

Small Fruits

For the Home Garden



NC COOPERATIVE EXTENSION
FORSYTH COUNTY CENTER

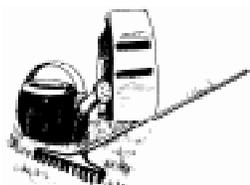
1450 Fairchild Road
Winston-Salem NC 27105

Phone: 336-703-2850
Website: www.forsyth.cc/ces

Small Fruits Contents

All of the leaflets in this booklet can be found via the internet. The link for each leaflet is listed beside the title. Horticulture Information Leaflets can be found at <http://www.ces.ncsu.edu/Publications/lawngarden.php> There are many more leaflets and useful information found on our State Urban Horticulture Site at <http://www.ces.ncsu.edu/depts/hort/consumer/>
Or on our local county websites at <http://www.forsyth.cc/ces> or <http://forsyth.ces.ncsu.edu> .

- Strawberries in the Home Garden (Leaflet 8205) -
<http://www.ces.ncsu.edu/depts/hort/hil/hil-8205.html>
- Growing Raspberries in North Carolina (Leaflet AG 569) –
<http://www.ces.ncsu.edu/depts/hort/hil/ag569.html>
- Growing Blueberries in North Carolina (Leaflet 8207) –
<http://www.ces.ncsu.edu/depts/hort/hil/hil-8207.html>
- Blackberries for the Home Gardener –
<http://www.ces.ncsu.edu/depts/hort/hil/pdf/blackberries.pdf>
- Bunch Grapes in the Home Garden (Leaflet 8202) –
<http://www.ces.ncsu.edu/depts/hort/hil/hil-8202.html>
- Muscadine Grapes in the Home Garden (Leaflet 8203) –
<http://www.ces.ncsu.edu/depts/hort/hil/hil-8203.html>
- Kiwi Fruit (Leaflet 208) –
<http://www.ces.ncsu.edu/depts/hort/hil/hil-208.html>
- Nursery List of Small Fruit Cultivars (Leaflet 8210) –
<http://www.ces.ncsu.edu/depts/hort/hil/hil-8210.html>



STRAWBERRIES IN THE HOME GARDEN

E. B. Poling, Extension Horticultural Specialist

Introduction

Strawberries can be grown anywhere in North Carolina. They are the first fruit to ripen in the spring, and no other small fruit produces berries as soon after planting as strawberries. In proportion to the size of the plant, strawberries are very productive. If 25 plants are set in the garden, these original plants and the resulting runner plants would produce a total of 25 quarts. Nutritionists rate strawberries as an excellent source of Vitamin C; ten large berries provide 60 milligrams of Vitamin C or 133% of the Recommended Daily Allowance. A single cupful of berries has only 55 calories, comparable to a thin slice of bread or half a cup of whole milk. Strawberries are low in sodium and contain measurable quantities of ellagic acid, which has inhibiting effects on chemically induced cancer in laboratory studies.

Origin

The modern garden strawberry, *Fragaria ananassa* (Fra-gah-ree-a an-a-nas-a), is derived from 2 native American strawberries, the Virginia "scarlet" strawberry, (*F. virginiana*), and the Chilean strawberry, (*F. chiloensis*), which is found on the Pacific Coast from Alaska to Chile. Early explorers to the New World collected both of these wild strawberries, and chance crosses between the two species in gardens in England and Europe in the

middle eighteenth century resulted in a hybrid strawberry, *F. ananassa*, first called the "Pineapple" strawberry by Dutch horticulturists. The new hybrids combined the size and firmness of the Chilean strawberry and the high productivity, flavor and disease resistance of the Virginian strawberry that is native also to North Carolina.

Wild strawberry species are more diminutive than the modern garden strawberry, and they are not cultivated in the United States, but in countries such as France it is not unusual to see "fraises des bois", or wild strawberries, in open air markets, bakeries and restaurants. The Alpine strawberry, *F. vesca sempervirens*, a sub-species of *F. vesca* that originated in the mountains of Italy, is cultivated in Europe and America for its "gourmet" fruits. The Alpines make attractive edging plants, having masses of small white flowers that bear fruits continuously or in flushes, depending on growing region.

Growth Cycle

Growth in our common garden strawberries is affected greatly by temperature and length of the daylight period. In new plantings, runner production occurs during the long days and warm temperatures of summer (Figure 1). Then, in the short, cool days of fall, runnering stops and flower buds form

Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914.

Employment and program opportunities are offered to all people regardless of race, color, national origin, sex, age, or disability.

North Carolina State University, North Carolina A&T State University, U.S. Department of Agriculture, and local governments cooperating.



**North Carolina
Cooperative Extension Service**

NORTH CAROLINA STATE UNIVERSITY
COLLEGE OF AGRICULTURE & LIFE SCIENCES

within the plant crown. The strawberry crown is at soil level; this swollen growing region gives rise to leaves, runners, and roots (Figure 2). The flower clusters that develop inside the upper portion of the strawberry crown in the fall emerge in early spring. Berries begin to ripen 4 to 5 weeks after the first flowers open and continue to ripen for about 3 weeks. Toward the end of the harvest period, when days are long and warm, plants again grow runners which produce new plants.

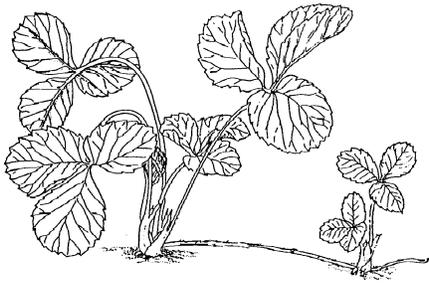


Figure 1. New strawberry plants set in the spring will send out runners during the long days and warm temperatures of summer. These runners, or “daughter” plants fill in the spaces between the original “mother” plants until a mat or matted row is formed.



Figure 2. The strawberry crown is basically a compressed stem that given rise to leaves runners, roots, flowers and fruit.

Environmental Preferences

Light: Full sun; a southern slope will encourage earlier blossoming and earlier fruit, but this may not be desirable in locations where late spring frosts often nip the flower buds, unless protection can be given in such emergencies.

Soil Type: Strawberries can be grown in most garden soils. However, they are very shallow rooted and grow best in sandy loam soils which drain well and are well supplied with plenty of humus and a pH factor between 5.5 and 6.0.

Soil Preparation: Clay soils drain poorly and are harder to manage, but can be improved by adding organic matter. Leaves, chopped straw, peat moss, rotted sawdust, grass clippings, etc., can be used to improve soil texture. Manure applied at 2 to 3 bu/100 ft² is a good source of organic matter. Apply the organic matter in the fall. Dig, rototill or plow it into the soil then, so that the material will be well decomposed by planting time in the early spring. In the year previous to planting, destroy all perennial weeds. Do not permit weeds to go to seed. Wherever possible, plant strawberries in soil which has not grown strawberries, potatoes, tomatoes, peppers or eggplants in the past 2 or 3 years.

Temperatures: For transplanting in the spring the temperature should be 40-50 °F; a spring frost generally will not harm new strawberry plants. Open blossoms are injured by temperatures of 31 °F or below. Frostbitten blossoms are distinguished by their darkened centers (Figure 3). Considerable blossom protection from frost can be obtained by covering plants with 2-3 inches of straw, old cloth, paper or row covers. Plastic sheets give little or no protection. Keeping plants continuously wetted will also give protection, since the change of water to ice on the plants releases heat. Low winter temperatures are not normally a problem in Eastern and Piedmont North Carolina. In Western N.C. and the Foothills, cover strawberry plants in early winter with straw (wheat, oat, rye, pine) after several hard frosts but before temperatures reach much below 20 °F. One bale will cover 100 ft². Do not use leaves of grass clippings because they will smother the strawberry plants. Remove the straw in the spring “as soon” as there are signs of new leaf growth under the straw (usually in March).

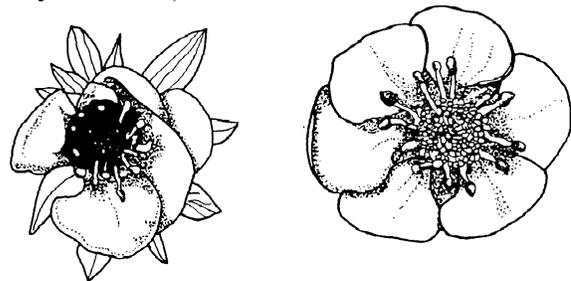


Figure 3. The strawberry blossom on the left is frost injured. The strawberry blossom on the right has not been frost injured.

Moisture: Strawberry plants have a shallow root system and cannot stand severe drought (see Irrigation).

Plants

Use healthy plants: Start with disease-free certified plants from a reliable nursery. Popular North Carolina varieties like ‘Apollo’, ‘Atlas’, ‘Earlibelle’ and ‘Titan’ can only be obtained from North Carolina certified strawberry nurseries. Strawberry varieties developed for other regions of the country are generally poorly adapted here. There are a few exceptions, including ‘Earliglow’ and ‘Tennessee Beauty’; these can be purchased from a reliable out-of-state nursery. Avoid nurseries that contract with other nurseries to grow the strawberry plants listed in their retail catalog.

Avoid Everbearers: The main type of strawberry recommended in North Carolina is called a Junebearer. ‘Apollo’, ‘Atlas’, ‘Titan’, ‘Earlibelle’, ‘Earliglow’ and ‘Tennessee Beauty’ are all Junebearers. The name Junebearers is somewhat confusing since these varieties bear most of their crop in May! Junebearers produce a single crop in the spring. The so-called Everbearing strawberry is one that produces a crop in spring and another in late summer and until frost in the fall. All of the everbearing strawberries advertised in nursery catalogs originated in the northern states; they succeed

best in those areas and are very poorly adapted to the mid-South. A few of the newest Dayneutral strawberries such as ‘Tristar’ and ‘Tribute’ can be grown in the higher elevations of Western North Carolina for a spring and fall crop of berries. The distinctions between Everbearing and Dayneutral strawberry varieties have little practical meaning for our purposes - both types will produce two crops a year (spring and fall).

Choosing Varieties: Strawberry varieties best adapted to the matted row system in North Carolina are listed in Table 2. Personal preference will, of course, dictate the choice of strawberry varieties to a great extent. More adventuresome gardeners may wish to experiment with newer strawberry varieties from other areas, but keep in mind that it is very rare that a variety bred for the Middle Atlantic, New England and Canada will be suitable for North Carolina. ‘Earliglow’ is an unusual strawberry because of its wide adaption through the northern U.S., Virginia and Piedmont and Western North Carolina. ‘Earliglow’ has the best dessert quality of all matted row varieties listed in Table 2; it is also resistant to red stele. No chemical controls are recommended for the homeowner for the control of this root disease, and planting a red stele resistant variety is the safest and most effective means of dealing with this problem.

Table 2. Strawberries for North Carolina

Variety	Area*	Quality			Fresh	Processing	Remarks
		Season	Size	Yield			
Atlas	CP,P	Early to mid	Large	High	Good	Poor	Pale flesh
Apollo	All	Mid to late	Large	High	Good	Good	Needs pollination
Titan	CP,P	Early to mid	Very large	Medium	Excellent	Very good	Hollow center
Tennessee Beauty	M	Late	Small	Medium to high	Fair	Fair	Standard variety
Earlibelle	CP,P	Early	Medium	Medium good	Very	Excellent berry	Firm
Earliglow	P,M	Very early	Small	Medium	Excellent	Excellent	Best quality
Sweet Charlie	CP,P	Very early	Large	Medium	Excellent	Fair	Sweet
Tribute	P,M	Ever-bearing	Large	Medium to high	Good	Good	Deep red

*CP--coastal plain, P--piedmont, M--mountains.

Culture

Before planting: Have a soil test made several months in advance. Soil should be turned and pulverized at least 2 to 3 weeks prior to planting. Mix the recommended fertilizer and lime at this time. If nematodes are a likely problem, consult your county extension office for recommendations. Soil should be worked into a fine mellow condition for planting.

Planting: Set plants any time from November to March in the east and during March or April in the Piedmont and Western North Carolina. Place the plants in the soil so the roots are spread out. Cover the roots until the crown (where the leaves arise) is just above the soil surface (Figure 4). Water newly set plants and press soil firmly around roots.

Training system and spacing: Matted row system is easiest to follow. Table 1 provides suggested in-row spacings for each variety. High vigor varieties are best set 2 to 2½ ft apart, and moderate to low vigor varieties are set 1½ to 2 ft apart in the row. The rows are usually spaced 3 to 4 ft apart. Most of the runners from mother plants are permitted to grow during first season, with only fruit buds being removed to strengthen plants (Figure 1).

Double-row hill system-- set plants 12 inches apart in double rows. Leave 2½ to 3½ ft between rows. Cut off all runners as they form. Large individual hills will produce abundant crops of excellent quality fruit. Hill training is ideal for most everbearing varieties (Fig. 5).

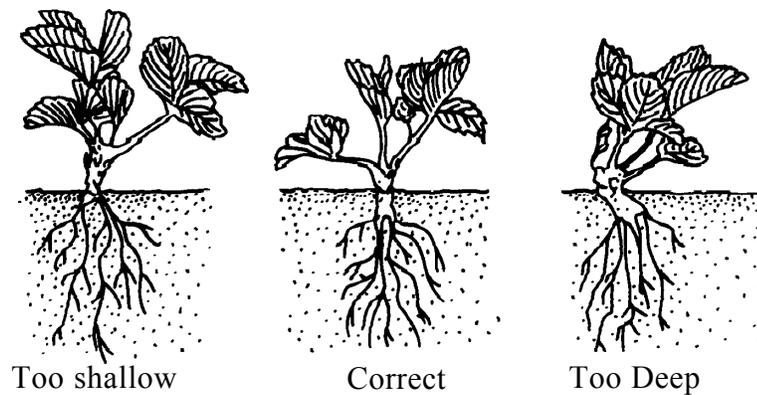


Figure 4. Correct planting depth for strawberry plants.

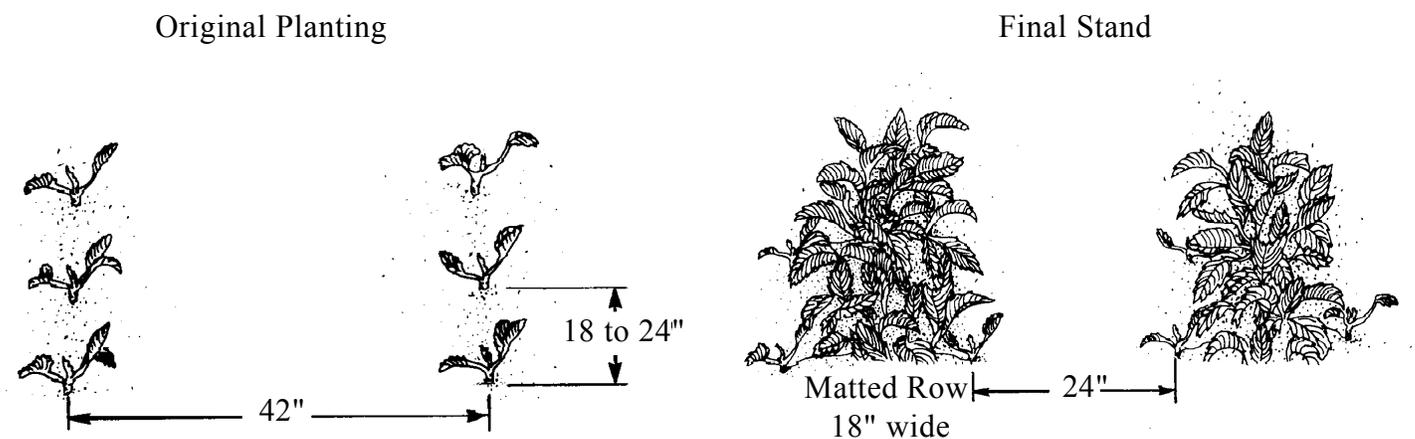


Figure 5. Matted-row system for planting strawberries. Spacing is 1 to 2 feet within the rows and 3 to 4 feet between the rows. Runners are allowed to set in all directions. Cultivation helps to straighten the runners into rows and to limit row width.

Fertilization: Before planting -- follow recommendations of soil test. If no test is made, broadcast about 4 pounds of 10-10-10 fertilizer for each 100 ft of row, 2 to 3 weeks before planting. First season fertilizer -- if new plants appear light green and don't grow well, sidedress with nitrogen about one month after planting. Apply 1½ pounds ammonium nitrate per 100 ft of row. A topdress application of ammonium nitrate at 1½ pounds per 100 ft of row should be made from August 15 to September 15. When broadcasting fertilizer over top of plants be sure foliage is dry and **brush all fertilizer off leaves to protect from fertilizer burn.** Special -- very light coastal soils need additional nitrogen again in late January or February. The rate suggested at this time is ¾ pounds ammonium nitrate (33% N) or the equivalent amount of nitrogen from complete fertilizer (10-10-10, 14-14-14). Renovation -- prior to mowing foliage at renovation, broadcast 3 to 4 pounds of a complete fertilizer (10-10-10) or about 1½ pounds ammonium nitrate per 100 ft of row. Older beds -- old beds should receive 1½ to 2 pounds ammonium nitrate per 100 ft of row sometime between August 15 and Sept. 15.

Mulching: Eastern Carolina and Central Piedmont -- apply pine needles or grain straw in February. Scatter lightly over plants and in middles between rows. Western Carolina and Western Piedmont -- in December, broadcast sufficient pine needles or grain straw in the middles and around the plants to protect crown. Use a light application on top of the plants at the higher elevations after the ground has frozen.

Irrigation: If drought comes during any of the following "critical" times, irrigate enough to wet the soil 6 to 8 inches deep once a week:

1. When plants are set and during dry periods following setting;
2. Just before harvest and during harvest when berry size appears to be suffering;
3. After renovation, as needed, to encourage new runner plant;
4. In late August, September, and early October when fruit buds are forming for the next season's crop;
5. Irrigation, if used properly, can help prevent frost injury to blossoms in spring (check with your county extension office for recommendation).

Weed Control: Methods of controlling weeds are as follows:

1. Machine cultivation plus hoeing and hand pulling;
2. Mulching with suitable material;
3. Chemical herbicides (check with your county extension office for recommendations). Herbicides

should not be applied when plants are blooming, when runner plants are taking root, and during late summer and early fall when fruit buds are being formed.

Harvest: Strawberry harvest begins in the latter part of April in Eastern North Carolina, early May in the Piedmont, and late May in the Mountains. You should pick strawberries every other day or three times a week. The best time to pick is in early morning, when berries are still cool. Not all berries ripen at the same time; pick only those that are fully red.

Renovation or renewing the planting: Matted row strawberry plantings may bear fruit for more than one season, and may be kept for two or possibly 3 to 4 fruiting seasons if properly renovated. The main purpose of renovation is to keep plants from becoming too crowded in beds. Do not attempt to renew strawberry beds infested with weeds, diseases, or insects; it is better to set a new planting. To renew a planting follow these three steps:

1. Mow off the leaves, rake away from plants and dispose of them (take your rotary lawn mower and mow over top of bed setting blade about 4").
2. Cut back rows with a cultivator, rototiller or hoe to a strip 12-18 inches wide.
3. Thin the plants leaving only the most healthy and vigorous. Plants should be about six inches apart in all directions.

Insect and disease problems: Although strawberries can have their share of insect and disease problems, most homeowners ignore them unless they become serious. Following these six precautions should minimize pest problems.

1. Use only certified virus free plants for setting.
2. Choose well-drained soil; follow rotation recommendations and have nematode assay made.
3. During harvest remove berries damaged by diseases and insects as this reduces the amount of fruit rot.
4. Properly renovate beds to remove older diseased foliage and keep them from getting too crowded.
5. Don't keep a planting in production too long; start a new planting every year or two to replace old plantings after their second or third crop.
6. Do not allow insects and diseases to build up. Follow recommendations in Fruit Disease Information Note (FDIN 005), Strawberry Diseases and their Control, to achieve control of diseases. http://www.ces.ncsu.edu/depts/pp/notes/Fruit/fruit_contents.html

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.

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.

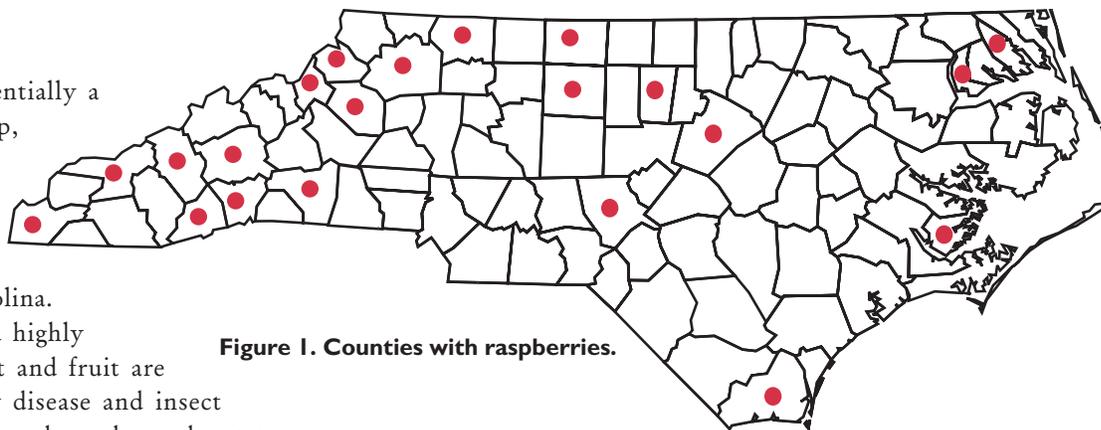


Figure 1. Counties with raspberries.

- ❑ **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 “black-caps,” 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 re-

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

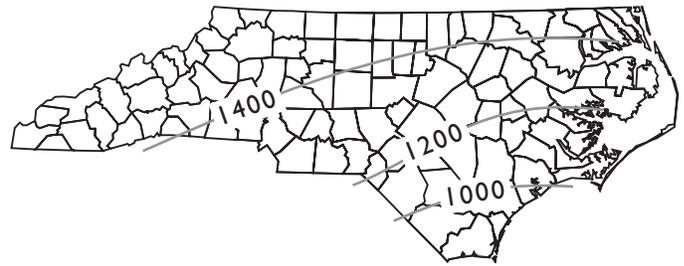


Figure 2. Average chilling units in North Carolina.

(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

gion 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.

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 floricanes 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.

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.

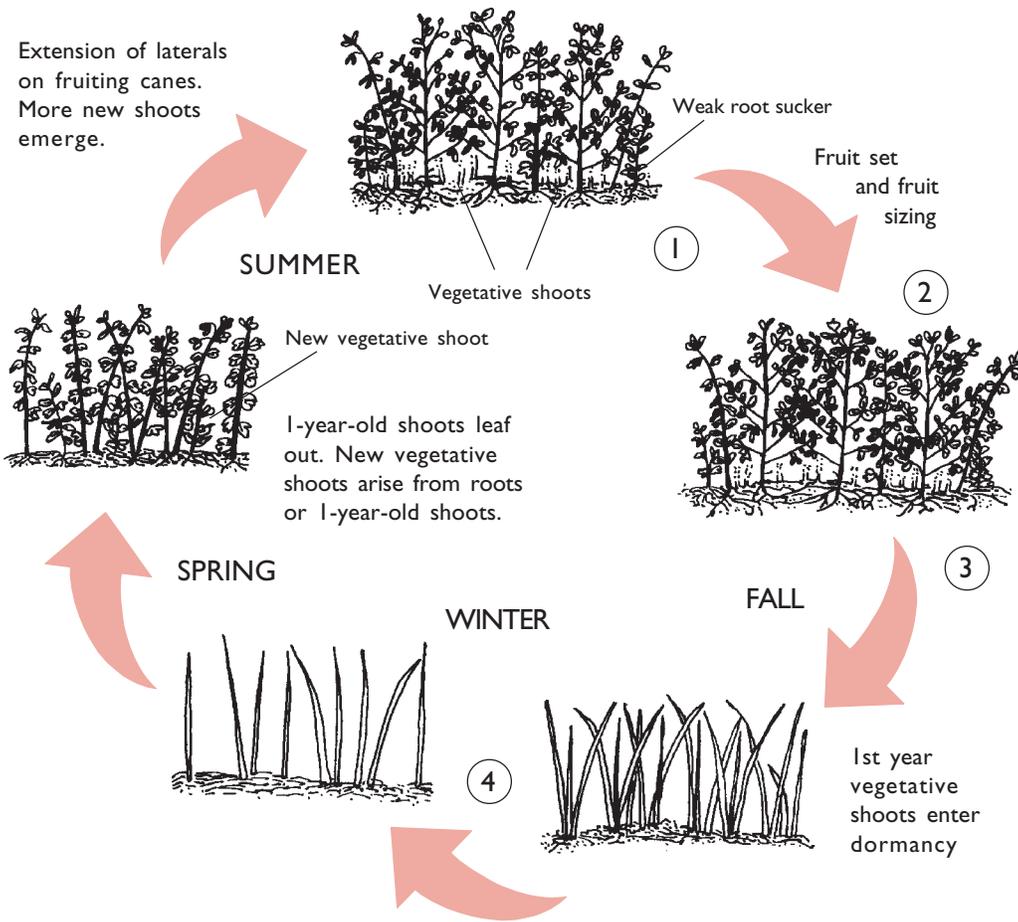


Figure 3. Generalized biennial life cycle of the mature raspberry plant. (From: Frank Louws. 1992. *Growing Raspberries in Ontario*. Ministry of Agriculture and Food. Publication 105).

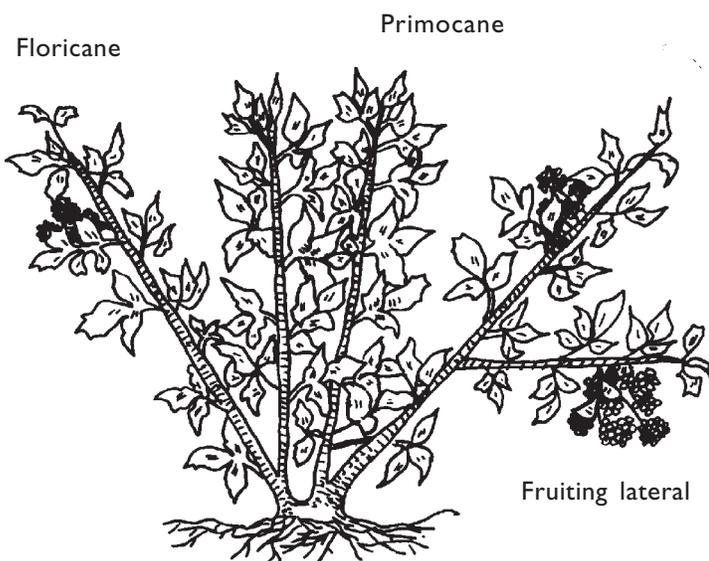


Figure 4. Raspberry cane architecture.

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 $\frac{3}{4}$ 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-leaved 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.

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 floricanes fruiting of raspberries. Growers should decide which system is best suited to their operations.

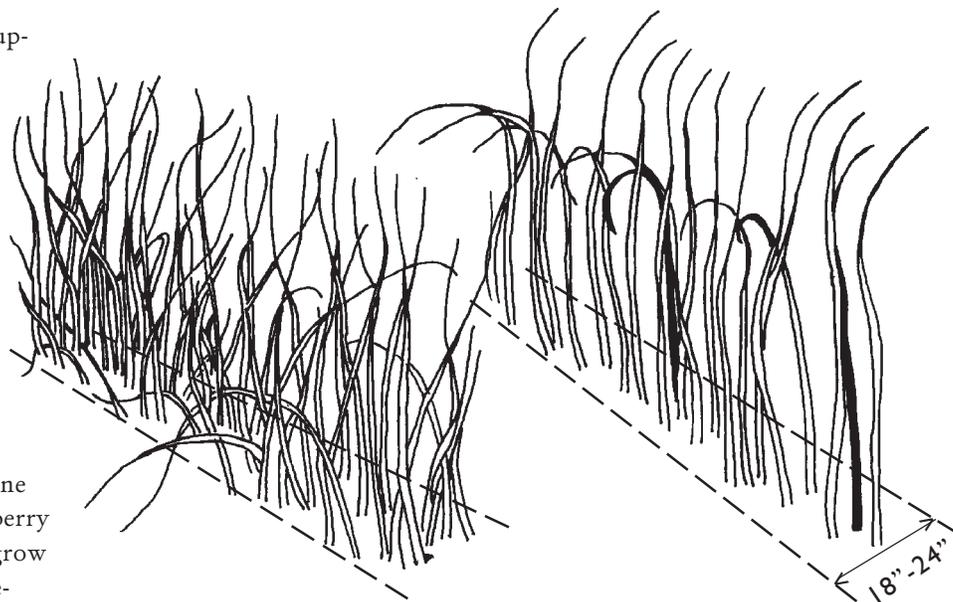


Figure 5. Red raspberries before and after summer pruning. These canes are planted in a narrow hedgerow. (From: Roper, T.R., D.L. Mahr and S.N. Jeffers. *Growing Raspberries in Wisconsin*. University of Wisconsin. Publication A1610)

Annual System

Floricanes 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

Floricanes 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.

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

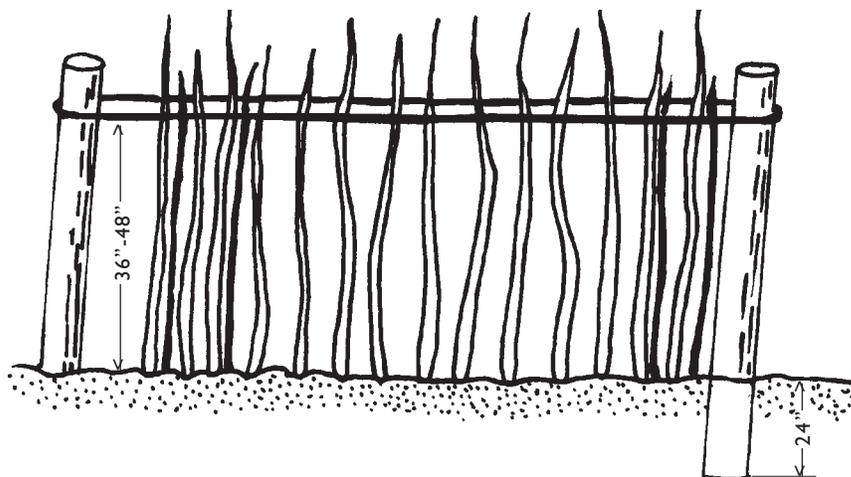


Figure 6. Hedgerow. Cedar or pressure treated posts (4 to 6 inches in diameter) are spaced about 20 feet apart. Set posts at least 24 inches into the ground. (From: Roper, T.R., D.L. Mahr and S.N. Jeffers. *Growing Raspberries in Wisconsin*. University of Wisconsin. Publication A1610)

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.

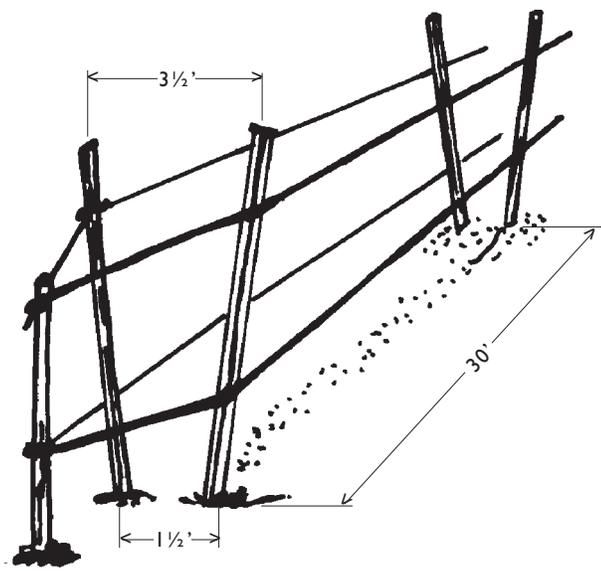


Figure 7. A V-trellis system for use with raspberries. Typical V trellis design with steel posts angled outwards from the center. The distance between the posts at the base is 1 1/2 feet and 3 to 5 feet at the top. Wire is fed through eyes or loops in the bars, stretched from post to post and anchored 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).

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

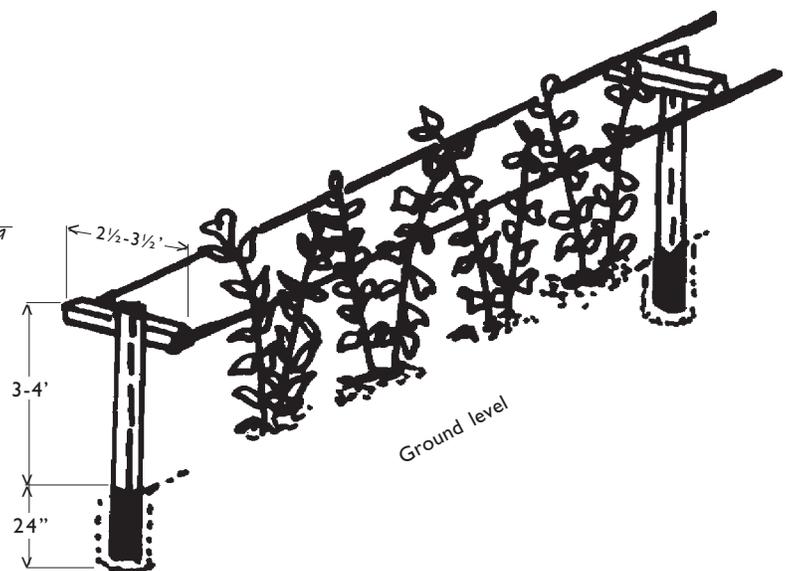


Figure 8. T trellis design. Height of the trellis and width of the cross-arms depend on the variety's growth habit. (From: Frank Louws. 1992. *Growing Raspberries in Ontario*. Ministry of Agriculture and Food. Publication 105).

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 drupelets develop to form a normal fruit. Drupelets are the small individual sections or drupes that are held together by tiny hair to make one fruit. When inadequate pollination occurs, the drupelets 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

Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Employment and program opportunities are offered to all people regardless of race, color, national origin, sex, age, or disability. North Carolina State University, North Carolina A&T State University, U.S. Department of Agriculture, and local governments cooperating.

College of Agriculture & Life Sciences
 Department of Horticultural Science

GROWING BLUEBERRIES IN THE HOME GARDEN

Charles M. Mainland and William O. Cline
 Extension Horticultural Specialists

Blueberries can be grown in home gardens anywhere in North Carolina if the right species and proper soil modifications are used. Blueberries are typically used in the landscape as hedges for screening purposes, but they can also be used in cluster plantings, or as single specimen plants. Blueberries are an ideal year round addition to the landscape. They have delicate white or pink flowers in the spring, the summer fruit has an attractive sky blue color, and the fall foliage adds great red and yellow colors to the landscape. In addition, blueberry plants lend themselves to the ‘organic’ approach of gardening, since pesticides are rarely needed in home garden plantings.

Soil pH - Blueberries require a lower pH than many other small fruit crops. Before planting, take a soil test. Apply wettable sulfur (90% S) if pH is above 5.3 for rabbiteye blueberries or 5.0 for highbush blueberries. Use 1.0 pound (2.5 cups) per 100 square feet on sandy soils to lower pH by 1 unit (for instance, from 6.0 to 5.0). Apply 2.0 pounds per 100 square feet for the same amount of pH lowering on heavier soils containing silt, clay or more than 2% organic matter. Try to achieve a pH of around 4.8; too much reduction can be detrimental to bush growth. Apply sulfur at least 3-4 months before planting, and take another soil test before planting. If pH is still above the acceptable range, additional sulfur can be applied. If you

must plant without an initial soil test, mix 1 cubic foot of peat moss with an equal amount of sand. On a heavy clay soil or a soil that sometimes remains wet, put the peat-sand mixture on the soil surface. If you are certain the soil has good internal drainage, part of the peat-sand mixture can go in a hole or furrow several inches below the soil surface. However, leave enough of the peat-sand mixture to form a mound (single plant) or ridge (row of plants) at least 6 inches above the surrounding soil surface (Figure 1). The mound or ridge will insure against damage from excess water, however, with this planting method, water thoroughly 2 to 3 times per week during dry periods, because the raised peat-sand mix will dry out quickly.

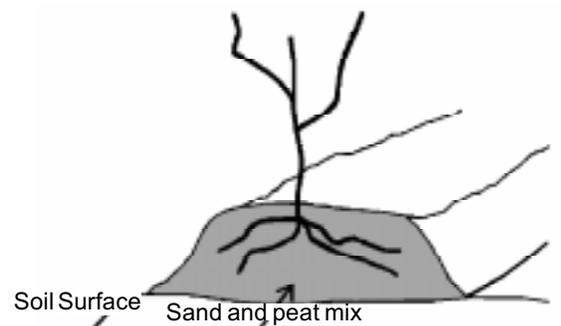


Figure 1. Blueberry plant set in peat sand mixture.

Organic Additions - If the soil contains less than 2% organic matter (OM on soil test report) incorporating peat moss or well-decayed pine sawdust or bark will improve plant survival and growth. Apply 3 to 4 inches of the organic material

Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Employment and program opportunities are offered to all people regardless of race, color, national origin, sex, age, or disability. North Carolina State University, North Carolina A&T State University, U.S. Department of Agriculture, and local governments cooperating.

over the row in a band 18 to 24 inches wide and incorporate thoroughly using a roto-tiller or spade to a depth of 6 to 8 inches. Preparing the beds in the fall will allow planting earlier in the season (late February to late March depending on the location). If the organic material is incorporated in the fall, any sulfur required to lower the pH can be added at the same time. Avoid opening a furrow, adding the organic material and planting directly in the pure organic material. Water and nutrient management is likely to be difficult in the pure organic material and plants are more likely to become weak and die.

Drainage - Blueberry plants require excellent soil drainage, so provisions for drainage must precede planting. Soil maps or observing the soil profile may be helpful in predicting internal drainage. Alternatively, digging a “dry well” can be a very effective means of determining soil drainage. Dig a hole(s) 6 to 8 inches deep and observe the water level following heavy rains. Water should not remain in the hole for more than 24 hrs, otherwise select another site or plant on ridges high enough for the water level to reach 6 to 8 inches deep within 24 hrs.

Irrigation - In most seasons and on most soils, irrigation is absolutely essential the year of planting. Hand watering with a hose is possible for several bushes, however, a soaker hose will usually give more uniform wetting. In larger plantings, systems using micro-sprinklers have been more successful than point-source drippers. Even 2 drippers per plant often do not wet enough of the soil in the root zone. At least 50% of the area under the drip line should be wetted. The irrigation system must be designed for the higher output of micro-sprinklers (about 10 gal per hr) compared with 1 or 2 gal per hr for drippers. Align the micro-sprinklers to avoid saturated soil around the crown of the bushes. The use of automatic timers on drip or micro-sprinkler irrigation systems can result in shallow root systems and root rotting if systems apply water daily. Apply irrigation no more than once every two days to reduce the chances of root rot infection.

Sun Versus Shade - Full sun is desirable but up to 50% shade is usually acceptable. However, yield is reduced with increasing shade, so plant in a sunny location to achieve maximum yield.

What Species - Both highbush (*Vaccinium corymbosum*) and the rabbiteye (*V. ashei*) types of

blueberries can be grown in the Coastal Plain and Piedmont. However, only highbush will consistently survive the minimum winter temperatures below 10° F that regularly occur in the Mountains. The rabbiteye is more drought and heat resistant and will tolerate a wider range of soil types than the highbush. For these reasons, rabbiteye is easier to establish and grow successfully in the Piedmont and on the drier soils of the Coastal Plain than highbush. More recently, a group of varieties referred to as southern highbush have been released. These varieties are intermediate between highbush and rabbiteye in soil and climate adaptation.

Varieties - Highbush varieties begin ripening in mid-May in the southeastern Coastal Plain and in early July in the Mountains. Rabbiteye varieties begin in mid-June in the southeastern Coastal Plain. More than one rabbiteye variety must be planted to provide the cross-pollination required for maximum yields. Following are varieties in order of ripening from early to late that have been grown successfully and are recommended for homeowners:

Coastal Plain - Highbush: ‘O’Neal’ (southern highbush), ‘Morrow’, ‘Reveille’, ‘Croatan’, ‘Murphy’, ‘Bounty’, ‘Blue Ridge’ (southern highbush), ‘Bluechip’, ‘Jersey’

Coastal Plain and Piedmont - Rabbiteye: ‘Climax’, ‘Premier’, ‘Tifblue’, ‘Powderblue’, ‘Centurion’.
Highbush: ‘Blue Ridge’ (southern highbush) and ‘O’Neal’ (southern highbush) have also been grown successfully on Piedmont soils. ‘Legacy’ (southern highbush) is worthy of trial in these regions as well.

Mountains and Upper Piedmont - Highbush: ‘Duke’, ‘Sunrise’, ‘Blueray’, ‘Bluecrop’, ‘Toro’, ‘Berkeley’, ‘Jersey’

Planting

- a) **Plants** - 2 or 3-year old nursery plants 12-36 inches tall will transplant well. The roots must be kept moist at all times between digging and replanting.
- b) **Time** - Late winter (Feb-Mar) as soon as the soil can be worked is best for bare-root plants; Fall (Nov-Dec) planting has been successful on sandy soil in the southeastern Coastal Plain with bare-root plants and in the other areas with potted plants.
- c) **Spacing** - Plant highbush varieties every 4-5 ft in the row and 8-10 ft between rows. Plant rabbiteye varieties every 6 ft in the row and 10-12 ft between rows.

- d) **Depth** - Plant to the same depth as the plants were growing in the nursery if organic mulch will be applied on the surface. When planting without mulch, plant 1-2 inches deeper to allow for soil settling, firm the soil around the plant with your feet and water thoroughly.
- e) **Cut Back** - Prune approximately $\frac{2}{3}$ of the top growth on bare-root plants and $\frac{1}{2}$ on potted plants leaving only 1-3 of the most vigorous upright shoots. Remove any remaining flower buds (plump rounded buds), so that the plants will not flower the first year.

Fertilization

- a) **Use Caution** - Blueberries are easily damaged by excess fertilizer. Apply the recommended amount from a soil test report and allow 4 inches of rain or an equivalent amount of irrigation between applications.
- b) **First Year** - Do not fertilize immediately after planting. Wait until the first leaves have reached full size, then apply 1 Tbs of a special azalea fertilizer, 12-12-12 or 10-10-10 within a circle 1 foot from the plants. Repeat application of fertilizer at 6 week intervals depending upon rainfall or irrigation until mid-August in the Coastal Plain and mid-July in the Mountains. Use $\frac{1}{2}$ Tbs of ammonium nitrate instead of the complete fertilizer for the second and subsequent applications if phosphorus was above 60 on the soil test.
- c) **Second Year** - Double the first year's rates, but increase the circle around plants to 1 $\frac{1}{2}$ ft. Apply the first application when new growth begins in spring.
- d) **Bearing Plants** - When growth begins in the spring, apply 1 cup of complete fertilizer such as 10-10-10 within a circle 3 ft from the plant. If more vigorous growth is desired, sidedress with $\frac{1}{4}$ cup of ammonium nitrate at 6 week intervals. On mature bushes 6-12 inches of new growth is adequate for optimal balance of plant size and yield. Additional growth must be pruned away. This may result in a loss in production, but it is necessary to keep the plants from becoming excessively large. Determine sidedressing requirement based on the amount of shoot growth.
- e) **Lowering pH** - If the soil pH is slightly high in an established planting based on a soil test; then sidedress with ammonium sulfate rather than

ammonium nitrate. If the pH is 0.5 units or more above the acceptable range, apply wettable sulfur in a narrow band under the drip line of the bush at the rate of 0.1 lb per bush to lower pH 1 unit.

Mulching

Organic material such as bark, wood chips, sawdust or pine straw as a 3 to 4 inch mulch on the surface after planting results in more uniform soil moisture, reduces soil temperature and generally promotes better bush growth and survival. Pine bark, chips or sawdust have a pH of 3.5 to 4.5 and are more desirable than the same mulches from hardwood with an associated pH above 5.0. However, hardwood mulches on the surface have been satisfactory. Avoid sticky hardwood sawdust that will "seal" the bed and prevent water infiltration.

Weed Control

- a) **Mulched** - Mulching home blueberry plantings is the best form of weed control. If mulch is applied following planting and replaced at the rate of 1 inch per year, few weed problems should develop. Hand pull or hoe the occasional weed growth. If row middles are in sod, mow often to reduce invasion by runner grasses and weed seeds into the mulched area.
- b) **Not Mulched** - Avoid deep cultivation since blueberry roots are very near the surface. Hoe no more than about 1 inch deep. In addition, hoe often (once every 2 weeks) when weeds are germinating to reduce competition with bush growth and to prevent disturbing the roots that will occur when large weeds are removed.
- c) **Herbicides** - There are some chemical herbicides that homeowners can use to control weeds. Please contact your local county extension agent for current recommendations.

Pruning

- a) **Highbush** - If the plants are cut back severely as recommended following planting, little pruning will be required the second year except removing all flower buds and any weak, damaged or diseased growth. Use a similar pruning strategy the third year with the exception that several flower buds can be left on vigorous shoots. In the fourth year, the bush should be 4-5 ft tall and capable of handling a crop, but carefully thin flower buds to prevent overfruiting and severe permanent bending of young canes under the fruit

weight. When bushes are mature, remove old canes that are weak, diseased or damaged; cut back tall, vigorous shoots to force branching at a lower level and to control bush height; and thin fruiting shoots to reduce the number of flower buds by about 50%. Prune during the dormant season. Late winter is most desirable especially in the Mountains.

- b) Rabbiteye** - During the first 3 years, pruning is very similar to highbush; however, excessively tall and limber shoots will need cutting back to stimulate branching and strengthen the shoot. With mature bushes that are excessively vigorous in spite of low rates of fertilization, cutting back the excessively vigorous shoots in late July will help control bush height and increase yield. Winter pruning of mature bushes is also similar to the recommendation for highbush except detailed thinning of fruiting shoots on each cane is less critical, and more suckers (shoots developing a distance from the crown) will require removal.

Harvest

- a) Yield** - With good care, mature highbush and rabbiteye plants should produce more than 10 lbs each year. Rabbiteye varieties can on occasion produce up to 25 lbs per plant.
- b) Bird Protection** - Birds love to harvest blueberries. They can consume the complete crop from a small planting. Plastic or cloth netting draped over the bushes or supported on a framework, while the fruit is ripening, is the only practical control.
- c) Frequency** - Highbush blueberries will be of best quality when picked every 5-7 days depending upon temperature. Rabbiteye flavor improves if berries are picked less often; about every 10 days allows for maximum flavor with few soft overripe fruit.

Potential for Organic Production - Blueberries can often be grown successfully without insecticides and fungicides outside of the commercial production areas of southeastern North Carolina. Japanese beetles can occasionally cause damage to the fruit during ripening, but the foliage is quite resistant. Susceptible plants such as roses or grapes will usually be defoliated before injury is seen on blueberries. The low rates of fertilizer required make organic sources a viable

alternative. Horse manure has proven to be a suitable source of nitrogen and rock phosphate provides adequate phosphate. Weeds can be controlled with shallow cultivation or more desirably with mulch.

Sources of Plants - Blueberries are propagated vegetatively through the use of cuttings. Both hardwood (winter) and softwood (summer) cuttings can be rooted under mist without the use of rooting hormones. While this can be accomplished by the backyard hobbyist or by a local nursery, the best sources of uniform plants for establishing a new planting are nurseries that specialize in blueberry propagation. Some commercial sources will sell single plants, while others require minimum orders of 50 to 100 plants. A partial list of nurseries is included below.

Finch Blueberry Nursery

P. O. Box 669
Bailey, NC 27807
(252) 235-4664
(Rabbiteye, southern highbush, highbush)

Ed Darden

106 Yellow Cut Road
Rose Hill, NC 28458
(910) 289-2849
(Southern highbush, highbush rabbiteye)

Atlantic Blueberry Company

475 S. Chew Road
Hammonton, NJ 08037
(609) 561-8600
(Highbush for mountains)

N.C. Foundation Seed Production

P. O. Box 33245, Method Station
Raleigh, NC 27606
(919) 737-2821
(Recent NC releases)

A. G. Ammon Nursery

P. O. Box 488
Chatsworth, NJ 08019
(609) 726-1370
(Highbush for mountains)

Tower View Nursery

70912 CR 388

South Haven, MI 49090

(616) 637-1279

(Highbush for mountains)

Fall Creek Farm and Nursery, Inc.

39318 Jasper-Lowell Road

Lowell, OR 97452

(541) 937 2973

(Highbush, southern highbush)

For Further Reading

-Blueberry Culture, Rutgers University Press, New Brunswick, NJ

-Blueberry Diseases in Michigan, MSU Ag Facts Extension Bulletin No. E1731

-Blueberry Science, Rutgers University Press, New Brunswick, NJ

-Blueberry Pest Management, NC Cooperative Extension Service AG-492

-Commercial Blueberry Production in Florida, University of Florida Pub. No. SP179

-Compendium of Blueberry and Cranberry Diseases. APS Press, St Paul, MN

-Diseases and Arthropod Pests of Blueberries. N. C. Agricultural Research Service Bulletin 468

-Highbush Blueberry Production Guide, NRAES-55, Ithaca, NY

-Small Fruits in the Home Garden. Gough, R.E. And E.B. Poling (eds). Food Products Press, Binghamton, NY.

-Small Fruit Pest Management and Culture, University of Georgia Cooperative Extension Service Bulletin No. 102



Blackberries for the Home Garden

Small fruits are becoming popular additions to the home garden. Blackberries, in particular, are productive and well suited for homeowners in most regions of North Carolina. Breeding programs have released a number of thornless varieties that are large, taste great, and because they have no thorns, are much easier to harvest than berries found in the wild. In addition, studies have shown that this fruit can help fight cancer, decrease cardiovascular disease, and slow down brain aging. And best of all, one blackberry plant can easily supply up to 10 pounds of delicious berries each year.

Blackberries are divided by their growth habit (trailing, semi-trailing, and erect), and by the presence or absence of thorns (thorny or thornless). All blackberries benefit from some sort of support such as a trellis or poles to support their canes. If you have room for several plants, select early-, mid-, and late-season varieties to extend your harvest (Table 1). Each of these varieties should perform well in all regions of North Carolina except where temperatures drop below 10° F.

Site Preparation

Prepare an easy-to-access location for your blackberries a year before planting. Blackberries need full sun and plenty of room to grow. The soil should be a well-drained sandy loam soil. A soil high in organic matter is beneficial under non-irrigated conditions. If the soil is not well drained, establish the plants in a raised bed.

Establishment and Maintenance

Erect and semi-trailing blackberry plants should be planted about 3 to 4 feet apart, while the trailing types need 6 to 8 feet between plants. They can be planted in the early spring several weeks before the last frost. Each plant can produce 10 to 20 pounds of fruit, so four to six plants can easily produce ample berries for a family of four.

Dig a hole that is large enough to allow the roots to spread out evenly. Set bare-rooted plants into the soil at the depth they were grown in the nursery. Fill in the hole and tamp down the soil. Water the newly set plants well, but don't fertilize until 3 or 4 weeks later.

Fertilize after growth starts with a complete fertilizer such as 10-10-10 at 5 pounds per 100 linear feet (or about 3 to 4 ounces around the base of each plant). In established plantings, apply the fertilizer in

March well before the plant starts to produce flowers and fruit.

Support the canes with a trellis. Erect and semi-trailing types perform well using a two-wire system with wires at 3 and 5 feet from the ground (Fig 1). As the canes emerge in the spring, evenly distribute them on the wires to form a fan pattern (Fig. 2) Once the canes have reached the top wire, remove the tips to encourage branching. Trailing types set further apart require a different system. Start with a similar trellis with wires at 3 and 5 feet, except *do not* tip the canes. Instead, allow them to grow to the top wire and then weave them back down to the bottom wire and back up to the top wire to fill in the space between plants (Fig. 3)

Blackberries require about 1 inch of water each week during the growing season. During fruit development, the plants will need about 2 gallons per plant each day. Mulch placed around the base of the plant reduces the need for water and helps keep weeds under control. Pine straw, wood chips, and seedless grasses are good mulches.

The fruit is ripe and at its peak sweetness when it is a dull black color. Pick fruits that are shiny black if you need to store them in your refrigerator. They won't be as sweet, but they will last longer. Harvest will continue for 2 to 3 weeks, depending on variety.

As soon as all the fruit is harvested, prune out all the old fruiting canes and remove them from the garden, as they no longer produce fruit. Continue to tie, tip, or train the new canes that have not produced fruit to the trellis until growth stops in the fall. During winter, prune laterals on erect types to 12 to 16 inches, and leave only 4 to 8 canes per square yard for fruit production in the following year (Fig 4).

Table 1. Comparison of blackberry varieties

Variety	Cane Type	Season	Comments
Arapaho	Erect	Early	Thornless, medium size, somewhat irregular shape
Natchez	Erect	Early to mid	Thornless, elongate fruit
Apache	Erect	Mid	Thornless, medium-size, portions of the fruit may turn white during hot weather
Navaho	Erect	Late	Thornless, late, small berry but stores better than all other
Ouachita	Erect	Mid	Thornless, medium size, stores well
Hull	Semi-trailing	Mid to late	Thornless, soft, not quite as late as Chester
Chester	Semi-trailing	Late	Thornless, large fruit, good for processing
Triple Crown	Trailing	Late	Thornless, distinct sweet flavor, fruit does not store well

Good horticultural practices can prevent insect and disease problems. Timely pruning, removing fruited canes, and maintaining a regular harvest schedule will help minimize common pests. If necessary, apply pesticides labeled for use on edible plants to manage insect and disease problems.

Blackberry Production Checklist

1. Choose a good site one year before you plant.
2. Prepare the soil before you plant: remove weeds, add organic matter, add fertilizer, make raised beds.
3. Choose a variety that is adapted to North Carolina and purchase disease-free plants.
4. Plant in spring (western NC) or spring or fall (central and eastern NC)
5. Build trellis (can be done before or within first year of planting).
6. Irrigate on a regular basis.
7. Allow 3 to 4 new canes per plant to grow to top wire.
8. Harvest a baby crop of fruit one year after planting, a full crop two years after planting.
9. After fruit is harvested, prune out fruiting canes.

Blackberry or black raspberry?

The core (technically the receptacle or torus) of the black raspberry fruit is hollow. The receptacle stays attached to the plant.



In a blackberry, the receptacle is harvested with the plant and you eat it.



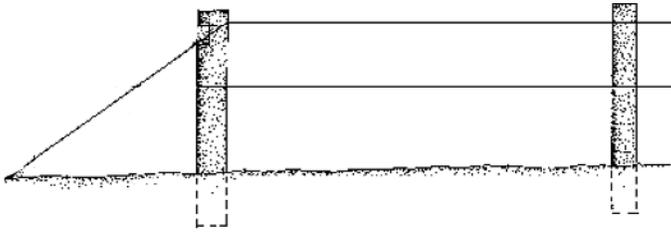


Fig. 1. Trellis system for blackberries.

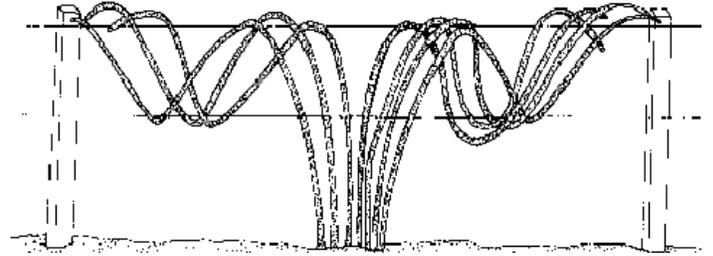


Fig. 3. Training system for trailing blackberries.

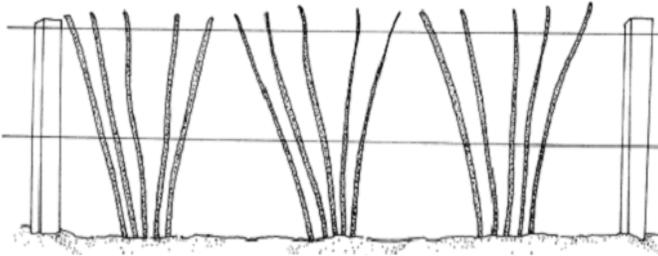


Fig. 2. Training system for erect and semi-trailing blackberries.



Fig. 4. Erect blackberries before and after winter pruning.

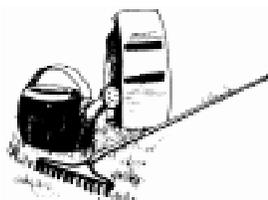
For More Information:
Commercial scale production:
<http://www.smallfruits.org/>

Other small fruits for the homeowner:
<http://www.ces.ncsu.edu/depts/hort/hil/hfruitnew.html>

Help with insect and disease identification:
http://www.ncsu.edu/project/berries/diagnostic_tool/blackberry_diagnostic_tool.html

Prepared by
Gina E. Fernandez
Small Fruit Specialist
Department of Horticultural Science
North Carolina State University

COLLEGE OF
AGRICULTURE & LIFE SCIENCES
ACADEMICS • RESEARCH • EXTENSION



BUNCH GRAPES IN THE HOME GARDEN

E. B. Poling, Extension Horticultural Specialist

Introduction: Grapes are welcome summer treats that can be eaten fresh, processed into jellies, jams, juice or even fermented into wine. Grapes are adapted to many soil types, and can be quite long-lived. There are basically two kinds of grapes grown in North Carolina, bunch grapes and muscadine. Bunch grapes produce berries in large clusters, and grow best in the mountains and piedmont areas. In coastal plain areas, Pierce's disease kills or shortens the life expectancy of many popular bunch grapes. Muscadine grapes, exemplified by the Scupper-nong variety and noted for having smaller clusters, are not affected by this disease. In these areas the kinds of grapes that may be expected to give the best results are muscadine (see Muscadine Grapes in the Home Garden - Hort. Leaflet No. 8203).

Your success with bunch grapes will depend upon the attention you give to all phases of production — including variety selection, soil management, fertilization, training, pruning, and pest control. This leaflet presents detailed suggestions for the establishment and care of bunch grapes.

Variety Selection: The choice of variety depends on a number of factors including its adaptation to your area and the type(s) of grape you prefer. There are seedless table varieties, native Fox-type table grapes such as Concord, muscats and many wine varieties. Newer hybrid bunch varieties resulting from crosses of European vinifera (the old-world grape)

with native American varieties are known as French-American hybrids. Both vinifera and French-American hybrids are used primarily for winemaking purposes. However, vinifera type grapes are more difficult to grow and require regular chemical sprays throughout the growing season to control diseases. Vinifera are easily injured by fluctuating winter temperatures and typically sustain greater losses to spring frost events than French-American hybrids. Vinifera should be grown on a rootstock (Couderc 3306, 3309, or SO4).

The bunch grapes listed in Table 1 are the most suitable for growing in piedmont and western North Carolina. Six grapevines should furnish enough fruit for most families. A mature vine can yield 10 pounds or more of fresh fruit. Early season table grapes will begin ripening in mid-summer, while a number of the wine varieties do not begin to ripen until late summer. All bunch grapes are self-fertile and may be planted alone or with other varieties.

Soil And Site: Good air circulation, sun exposure and a soil that is well drained are desirable for quality crops of grapes. Air circulation is best if the location has a gentle slope; avoid low frosty pockets. Plant the vines away from trees so that they will receive full sunshine. Grapes are not as particular to soils as other fruit crops; as long as the soil is best; rich soils stimulate excessive vine growth at the expense of fruit quality. Grapes require a soil pH of 5.5 to 7.0.

Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914.

Employment and program opportunities are offered to all people regardless of race, color, national origin, sex, age, or disability. North Carolina State University, North Carolina A&T State University, U.S. Department of Agriculture, and local governments cooperating.



**North Carolina
Cooperative Extension Service**
NORTH CAROLINA STATE UNIVERSITY
COLLEGE OF AGRICULTURE & LIFE SCIENCES

Table 1. Bunch grapes recommended for piedmont areas and western North Carolina

Variety	Season	Color	Size	Use	Remarks
Alwood	E. Mid	Purple	Med	FF,J	Resembles Concord
Catawba	Late	Red	Med	FF,J,W	All purpose grape
Cabernet-Sauvignon	V. Late	Black	Sm	W	Vinifera, excellent
Chambourcin	Late	Purple	Med	W	French hybrid, red wine
Chardonnay	Late	White	Sm	W	Vinifera, excellent wine
Concord	E. Mid	Black	Med	FF,J	Not recommended in piedmont
Delaware	Mid	Red	Sm	FF,J,W	Good wine or table grapes
Fredonia	E. Mid	Purple	Lge	FF,J	Heavy producer
Himrod	V. Early	White	Sm-Med	FF	Seedless, disease susceptible
Lakemont	E. Mid	White	Sm-Med	FF	Seedless, good quality
Leon-Millot	Late	Black	Sm	W	French hybrid, red wine
Moored	Early	Red	Med-Lge	FF	Fruity, productive
Niagara	Mid	White	Med	FF,J	Popular, fruit, hardy
Seyval	Late	White	Sm-Med	W	French hybrid, good wine
Suffolk Red	E. Mid	Red	Med	FF	Seedless, good quality
Venus	Mid	Black	Med-Lge	FF	Seedless, avoid overcropping

*Designations used: FF = fresh fruit; J = juice; W = wine

Planting: Plant grapevines in late winter and early spring. Vigorous one-year-old plants are best. Planting will be easier if the soil is spaded or tilled beforehand. Bunch grape roots rapidly grow out several feet in the first two years, so working compost or fertilizer into the planting hole will be of little value. Open a hole large enough to let the roots spread out naturally (root pruning is not recommended except to remove damaged roots). Plant the vines the same depth or slightly deeper than they grew in the nursery. Keep the topsoil separate to place over and around the roots. Be sure not to place fresh manure or fertilizer in the hole. Tamp the soil firmly around the roots, and water if dry. After setting the vine, prune it to one stem and cut this stem back to two or three buds.

Training and Pruning: To simplify installation and avoid damage to young vines, build and set the trellis system before the vines are planted. Use wood treated to resist decay or a durable type of wood such as cedar or locust. Construct the trellis according to the diagram in Figure 1. Set the line posts 20 feet apart down the row. Brace the end posts as shown.

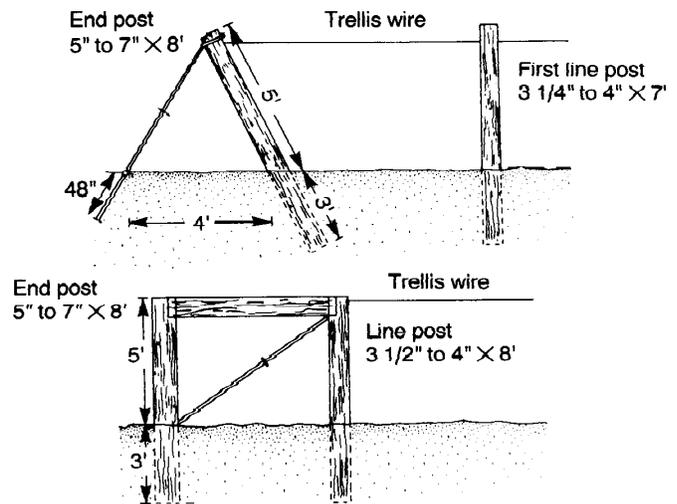
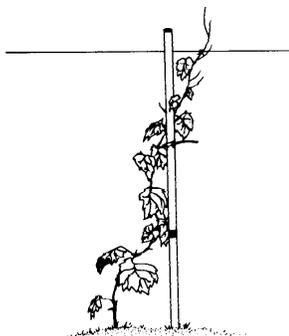


Figure 1. Dimensions for the end post construction for a grape trellis that can be used for either midwire or high-wire cordon training systems.

During the first season, the primary objective for grapevine growth is development of a healthy root system and straight trunk. After setting the vine, prune it to one stem and cut this stem back to two or three buds. When new growth begins and the first shoots from the two-bud cane reach 6 to 10 inches in

length, select the most vigorous and prune away the others. Tie the shoot gently to the training stake several times during the first season (Figure 2). Pinch lateral shoots back to the leaf growing from the main shoot. This allows the main shoot to grow more rapidly, possibly saving as much as a year in establishing a healthy vine.

Figure 2. Train the new grape shoot by twisting it around the training stake as it grows. Tie it loosely every 8 to 10 inches.



Mid-trellis Cordon System (for use with French hybrid vines such as Seyval and vinifera vines such as Chardonnay and Cabernet Sauvignon). Allow the main shoot to grow until it reaches 3 feet (Figure 3). Tie it there, pinch off the tip, and allow several of the lateral shoots to grow. Begin training in the second year by evaluating the extent of growth achieved during the first year. If no cane has reached the first wire, remove all but one cane. Prune this cane back to two buds and treat it as a new vine.

In the winter following the first season of growth, remove all but a few good canes the diameter of a pencil. No added training is necessary, but it is vital to remove flower clusters in the second growing season. Vines that grew extensively in the first year will likely have one or more canes suitable for retention as a trunk. If a cane is long enough to reach the lowest trellis wire and is of adequate diameter (approximately

¼ inch), retain the cane as a trunk. The distal (tip) portion of such canes can be trained horizontally along the training wire to serve as the basis for a cordon (see Figures 3 through 5).

Cordon establishment begins in the second season of growth and should continue over a two-year period for best results. To establish a 3-foot-long cordon, begin with an 18-inch cane (or trunk extension) in the second year, and complete the cordon in the third year with another 18-inch cane from the distal end of the short cordon (Figures 4 and 5). Canes that are used to establish the cordons should be wrapped loosely around the trellis wire and tied securely at the end with wire to prevent the cordon from rotating or falling from the wire.

During the second growing season, shoots that develop below the lowest trellis wire should be pruned to one or two near the graft union. Retain 10 or more shoots that develop on the cordon in the second year.

In the third year the cordon system should be completed. For the trellis mid-wire cordon, canes that rise from the upper side of the cordon arms should be pruned to one- or two-node spurs (see Figure 5). These spurs should be 4 to 6 inches apart. Develop a second trunk and cordon from a cane that originates near the graft union. Keep a small crop of fruit (for example, one cluster for every two shoots) on vines that had at least 1 pound of cane prunings from the second-year growth. Tie shoots to wires as necessary during the growing season. Treat weak vines as second-year vines and remove all crop.

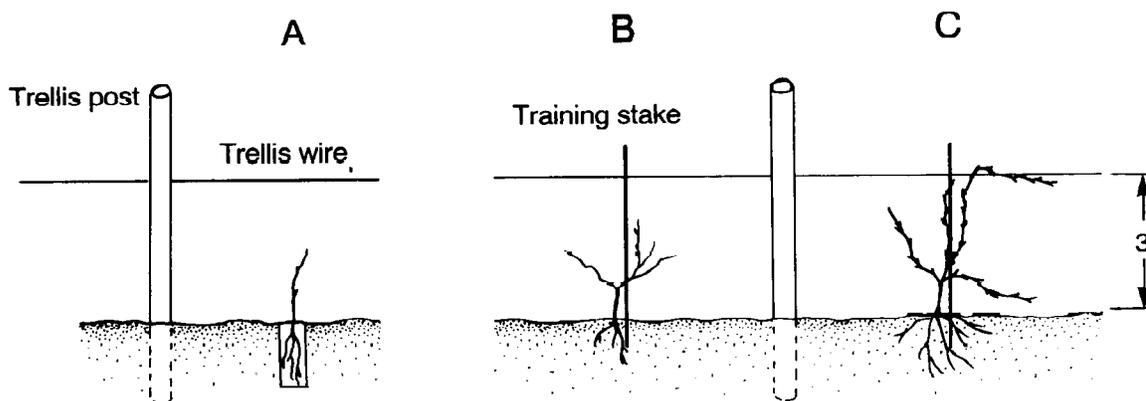


Figure 3. Bilateral cordon training system for grape vines, year 1. (A) Spring, at planting; (B) Fall, weak vine at end of growing season; (C) Fall, vigorous vine at the end of growing season.

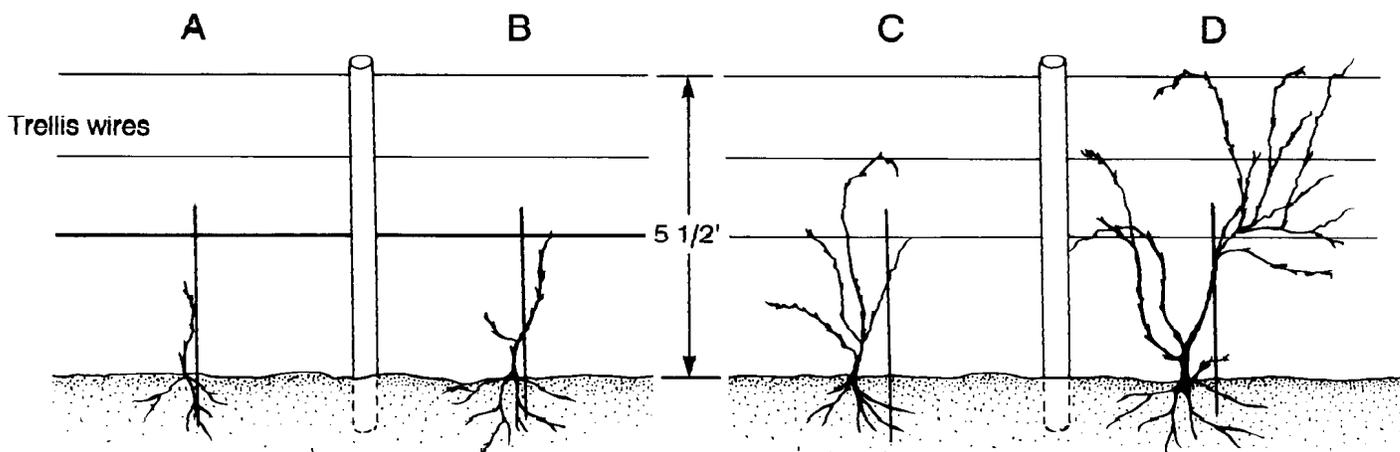


Figure 4. Bilateral cordon training system for grape vines, year 2. (A) Spring, weak vine after pruning; (B) vigorous vine after pruning; (C) Fall, weak vine; (D) Fall, vigorous vine.

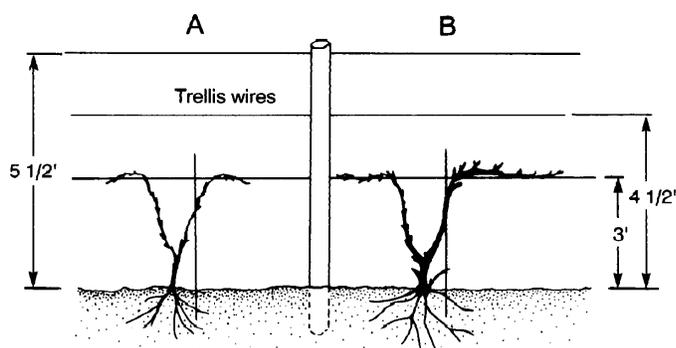


Figure 5. Bilateral cordon training system for grape vines, year 3. (A) Spring, weak vine after pruning; (B) Spring, vigorous vine after pruning.

Cordons may be either unilateral or bilateral; in either case, cordons should ultimately span the distance between two adjacent vines in a row.

High-Trellis Cordon System (for use with American bunch grapes and Muscadine). The initial training of the trunk is the same as used with the midwire trellis system, but in this system cordons are trained along the *top* wire of the trellis. Spurs (short canes) are retained on the *lower* sides of the cordons to promote downward growth in American bunch varieties.

The vine must be pruned every year to avoid alternate-year bearing and to make harvesting easier (Figure 6). Pruning mature vines consists of three operations. The first step is pruning last season's growth. In the dormant season, prune back all canes that grew during the previous summer to 4 or 5 inches in length. Leave the remaining spurs at a 6-inch spacing on young vines. As the vines age, they will

develop clusters of spurs. These spurs must be thinned after the third season to force new spur growth. This process also minimizes the labor necessary for cane tying and keeps fruit and renewal regions at a uniform height, facilitating harvesting and pruning. The second step is to remove suckers or shoots growing from the trunk and any damaged arms. A new cane must be trained (from the renewal canes at graft union height) to replace the removed arm. As the third step, remove all tendrils that attach themselves to the trunk *or* fruiting arm of the vine.

Overcropping will greatly reduce fruit quality. Some cluster thinning in years of heavy fruit set (thinning to one cluster per shoot) is the simplest way to ensure that those remaining will develop into larger, more fully ripened clusters. A good rule of thumb for mature vines is to allow no more than two clusters per shoot. Excess clusters should be removed before bloom (early May in the piedmont, late May in the mountains).

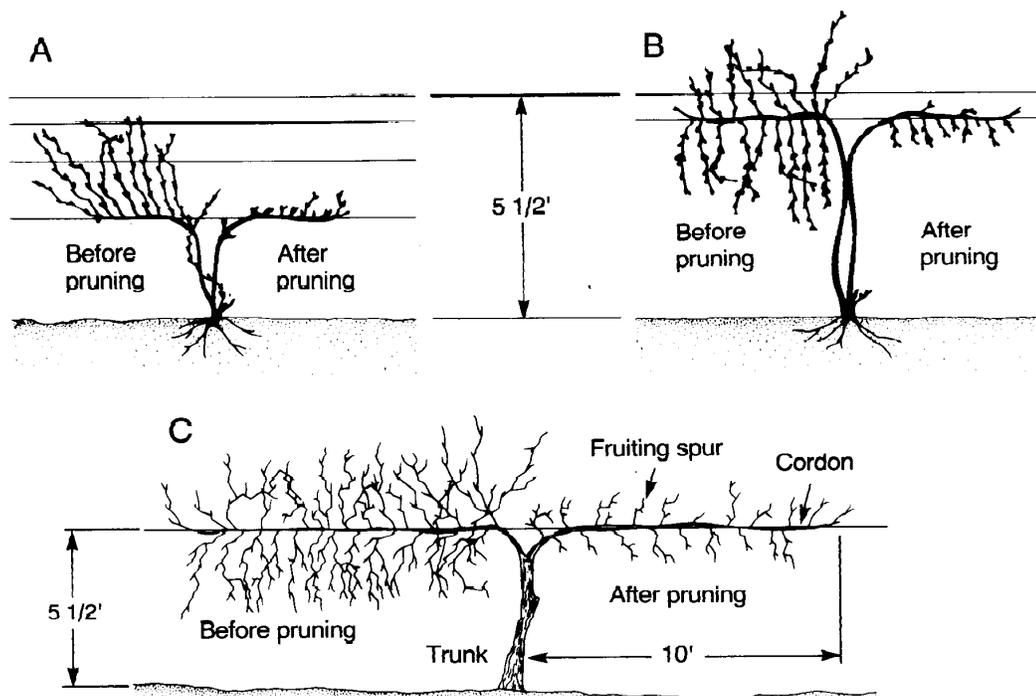


Figure 6. Completed bilateral cordon training system for grapes. (A) Midwire system for use with French vines such as Cabernet Sauvignon and Seyval. Spurs are trained upward. (B) High-wire system for use with American bunch varieties. Spurs are trained downward. Spurs should be pruned to four buds and spaced 4 to 6 inches apart along the cordon. (C) System for Muscadine varieties. Essentially a high-wire system, but the growth characteristics of these grapes prevents training spurs in a downward direction. Approximately 20 two-bud spurs should be retained for each 10-foot permanent arm (cordon); the spur orientation (upward or downward) is not important in Muscadine training.

Fertilization: Proper fertilization is essential to high yields and quality. Before planting vines, broadcast and work fertilizer and lime into the soil as indicated by the soil test (usually about 2 pounds of fertilizer and 5 pounds of dolomitic limestone per 100 square feet).

After setting the vines and just before growth starts, apply 1/2 cup (1/4 pound) of 10-10-10 fertilizer in a 20-inch circle around each vine. Repeat monthly until July 15th. In the second year, double the first year amounts but follow the same schedule. For bearing vines, scatter 1 to 2 pounds of 10-10-10 fertilizer per plant over the area. Repeat with 1 pound per vine in mid-June.

For at least the first two years, keep an area 1 to 2 feet in diameter around each vine free of weeds by hoeing, hand cultivation, or mulching. Black plastic is a satisfactory mulch material, but it does not add to the humus content of the soil. **DO NOT USE A COMBINATION FERTILIZER AND WEED KILLER** on lawn areas near grape vines; the weed

killer may be absorbed by the grape roots and injure the vine.

First year - after setting and just before growth starts, apply 1/2 cup (1/4 pound) 10-10-10 in a 20-inch circle around each vine. Repeat monthly until mid-July. Second year - double first year amounts. Follow same schedule as for first year. Bearing - in March apply 2 pounds 10-10-10 fertilizer per plant, scattered over the area beneath the vine. Repeat with 2 pounds per vine after fruit sets.

Cultivation: For at least the first 2 years, an area 1 to 2 feet around each vine should be kept free of weeds by hoeing, or with a heavy mulch of grass clippings (4 to 6 inches deep). Black plastic is a satisfactory mulch material, but it does not add to the humus content of the soil. Once established, the vine will shade out some weed growth. Recommended chemical herbicides may also be used for weed control in grapes, but mulching is the preferred management practice. Certain types of herbicides should not be used near grapes as they are very

sensitive (e.g. terbacil, 2,4-D). Do not use the combination of fertilizer plus weed killer on lawn areas near a grape vine; the weed killer may be picked up by the grape roots, and cause vine injury.

Cluster Thinning: Overcropping will greatly lower fruit quality and vine vigor. It is better, especially on young vines, to do some cluster thinning in years of heavy fruit set. Thinning to one cluster per shoot (a single shoot may carry three or four clusters), is the simplest way to ensure that those remaining will develop into larger, more fully ripened clusters. With mature vines a good rule of thumb is not to allow them to develop more than two clusters per shoot. Excess clusters should be removed prior to bloom (Piedmont - early May; WNC - late May).

Harvest: An acceptable taste is the main criterion for table use. On a vine that is not overcropped, the berries of black varieties lose their red color and white varieties will change from green to golden yellow. Ripe berries will soften and seeds become brown. Determining the harvest of wine grapes requires either experience or a means of measuring both sugar and acid content.

Insects and Diseases: Bunch grapes require frequent and thorough spraying to avoid diseases and insects. Current recommended spray programs are available through your local Cooperative Extension agent or the Plant Pathology and Entomology Departments, N.C. State University, Raleigh, N.C.

College of Agriculture & Life Sciences
Department of Horticultural Science

MUSCADINE GRAPES IN THE HOME GARDEN

Barclay Poling, Professor and Extension Specialist
Connie Fisk, Muscadine Extension Specialist, (Duplin County)

Introduction

Muscadine grapes are well adapted to the Coastal Plain of North Carolina, where temperatures seldom fall below 10°F. Considerable injury generally occurs where winter temperatures drop below 0°F. Some of the more hardy cultivars such as ‘Magnolia’, ‘Carlos’ and ‘Sterling’ survive northward to Virginia and westward to the foothills of the Blue Ridge Mountains. Muscadines have a high degree of tolerance to pests and diseases that makes the production of bunch grapes nearly impossible in eastern North Carolina. There is no other fruit with such strong personal associations for so many native North Carolinians. The fruit has a distinct fruity or “musky” aroma, while the juice by itself is sweet with a light taste and aroma. The fruit is very popular with native Southerners for making into wine, pies and jellies.

Origin

Muscadine grapes, (*Vitis rotundifolia*, or alternatively, *Muscadiniana rotundifolia*) are often referred to as *scuppernongs*. Muscadine is native to the Southeastern United States and has been cultured for more than 400 years. Native Americans preserved muscadines as dried fruit long before the Europeans inhabited this continent. As early as 1565, Captain John Hawkins reported that the Spanish settlements in Florida made large quantities of muscadine wine. For much of the history of the crop, varieties were simply selections from the wild. The first recognized muscadine cultivar was a

bronze selection, found before 1760 by Isaac Alexander in Tyrrell County, NC. It was first known as the ‘Big White Grape’, and was later named ‘Scuppernong’ after the area in which it was found. With time, the name scuppernong became generic with all bronze muscadines, regardless of actual variety name. However, this is incorrect nomenclature, since ‘Scuppernong’ is only one of many cultivars of muscadine grapes. Bullis and its variants (bullace, bullet grape, bull grape) are very old names for dark-fruited muscadines. Some authorities have written that the name “Bull” grape reflects comparison of the berries with cow or pig’s eyes; or, alternatively, muscadines were called “Bullace” because of their resemblance to a European plum of the same name, and that Bullis, Bull and Bullet are all corruptions of the Bullace!

Nearly 100 years of breeding work has resulted in the release of many improved cultivars. ‘Carlos’, ‘Doreen’, ‘Nobel’, ‘Magnolia’, and ‘Nesbitt’ are some of the most important cultivated varieties in North Carolina.

Environmental Preferences

Light – Avoid shaded areas. Fruit set and production will be reduced if the vines are shaded for more than several hours each day during the growing season.

Soil – Muscadine grapes will survive and produce a crop on a wide range of soils as long as internal drainage is good. Plant failure

Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Employment and program opportunities are offered to all people regardless of race, color, national origin, sex, age, or disability. North Carolina State University, North Carolina A&T State University, U.S. Department of Agriculture, and local governments cooperating.

can be expected in locations where water stands for even short periods after heavy rains. Soils with a hardpan are not suitable. Active growth late in the growing season makes vines susceptible to winter injury on soils with more than 1½% organic content. Proven tobacco sites have generally supported good muscadine grape growth and production. Apply and work in dolomitic lime at the rate recommended by the soil test to bring the pH to 6.5 before planting. Your county extension office has more information and kits for soil testing.

Varieties

‘Scuppernong’ bronze and ‘Thomas’ black are the cultivars most widely known and asked for by the public. The following are much-improved, recommended cultivars.

- **Carlos** – bronze, mid-season, medium size, perfect flowered, very dry stem scar, good fresh or for wine.
- **Doreen** – bronze, very late, medium size, perfect flowered, dry stem scar, good fresh or for wine.
- **Magnolia** – bronze, early, medium to large size, perfect flowered, wet stem scar, excellent fresh flavor, wine and juice.
- **Nesbitt** – black, early, large size, perfect flowered, dry stem scar, good fresh, but poor wine color.
- **Noble** – black, early, small size, perfect flowered, wet scar, good fresh, wine and juice.
- **Regale** – black, mid-season, medium size, perfect flowered, wet scar, good fresh, wine and juice.
- **Triumph** – bronze, early, large size, perfect flowered, dry scar, good fresh, fair wine.

All of these cultivars are perfect flowered (male and female flower parts), so a single vine will be fruitful. Other available cultivars such as ‘Fry’, ‘Higgins’, ‘Scuppernong’, and ‘Jumbo’ have flowers with only female flower parts and must be planted near a perfect-flowered cultivar.

Planting

Wait until there is little chance of sub-freezing temperatures before spring planting. Potted plants are easier to hold until the proper planting time, but bare-root plants are satisfactory if the roots are kept moist (not wet), and the plants are refrigerated until planting time. Plant at the same depth or slightly deeper than the previous planting depth. Vines should be a minimum of 10 ft apart in the row, but

more desirably, 20 ft apart. Distance between rows can depend on the equipment used for mowing, but 8 ft should be a minimum.

Trellising

The type of trellis selected will often determine where the plant(s) can be established. A space at least 10 ft long by 6 ft wide should be provided for each vine. Decide on the trellis system and complete the construction before planting. Many types of trellising have been used successfully, but an equal number have been designed by homeowners that have not been practical for long-term management of vines. A practical system allows for establishing permanent cordons (arms) that can be easily reached for the required annual pruning. This requires training of the cordons to single strands of wire (No. 9 is recommended). Training to woven-wire fencing or overhead structures, where individual cordons are not maintained at least 4 ft apart, will be difficult to prune. A single wire 5 to 6 ft above the ground and well anchored on each end is the easiest trellis to construct and maintain. Four-ft cross arms of 2 x 6 inches, treated lumber, can be attached to treated posts to support double wires. The double-wire system will yield about 30% more than the single-wire system. Growing muscadine vines over a garden arch or a pergola can be aesthetically pleasing and provide shade, but if individual cordons are not maintained, management will be difficult, neglect is likely, and fruit production will decline.

Training

After planting, prune to one stem and cut this stem back to 2 to 3 buds. When new growth begins, select the most vigorous shoot and cut away the others. A bamboo-training stake beside the plant is convenient for attaching the growing vine. Loosely tie the shoot to the stake. Paper-covered wire ties that are wrapped around the vine and stake work well but to avoid girdling, do not twist the ties. Continue tying the vine each week and removing side shoots. When the vine is just below the wire, cut the growing tip to force lateral buds. Shoots from the lateral buds should be trained down the wire to form the cordons, just as the trunk was trained up the stake. The goal should be to get the vine on the wire the first growing season and to full length in the second season. After the cordon has developed to full length, side shoots can be allowed to develop. These side shoots should be cut back to 2 to 3 buds during the dormant season. The next season, the buds on these side shoots will develop into shoots that produce flowers and fruit. Each dormant season, the

lateral shoots must be cut back to 2 to 3 buds by hand or with a hedge trimmer.

Fertilization

Apply ¼ lb of 10-10-10 in an 18-inch circle around each vine after planting (late April to early May). Repeat every 6 weeks until early July. The second year, apply in early March, May and July at double the first year's rate (½ lb per vine). Do not put the fertilizer closer than 21 inches from the trunk. To minimize the potential for winter cold injury, piedmont and foothills growers should omit July fertilizer applications. For mature vines, scatter 1 to 2 lbs of 10-10-10 uniformly under the vine (60 to 120 sq ft) in early to mid-March and apply another 1 lb in mid-June. If the average length of new vine growth exceeds 3 to 4 ft during the season, reduce the amount of fertilizer the following year by 20%. Continue adjusting fertilizer rate until the desired vigor (based on vine length) is obtained. Avoid mulching materials that will release nitrogen late in the season and cause increased susceptibility to winter damage.

In eastern NC, an alternative fertilizer to 10-10-10 that shows promise involves the application of 6-6-18 tobacco fertilizer because it contains several micronutrients in addition to N, P and K. It should be applied in March and then again in late June, at ¼ lb per vine after planting and ½ lb per vine in the second year. Mature vines should receive 2 to 3 lb at each application. An application of calcium nitrate should also be applied in mid-May at 6 to 7 oz per vine. Leaf samples can be taken in mid June to determine the actual nutritional status of mature vines.

Magnesium—Grapes have a relatively high magnesium requirement. You may want to apply Epsom salts in July at 4 lbs per 100 gals of water (roughly 1 Tbsp per gal) or by sprinkling around the vines at 2 to 4 oz per vine for young vines and 4 to 6 oz per vine for mature vines to prevent or correct a magnesium deficiency.

Boron—For mature vines apply 2 Tbsp of Borax mixed in with the fertilizer and spread over a 20 ft x 20 ft square every 2 to 3 years, before bloom. Boron deficiency is more likely on sandy soils with high pH. Excessive boron causes injury; do not exceed boron recommendations.

Weed Management

Keep an area 1 to 2 ft in diameter around each vine free of weeds by shallow cultivation for the first 2 years. A coarse, non-nitrogen-releasing mulch such as bark will also help control weeds and reduce moisture loss from the soil.

Irrigation

Muscadine grapes are quite drought tolerant. Water during dry periods the first two years, then the vines can usually obtain adequate water from the soil even during dry periods.

Potential for Organic Production

Muscadine grapes can often be grown successfully without insecticides or fungicides. Japanese beetles are often the most damaging insects. Selecting cultivars with some disease resistance such as 'Carlos', 'Nesbitt', 'Noble', 'Triumph' or 'Regale' will reduce the losses without fungicide applications. Netting may be required for bird protection; however, birds are generally a much more serious problem on blueberries and bunch grapes.

Sources of Plants

Bottom's Nursery
360 Pulliam's Rd.
Concord, GA 30206
(770) 884-5661

Duplin Nursery
276 Bay Road
Rose Hill, NC 28458
(910) 289-2233

Ison's Nursery & Vineyards
Route 1, Box 191
Brooks, GA 30205
(770) 599-6970
1-800-733-0324

Woodard Pecan Nursery
5194 US Highway 70 E
Princeton, NC 27569
(919) 965-3561

KIWIFRUIT

**Charles M. Mainland, Emeritus Professor and Extension Horticultural Specialist,
 Connie Fisk, Extension Associate, (Duplin County)**

History

The kiwifruit (*Actinidia deliciosa*) is a large, woody, deciduous vine native to the Yangtze Valley of China. Seeds from China were taken to New Zealand and planted in 1906. Plants developing from these seeds first fruited in 1910. Commercial planting began in New Zealand in about 1940 and by 1970 there were 900 acres. Commercial planting in California began in the late 1960s. From 50 acres in 1970, the industry in California had grown to more than 8,000 acres by 1988 (University of California Cooperative Extension estimate). US kiwifruit production has been declining since the 1990s. Acreage in 2006 was reported as 4,300 by the California Kiwifruit Commission. In 1974 kiwifruit became the internationally accepted name, replacing Chinese gooseberry and kiwi.

In the eastern United States, kiwifruit vines have fruited at Virginia Beach, Virginia, and at several locations in South Carolina, and are part of evaluation programs in Alabama and Georgia. The first commercial shipments began in 1980 from a planting in South Carolina located about 30 miles north of Augusta, Georgia. In North Carolina, several vines were planted at a research farm near Raleigh in the early 1970s, but these did not survive the first winter. A 1979 planting at the Horticultural Crops Research Station near Wilmington was severely damaged when the temperature dropped to 2°F in early March of 1980. Almost half of the vines were

completely killed, and the other half were killed to the ground. Surviving plants sprouted from below the soil line and slowly reestablished vine growth in 1980. No vine damage occurred in the winter of 1980-81. Vine vigor increased during the summer of 1981, but severe trunk and arm cracking occurred in January, 1982, following a temperature of 5°F. Surviving vines only fruited twice in the following 9 years. Severe winter damage occurred about once every three years. As a result of poor survival and fruiting, the vines were removed in the fall of 1991.

Reducing Winter Damage

Several techniques, including planting on the north side of a building and piling pine straw around the base of the plant in the fall, have reduced damage. Damage is usually the most severe on the lower 18 inches of the trunk. If this area is not warmed by afternoon sun or is protected by pine straw prior to a freezing night, less damage has been observed. Another alternative is to plant a species of kiwifruit that is more winter hardy. These kiwifruit species are known as hardy kiwifruit because they can withstand temperatures below -10°F. However, even hardy kiwifruit require protection from frost injury in the form of overhead irrigation or another frost protection strategy when temperatures are expected to drop below 32°F after bud break. *A. arguta* is the most common of the winter hardy species that are offered by commercial propagators.

Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Employment and program opportunities are offered to all people regardless of race, color, national origin, sex, age, or disability. North Carolina State University, North Carolina A&T State University, U.S. Department of Agriculture, and local governments cooperating.

Potential in North Carolina

Based on experience over the past 18 years, there is little reason to be optimistic about successful commercial kiwifruit production in North Carolina. However, the more positive results in several Virginia and South Carolina locations provide sufficient encouragement to continue kiwifruit trials on a limited scale. Vine establishment during years with less severe winters combined with increased cold tolerance of older vines may account for the success in Virginia and South Carolina. The information and suggestions in this leaflet were gathered from New Zealand, California, Oregon, Virginia, and South Carolina sources. The purpose of the information is to provide a basis for establishing trial or home plantings and not as tried and proven recommendations for commercial kiwifruit production in North Carolina.

Fruit and Vine Characteristics

A. deliciosa kiwifruit is about the size and shape of a large hen's egg with a fuzzy, dull-brown exterior. Inside, the flesh is emerald green with rows of black, edible seeds. Fruit texture is similar to strawberry and the flavor resembles a blend of strawberry and pineapple. Vines are very vigorous. Large, thick leaves combined with a fruit crop that may exceed 14,000 lb per acre contribute to a very heavy trellis load.

Hardy kiwifruit (*A. arguta*, *A. kolomikta*) are much smaller than *A. deliciosa* in size. Their size is similar to that of a grape and few are larger than a man's thumb. Instead of the fuzzy skin, *A. arguta* has a smooth, edible skin. On the interior, hardy kiwifruit resemble fuzzy kiwifruit in color, texture and flavor, though they are usually described as having more intense flavor and sweetness. From our experience, the fruit is best when soft-ripe at harvest and will only ripen during storage if harvested after the fruit reaches a stage of physiological maturity (after seeds turn black and sugar content [measured as soluble solids with a refractometer] reaches 8-14%). Storage life of the fruit is short. Variable fruit quality, dehydration, and short storage life seem to give *A. arguta* limited commercial potential. However, hardy kiwi is being grown and marketed as "baby kiwi" in Oregon and as "grape kiwi" in British Columbia. The primary cultivar is 'Ananasnaya,' sometimes shortened to 'Anna.' 'Ananasnaya' came to North America from the Russian breeding program of Ivan Michurin during the Stalin regime. 'Issai,' a less hardy *A. arguta* cultivar came from Japan in 1986. Based on recent research findings, 'Ananasnaya' in particular may be worthy of trial in North Carolina.

Adaptation

Classified as a subtropical plant, *A. deliciosa* kiwifruit will not tolerate winter temperatures much lower than 10°F. When the winter minimum temperatures decline gradually over a number of weeks with a few warm days interspersed, well hardened, mature vines have survived temperatures approaching 0°F with little damage. However, in the fluctuating temperatures of North Carolina, damage often occurs just below freezing. The long growing season required for fruit to mature can also limit production. A frost free period of at least 220 days is required for adequate fruit ripening. In southeastern North Carolina, the vines can be expected to leaf in mid-to late-March and flower in mid-May. Fruit should be sufficiently mature for harvest in late October or early November. Temperatures lower than 29°F between leafing and harvest can damage the leaves, blossoms and fruit. If new growth is damaged in the spring before blossoms develop, no blossoming will occur. *A. arguta* has been reported to tolerate winter temperatures as low as -25°F, but freeze damage to new growth in the spring is similar to the damage described for *A. deliciosa*. *A. arguta* fruit begins ripening in mid-August in southeastern North Carolina.

Culture

Kiwifruit plantings can be handled much like muscadine grapes, however, they are much more susceptible to wind damage and root-knot nematodes, and require more supplemental irrigation than muscadine grapes. Many soil types are suitable, provided they are well drained. The soil pH should be adjusted to 6.0 to 6.5 and nematodes controlled before planting.

Planting - Dormant plants from a nursery can be planted in the spring after there is little chance of freezing weather. Plant to the same depth as the plants grew in the nursery. After planting, prune the plant back to a single, healthy shoot 6-12 inches long.

Training and Trellising - See North Carolina Cooperative Extension Circular AG-94, *Muscadine Grape Production Guide for North Carolina*, for examples of training and trellising systems. Similar to grapes, commercially grown kiwifruit plants are trained to a permanent framework, either a T-bar (like a clothesline with 4-5 wires) or pergola (solid overhead canopy with wires going in both directions). Vines can also be trained to a simple single wire or double wire system. For ease of harvest, the wires of the trellis should be at least 6 ft above

the ground. Cross arms on the T-bar and double wire systems should be 5-6 ft long. Solid cross arms made from pressure treated 2- to 6-inch lumber attached to a treated post with a top diameter of at least 4 inches should support the vines if large (>6 inch), well-braced end posts are used.

Because kiwifruit vines are more vigorous than muscadine grape vines, more space should be allowed between rows. On a single wire the spacing should be 10-12 ft and with the double wire, 15-16 ft. The width of equipment to be used in the planting may influence row spacing. Space vines 18-20 ft apart in the row.

After growth begins on newly set plants, select a strongly growing shoot as the main leader to carry the vine up to the wire. Remove side shoots at least once a week for maximum growth of the main shoot. A bamboo stake is a convenient support for training the vine up to the wire. Follow the training instructions for muscadine grapes.

Pruning - With weekly attention to training, shoots that will develop into the permanent arms (cordons) will extend the length of the wire in 1 to 2 years. After cordons extend the length of the wires, lateral shoots (canes) are allowed to grow but may require thinning to maintain a distance of 8-12 inches between them on the cordon. Mixed buds that produce both flowers and vegetative growth will develop in the leaf axils of these side branches. The following spring these buds will develop into new shoots with flowers at the first 3 to 6 nodes.

Both summer and winter pruning are required to maintain a balance between vine growth and profitable fruit production. Excessive vine growth is removed during the growing season to keep the vines open and avoid shading of the fruiting wood. If summer pruning is neglected, the fruit will be smaller and of poorer quality and winter pruning will take considerably more time. During winter pruning, shoots that are less than a pencil width in diameter should be cut back as well as wood that fruited the previous year. New fruiting wood usually will have developed at the base of the previous year's canes.

Pollination and Varieties - A kiwifruit vine produces either male or female flowers. Plants of both sexes are essential for fruit production and they must flower at the same time to ensure pollination. Male vines are usually spaced every third vine in every third row and represent

10% of the planting. In California, 3 to 4 hives of honeybees are provided per acre.

A. deliciosa varieties grown in New Zealand are Abbott, Allison, Bruno, Hayward, and Monty. Large fruit size and excellent keeping quality are responsible for Hayward becoming the predominant commercial variety. The Chico or Chico Hayward plants available from U.S. nurseries are similar to the New Zealand Hayward or are a selection that is almost identical. Hayward females are successfully pollinated by Chico-male, Matua or Tomori in California. For earlier flowering female varieties such as Abbott, Allison and Bruno, the male variety Matua is a better choice.

Fertilization - Kiwifruit respond to high rates of fertilizer application. In California, 150 lb of nitrogen per acre is recommended on mature vines. New Zealand recommendations go as high as 200 lb of nitrogen per acre. Only nitrogen is generally applied in California, but a complete fertilizer with a ratio of about 3-1-2 is recommended.

On sandy soils in North Carolina, use repeated applications of small amounts of fertilizer to avoid injury. Several weeks after planting when rain or irrigation has thoroughly settled the soil around the roots, begin fertilizer application. Apply 1 oz of a complete fertilizer such as 10-10-10 uniformly within a circle 12 inches from the plant. Avoid concentrations of fertilizer around the plant base. Repeat these applications after 4 inches of rain or irrigation until mid-June. Later applications could increase winter damage by causing the plant to continue growth late in the season. During the second growing season, begin applications in early March following the first year schedule, but increase the rate to 2 oz per vine and increase the diameter of the application circle to 18 inches. Every other application, 2 oz of calcium nitrate or 1 oz of ammonium nitrate may be substituted for the 2 oz of 10-10-10. During the third year, follow the second year schedule but increase the rate to $\frac{1}{4}$ to $\frac{1}{2}$ lb per vine of 10-10-10, calcium nitrate or ammonium nitrate at each application within a 24- to 36-inch circle around the vine. From the fourth year on, broadcast the fertilizer over the entire area, increasing the amount gradually as production increases. In the fourth year, 200 lb per acre of 10-10-10 in early March, followed by 100 lb per acre of ammonium nitrate in early May and mid June should stimulate adequate plant vigor without contributing to increased

susceptibility to winter damage. Rates can be increased or decreased in subsequent years, depending on vine vigor. Please note: do not use fertilizer containing chloride (such as KCl) as kiwifruit vines are very sensitive to chloride.

Irrigation - In California, vines are generally irrigated weekly during the first three growing seasons. A combination of 1 inch to 1½ inches per week of natural rainfall and irrigation during the growing season would be desirable in North Carolina.

Sprinkler irrigation offers the potential for protecting from freeze damage to tender new growth in the spring and fruit in the fall as well as providing soil moisture.

Weed Control - Permanent sod is often maintained between plant rows. Frequent mowing reduces competition with the vines. Competition for moisture and fertilizer is further reduced by destroying all vegetation in a 4-6 ft band under the vines with a herbicide or shallow cultivation. Deep cultivation can seriously damage the shallow, fleshy kiwifruit roots.

Pests - Few serious insect and disease problems have been encountered by kiwifruit growers. Root-knot nematodes have been found on roots in all production areas as well as the trial planting in North Carolina. However, the nematodes do not seem to seriously reduce vine vigor. If a high population exists in the soil, fumigation prior to planting may be desirable. Japanese beetles occasionally feed on the foliage, but they prefer other plants. New pests can be expected as plantings increase. Close observation of the vines increases the chance for control of a new insect or disease before serious damage occurs.

Wind Damage - Spring winds can break the tender young shoots at their point of attachment to the arm. Wind rub while the fruits enlarge and mature can cause flesh bruising and unsightly blemishes on the skin. Use of a pergola trellis minimizes wind damage. Lombardy poplar (*Populus nigra* var. *italica*) has been used as a

windbreak in New Zealand and South Carolina. Plants are spaced 16-20 inches apart around the planting and perpendicular to the prevailing wind between every 4-6 kiwifruit rows.

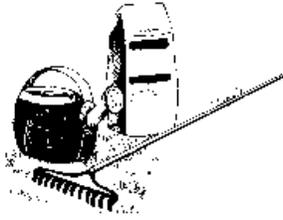
Harvesting - In California, vines generally provide their first commercial crop in the fourth season. Full production is reached within 8-12 years.

A. deliciosa fruits reach almost full size in August but are not mature enough for harvest until late October or early November (after the seeds turn black and sugar content is >6.5%). Fruit will soften off the vine if harvested after the sugar content reaches 4%, but full flavor does not develop until the sugar content reaches 6-8% on the vine. Starch in the fruit is converted to sugar following harvest. When the fruit is ready to eat, it should contain 12-15% sugar.

Fruits are harvested by snapping the stem at the abscission layer at the base of the fruit. Commercially, kiwifruit vineyards are harvested all at one time, but in the home garden the largest fruit can be removed first and the smaller fruit allowed to develop more size.

Storage and Ripening - Mature *A. deliciosa* fruit can be stored for 4-6 months at 31-32°F if protected from dehydration. Storage life is substantially reduced if ethylene producing fruits such as apples or pears are present in storage. For maximum storage life, store kiwifruit alone. Fruit will ripen at room temperature when removed from cold storage. Ripening can be hastened by exposure to ethylene. This hastened ripening can be accomplished in the home by placing kiwifruit in a plastic bag with an apple.

From our experience, *A. arguta* is best when soft at harvest, but can be harvested firm (after seeds turn black and sugar content reaches 8-14%) and stored in vented plastic bags or clamshell packages under refrigeration for up to 6 weeks. Ripen at room temperature as for *A. deliciosa*. Soft, vine-ripe hardy kiwifruit will not store.



NURSERY LIST OF SMALL FRUIT CULTIVARS FOR HOME USE IN NORTH CAROLINA

Gina E. Fernandez, Extension Horticultural Specialist

As a service to our readers, we have cross referenced small fruit cultivars with the nurseries where they may be purchased. If any of the nurseries included in this list sells a particular cultivar, the corresponding letter code will appear after the name (e.g. Sweet Charlie Edi, Nou, She). Some cultivars have not been fully tested by NCSU and are included here as worthy of trial. Please consult your local agricultural agent for specific cultivar recommendations best adapted to your area.

Strawberry

Apollo	LSN
Atlas	LSN
Cardinal	BNV, Ber, Bri, INV, KPF, Mil, Pen, SBF, SBN
Earlibell	LSN
Earliglow	Ber, Bri, Fed, KPF, Mil, Nou, Pen, SBF, WKM
Sunrise	Bri, Mel, WKM
Sweet Charlie	Edi, Nou, She
Tenn. Beauty	BNV, INV
Tribute	Bri, Har, HLN, Mil, Nou, SBF, SBN
Tristar	Bri, Edi, Fed, Har, HLN, Mel, Nou, Rai, SBF, SBN,

Blueberry

Highbush

Berkeley	AGA, Bri, DeG, FBN, Nou, WKM
Bluechip	FBN, Hig
Bluecrop	FBN
Blueray	AGA, BCN, Ber, Bri, BSP, Fed, FBN, Gir, Har, HLN, Hig, Mel, Mil, Nou, Pen, RON, WKM
Bounty	FBN
Collins	AGA, HLN, Hig, Pen, WKM
Croatan	FBN
Earliblue	AGA, Ber, Bri, Gir, Har, INV, She, SFG
Jersey	AGA, Ber, Bri, DeG, Fed, FBN, Gur, HFS, Mil, Nou, Pen, WKM
Patriot	AGA, BCN, Bri, DeG, Fed, FBN, Gur, HFS, Mil, Nou, Pen, WKM

Southern Highbush

Bladen	FBN, WPN
Blue Ridge	FBN
Cape Fear	BNV, FBN
O'Neal	BNV, Edi, FBN, Hig, WPN

Distributed in furtherance
of the Acts of Congress
of May 8 and June 30, 1914.

Employment and program
opportunities are offered to
all people regardless of
race, color, national origin,
sex, age, or disability.

North Carolina State University,
North Carolina A&T State
University, U.S. Department
of Agriculture, and local
governments cooperating.



**North Carolina
Cooperative Extension Service**

NORTH CAROLINA STATE UNIVERSITY
COLLEGE OF AGRICULTURE & LIFE SCIENCES

Rabbiteye

Centurion FBN
 Climax BNV, Edi, FBN, Har, INV, WPN
 Delite BNV, FBN, INV
 Powderblue BNV, Edi, FBN, Wom
 Premier FBN
 Tifblue BNV, Edi, FBN, INV, SBN, WPN

Blackberry Erect

Arapaho BNV, CVN, Edi, Eno, INV, NSG, Pen, SBF, She, WKM, Wom
 Cherokee BNV, Pen
 Cheyenne BNV, Bri, INV, Pen, SBF, Sun
 Choctaw BNV, INV, NSG, Pen, SBF, SBN, Sun
 Comanche BNV, Pen
 Navaho BNV, Bri, CVN, Edi, Eno, Gur, Rai, She, SNC, SBN, Sun, WBN, Wom
 Kiowa Eno, Pen, SBF
 Shawnee BNV, CVN, INV, NSG, Pen, SBF

Semitrailing

Chester Thornless Bri, CVN, Edi, INV, Rai, SBF, SBN
 Dirksen Thornless HFS
 Waldo CVN, SBF

Raspberry Red

Autumn Bliss Bri, Edi, NSG, Pen, SBF
 Citadel Har, NSG
 Cherokee BNV, Pen
 Dorman Red BNV, INV, Pen, SBN, Sun, Wom
 Heritage BNV, Bri, BSP, CVN, Edi, Gur, Har, HFS, HLN, INV, Mel, NSG, Nou, PSC, Pen, RON, SBF, SNC, SBN, WKM, WBN

Reveille Nou
 Southland INV, SBN
 Titan Bri, Gur, Nou, SBN

Black

Bristol Bri, Har, Mil, NSG, Nou, SBN
 Cumberland BSP, Gur, HFS, INV, Mel, Pen, RON
 Jewell Mil, NSG, Nou, Pen

Purple

Royalty Bri, Fed, HFS, Mel, Mil, NSG, Nou, Pen, SBN

Grape Wine

Cabernet-Sauvignon SGI, Wom
 Cabernet franc SGI
 Catawba Bri, BSP, Mel, Mil, SNC, SGI, SFG, WKM
 Chambourcin Pen
 Chardonnay BCN, SGI
 Reisling SGI
 Seyval HLN, Pen
 Vidal Blanc Pen

Seedless Table

Einset PSC, Pen, Rai, Wom
 Glenora Mel, Mil, Pen, Rai, SNC, SBN
 Himrod BCN, Gur, HFS, HLN, Mil, Pen, RON, SNC, SGI, SFG, SBN, Wom
 Interlaken BSP, HFS, HLN, Mil, Rai, RON, SFG
 Lakemont Bri, BSP, Mel, Mil, SFG, SBN
 Mars BSP, Edi, Fed, Pen, SBN
 Reliance BCN, BSP, Gur, HFS, Mil, SFG, SBN, Wom, WPN
 Suffolk Red BCN, HLN
 Vanessa Pen, Rai, SFG, SBN
 Venus Pen, Rai, SBN, Wom

Seeded Table

Concord	BCN, Bri, BSP, Edi, Gur, HFS, Mel, Mil, PSC, Pen, SNC, SGI, SFG, SBN, WKM, WPN
Niagara	Bri, BSP, Mel, Mil, Pen, SNC, SGI, SFG, SBN, WKM, WPN
Seneca	Mil
Stueben	BCN, HLN, Mel, Mil, SFG

Muscadines

Carlos	BNV, BSP, INV, WPN
Dixie	INV
Doreen	BNV, INV
Fry	BNV, BSP, FTN, INV, WPN
Higgins	BNV, BSP, FTN, INV, WPN
Jumbo	BNV, FTN, INV, WPN
Magnolia	BNV, INV, WPN
Nesbitt	BNV, INV
Noble	BNV, BSP, INV
Scuppernong	BNV, INV, SBN, WPN

Nursery list for small fruit cultivars for homeowners in North Carolina.

The line following the address is a reference code used in the cultivar list. Telephone and Fax numbers are included when available. No endorsement of the nurseries is intended and if any are not included, it means we have not received a recent catalog.

A.G. Ammon Nursery Inc.

PO Box 488
Chatsworth, NJ 08019
Phone: 609-726-1370
Fax: 609-726-1270

AGA

Ames Orchard and Nursery

18292 Wildlife Road
Fayetteville, AR 72701
Phone: 501-443-0282

AON

Bear Creek Nursery

PO Box 411
Northport, WA 99157
Fax: 509-732-4417

BCN

Berlin Seed

Route 62, Box 212
Berlin, OH 44610
Phone: 216-893-3817 Ext. 5371

Ber

Bottoms Nursery and Vineyard

360 Pullins Road
Concord, GA 30206
Phone: 770-884-5661

BNV

Brittingham Plant Farms

PO Box 2538
Salisbury, MD 21801
Phone: 410-749-5153
Fax: 1-800-448-1267

Bri

Burgess Seed and Plant Co.

905 Four Seasons Road
Bloomington, IN 61701

BSP

Cedar Valley Nursery

3833 McElfresh Road
Centralia, WA 98531
Phone: 360-736-7490
Fax: 360-736-6600

CVN

Chestnut Hill Nursery Inc.

Rt. 1 Box 341
Alachua, FL 32615
Phone: 904-462-2820

CHN

DeGrandchamps Blueberry Farm

15037 77 Street
South Haven, MI 49090
Phone: 616-3915
Fax: 616-637-2531

DeG

Edible Landscaping

PO Box 77
Afton, VA 22920
Phone: 804-361-9134 or 1-800-524-4156
Fax: 804-361-1916

Edi

Enoch's Berry Farm

Route 2, Box 227
Fouke, AR 71837
Phone: 501-653-2806

Eno**Fedco Trees**

Box 520
Waterville, ME 04903-0520
Phone: 207-873-7333

Fed**Fig Tree Nursery**

PO Box 124
Gulf Hammock, FL 32639
Phone: 904-486-2930

FTN**Finch Blueberry Nursery**

P.O. Box 699
Bailey, NC 27807
Phone: 1-800-245-4662

FBN**Golden Bough Tree Farm**

Marlbank
Ontario, KOK 2L0
Canada

Gol**Gurney's Seed & Nursery Co.**

110 Capital St.
Yankton, SD 57079
Phone: 605-665-1930
Fax: 605-665-9718

Gur**Hartmann's Plantation, Inc.**

PO Box E, 310 60th Street
Grand Junction, MI 49056
Phone: 616-253-4281
Fax: 616-253-4457

Har**Henry Field Seed & Nursery**

415 North Burnett
Shenandoan, Iowa 51602
Phone: 605-665-9391
Fax: 605-665-2601

HFS**Henry Leuthardy Nurseries**

Montauk Hwy., Box 666
Long Island, NY 11940
Phone: 516-878-1387

HLN**Highlander Nursery**

Box 177
Pettigrew, AR 72752

Hig**Ison's Nursery & Vineyards**

Route 1, Box 191
Brooks, GA 30205
Phone: 1-800-733-0324 or 770-599-6970

INV**Krohne Plant Farms**

64110 94th Ave.
Dowagiac, MI 49047
Phone: 616-424-5423

KPF**Lewis Strawberry Nursery Inc.**

PO Box 24
Rocky Point, NC 28457
Phone: 910-675-9409

LSN**Louisiana Nursery**

Rt. 7 Box 43
Opelousas, LA 70570
Phone: 318-948-3696

Lou**Mellinger's Inc.**

2310 S. Range Road
North Lima, OH 44452
Phone: 330-549-9861
Fax: 330-549-3716

Mel**Miller Nursery**

5060 W. Lake Road
Canandaigua, NY 14424

Mil**North Star Gardens**

19060 Manning Trail N.
Marine, MN 55047
Phone: 612-227-9842
Fax: 612-227-9813

NSG

Northwoods Nursery
27635 S. Oglesby Rd.
Canby, OR 97013
Phone: 503-266-5432
NWN

Nourse Farms
41 River Rd.
South Deerfield, MA 01373
Phone: 413-665-2658
Fax: 413-665-7888
Nou

Park Seed Company
Cokesbury Road
Greenwood, SC 29647
Phone: 864-223-7333
Fax: 864-941-4206
PSC

Pense Nursery
16518 Marie Lane
Mountainburg, AR 72946
Phone/Fax: 501-369-2494
Pen

Raintree Nursery
391 Butts Road
Morton, WA 98356
Phone: 360-496-6400
Rai

Richard Owen Nursery
2300 E. Lincoln Street
Bloomington, IL 61701
Phone: 309-663-9551
RON

Sakuma Brothers Farms, Inc.
PO Box 427
Burlington, WA 98233
Phone: 360-757-6611
Fax: 360-757-3936
SBF

Sherwood's Greenhouses
PO Box 6
Sibley, LA 71073
Phone: 318-377-3653
She

Smith Nursery Co.
PO Box 515
Charles City, IA 50616
Phone: 515-228-3239
SNC

Sonoma Grapevines Inc.
PO Box 160
Santa Rosa, CA 95403
Phone: 707-542-5510
Fax: 707-542-4801
SGI

Southmeadow Fruit Gardens
Box SM
Lakeside, MI 49116
Phone: 616-422-2411
SFG

Stark Brothers Nursery
Box 10
Louisiana, MO 63353
Phone: 1-800-325-4180
SBN

Sunshine Berry Farm
Route 1, Box 92
Macon, MS 39341
Phone: 601-726-2264
SBF

Walter K. Morss & Son
Route 2
Boxford, MA 01921
Phone: 508-352-2633
WKM

Womack's Nursery
Route 1, Box 80
DeLeon, TX 76444
Phone: 817-893-6497
Wom

Woodard Pecan Nursery
5194 US Hwy 70 East
Princeton, NC 27569
Phone: 919-965-3561
WPN



North Carolina State University and North Carolina A&T State University commit themselves to positive action to secure equal opportunity regardless of race, color, creed, national origin, religion, sex, age, veteran status, or disability. In addition, the two Universities welcome all persons without regard to sexual orientation. North Carolina State University, North Carolina A&T State University, U.S. Department of Agriculture, and local governments cooperating.