nordic

October:

Primocane fruiting: Heritage, Nova

All fruit recommended for this area are of good or better quality. Reveille has large bright red soft fruit. Latham fruit is small to medium sized, bright red, is somewhat soft and tends to crumble. Citadel is generally recommended for the mid-Atlantic states and has done well in our studies. The fruit is firm and suitable for commercial harvest. Mandarin fruit is red and of good quality. Autumn Bliss fruit is large and slightly oval-conic, with a pleasant, mild flavor. Cherokee fruit is large, round, and medium to bright red. The fruit is firm and well-exposed so it is easy to harvest. Summit fruit is small to medium in size, medium red in color, and firm and round. The fruit is good for fresh market and processing. Red Wing fruit are small to medium in size and can be soft. Flavor is similar or slightly inferior to Heritage. Heritage fruit is medium-sized, conic, red, and attractive. Fruit flavor is good to excellent. Ruby fruit is large, a medium to bright red, and has flavor similar or slightly inferior to Heritage. Nordic is red, with good firmness and flavor. Nova has medium-sized, dark red fruit with a mild flavor.

Piedmont. On-farm and research station trials have furnished a good deal of information about raspberry varieties appropriate in this region, where temperatures can easily soar into upper 90s at any point from early June until mid- to late September. Although many varieties can produce a crop in this region, there are few raspberry varieties that have a particularly good tolerance to extreme heat. The best are Southland, Dormanred and Mandarin.

Southland produces fruit in the spring and summer and can also produce a small crop again in the fall. The fruit are light red and do not crumble. Southland has acceptable flavor but may not perform as well in the warmer regions of the piedmont region as Dormanred. Dormanred is a highly productive red raspberry; it is not uncommon to harvest up to 8 pints per plant. At a plant spacing of 4 by 12 feet, this would amount to 907 plants per acre with a potential production of roughly 7,250 pints per acre. The fruit of Dormanred does not have "true" red raspberry flavor and aroma, and it has an unpleasant aftertaste. In spite of its less than desirable flavor, Dormanred is a particularly good berry for cooking and processing. The berries hold up very well when frozen. The picking season is in the first two to three weeks of June. Because Dormanred is a trailing red raspberry, a trellis support system is required. Mandarin produces average size fruits with good quality. Unfortunately, nursery stock of Mandarin is quite limited at the present time.

Most northern types of primocane fruiting raspberries do not perform well under high temperatures. The northern red raspberry, Heritage, does perform well in the climate of the piedmont region. Heritage, produces fruit in late July and August, depending on location, site exposure and cultural practices used. Cherokee, a variety from the Virginia Polytechnical Institute and State University program, is worthy of trial, although nursery supplies are limited at the moment.

Coastal Plain. Although these regions accumulate adequate number of chilling units, the widely fluctuating temperatures during winter necessitate the need of additional chilling units well above the 800 to 1,800 units normally required. Failure to receive adequate chilling results in poor lateral bud break, reducing yields, which is commonly seen in this region with poorly adapted varieties. At the present time only Dormanred can be recommended for commercial production in this region.

Growth and Development

Raspberries are shallow rooted with most of their root system in the top 10 inches of soil. Their roots continue to grow and remain active for the life of the planting, while above-ground stems (canes) have a two-year life span (Figure 3). New canes (primocanes) arise from basal buds of old canes or from buds on the roots in the spring. These same canes develop flower buds in the late summer and fall. The following season they are called floricanes and produce fruit on lateral shoots in the late spring and early summer (Figure 4). Varieties that follow this pattern of development are called summer or floricane fruiting. After fruiting, the floricanes die.

Some raspberry varieties also produce fruit on the growing tips of the primocanes. These types of raspberries are called fall fruiting, primocane fruiting, or everbearing raspberries. When the primocanes of these varieties attain a certain number of nodes, the growing tip of the cane switches to a reproductive mode and floral buds are initiated, followed by flowering and fruiting in summer and fall. If not removed during the winter, these canes will also become floricanes the following spring and will produce fruit on shoots that develop from lateral buds that did not grow and fruit in the previous year.

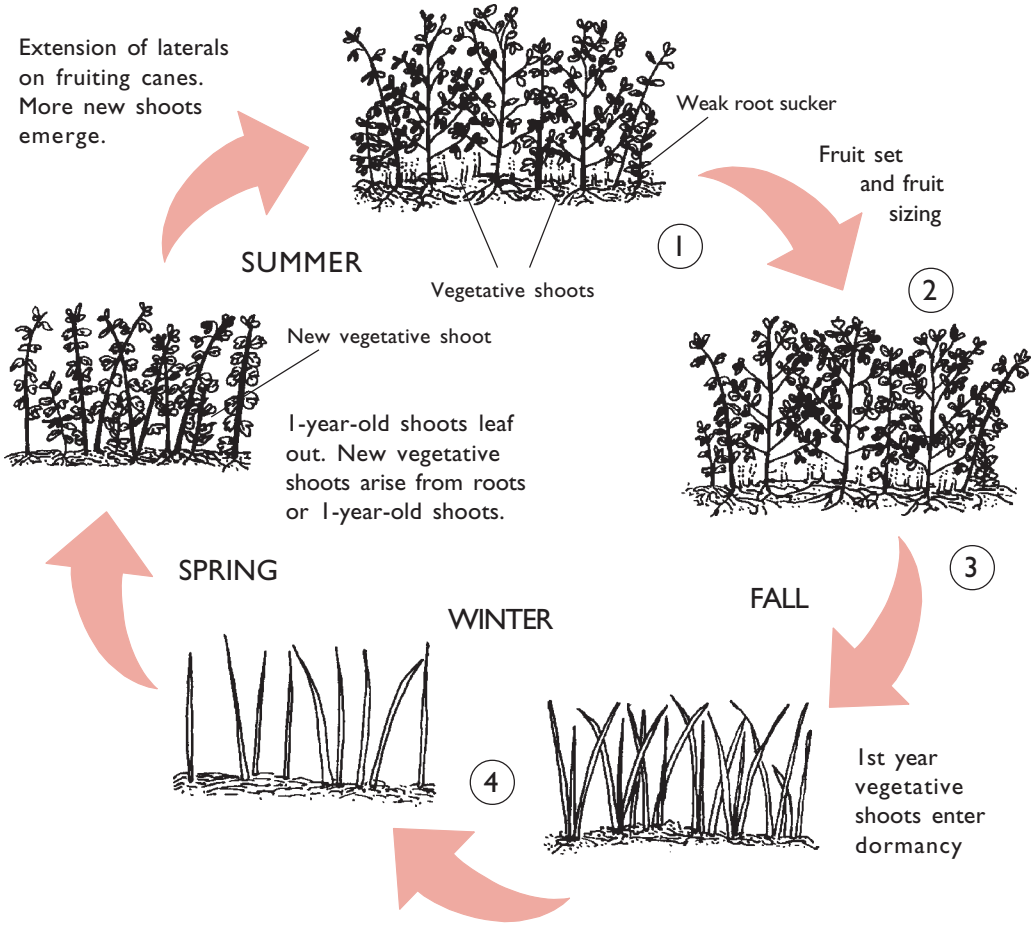

Figure 3. Generalized biennial life cycle of the mature raspberry plant. (From: Frank Louws. 1992. *Growing Raspberries in Ontario*. Ministry of Agriculture and Food. Publication 105).

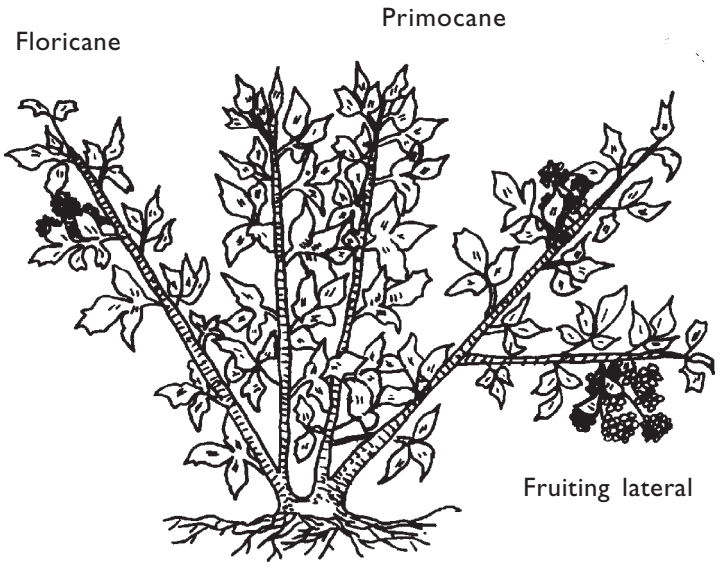

Figure 4. Raspberry cane architecture.

Climatic Requirements

Raspberries are not well suited to southern climates because most cultivars have relatively high chilling requirements and do not tolerate our high summer temperatures. These undesirable climatic conditions are typical of most areas of North Carolina, although with careful attention to the varieties planted and to cultural practices, there can be success, despite the odds.

Summer. Most red raspberries do not perform well under high temperatures. Both shoots and roots are sensitive to high temperatures. Research has shown that optimal leaf temperatures are near 65 to 70°F while roots perform well in temperatures up to about 75 to 80°F. During heat stress, photosynthesis, the process by which plants produce their own food, shuts down once optimal air and soil temperatures are exceeded. This can result in reduced plant and fruit size. There may also be a reduction in the amount of food that the plant should store to get through the winter.

Winter. Two aspects of winter temperatures are critical to the survival of raspberries. These are cold hardiness and accumulation of chilling units. As in many other fruit crops, the short, cooler days of late summer and fall prepare the raspberry plant for the upcoming winter season. The canes stop growing and undergo physiological changes that allow them to endure the cold winter temperatures. This is called cold hardiness. Some raspberry varieties are able to withstand temperatures to -20°F during the coldest period in the winter. Injury from low temperatures can also occur in late winter after chilling has been satisfied and in early spring when the raspberry plant is no longer dormant. Damage to flowers can result when flower or fruit temperatures drop below 30°F.

While exposure to extreme cold winter temperatures are not a primary concern for the piedmont and coastal plain regions of North Carolina, insufficient exposure to long periods of optimal cold temperatures is a concern. The raspberry plant requires an extended period of time to overcome a "rest period," which will allow the plant to resume normal growth. Most raspberries require at least 800-1800 hours of chilling between 37° and 50°F. Intermittent warm and cold periods during winter result in the need for more chilling than continuous chilling temperatures. Temperatures above 59°F can reverse the accumulation of chilling units, and temperatures at or near freezing do not result in additional chilling accumulation. The temperatures that can reverse chilling accumulation are common during the relatively mild fall and winters in some regions of North Carolina. Failure to receive adequate chilling units results in poor lateral bud break (commonly called blind buds) and therefore reduced yields. The number of chilling units varies significantly across the state (Figure 4). Even though most of the state receives adequate chilling for some raspberries, the amount of uninterrupted chilling unit accumulation may be one of the primary factors that will dictate what varieties will do best in your region.

Site Selection

A planting site should be selected and prepared at least one year before planting. Raspberry plants require full sunlight, good air movement, adequate moisture, and protection from wind and frost injury. Cold, dry air can cause serious winter damage. A site that is elevated above the surrounding area should provide adequate exposure to sunlight and protection from late spring frosts. Windbreaks can provide some protection from excessive winds on exposed sites. Raspberries planted on south-facing slopes ripen earlier than those on north slopes, but may be prone to flower damage due to late spring frosts. Variations among local environments, microclimates, and cultural conditions can affect a variety's performance at different sites within a region; on-farm trials provide the best information on which to base production decisions.

Raspberries grow best in deep, well-drained loamy soils, with a good water holding capacity and high organic matter content that is greater than 3 percent. Sandy loam soils dry out rapidly, however, they can be used with supplemental irrigation and mulches. Heavy soils can be made suitable for raspberry production through the use of properly installed drainage systems and use of transplanting on raised beds.

Raspberries should not be planted immediately following potatoes, tomatoes, eggplants, or peppers since this increases the risk of verticillium wilt. In addition, a raspberry planting should be isolated as much as possible from wild raspberry and blackberry plants, which harbor virus diseases. Remove all wild brambles within *at least 600 feet* of the raspberry site. This same area should be scouted on an average of two to three times a year to remove any new brambles that may establish themselves.

Site Preparation

Fertility adjustments. Soil tests should be conducted before planting and then the site should be fertilized accordingly and soil adjusted to pH 6.5. It is necessary to apply lime to increase pH or sulphur to decrease pH at least one year in advance of planting, as it often takes a year to change soil pH. Potassium, phosphorous, or magnesium should be added in the fall prior to planting in spring. Fertilizers should not be added to raspberries immediately after they are planted. The plant needs time to develop a vigorous root system. Nitrogen can be added several weeks after planting depending on soil type. High levels of N are needed for sandier soils, fall fruiting varieties, older plantings, and mulched plantings.

Preplant cover crops. Recent research has shown that legumes, vetches, clovers, and killed sods show promise as ground covers in fruit plantings. Legumes are a good source of nitrogen, and seeding a legume as a preplant cover crop the year before planting is a good way to improve soil organic matter content. Vetches are adapted to a wide range of soil conditions, are fast growing, and can supply nitrogen to the soil. Clovers are low growing and less competitive than other legumes, however certain clovers will encourage nematode populations. Killed sods can consist of an annual ryegrass or fescue that is killed in the spring with systemic herbicides before planting. After a season of growth, most cover crops can be plowed into the soil where they will decompose, followed by the planting of the raspberry stock. Incorporating animal manure, if available, to sandy soils is also good way to increase organic soil content.

Plowing and Fumigation. If you choose to plant directly into bare soil, preparatory plowing and subsoiling should be deep. The land should be left undisturbed to settle for at least several weeks. Soils should be tested for nematodes. If nematodes are present in the soil, fumigation will be necessary. Fumigation in the absence of nematodes may also give raspberry plants an extra advantage by killing most weed seeds and soil pathogens.

Raised beds. Raised beds are recommended if soils are wet or heavy. Raspberries may be short-lived on sites with poor soil drainage. A typical raised bed should be 10 to 12 inches high and 4 to 6 feet wide at the base, though this may be adjusted for your own particular site and soil conditions. Soil temperatures in raised beds may exceed the optimal and should be monitored. Light irrigation of the soil can keep soil temperature down.

Establishment of the Planting

Selection of plants. Raspberry plants should be purchased from nurseries that have grown the plants on fumigated soils well isolated from other brambles, sprayed regularly for insect and disease control, and inspected by state officials. Tissue culture plugs and dormant bare root stock are the primary types of planting stocks used to establish a raspberry planting.

Tissue-culture plug plants should be clean and healthy in appearance upon arrival. They should be hardened off for a few days before transplanting. This can be done by gradually moving the plants into full sun over a period of a week. Tissue-culture plants should be transplanted in the spring using a mechanical vegetable or tobacco transplanter, or they can be planted by hand. The newly set plant should be planted ¾ inches deeper than the top of the soil around the plant, water should be added to soil, and soil should be firmed down around the transplant to ensure good root to soil contact. Since these plants are small, they also need to be watched carefully after transplanting.

Bare root stock plants and nursery matured tissue-culture plants can be handled like other perennial transplants. They both should be transplanted at the same depth that they were in at the nursery. The roots should be spread laterally from the center. The transplant stem should be cut off at 5 inches tall.

Time of planting. Tissue-culture plug plants should be set later in the spring when the chance of heavy frosts are over. It is essential that the newly set tissue-culture plants receive adequate moisture until the root system is well established, usually 7 to 10 days. Plant dormant stock in the early spring. Dormant stock will need to be watered for a shorter period of time after transplanting.

Planting system. The ultimate planting system will depend on equipment, the trellis system used, and the variety planted. If possible, rows should run north to south, which will optimize light interception by the raspberry canopy. Rows should also run in the direction of the prevailing wind, to allow better air movement in the planting.

A bed width of 3 to 4 feet is recommended for most planting systems. Between-row width can be from 7 to 12 feet or whatever your equipment allows. However, rows should be spaced as close as possible to ensure highest possible yields per area. To calculate how many plants you will need, divide 43,560 square feet per acre by the distance in feet between rows, then divide this number by the desired distance in feet between plants within the row.

Management of aisles. It is very important to manage weeds in the aisles between the rows. The natural seed bank in most fruit plantings can contain numerous weed species, and every tillage will bring up more seeds. Weeds compete with the raspberry plants for water and nutrients, which can reduce yields. Some weeds also serve as alternative hosts for insects and diseases, as well as a continual reservoir for additional weed seeds. In addition, successful weed control reduces problems with rodents, allows for good air circulation, and improves the aesthetics of the planting.

Many raspberry growers practice clean cultivation, use herbicides to control weeds, or both. In these systems, the weeds and raspberry suckers are eliminated from the aisles using a shallow mechanical cultivator. Cultivation is stopped in the late summer, so the plants will harden off sufficiently.

The above weed control mechanisms can offer short-term benefits, especially to young plantings. However, recent studies suggest that a properly managed cover crop or sod in between rows, used with herbicides, and clean cultivation within rows may result in a healthy and more productive raspberry

planting. In addition to weed suppression, cover crops between rows offer erosion control, nutrient cycling, groundwater protection, nematode and pathogen suppression, enhanced soil structure, microbial activity, improved water penetration, and serve as a habitat for beneficial species. Each type of cover crop has its advantages and disadvantages. Growers should examine their own needs to best determine what may be best for their raspberry plantings. Grasses are easier to grow than legumes, such as clover, because they germinate more quickly and do not require inoculation. Small-seeded crops are more difficult to establish than large-seeded types, such as oats and buckwheat. In poorly drained areas, grasses may be easier to get started. Winter rye and ryegrass produce a very dense ground cover and are much more effective at shading out weeds than oats or small-seeded legumes. Fine-leafed fescue species will have minimum negative impact on a raspberry planting as they have a low water demand, compact growth habit, and show resistance to insects and diseases. They also require less mowing. Most grain species do not serve as alternate hosts for botrytis and verticillium, thereby minimizing the inoculum of these diseases. It is essential that permanent living cover crops do not crowd the rows of raspberries. A 3- to 5-foot-wide strip free of any cover crop of this kind should be maintained in the row, to reduce competition with the crop.

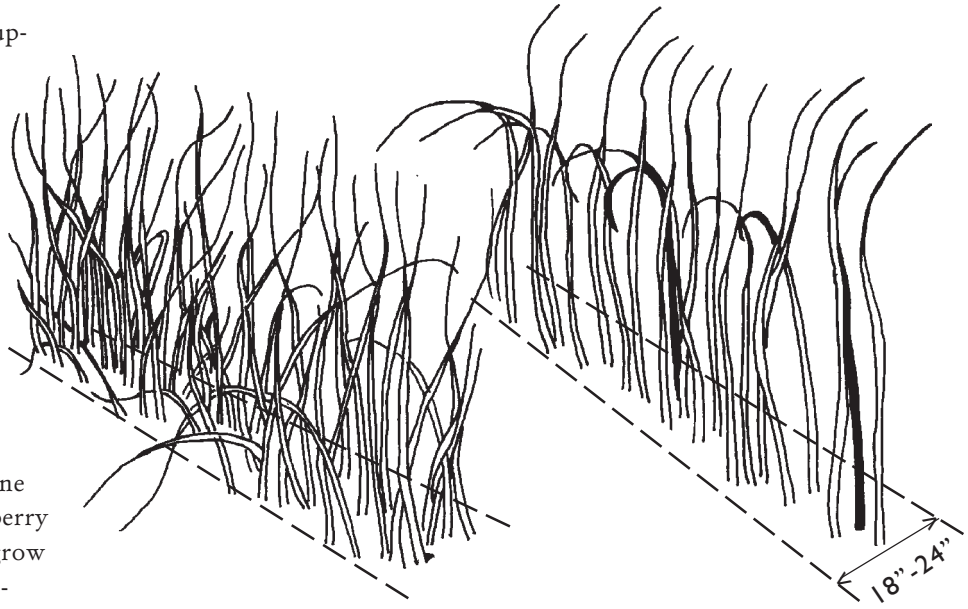

Figure 5. Red raspberries before and after summer pruning. These canes are planted in a narrow hedgerow. (From: Roper, T.R., D.L. Mahr and S.N. Jeffers. *Growing Raspberries in Wisconsin*. University of Wisconsin. Publication A1610)

Pruning and Training

The purpose of pruning and training systems is to remove dying floricanes after harvest and to optimize cane density for the following growing season. There are several types of systems. Each system varies in the amount of labor, economic inputs, and maintenance. Two basic pruning and training systems are presented here for primocane and floricane fruiting of raspberries. Growers should decide which system is best suited to their operations.

Annual System

Floricane fruiting varieties. The annual system is the most common training and pruning system in the eastern United States for summer fruiting raspberries. In this system, primocanes are allowed to grow throughout the season. In most cases, floricanes that produced fruit are removed immediately after fruiting, to increase air movement and decrease disease pressure in the canopy. However, recent research suggests that these canes may serve as a source of stored carbohydrates for cold protection in the winter. In the mountain regions, growers may want to consider pruning out floricanes after the coldest part of the winter is over. In early spring, remaining canes should be topped to a convenient picking height (usually 3 to 4 feet). If canes are too dense, fruit size is reduced. If canes are thinned too much, total yield will suffer. In early spring, weaker canes should be removed and the remainder thinned to 3 to 4 canes per square foot (Figure 5). Leave only the most vigorous canes, those having good height, large diameter, numerous nodes in the fruiting zone, and no obvious signs of disease or insect damage or winter injury.

Primocane fruiting varieties. In North Carolina, primocane fruiting raspberries naturally ripen during the hottest part of the summer. This results in ex-

tremely soft and perishable fruit. In many parts of North Carolina, fruit ripening can be delayed by pruning. To prune primocanes for a single late-season crop, the canes need to be cut to the ground in the early spring, before growth begins. Then prune the canes a second time when they are approximately 1 foot tall. This will help delay harvest until late summer.

Biennial Cropping

Floricane fruiting varieties. This type of system is often called alternate-year cropping. With this system, the crop is harvested from every other row, allowing for half of the rows to fruit in any one season. This system eliminates detailed pruning and reduces costs of spraying pesticides. However, fruit size, yields, and berry quality are reduced. Canes should be mowed to the ground during the dormant season. In the spring after mowing, primocanes will emerge and grow without the interference of floricanes. These same canes will flower and fruit in the second year. Reduction of yields can be lessened by thinning primocanes before fruiting, but this is a labor-intensive process.

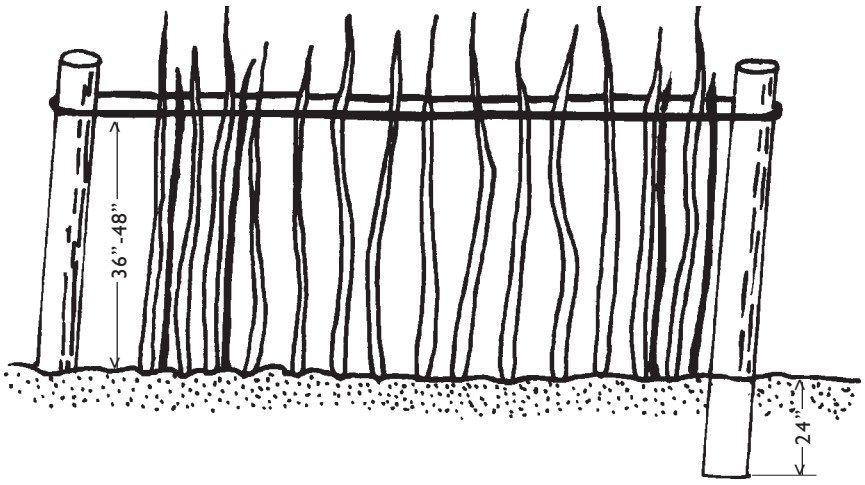

Figure 6. Hedgerow. Cedar or pressure treated posts (4 to 6 inches in diameter) are spaced about 20 feet apart. Set posts at least 24 inches into the ground. (From: Roper, T.R., D.L. Mahr and S.N. Jeffers. *Growing Raspberries in Wisconsin*. University of Wisconsin. Publication A1610)

Trellising

With most raspberry varieties a trellis facilitates mechanical and hand harvest, eases pesticide application, improves light penetration into the canopy, and keeps fruit from touching the ground. In this publication we will report on the three basic types most often used, the Hedgerow, V, and T trellises. A new type of trellis, developed at Virginia Polytechnic Institute, called a shift trellis may reduce harvest costs while increasing yields. The shift trellis operates like a hinged door. During flowering the floricanes are in horizontal position to optimize flower development. The canopy is rotated 110 to 120 degrees during fruiting for easier access during harvest. Shift trellises have merit and should be tried on a limited scale at first.

The hedgerow trellis is a simple system in which plants are tied to a single wire 3 to 4 feet off the ground (Figure 6). Posts are placed every 20 to 30 feet in a row. The posts should be buried at least 2 feet in the ground with 4 to 5 feet remaining above ground, to support the canes. Floricanes should be tied to the wire in late winter or early spring. This system is easy to build and requires less initial capital input than the T or V trellises. However, light penetration into the canopy is less and primocane growth is forced into the aisles, which can interfere with mowing and spraying. To avoid these problems, space can be left on the trellis to train primocanes as they emerge. This will minimize growth into aisles and reduce training the following spring. Although, this will crowd floricanes if plant density is high.

The V trellis minimizes competition between primocanes and floricanes for light and other resources. Here the wires are strung along posts placed at a 20 to 30° angle along the outer margins of the row forming a V-shape (Figure 7). For red raspberries, tie half the floricanes on each side of the V. Spraying, pruning, and harvesting are easier and yields of most varieties are greater with this type of system.

A T-type trellis is most commonly used for primocane fruiting varieties (Figure 8). To construct a T trellis, place single posts every 20 to 30 feet. Cross-arms 2 ½ to 3 ½ feet wide are secured to these posts, and wire is stretched from cross-arm to cross-arm. For support, primocanes are either tied to these cross-arms or trained to stay inside the wires as they emerge.

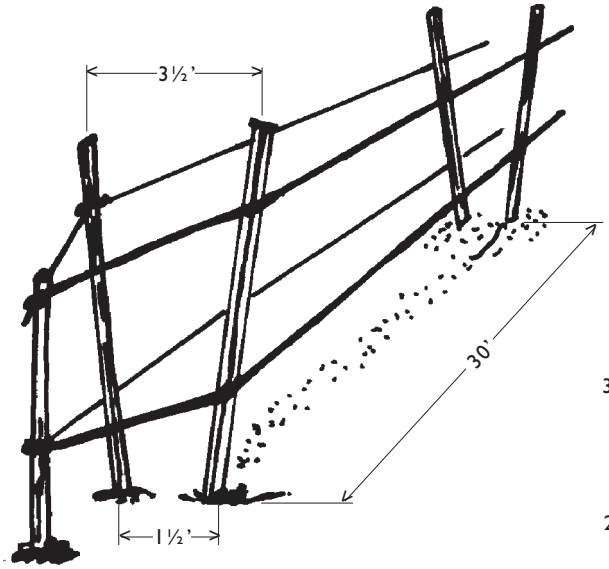

Figure 7. A V-trellis system for use with raspberries. Typical V trellis design with steel posts angled outwards from the center. The distance between the posts at the base is 1 ½ feet and 3 to 5 feet at the top. Wire is fed through eyes or loops in the bars, stretched from post to post and anchored at the ends by another post angled away from the row. Fruiting canes are trained to the outside, allowing new shoots to grow in the center. Posts are set 20 to 30 degrees from vertical. (From: *Bramble Production Guide*. Northeastern Regional Agricultural Engineering Service. 152 Riley Robb Hall, Cooperative Extension, Ithaca, NY).

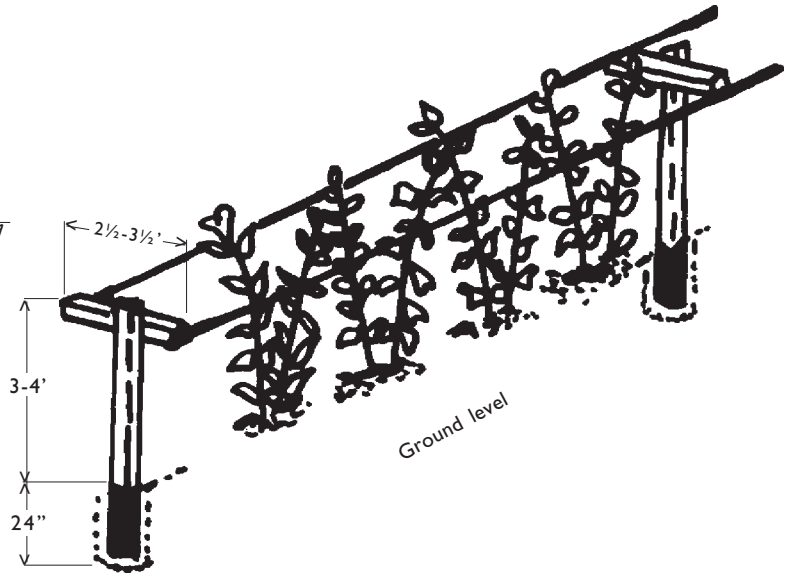

Figure 8. T trellis design. Height of the trellis and width of the cross-arms depend on the variety's growth habit. (From: Frank Louws. 1992. *Growing Raspberries in Ontario.* Ministry of Agriculture and Food. Publication 105).

Maintenance of the Planting

Proper water and fertility management, adequate pollination during flowering, and control of insects, diseases, and weeds are all necessary components for the success of a long-lived, healthy, and productive raspberry planting.

Water Management

The amount of water available to the raspberry plant during the growing season is very important. Excess water can result in root disease problems, while a shortage of water can reduce overall plant vigor, especially yield. Raspberry plants need plenty of water, especially during fruiting. Water needs can easily be determined using a tensiometer or other soil moisture measuring device. In general, raspberry plants need about 1 inch of water a week (depending on soil type), and more during hot windy weather. Water should be applied before leaves begin to wilt. In North Carolina, irrigation of some sort is essential to achieve maximum yields from this high-value crop.

Trickle irrigation allows water to be applied to the root zone directly. Water can be applied as needed and flow rates can be controlled. This type of system uses less water, and once installed, labor and operating costs are low. In addition, fertilizers can be added through drip lines if nutrient deficiencies are detected. However, lines can become clogged and moisture distribution may be limited on sandy soils. Also, lines may become damaged over the years from mowers or rodents.

Overhead Irrigation. Sprinklers are set on vertical aluminum or PVC pipes and are evenly spaced throughout the field to deliver water to plant above the canopy level. This system is portable, so it can be used on other parts of the farm (i.e., strawberries and vegetables), thereby reducing initial investment. In addition, this system can double for frost protection in the spring and evaporative cooling in the summer. However, more plant diseases may occur with this system due to excessive leaf, flower, and fruit moisture.

Evaporative cooling. During fruiting, plants are often exposed to excessive heat that can result in fruit loss. This stress can be lessened through the use of evapo-

rative cooling. Cool raspberry plants by using overhead sprinklers or micromist system during the hottest period of the day. Keep the rate of water applied low so that the soil does not become saturated. Turn the irrigation system off in late afternoon to allow adequate time for excess water to evaporate off the plant before nightfall. Use evaporative cooling only when the fruit is being harvested. These precautions will minimize disease infection that may occur due to moisture on the plant, but the grower still needs to pay close attention to the plants and fruit, scout for diseases, and take appropriate actions to control problems.

Fertility Management

Fertilizer applications should be made according to soil test recommendations. Apply 500 to 800 pounds of 10-10-10 fertilizer per acre in split applications on established plantings. Apply half the fertilizer in March and the remainder in May. Fertilizer can be spread uniformly across the row or side dress with half on each side of the row in a 3-foot-wide band. Leaf analyses provides an accurate measure of nutrients needs present in the plant, because actual nutrient levels in the plant are determined. Leaf samples should be taken shortly after harvest, and should consist of randomly selected young primocane leaves. Leaves should be washed in distilled water and sent to a lab for analysis. Growers should adjust fertilizer based on test results.

Pollination

Raspberries are self-fruitful, but require bees to move pollen from the anthers to the pistil within an individual flower. Raspberry flowers have a high nectar content, which attracts bees. However, at times poor pollination can result in a condition known as crumbly berry. Crumbly berries result when an insufficient number of druplets develop to form a normal fruit. Druplets are the small individual sections or drupes that are held together by tiny hair to make one fruit. When inadequate pollination occurs, the druplets are loosely joined and when the fruit is picked, it crumbles. A number of factors in addition to poor pollination can result in crumbly berries. However, if poor pollination is the problem, contact the Cooperative Extension Office for names of area beekeepers.

Insects and Diseases

Many insects and diseases can damage raspberries. Damage can be kept to minimum if these general rules are followed:

1. Remove all wild bramble plants near the area.
2. Select high quality planting stock.
3. Destroy plants in which disease appears and prune out insect infested canes and burn them.

Weed Control

Most raspberry plantings have a permanent sod between rows, which is mowed at regular intervals. Alternatively, clean cultivation between rows will limit weed growth and control the spread of the raspberry suckers into the aisles. In the rows, herbicides are most commonly used to control weeds.

Contact your county Extension agent for diagnosis and control of specific pest problems. In addition, many publications are available that can help you in the identification of your pest problems.

Post-Harvest Considerations

Raspberry fruit are very soft and perishable, but strategies can be taken to extend shelf life. Harvest at the pink or light red stage for fresh market or at full redness for immediate sale at pick-your-own operations. However, raspberries do not increase in sweetness or flavor after picking. Handle the fruit gently, and pick fruit daily during hot or dry weather. Approximately 6 to 8 trained pickers are usually recommended per acre. Since raspberries crush easily, use shallow half-pint containers for harvest and storage. If the fruit cannot be picked directly into the "final containers," they should be graded out as soon as possible. Field heat is retained in the center of deep picking containers and can result in crushed fruit.

A variety of picking containers are available from your local distributor. Each one has its advantages and disadvantages. You should decide what type of basket suit your individual needs. Pulp baskets are inexpensive, have ventilation holes for cooling, and can absorb water from fruit harvested wet. However, they absorb juice on the bottom, which may be undesirable. Polystyrene baskets are lighter, absorb less water, and can be printed with a label. "Clamshells"

are sturdy, plastic, vented boxes with hinged lids that allow boxes to be stacked without crushing the fruit. An absorbent pad is placed in the bottom of each clamshell to absorb excess juice and moisture from the fruit.

Close attention to fruit temperatures before, during, and after harvest are the most important factors to control for a maximum shelf life. Fruit should be picked in the early morning, before they absorb heat from the sun. Avoid picking fruit during rain or when plants are wet, which encourage the spread of fruit rot diseases. Fruit ripened during rainy weather should be picked and discarded or used for processing. Place harvested fruit in the shade or, preferably, move directly into coolers. Use of forced-air cooling, if available, will reduce cooling time and increase shelf life. If forced-air cooling is not available, spread recently harvested flats around the cold room to maximize air circulation and to bring temperatures down quickly. As more fruit is brought into the cooler, previously harvested containers may be stacked. Spread the more recently harvested fruit out in the cooler to allow it to cool down. Keep harvested fruit at 32°F and 95 to 100 percent relative humidity. These conditions reduce fruit weight loss and darkening of fruit that can occur at higher temperatures.

References

North Carolina Cooperative Extension Service. Horticulture Information Leaflet 8204. *Raspberries for the Home Garden.*

Bramble Production Guide. Northeastern Regional Agricultural Engineering Service. 152 Riley Robb Hall, Cooperative Extension, Ithaca, NY 14853. Telephone: (607) 255-5701.

A Small Scale Alternative Agriculture: Brambles. USDA. Office for small-scale agriculture. Ag Box 2244 Washington, D.C. 20250-2244. Telephone: 202-410-1805. Fax: 202-401-1804.

Bramble Production. The Management and Marketing of Raspberries and Blackberries. 1994. P.C. Crandall. Food Products Press, New York.

Shift-trellises for Better Management of Brambles (Rubus cvs.) Virginia Agricultural Experiment Station. Bulletin 95-2. Virginia Polytechnic Institute and State University. Blacksburg, Virginia, 24061-0402.

Prepared by

Gina E. Fernandez, Extension Horticulture Specialist

Frank J. Louws, Extension Plant Pathology Specialist

James R. Ballington, Professor, North Carolina State University

E. Barclay Poling, Extension Horticulture Specialist

2,000 copies of this public document were printed at a cost of $1,853, or $.93 per copy.

Published by

NORTH CAROLINA COOPERATIVE EXTENSION SERVICE

3/98—2M—JMG/KEL AG-569

E98-32731