



# GROWING SMALL FRUITS IN THE HOME GARDEN

*Home Garden Series*

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By

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## Abstract

Backyard gardens in Washington State can yield a wide array of berries and other small fruits. This publication provides details on how to choose, plant, and maintain some of the most popular home-grown small fruits, including blueberries, raspberries, blackberries, strawberries, kiwi, currants, gooseberries, American elderberries, and lingonberries.

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# GROWING SMALL FRUITS IN THE HOME GARDEN

Home gardeners across the state can enjoy a bountiful crop of cultivated berries in a relatively small garden plot. Unlike most vegetables, berries are perennials that don't need to be planted every year. Berries are an important source of vitamins, anti-oxidants, and fiber. Once picked, berries can easily be frozen, made into jams and preserves for year-long use, or simply consumed fresh.



## **Blueberries**

Blueberries are native to North America and are comprised of many different species under the genus *Vaccinium*. Northern highbush (*V. corymbosum*) are taller than lowbush (*V. angustifolium*) and more cold tolerant than southern highbush and rabbiteye (*V. virgatum* syn. *V. ashei*) blueberries. Blueberries can be used as both fruit-producing and ornamental plants for Pacific Northwest gardens. They bear abundant crops from late June through September, depending upon the cultivars grown and the region in the state they are planted.

## ***Nutritional Value***

A one cup serving (148 grams) has only 84 calories, 1.1 grams of protein, and can supply 14.4 milligrams of vitamin C (National Nutrient Database 2011), presenting 24% of the suggested Daily Value for vitamin C. The recommended daily intake by the U.S. Food and Nutrition Board of the Institute of Medicine for men more than 18 years old is 90 milligrams of vitamin C daily; for women more than 18 years old, it is 75 milligrams daily (National Institutes of Health 2015). Blueberries are also relatively rich in potassium, supplying approximately 3% of a person's daily value per one cup (148 g) serving.

## ***The Blueberry Plant***

Blueberries are shallow rooted, deciduous perennial plants that can live for more than 40 years. There are four main types of cultivated blueberries and multiple cultivars from which to select.

## ***Popular varieties***

The majority of Washington State gardeners choose northern highbush cultivars (*V. corymbosum*). These plants will grow from 5' to 8' in height and 5' in width, if given full sun. The northern highbush cultivars are the preferred types for gardeners in the temperate zones of the United States, where mid-winter temperatures don't drop below -20°F (Zone 5a, USDA 2012). They offer the highest and most consistent yields of all the different types of blueberries, and their fruit is commonly found in grocery stores. Cultivars are described in Table 1.

The second type of popular blueberries are called southern highbush (*V. darrowi* x *V. virgatum*). Cultivars released in this category were designed for the milder regions of the country, where mid-winter temperatures don't drop below 0°F (Zone 7a). Southern highbush cultivars may be grown in Washington, but will have lower yields than northern highbush types (Strik et al. 2014). In addition they tend to bloom early in the season, when there are mild winters, making their flowers more susceptible to spring frost injury.

Table 1. Northern highbush blueberry cultivars

Cultivar	Origin	Harvest period <sup>1</sup>	Fruit and plant characteristics	Fruit Flavor	Mummy berry (MB) disease resistance (Ehlenfeldt et al. 2010).
Earliblue	1952 USDA-Rutgers University release	Early	First to ripen, large fruit size. High yields but not consistent (Fuqua et al. 2005). Ensure good fruit set by avoiding frost pockets on this early bloomer. Avoid planting on poorly drained soils. Early maturity helps avoid Spotted wing drosophila infestations (Demchak 2014).	Good to excellent (Strik et al. 2014)	Susceptible to both the primary and secondary stage of MB.
Spartan	1977 Rutgers University release	Early	Very large fruit, light blue. Moderate yield. Upright bush; productive. Prefers light soils with high organic matter (Gauthier and Kaiser 2013). Blooms late. Needs pollinizer.	Excellent	Moderate resistance to both stages of MB (Pavlis 2000).
Duke	1987 USDA release	Early	Large fruit size. Moderate to high yield. Short harvest season. Vigorous, stocky plant. Considered the standard for early season cultivars (Fuqua et al. 2005).	Fair flavor; improves with refrigeration	Unknown resistance to the primary phase; moderate resistance to secondary stage of MB.
Draper	2004 Michigan State University release	Early	Very large fruit; stores well. High yielding, but shorter harvest season. Vigorous, upright plant. Stores longer in cold storage than other cultivars (Hancock 2004).	Excellent	Susceptible to both stages of MB.
Olympia	1930 private breeder release	Mid	Medium size fruit. Low to medium yield (Strik et al. 2014).	Excellent	Good resistance to both stages of MB.
Bluecrop	1952 USDA-Rutgers University release	Mid	Large to very large size; light blue fruit. Most widely planted cultivar in the world (Langstroth and Hanson 2012). Very productive; vigorous bushes bear fruit over a 1-month harvest season.	Good; tart if picked early	Susceptible to the initial phase of MB, but resistant to the secondary stage (Gauthier and Kaiser 2013).
Liberty	2003 Michigan State University release	Mid-Late	Firm, light blue. Moderate to large fruit size. Stores well under refrigeration (Weber 2012a). Vigorous, upright habit. Rated as very high in antioxidants (Pavlis 2003, Hancock 2003).	Excellent	Resistant to the primary stage of MB; unknown resistance to the secondary stage.
Darrow	1965 USDA-Rutgers University release	Late	Very large fruit size. High yields (Fuqua et al. 2005). Vigorous, upright bush.	Excellent	Resistant to the initial stage of MB; intermediate resistance to the secondary stage.
Chandler	1994 USDA	Late	Very large fruit size. Very long ripening period (6 weeks, Pavlis 1998). Moderate vigor and high yield. Best in the milder regions of Washington state.	Good	Intermediate resistance to the primary stage of MB; susceptible to the secondary stage.

<sup>1</sup> The earliest ripening cultivars ripen in late June in southwest Washington, and mid-July in the northwest portion of the state. The latest ripening cultivars ripen in early to mid-August in the southwest portion of the state and late August-early September in the northwest portion of the state. Ripening tends to be earlier in eastern Washington.

Rabbiteye cultivars (*V. virgatum* syn. *V. ashei*) are grown on a very limited scale in Washington, as they are less winter hardy. This species of blueberry is native to southeastern United States and can grow to be up to 10' high. Fruit of rabbiteye blueberries are slow to ripen in Washington and may not reach full maturity in some years. This type of blueberry is not recommended for Washington.

The fourth type of blueberries available is known as half-high blueberries (*V. corymbosum* x *V. angustifolium*). They were designed for cold regions where mid-winter temperatures can drop to -35°F to -45°F (Zones 4b to 3b). Fruiting buds are borne low on the bushes, where the insulating winter snow protects them. Halfhigh cultivars that would be especially suitable for gardens in Washington include "Polaris," "Northland," "Northcountry," "Northsky," and "Northblue." Eastern Washington residents may wish to explore half-high cultivars (Barney 1999) for cold regions, although northern highbush blueberries can be successfully cultivated in eastern Washington.

This publication will only cover the cultural requirements for the northern highbush cultivars.

### Flowering

Blueberries are primarily self-fertile, but gardeners should plant at least two different cultivars with overlapping bloom times near one another to ensure optimum fruit set, to get larger fruit size, and to extend the season (Gauthier and Kaiser 2013). All of the northern highbush cultivars are compatible in terms of cross pollination.

European honey bees (*Apis mellifera*) are the primary insects for pollination, though bumble bees (*Bombus* spp.) and orchard mason bees (*Osmia lignaria*) can also be found actively pollinating the pinkish, urn-shaped flowers (Figure 1) in their search for pollen and nectar.



Figure 1. Highbush blueberry, full bloom in April.  
Photo: Charles Brun.

When the flower buds begin to swell in April, they can be injured by temperatures that drop below 28°F (Demchak 2007). Cultivar selection is important both for avoiding frost and choosing a proper planting site. Both "Spartan" and "Duke" are known for their frost resistance, as they bloom later in April (Schloemann 2000; Weber 2012a).

Select planting sites on gently rolling slopes for cold air drainage. Small plants could be covered with floating row covers when night temperatures are expected to drop below freezing and when swollen buds or blossoms are present. Avoiding late season fertilizer applications can also help plants develop cold hardiness for the winter.

### Fruiting

Healthy blueberry plants thrive in areas with moderate summer temperatures, acidic soils, and soils that are free draining (Strik 2008a). Eastern Washington gardeners can raise blueberries successfully if they modify the naturally higher soil pH.

Vegetative growth begins in the spring when soil temperatures exceed 43°F. Fruiting begins two to three months after flowering, from late June through mid-September, depending on the cultivar, region, and season.

Fruit size can range from less than 1/4" to over 1" in diameter. Fruit size depends on cultivar, pruning practices, pollination, irrigation, and location in the cluster, with earliest fruits being the largest in a cluster.

Mature and productive plants can yield 15 to 20 lb of fruit per plant (Figure 2). Fruit firmness will decline when the summer temperatures exceed 95°F. Firmness also depends on cultivar. Long growing seasons of more than 225 frost-free days produce the best yield and fruit quality.



Figure 2. Blueberries nearing harvest.  
Photo: Charles Brun.

## Winter Chilling

Northern highbush blueberry plants need between 800–1500 hours of winter temperatures between 32°F and 45°F in order to break dormancy in the spring and resume normal growth. This is the plant's physiological chilling requirement (Gauthier and Kaiser 2013). The long winters in Washington easily satisfy the chilling requirements of blueberries in most locations. Cold hardiness is usually not a major factor in western Washington, as the winters are relatively mild. Cold hardiness can be an issue in eastern Washington during very cold winters. Cold temperatures in spring can also damage blossoms if not protected.

## Cultivar Selection

All of the northern highbush cultivars described here were released by the U.S. Department of Agriculture and state land-grant universities over the past 60 years. They are the result of crosses with wild blueberry species indigenous to the eastern United States. The cultivars listed in Table 1 have performed very well in the Pacific Northwest (Strik et al. 2014), though none of them have been regionally developed in Oregon, Washington, or British Columbia.

Gardeners can base their selection of a cultivar on season of ripening (early July through mid-September), yield, plant-growth habit, fruit size, color, flavor (sugar/acid ratio, aromatic components), and susceptibility to plant pathogens. Home gardeners may wish to plant three to four different cultivars of highbush cultivars, with varying ripening periods to extend the harvest season. Consider grouping cultivars by ripening date so that harvesting will progress in an orderly fashion (Gauthier and Kaiser 2013).

## Site Selection and Preparation

As members of the Ericaceae plant family, blueberries share the same soil and climatic preferences as rhododendrons and azaleas. An acid soil with a pH of 4.0 to 5.5 is the most important condition for growing blueberries successfully.

In western Washington, blueberries do well, as the soil pH is often naturally lower than in eastern Washington. Frequent winter rains in western Washington wash the basic ions (like calcium) out of the soil, leaving it with a greater percentage of hydrogen ions and thus a lower soil pH.

Conversely, in areas east of the Cascades, where rainfall amounts are considerably less and the native soil characteristics differ, the soil pH is often above 7.5. When this occurs, blueberry plants suffer from high pH conditions. Leaves will become yellow, but retain green



Figure 3. Iron deficiency symptoms include interveinal chlorosis (loss of green color) on highbush blueberry. Photo: John Hartman, University of Kentucky, Bugwood.org.

veins (Figure 3), and the plants will be stunted due to iron deficiency unless the pH is adjusted. Rooting Habit

Blueberry plant roots are very fine and shallow (14–18" deep). Plants prefer an open, porous soil that allows good root penetration and growth (Cogger 2014). It is best to avoid sites that flood during the winter, as poor drainage can stunt the plants and promote root rot.

The shallow rooting habit makes the plants prone to drought injury, unless they receive supplemental watering during the summer. Mulching can reduce water loss, reduce the potential for drought injury, and promote a soil temperature ideal for root growth.

## Soil Testing

Home gardeners should test their soil and lower the soil pH when it is higher than 5.7 (Strik 2008a). There are high pH soil conditions in eastern Washington. Even some locations

in western Washington will benefit from reducing soil pH. Elemental sulfur (S) additions work well to lower soil pH by acidifying it. It is best to add sulfur one year to six months prior to planting in order to allow the sulfur to sufficiently react and lower the pH.

A list of regional soil testing labs is available where gardeners can have their soil pH checked (Daniels 2015). Soil testing kits for home use are generally un-reliable. When the soil pH exceeds 6.5, add 4 lb of sulfur per 100 square ft. Apply 2.5 lb of sulfur per 100 square feet when the pH is above 6.1. On sites with heavy clay texture, additional sulfur may be required to adequately lower the pH.

In eastern Washington, gardeners will need to re-check the soil pH each year (Locke 2006). If soil pH is greater than 6.5, gardeners could consider growing their blueberry plants in large tubs filled with acidic potting soil. The tubs can first be placed into existing soil, nearly up to their rims, in order to keep the tubs from drying out. Drainage holes should be placed into the bottom of the tub.

Some western Washington gardeners may find their soils have too low a pH. If the native soil pH has dropped below 4.0, agricultural lime will be needed to neutralize the acidity and adjust the pH to an optimum level. Consider 5–10 lb of lime per 100 square feet to raise the pH.

### ***Site Preparation***

Prepare the site in the spring or fall, before spring planting the next year. Early preparation is recommended if soil pH needs to be adjusted, as sulfur needs time to react. Eliminate all weed growth through cultivation or use a non-selective herbicide that kills all green vegetation. If perennial weeds are not suppressed before planting, they will return to infest the planting site and compete with the blueberry plant. Blueberries are not good competitors with weeds.

The use of an annual fall cover crop, such as rye or barley (one cup per 100 square feet), reduces fall germination of weed seeds, protects the prepared site from erosion, and helps build up soil organic matter levels (Cogger et al. 2014). For optimum results, amend the planting site with a 3" layer of yard-debris compost and/or aged Douglas fir sawdust, spread over a 3' diameter around each plant (Gauthier and Kaiser 2013). Use a spade to work these amendments into the top 12–16" of the soil. On lighter soils, these additions will improve the soil texture and increase the water holding capacity. If sulfur applications are needed (pH >6.5), apply it and work it in well to depth of 12".

### ***Establishment and Cultivation***

Blueberries are typically planted during the dormant season, from January to March in western Washington and in April in eastern Washington. Look for either two-year-

old (1-gallon container) or three-year-old plants (3-gallon container). The smaller sized plants are the least expensive.

Remove any flowers and fruit during the first year, as early fruiting will stunt the plants (Strik 2008a). Three-year-old plants can be allowed to fruit the first year after planting.

Space the plants at least 4–5' apart in rows, with 8–10' between the rows, as the plants become quite large at maturity. Some commercial grower's use closer in row spacing, but this is not recommended in a home garden setting.

Be sure to select a planting site that receives full sun all day long. A site with good air circulation will greatly reduce the occurrence of fungal disease problems, especially in areas of western Washington where rainfall exceeds 60" per year.

Plants perform best when planted on hills or raised beds that are 12" wide and 8–12" tall, respectively. Blueberry plants also do well in raised wooden beds (12–18" tall). Utilizing raised beds is an especially good management technique on sites that drain poorly (Cogger 2012). The frames of raised beds can also serve to support plastic hoops (3/4" PVC tubing), over which different types of nets or covers can be supported.

When planting, dig a hole large enough to spread out the roots. Carefully place the plants in the hole and gently fill in the soil, pressing firmly to ensure good root-to-soil contact.

### ***Fertilization***

It is best to annually fertilize blueberries to encourage the development of a number of well-spaced, stocky canes with many branches and good fruit production. Give live plants without extensive shoot growth the maximum recommended amount of fertilizer.

Blueberries are unique in that they use the ammonium form of nitrogen (NH<sub>4</sub>) and subsequently prefer either ammonium sulfate or urea fertilizers as their primary nitrogen source. Use of nitrate (NO<sub>3</sub>) fertilizers is not recommended, as it can injure the plants.

Apply fertilizers in the spring (Table 2). Late April to May is an ideal time to begin applying fertilizers, as roots do not take up many nutrients before the end of April. Splitting applications into thirds, with applications in late April, May, and June, encourages efficient uptake. Fertilizer rates can be adjusted as the plants grow and age.

Evaluate the plants visually to determine if the fertility regime is appropriate. Growth should not be overly vigorous, as this can limit fruit production. If growth is too vigorous, reduce nitrogen applications. Growth should also not be too weak and leaves should be green and full, with 2–4 flushes of shoot growth per season. Laboratory

Table 2. Blueberry fertilization rates (oz) based on plant age.<sup>1</sup>

Age of plants from transplants	Ammonium sulfate in late April	Ammonium sulfate in late May	Ammonium sulfate in late June
Newly set	1.0	1.0	1.0
Year 2	1.2	1.2	1.2
Year 3	1.2	1.2	1.2
Year 4	3.0	3.0	3.0
Year 5 and older	4.0	4.0	4.0

<sup>1</sup> As plants age they should exhibit healthy green leaves, with 12" of new lateral growth per year. Plants yielding more than 15 lb of fruit/year require little supplemental fertilizer. If urea is used, reduce the rates by one half.

testing is recommended, which can determine if nutrient deficiencies are present. Manifestation of nutrient deficiencies can look alike.

Commercially packaged evergreen and azalea fertilizer can be substituted for ammonium sulfate. Liquid fertilizers, such as fish emulsions, may also be applied. Liquid fertilizers can be applied at the same rate as dry fertilizers, but it is best to apply small amounts weekly during the growing season. Keep inorganic fertilizers away from the crown of the plant to prevent burning. Apply dry fertilizers evenly by hand within the dripline of the bushes. Apply extra nitrogen when fresh sawdust and bark has been applied to allow sufficient nitrogen to be available to the plants. A detailed guide to nutrient management in blueberries is available from Oregon State University (Hart et al. 2006).

### Watering

Supplemental watering from May to August is required, as blueberries are shallowrooted plants that require uniform moisture. A general rule of thumb is to apply an inch of water per week from May through August to ensure large fruit sizes. Rainfall additions can be factored into irrigation scheduling so as to achieve approximately one inch of water per week.

Later summer irrigation ensures good fruit bud formation for the following season's crop. Drip/trickle irrigation is preferred and a timer can be used to apply water on a regular basis (Peters 2011). Overhead irrigation may be used, but this form of irrigation is not as efficient and leaves behind water on leaves and fruit, which can encourage disease.

Operate the drip system until the top 6" of the soil is wet, as most of the roots are within this depth. Drought symptoms include brown-reddened foliage (Figure 4), weak thin shoots, and reduced fruit set. If you see these symptoms, it is usually too late to correct it for the current season.



Figure 4. Drought injury results in leaf edge scorching. Photo: Charles Brun.

### Mulching

As long as perennial weeds have been suppressed prior to planting, the addition of 2" of Douglas fir sawdust or bark mulch each year will help manage the germination of annual and broadleaf weeds, as well as conserve soil moisture. Home gardeners can have area landscapers supply them with wood chips from trimming trees. Socalled arbor chips are generally free for the asking (Chalker-Scott 2015).

Commercial growers prefer sawdust (Figure 5) for mulching, as it is consistent in quality and generally available. Arborist chips don't tie up soil nitrogen to the degree that the sawdust will.

Landscape fabrics can also be used as mulch, but drip lines must be applied underneath and the fabric will need to be removed when applying dry fertilizers.



Figure 5. Sawdust mulch makes an excellent amendment, both before and after planting. Photo: Charles Brun.

With regular mulching, there should be very few weeds (Fuqua et al. 2005). If needed, hand cultivate carefully within the dripline of the bushes to avoid severing the shallow roots. Do not hoe more than 1" deep. Look for annual weeds, such as crabgrass and annual bluegrass, and pull them when they are very small. Keep all vegetation away from the plants within 2' of the crown.

Some herbicides are available for weed control, but care must be taken to not damage the blueberry plants. Read and follow label instructions. Herbicides can be applied to the soil surrounding the bushes in the winter and provide four to six months of weed control (HortSense 2015). These products are typically applied in the winter (November-January), when the soil is cool and moist. Avoid disturbing the soil surface after the herbicide has been applied.

### Pruning

Blueberry plants are shrubs, and can produce as many as 15 canes when the plants mature. Pruning is required every year during the dormant season in order to remain productive. Pruning helps balance leafy vegetative growth with fruit growth.

Some cultivars have a spreading growth habit, producing drooping branches that bear fruit near the ground, which is un-desirable unless trellising is provided. Others have erect growth habits. Older plants left unattended will gradually produce fewer and smaller fruit each year.

The most productive parts of the plant are one-year-old laterals that arise from two-year-old wood. Laterals that arise from three-year or older wood start to decline in productivity and appear "twiggy." Laterals will arise from canes that are approximately 1 to 8 years old and ½–1" in diameter at the base. Berries produced on one-year-old wood are concentrated at the tips of the laterals (Figure 6). Fruiting buds on laterals can be easily discerned at the time of pruning. Dormant fruit buds are large and teardrop-shaped. Smaller, scale-like buds further down the cane produce shoots that will bear leaves.

### Young Plants

During the first two years, very little pruning other than removing the flower buds on young plants is required. Any diseased or dead wood should also be removed. Removing flower buds is recommended to direct plant growth into roots and shoots, thus encouraging plant establishment and increasing yields starting in the third year (Fuqua et al. 2005). After three years, the plants should have developed healthy upright canes.



Figure 6. Blueberry flower buds at the tips of the stems. Photo: Charles Brun.

### Mature Plants

As the plants mature, the goal of winter pruning is to remove all but 2–3 new canes that grew from the previous season. Gardeners should strive to direct growth into an upward (not outward) direction. By year seven, with annual pruning, a healthy bush will have 6–12 canes (Strik 2008a). The following guide can help in making pruning cuts:

- Remove low growth that does not stand erect or canes that bend with a crop of berries at harvest.
- Cut out all diseased canes or canes that rub one another.
- Remove twiggy growth at the tops of the bushes that has few flower buds.
- Remove cross-branching growth
- Thin out at the ground older canes with few side shoots.

Over time, the bushes will begin to slow in their growth and production. When canes have exceeded 1" in diameter at the ground, they become decreasingly unproductive. These older canes will devote more of their energy to leaves at the expense of fruit production and should be pruned. Un-pruned plants can grow quite tall and wide (more than 10' in height, and 6' in width). With hand shears or loppers, give the upright vigorous canes a "heading back" cut to keep them from getting too tall. Use long

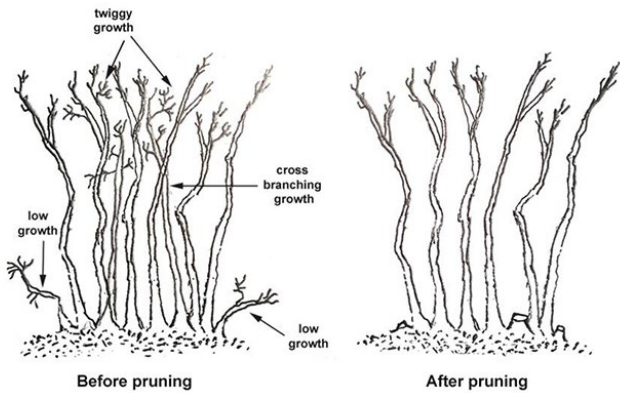


Figure 7. A blueberry plant before and after pruning. Illustration: Charles Brun.

handled loppers to remove 1–2 of the largest canes at the ground (Figure 7). Up to 20% of the older canes can be safely removed without hurting overall yield. Nearly half of the total bush should be pruned out if it has become overgrown.

A thorough renovation of over-grown bushes can be used to rejuvenate plants and keep them producing well into the future. Overgrown or weak plants can be rejuvenated by cutting them back entirely to the ground (Gauthier and Kaiser 2013). Follow up with annual pruning as previously described.

### Harvest and Storage

Harvest can occur from late June through the end of September, depending upon the cultivar, region, and season. Each cultivar bears for two to five weeks. Pick berries every four to five days after the first ones turn blue, so to maximize on fruit size and sugar level. Use your thumb to gently roll berries from the fruiting cluster into the palm of your hand. Gently transfer the berries to a picking container to avoid bruising.



Figure 8. Bird netting draped over plants keep the birds out. Photo: Charles Brun.

Fresh berries have a 7–10 day shelf life if they are kept in a refrigerator. Chilling berries immediately after harvest to 34°F will slow or stop the development of any Spotted Wing Drosophila (SWD) larvae that may have been in the fruit at harvest (McDemott et al. 2014). To freeze blueberries, simply rinse them in water and place in freezer on cookie sheet lined with wax paper. The berries will freeze without sticking together.

### Pests

#### Birds

Robins, starlings, and finches can strip blueberry plants clean of fruit if plants are left unprotected. They also peck holes into fruit, leaving them exposed to secondary infections. The most successful protection comes from netting. This can be achieved by building a PVC frame above the individual plants or rows, which serves to support bird netting (Figure 8). The netting only needs to cover the plants from the time the berries first turn light blue until harvest is complete. Be sure to adequately secure the netting to the ground so that the birds can't fly or crawl under the netting.

#### Spotted Wing Drosophila

Blueberries have historically had relatively few insect pests in the Pacific Northwest. In 2009, spotted wing drosophila (SWD, *Drosophila suzukii*) was first detected in Washington and now has become established across the state.

Fruits infested with the larvae of SWD are ruined, as the larvae consume the fruit and accelerate rotting (Figure 9). Larvae in fruit are also undesirable for human consumption. SWD is classified as a vinegar fly, attracted to decaying and rotting fruit in the garden and feeding on yeast on the surface of the fruit. Infested fruit will show a tiny scar on the side of the berry, which is where female SWD deposits her eggs.



Figure 9. SWD instars have infested this blueberry fruit, leaving it spoiled. Photo: Todd Murray.

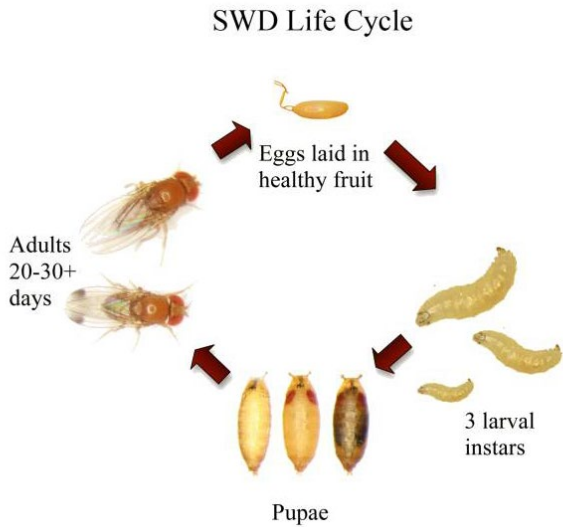


Figure 10. SWD life cycle. Illustration: Bev Gerdeman.

Early instars of SWD can be difficult to see with the naked eye. The presence of early instars in the fruit can be determined by placing the suspect berries in a solution of sugar or salt (Gerdeman et al. 2011). Larval instars develop into easily identifiable pupae (Figure 10).

Male SWD flies have characteristic dark spots on their wing tips (Figure 11), while females have a characteristic serrated ovipositor for egg laying. While common vinegar flies are attracted to rotting fruit that has fallen from a plant, SWD flies prefer ripe or overripe fruit still on the plant.

They sometimes infest ripening fruit. Harvest berries



Figure 11. Male SWD adult with the noted dark spots. Photo: Mike Bush.



Figure 12. Aphids on the underside of the leaves. Photo: Charles Brun.

frequently as soon as they are ripe to avoid infestation. At the first signs of infestation, begin harvesting every day. Pick cleanly and remove fruit on the ground to reduce populations from building. Freeze the fruit to kill any of the microscopic eggs or early instars.

Gardeners can protect their plants from SWD by building a plastic frame over the bushes and covering it with fine mesh netting, such as organza fabric, available at sewing and fabric stores (Dreves 2011). Ensure that the net enclosure extends to the ground so that the flies can't enter under the sides. Drape the netting over the enclosure before the fruit begins to ripen. Hardware stores carry five-gallon paint strainer bags made of organza fabric, which could be used for individual branches.

SWD populations expand rapidly in late July and August. For this reason, later maturing cultivars (Table 1) are more susceptible to SWD infestations (Dreves and Langellotto 2015). If SWD populations are high and the fruit can't be picked fast enough, or if the bushes have not been netted, use a registered insecticide (HortSense 2015) to protect the plants. The pesticides only work on the adult flies and will have no effect on any pupae or larvae within the infected fruit. As always, follow the label and rotate so not to build resistance.

### ***Aphids and Scale Insects***

An aphid (*Illinoia pepperi*) infestation can reduce plant vigor and leave a buildup of sticky honeydew on the leaves and fruit (Figure 12). Gardeners who have tried releasing ladybird beetles (*Coccinella septempunctata*) to reduce aphid numbers have found the beetles disperse too quickly to be effective. Avoid over-applying nitrogen fertilizer to blueberries, as it can encourage the buildup of aphids (Pitchay 2015).

A heavy infestation of Azalea bark scale (*Eriococcus azalea*; Figure 13) stunts bushes and leaves them sticky and sooty with honeydew and mold (Hollingsworth 2015). Prune out stems encrusted with high scale populations and apply an insecticide during the dormant phase in late winter before the flower buds emerge. Don't spray when the overnight temperatures are expected to drop below freezing. As with aphids, avoid excess fertilizer applications.

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### **Root weevils**

Root weevil larvae (*Otiorhynchus sulcatus*; Figure 14) can damage blueberries as well as other small fruits. The C-shaped larvae range from 1/5" to 1/3" long. They are legless and have white bodies and brown heads. Larvae feed on the root systems of all berries, severely weakening the plants. In the case of blueberries, the larvae can girdle the plant stems at the ground, resulting in the wilting of the bushes.

Adult root weevils (Figure 15) are rarely seen during the day, as they feed on the plants in the evening. Adult weevils feed on the edges of the leaves, resulting in leaf notching. While leaf feeding damage is not regarded as harmful to the plant, the presence of notching is a good indication that the larvae are present in the soil.

There are registered pesticides for the adults (HortSense 2015), but not the larvae. Gardeners can also consider applying entomopathic nematodes to the ground around the plants to reduce the larval populations (Miles et al. 2012)

### **Fruitworms**

Cherry fruitworm (*Grapholitha packardii*; Figure 16) and cranberry fruitworm (*Acrobasis vaccinia*) are insects that, in their larval stage, feed on the inside of the fruit and create a pinhole entrance/exit between fruit. Adults are small, dark gray, with a 1/3" wingspan. Cranberry fruitworm larvae have green bodies with a dark head, while cherry fruitworm larvae have pink-red bodies with brown or black heads.

Manage fruitworms by keeping weeds under control and eliminating wild cherries, which serve as the alternate host. In small plantings, larvae can be physically removed and destroyed. There are registered insecticides for the management of fruitworms (HortSense 2015).



Figure 13. Lencanium scale. Photo: Todd Murray.



Figure 14. Black vine weevil larvae. Photo: Mike Reding, USDA Ag Research Service, USDA ARS, Bugwood.org.



Figure 15. Black vine weevil adult. Photo: Joseph Berger, Bugwood.org.



Figure 16. Cherry fruitworm. Photo: Jerry A. Payne, USDA Agricultural Research Service, Bugwood.org

## ***Inchworms***

Winter moth and Bruce spanworm (genus *Operophtera*; Figure 17) can cause significant fruit loss. Larvae feed on flower buds, flowers, and foliage. However, the key damage indicator is a small tunnel or hole on buds.

Male moths (adults) are mottled brown and gray with lighter gray underwings. Females do not have wings. Larvae are pale green with three stripes on each side. Bruce spanworms begin the larval stage with dark head capsules, but then turn green over time.

The same insecticides registered for fruitworms can be used on inchworms. Monitor the plants for the presence of worms when the buds begin to swell in March. If the caterpillars are numerous, spray the plants when the larvae are first noted.

## ***Mummy berry***

Mummy berry (*Monilinia vaccinii-corymbosi*) is the most serious fungal disease of highbush blueberries in Washington. Symptoms of the disease appear in the spring, as the bushes leaf out. Infected leaves display a characteristic brown leaf pattern along the veins (Figure 18) before they wilt. This is referred to as a mummy berry shoot strike.

Fruit infection is characterized by the occurrence of hard, white, mummified fruit that are inedible (Figure 19). During a wet spring, the incidence of this disease can be quite high. The disease cycle starts in late-March, when over-wintered mummified fruit from the previous season begins growing small, brown, mushroomlike spore cups (Figure 20). These fungal cups, called apothecia, are on the ground and release spores that infect new flower clusters and developing leaves.

Secondary spores subsequently infect developing fruit and may be carried by pollinating insects such as honey bees. Bees are attracted by the ultraviolet light and sugary scent that the secondary spores release (Grubinger 2004). As bees collect nectar and transfer pollen between plants, they can also carry the fungal spores and spread the infection.

Managing mummy berry requires a multi-faceted approach. Sanitation is key for keeping the disease at low levels. Monitor the soil surface for the characteristic apothecia beginning in February. Remove apothecia and destroy them. Soil disturbance, such as the use of a leaf rake, can also help destroy the apothecia beneath the plants. Thick layers (2" or more) of sawdust mulch, arborist chips, or other mulches can also help by burying the apothecia. Continue to monitor and remove apothecia, as they can sometimes grow through mulch.

As the berries form in the late spring, pick off and remove infected ones before they drop to the ground.



Figure 17. Bruce Spanworm. Photo: Ron Kelly, Vermont Department of Forests, Parks, and Recreation, Bugwood.org.



Figure 18. Foliar leaf blighting due to mummy berry disease. Photo: Colleen Burrows.



Figure 19. Mummy berry infected berries. Photo: Colleen Burrows.



Figure 20. Mummy berry spore cups. Photo: Colleen Burrows.

If they are allowed to remain on the soil surface, they can contribute to disease in subsequent years.

There are fungicides registered for blueberries raised in the home garden (HortSense 2015). Apply them at leaf bud break (prior to flowering) in late March. Reapplication may be necessary to provide adequate protection.

Avoid planting the cultivar Berkeley, as it is highly susceptible, while the earlymaturing cultivar Spartan offers good resistance.

## Pollinator protection

Small fruits will produce poor yields without insect pollinators. European honey bees are the principal pollinator in commercial settings, but home gardeners may have the benefit of native pollinator populations.

In order to protect honey bees and other pollinators:

- Limit the use of pesticides, especially insecticides, when crops are in bloom.
- Avoid spraying insecticides on flowers or weeds near the berry plants.
- Select pesticides with low toxicity to bees.
- Do not apply until late in the day, just before dark—when pollinators are less active and the product has sufficient time to dry.
- Look for the “Protection of Pollinators” section on the product label for information on the toxicity of the product to bees and application instructions.
- Always follow label recommendations when applying any product.

## Raspberries

Red raspberries (*Rubus idaeus*) thrive in the relatively cool, marine climate of areas west of the Cascade Mountains. Commercial production extends from Salem, Oregon, north through Washington into the Fraser Valley of British Columbia. With the proper selection of adapted cultivars, raspberries can also be raised east of the Cascades.

### Nutritional Value

The U.S. Department of Agriculture states that a one-cup serving of raspberries (123 grams) has 64 calories. This serving size will supply 32.2 milligrams of vitamin C (National Nutrient Database 2011), representing 54% of the daily suggested intake for a 2,000 calorie diet. Red raspberries are also fiber rich, providing 32% of the recommended daily value of fiber per serving.

## The Raspberry Plant

Raspberries are perennials, but typify biennial growth and fruiting habits. The extensive roots are perennial (Finn & Strik 2014) and are concentrated in the top 12–18” of soil, although they can be found at depths of 6’ in well-draining soils. Canes emerge from shoot buds on the crown or roots and are called primocanes. Primocanes typically emerge in early April in western Washington.

There are two different types of red raspberries: summer-bearing and fall-bearing. Summer-bearing types, also known as “floricane raspberries” (Table 3), produce vegetative primocanes the first year that set flower buds in the fall. Canes overwinter and bear fruit the following summer. Overwintered primocanes that bear fruit the second year are referred to as floricanes. After fruiting is complete, the floricanes naturally die off.

The summer-bearing cultivars listed in Table 3 are generally hardy to -10°F (Zone 6). However, even if mid-winter temperatures don’t fall below -10°F, the plants should be sheltered from strong winds to prevent desiccation (drying out). Nearly all of the commercial red raspberries produced in Washington State are summerbearing types.

Fall-bearing types, also known as “primocane” or “everbearing” raspberries, set flowers and bear fruit on first-year primocanes. These canes can be allowed to overwinter and will bear a second crop lower on the floricanes before senescing (dying off).

Fruit production is related to cane height, with most cultivars producing fruit when 40–50 nodes have developed. In western Washington, primocane fruit production usually occurs from late July to October. In eastern Washington, primocane production extends from late August to October.

A killing frost in the fall can also end fruit production on primocanes. The fallbearing cultivars listed in Table 4 are hardy to -20°F (Zone 5) and may be more suitable for eastern Washington climates. Mid-winter temperatures below -20°F can cause extensive injury. Fall-bearing raspberries can be excellent for home gardeners and farmers that wish to sell raspberries during periods when summer-bearing raspberries are not producing fruit.

### Flowering

Summer-bearing cultivars begin flowering in early May in western Washington. The flowers are self-fertile, thus negating the need for an additional cultivar for cross pollination.

Table 3. Summer-bearing red raspberry cultivars.

Cultivar	Origin	Harvest period <sup>1</sup>	Fruit and plant characteristics	Fruit Flavor	Disease resistance to root rot and raspberry viruses
Chemainus	2006 Agriculture Canada	Early	Medium-sized fruit. Medium yield. Considered a replacement for “Meeker” in terms of yield (Kempler 2006).	Excellent (Finn and Strik 2014)	Prone to root rot, though less than “Meeker”; prone to viruses (Martin et al. 2013).
Meeker	1967 WSU Puyallup	Mid	Medium fruit size and firmness. Medium to high yield. Most widely grown cultivar in the Northwest (Steury 2012).	Excellent (Moore, Daubeny 1993)	Prone to root rot and susceptible to viruses.
Tulameen	1991 Ag Canada	Mid-late	Very large fruit size; firm and attractive berries. Extended harvest season. Widely grown for the fresh market (Daubeny 1991).	Excellent	Very prone to root rot and susceptible to viruses.
Cascade Delight	2004 WSU Puyallup	Late	Very large fruit size (exceeds “Tulameen”). Very firm berries with attractive, glossy appearance (Moore 2004)	Excellent	Tolerant to root rot and susceptible to viruses.

<sup>1</sup> The earliest-ripening cultivars ripen in late June in southwest Washington, and early July in the northwest portion of the state.

Table 4. Fall-bearing red raspberry cultivars.

Cultivar	Origin	Harvest period <sup>1</sup>	Fruit and plant characteristics	Fruit Flavor	Disease resistance to root rot and virus susceptibility
Autumn Bliss	1984 Great Britain	Very early	Larger than “Heritage.” Medium yield. Ripens 10–14 days earlier than “Heritage.” Fair firmness (Keep 1989).	Good	Resistant to root rot, but susceptible to viruses.
Fall Gold	1967 New Hampshire	Early	Yellow fruited. Soft fruit. Medium yield (NCGR 2015b).	Mild, sweet flavored fruit	Tolerant to root rot, but susceptible to viruses.
Summit	1989 Oregon State University	Early	Equal in size and firmness to “Heritage.” Difficult to pick under hot conditions. Medium to high yield (NCGR 2015a).	Good	Resistant to root rot, but susceptible to viruses.
Anne	1996 Rutgers University	Early	Large, yellow fruit. Medium-to-high yield. Soft fruit (Swartz et al. 1998a).	Excellent	Highly prone to root rot, and susceptible to viruses.
Caroline	1998 Rutgers University	Early	Large red fruit with moderate firmness. Ripens 1–3 weeks prior to “Heritage” (Swartz et al. 1998b).	Good	Good resistance to root rot; virus susceptible.
Polka	1981 Poland	Mid	Medium to large fruit. Soft (Weber 2012b).	Excellent	Resists root rot and viruses.
Heritage	1969 New York	Late	Large, dark fruit. Winter hardy to -30°F. Medium yield (NCGR 2015c). Late ripening can limit yield.	Bland	Prone to root rot; virus resistant (Finn and Strik 2014).
Vintage	2013 USDA/ Oregon State University	Very late	Large, bright fruit. High yield. Overall fruit characteristics considered better than “Heritage,” as they are 30% larger (Finn et al. 2013).	Excellent	Susceptible to root rot. Susceptibility to viruses has yet to be determined.

<sup>1</sup> In the southwest part of the state the earliest cultivars ripen in early August, while the latter season cultivars ripen in the last half of August into September.



Figure 21. European honey bee (*Apis mellifera*).  
Photo: Wikimedia Commons.

The flowers produce copious amount of nectar, which makes them highly attractive to pollinators (Figure 21). Flower injury due to spring frost is typically not an issue west of the Cascades because night temperatures in May are mild. Secondary raspberry fruiting buds can break if damaging frost or cold temperatures are experienced.

### **Fruiting**

Raspberries thrive in the mild, maritime climate of western Washington. Fruit production on summer-bearing types begins in mid-June. Hot and dry conditions (>80°F), combined with excessive wind during fruit development and ripening, can result in shorter canes, softer fruit, and reduced yields (Barney & Miles 2007). Healthy plants west of the Cascade Mountains can produce up 50–70 lb of fruit (Figure 22) on summer-bearing cultivars per 20' of row (Strik 2008b).

Raspberries are classified as aggregate fruits, made up of many drupelets (arranged around a receptacle), each with a separate seed. When picked, a properly ripe fruit detaches from the receptacle, yielding a hollow-cored berry.

### **Winter Chilling**

Raspberries require 800 to 1,400 hours of winter chilling in order to satisfy their dormancy requirements and resume normal growth in spring. After the plants have satisfied their chilling requirements, they can suffer from cold injury if a short warm spell occurs followed by colder winter temperatures. The canes can rapidly deacclimate (lose accumulated chilling hours) under these conditions, resulting in winter injury to developing buds in the spring. The tips of canes often de-acclimate first, resulting in fewer fruit.



Figure 22. "Tulameen" red raspberry. Photo: Charles Brun.

### **Cultivar Selection**

Home gardeners in Washington have a wide range from which to select both summer-bearing and fall-bearing cultivars. For summer-bearing cultivars, gardeners can capitalize on breeding research that has been conducted by university scientists from Oregon, Washington, and British Columbia. Efforts have gone into breeding new cultivars that have high yields, favorable fruit firmness, and disease resistance.

### **Summer-Bearing Cultivars**

Northwest plant breeders understand that nearly all of the red raspberries grown in the Northwest are destined for processing, with more than 95% being collected by over-the-row mechanical harvesters. Commercial growers thus need cultivars that have flexible, medium-length fruiting laterals (fruit-bearing limbs), with fruit that easily separates from the receptacle. Selections with very short or very long laterals, as well as brittle laterals, will not be suitable for mechanical harvest and will thus be destined for the fresh market.

The cultivars listed in Table 3 are highly suited to fresh consumption and are available at retail garden centers or from Northwest mail order sources. Some of the listed cultivars can be used for both processing and fresh-market scenarios. Refer to PNW 655 (Finn and Strik 2014) for the processing cultivars, which are typically not available to the home gardener.

Summer-bearing cultivars should be selected based on their tolerance or resistance to root rot, if they will be planted in a site with poor winter drainage or a history of root rot (Hoashi-Erhardt et al. 2008). Root rot will shorten the life span of susceptible cultivars and reduce production.



Figure 23. 'Cascade Delight' red raspberries.  
Photo: Charles Brun.

The cultivar, "Cascade Delight" (Figure 23), has good root rot resistance and is recommended if root rot is a concern (Moore 2004). Cultivars that are prone to raspberry viruses, such as bushy dwarf virus (RBDV), can produce crumbly berries making harvest difficult and fruit undesirable.

Cultivars listed in Table 3 have only been thoroughly tested in western Washington, in either Puyallup or Mt. Vernon. The potential harvest season lasts four to six weeks, depending upon the cultivar selected. Gardeners will find many summerbearing raspberry cultivars available through mail order sources outside of the Northwest. Avoid them in Washington, as they are generally not well adapted and often have lower yields with fruit of poor quality.

### **Fall-Bearing Cultivars**

Fall-bearing cultivars bear their first crop on primocanes in late July through late September (Table 4). As mentioned, fruit production can extend into the spring if primocanes are allowed to overwinter. Because the Washington red raspberry industry is almost exclusively based on summerbearing types, there has been less breeding and research on fall-bearing cultivars and production. Fall-bearing cultivars have been primarily bred for fresh market consumption.

The late ripening "Heritage" cultivar has had limited acceptance in the past because its fruit matures late in the season, when fall rains begin. In the early 1970's, plant breeders began developing cultivars that produce fruit earlier than "Heritage." Some of the fall-bearing cultivars have good root rot resistance, which makes them better suited to heavier ground with poor drainage. However, the later fruit production season of fall-bearing cultivars makes them more susceptible to spotted wing drosophila (SWD) infestations.

### **Black Raspberries**

Black raspberries (*Rubus occidentalis*) ripen around the beginning of August, depending on region. The two most commonly recommended cultivars are "Cumberland" and "Munger". Black raspberries are hardy to -5°F (Zone 6b). Both of these cultivars are susceptible to diseases, especially *Verticillium* wilt.

Viruses and rusts can also be problematic, which limits their production. Black raspberries, commonly referred to as "blackcaps," are typically used for jelly, as the fruit is very seedy, making the berries less desirable for fresh consumption.

### **Site Selection and Preparation**

Raspberries are among the most demanding of all small fruits in their preference for well-drained, sandy loam soils with a depth of at least 18–24". Excessive soil moisture can favor development of root rot due to *Phytophthora rubi*. Gardeners should check the future planting site after a heavy rain and evaluate for the presence of standing water.

If drainage is poor, the best option would be to select a different planting site with better drainage. If no other sites are available, the best technique to manage poor soil drainage involves the installation of perforated drainage tile at a depth of 25" prior to planting (Johnson and Koenig 2010). Sites with properly installed drainage tile don't flood during the winter.

Raspberry plants should also be placed on raised beds or hills, 10–12" high, to reduce the exposure of roots to constant water (Figure 24). Gardeners can also utilize constructed raised beds that are at least 2' tall. Limit the width of the planting bed or hill to 4' to allow hand picking of fruit from either side.



Figure 24. Newly established red raspberry plants on weed-free raised beds. Photo: Charles Brun.

Constructed raised beds can be amended with a blended soil mixture, but be careful not to create a perched water table (Cogger 2012). Raspberries should be planted on sites that receive full sun all day long. While red raspberries can tolerate more shade than other small fruits, they will be more productive and yield higher quality fruit if given full sun.

### **Rooting Habit**

The majority of red raspberry roots are found in the top 10–18” of the soil profile. Roots start to grow rapidly in the spring with the beginning of bud break. If there is adequate soil moisture, they will continue to develop into mid-summer. As many as 15 new primocanes can develop per plant under optimal conditions. The primocanes of summer-bearing types can grow from 6–12’ by the end of the summer, depending upon the cultivar, site, fertility, and the environmental growing conditions. Primocane bearing cultivars typically only attain heights of 4–6’ in length and produce much shorter laterals.

### **Soil Preparation**

Proper site selection and preparation is the key to ensuring a bountiful stand of raspberries that remain productive for many years. All perennial weeds need to be removed a year prior to planting. Use a contact, foliar-applied herbicide to kill the sod or native vegetation. Some of the most problematic weeds include quackgrass (*Elytrigia repens*), Canadian thistle (*Cirsium arvense*), and field bindweed (*Convolvulus arvensis*).

Once the weeds are under control, use a fall cover crop, such as cereal rye or barley (1 cup/100 square feet). This reduces fall germination of weed seeds, protects the site from erosion, and helps build the soil organic matter levels (Cogger et al.2014). Heavy textured native soil should be amended with organic matter, such as yard debris compost, well-rotted animal manure, or leaf litter. Apply 2–3” of organic amendments and work it into the site with a spading fork or shovel (Cogger 2013).

Perform a soil nutrient test prior to planting if there are concerns regarding soil pH or nutrient availability. The ideal pH range is between 6.0 and 6.5. Amend the soil with lime when the soil pH is less than 5.5. If the soil needs lime, apply it the fall, before planting, as the winter rains will help move the lime into the soil profile.

### **Establishment and Cultivation**

Gardeners should plan to purchase dormant plants from nurseries between mid January and March in western Washington. Garden centers sell either dormant bareroot plants or container nursery stock. Purchase virus-free, certified nursery stock from a reputable nursery or garden center.

Home gardeners should not dig plants from a neighbor’s established garden because they can harbor diseases that can reduce the yield and quality of the subsequent crops. Also, using a neighbor’s plants can introduce diseases into the soil, complicating management, as many diseases can persist in soils for years.

Under ideal conditions, raspberries can remain productive for 10–20 years. Avoid replanting raspberries in the same site or where a closely related species was grown in order to avoid incidence of disease.

Red raspberries can grow quite vigorously and thus will need to be planted in rows at least 8’ apart (Figure 25). There are many different types of training systems, with the hill and hedgerow system being the most common.

The hill system is the most common in commercial production. In this system, plants should be set at 2 ½-inch intervals within the row and be allowed to grow into a clump (referred to as “hills”; Strik and Cahn 1999). Each hill should grow 15 to 20 primocanes (new shoots) per year. During the life of the planting, the hills should be maintained as distinct entities through selective pruning, as new primocanes will develop from root buds in between the hills.

In the hedgerow system, raspberry plants are set at 2’ intervals within the row and new primocanes are allowed to fill in the row. There may be a better distribution of fruiting canes in the hedgerow system, thus making harvest easier. With the hill system, the row width should not be allowed to exceed 18”. For the hedgerow planting system, keep the row width under 12”. Row width can be maintained by cultivation with a hoe or use of contact herbicides.



Figure 25. Healthy red raspberries grown in rows spaced 10’ apart. Photo: Charles Brun.

## Fertilization

Summer-bearing red raspberries require 1/2 to 1 oz of nitrogen per plant at planting and 1–1 1/5 oz per plant when established. This can be applied using a balanced fertilizer (e.g., 16–16–16). At planting, fertilizer applications can be split into thirds to maximize fertilizer efficiency with 1/3 applied two weeks after planting, 1/3 applied one month later, and the remaining 1/3 applied one month after the second application. Split fertilizer applications for established raspberries, as well, with 1/3 applied when primocanes start to grow, 1/3 at end of May/early June, and the last 1/3 at end of June/early July. Fall-bearing raspberries can be fertilized similarly.

Ammonium sulfate is an economical fertilizer for red raspberries, although the plants prefer nitrogen in the nitrate (NO<sub>3</sub>) form. Broadcast dry fertilizer by hand

within the row (not the alleyway) and water afterwards to encourage movement into the root zone. Liquid fertilizers may also be applied at the same annual rate, but with applications divided into smaller amounts every week from the beginning of primocane emergence to prior to harvest. Organic fertilizers can be used and include well-rooted animal manure and yard debris compost applied in the fall. Refer to Oregon State University's organic fertilizer calculator to determine rates.

Base the amount of fertilizer applied on the plant's annual growth rates. On sandy loam sites in areas west of the Cascades, a healthy planting of summer-bearing raspberries should grow to 8–9' and bear green leaves. Primocane-bearers should grow 4–6'. Plantings that exceed these lengths don't need any supplemental fertilizer and may in fact benefit from reduced fertilizer. If a deficiency is suspected, leaf tissue tests are recommended to determine the cause of the deficiency and appropriate intervention.

## Watering

Even though raspberry plants have extensive root systems, they can still suffer drought stress from a shortage of summer rainfall. Moisture is critical during the fruit development and ripening stages. Irrigation should be applied from early-June to late-August and into September, when flower buds form for the following year's crop.

In the absence of rainfall, apply irrigation within the row with drip/trickle irrigation. Use a shovel to ensure that the top 12–18" of the soil profile is wet. Approximately 1" of water should be applied per week to ensure moisture needs are met. This amount can include contributions due to rainfall.

More irrigation may be needed during hot, dry, and windy conditions and with the stress of fruit production. On heavier sites in western Washington, there may be less need for supplemental irrigation if cane growth and yield are adequate. In areas that exceed 50" of annual precipitation, there is little need for supplement irrigation.

## Weed Management

A heavy stand of weeds in a row of red raspberries will severely limit the growth of the raspberry plants. Home gardeners generally rely on tillage and/or hoeing to manage their weeds. Properly prepared and managed sites should be free from perennial weeds, but will still need to be checked periodically for weed encroachment, such as quackgrass, (Figure 26), Canada thistle (Figure 27), and Himalayan blackberries.



Figure 26. Quackgrass roots can extend 5' from the top growth, and easily break up during cultivation. Photo: Ohio State Weed Lab , The Ohio State University, Bugwood.org.



Figure 27. Canada thistle has sharp, spiny leaf margins that may be smooth to lobed/toothed. Photo: Charles Brun.

Deeply rooted perennial weeds will need to be removed by hoeing or digging when they are small. Repeated hoeing may be necessary to sufficiently remove weeds. A layer of mulch can be applied to suppress the growth of weeds, but care must be taken to avoid smothering the crowns and subsequent emergence of new primocanes. Mulching must be approached carefully in hedgerow systems, whereby primocanes are supposed to fill in the row.

Avoid using any lawn herbicides near the raspberry planting or the application of herbicide-treated lawn clippings on the rows or alleyways. Use a registered, granular, soil-applied herbicide in the winter months to suppress the growth of weeds the following spring. Avoid disturbing the soil after the herbicide has been applied to preserve the weed barrier that the herbicide provides.

### ***Trellising and Training***

Raspberry canes lack sufficient strength to remain erect without added support. Trellising is thus required and has many benefits, including improvement of air circulation, which helps reduce foliar disease development. Construct a post and wire trellis the first summer the new plants are in the ground. If the newly planted canes grow vigorously the first summer, tie them to a wire support.

The first step in building a trellis system involves placing secure, 6" diameter end posts at the ends of the rows. Use posts that have been treated with an environmentally safe wood preservative. Within the row, space 3–4" diameter wooden posts at 25–30' intervals or place metal posts every 20'. Use 12-gauge or stronger wire to support the heavy fruit-laden canopy (Figure 28). A 3-wire trellis system is the universally accepted design. Place the top wire 60" above the soil line and fix 2 detachable training wires 30" above the soil line. During



Figure 28. Red raspberries grown in the hill system. In this late February picture the spent floricanes have been removed, and the primocanes have been tied up. Photo: Charles Brun.

the late summer renovation process, tie primocanes to the top wire, leaving the lower two wires on the ground.

In the hill system, canes are gathered together in upright bundles and tied to the top wire with binder twine. For the hedgerow system, space the canes along the top wire and tie each cane individually. During the following spring, the two lower wires can be lifted out and around the new primocanes thus keeping them from falling into the alleyway during the summer (Smith et al. 2007). The lower wires can be secured to the posts through the use of hooks or bent nails.

### ***Pruning***

On summer-bearing cultivars, prune out spent floricanes in the late fall or winter, after the canes have senesced. Pruning before then can reduce the natural flow of carbohydrates and nutrients from the senescing floricanes into the crown, which can negatively impact raspberry growth in the future. The best time to prune is late December to January, when canes are fully dormant.

Retain 10–12 of the healthiest primocanes and secure them to the top trellis wire. Tie the top portion of the canes to the trellis wire and then cut them off 6" above the wire (Figure 29).

Alternatively, growers may bend the primocanes over the trellis in a semi-circle and tie them to the trellis wire (Figure 30) in the arc-trained approach. The arc-trained approach reduces fruit weight slightly, but yields more fruit. Arced canes are preferred in commercial settings, as it facilitates machine harvesting. Either pruning method forces lateral branches to grow in the spring at a convenient picking height.

Home gardeners might consider removing the first flush of primocanes in summerbearing raspberries, when they



Figure 29. Dormant red raspberry canes topped 6" above the top trellis wire. Photo: Ralph Byther.



Figure 30. Dormant red raspberry canes arched over the top wire.  
Photo: Charles Brun.

are 7–8" tall in late April. This approach can be useful in increasing yields on vigorous plantings where cane growth is greater than 9'. After primocane removal, new primocane growth follows shortly.

For fall-bearing red raspberries, there are two methods of pruning. The preferred technique is to cut all of the fruiting primocanes off at the ground level after all the fruit has been picked. It is best to remove these primocanes in the winter, when most of the leaves have abscised and the plant is dormant. This technique sacrifices the fruit that would be borne lower on the floricanes the following year. However, the yield and berry quality of the second crop is not as high or as good, respectively. The alternative practice involves removing of the spent portion of fruiting primocanes (the top half) in the fall and the leaving the lower green portions to fruit the following year (Strik 2008b).

### **Harvesting and Storage**

Harvest fruit as they reach the peak of color and sugar development. A properly ripe raspberry should detach

easily from the receptacle. Avoid picking wet fruit, as it deteriorates soon after harvest. Berries will not ripen further in storage, which is why harvesting ripe fruit is important. Frequent harvesting greatly reduces the incidence of fruit rot and contamination by SWD. As with blueberries, freezing stops the development of SWD eggs and larvae. Fresh berries have a shelf life of only 2–3 days in the refrigerator. Raspberries freeze well and can be stored for 12 months.

### **Pests**

Red raspberries suffer from a number of different soil-borne and foliar diseases. The best practice to minimize the occurrence of these diseases is to locate planting in a sunny location on well-drained sites.

### **Root Rot**

The most limiting soil-borne root disease of red raspberries is *Phytophthora* root rot (*Phytophthora rubi*). This soil pathogen is the leading cause of plant decline when the soil is imperfectly drained, although it can also be found on sites with reasonably good drainage.

Symptoms include wilting of leaves in the spring, bronzing along leaf margins (Figure 31), and premature death of fruiting canes during harvest. Affected plants also have deteriorated root systems. Unhealthy root tissue is brick red in color, while healthy tissue is white to green (Figure 32).



Figure 31. Foliage collapsing due to root rot infection.  
Photo: Charles Brun.



Figure 32. Roots damaged by root rot display red discoloration. Photo: Ralph Byther.

Little can be done to control root rot in an established planting. Reduce incidence of root rot by growing raspberries on raised beds (refer back to Figure 24), using resistant cultivars (Tables 3, 4), or set plants in raised grow boxes which are at least 2' tall. Proper site selection is also critical.

The most recently released cultivars, "Cascade Delight" and "Vintage," offer some root rot resistance (Moore 2004; Finn et al. 2013). The pathogen causing *Phytophthora* root rot can persist in the soil for years, so either plant resistant cultivars or construct grow boxes and bring in new landscaping fill (2- or 3- way mix) if this organism is a problem (Cogger 2012). Use care to not mix new soil with the root-rot-infested soil beneath and to not create a perched water table.

### **Fruit Rot**

*Botrytis* fruit rot (*Botrytis cinerea*) is one of the biggest threats to ripening fruit, especially in wet springs. Berries with *Botrytis* fruit rot appear water-soaked and subsequently develop gray fungal strands which will grow over the surface of the fruit (Figure 33).



Figure 33. *Botrytis* fruit rot on red raspberry. Photo: Carolyn Teasdale.

Reduce the incidence of fruit rot by avoiding overhead irrigation during the bloom and fruiting period and locate plantings in sunny locations with good air flow. The incidence of fruit rot is related to the weather in May. If conditions are dry, there is often little fruit rot at harvest. Harvest fruit before it becomes over-ripe to reduce incidence of fruit rot due to *Botrytis*.

There are registered fungicides for *Botrytis* fruit rot, which need to be applied at 5% bloom and reapplied according to weather conditions. Avoid re-applying the same fungicide with the same mode of action to reduce the development of fungicide resistance.

### **Viruses**

A number of viruses infect raspberries. Raspberry bushy dwarf virus (RBDV) is among the most significant virus for raspberry production in Washington. With viral infection, plants can be stunted, leaves may display bright veins, and berries can become crumbly (Figure 34). Before taking action, confirm the presence of a virus. Some of the symptoms of viral infection are similar to other problems, including poor pollination, drought, and boron deficiency.



Figure 34. Leaf symptoms of raspberry bushy dwarf virus. Photo: Charles Brun.

If a viral infection is confirmed, remove virus-infected plants. This can be done by digging up and removing the plant or applying non-selective foliar herbicides to kill the infected plants. The removed plant may then be replaced with certified, virusfree nursery stock. The viruses responsible RBDV do not live in the soil, thus gardeners can plant new plants in the same area.

### ***Cane Diseases***

Raspberry canes are susceptible to diseases that can reduce the vigor of the planting (Heidenreich 2006). Anthracnose (*Elsinoe veneta*; Figure 35) causes spots and cracking of stems. Spur blight (*Didymella applanata*; Figure 36) results in the loss of new shoots (spurs) at the base of the canes.

For both anthracnose and spur blight, remove heavily infested stems and use a suitable fungicide in the spring, as new shoots and leaves emerge. Spray the fungicide on the new shoots as they are first emerging to protect them.



Figure 35. Anthracnose lesions feature grey sunken areas surrounded by purple borders. Photo: Charles Brun.



Figure 36. Purple discoloration on stems due to spur blight. Photo: Charles Brun.

Figure 37. Crown gall swelling on raspberry stems. Photo: Charles Brun.

The bacterial disease, crown gall (Figure 37), causes rough outgrowths to appear on canes, crowns, and root plantings. Exercise care when pruning affected plants. Accidentally wounding healthy plants encourages the entrance of the pathogen in wounds. Impacted canes with galls should also be removed and destroyed. There are no fungicides for crown gall management.

### ***Insects***

Red raspberries are susceptible to SWD as populations of the fly start to build in July through the end of the summer. The fruit will readily attract the adult flies as they ripen (Figure 38). As the early instars develop, fruit will appear deformed, collapsed, and soft on the outside and watery on the inside (Figure 39; Walton 2010).



Figure 38. Male SWD fly on the surface of ripe fruit. Photo: Tim Baker, University of Missouri Extension.



Figure 39. Infestation of SWD instars. Photo: Charles Brun.

Gardeners will need to pick their red raspberries as soon as they ripen (at least 3 times per week) to reduce the incidence of damage to the fruit (Dreves 2011). Do not leave infested fruit on the ground, as the larvae continue their development there unless destroyed. Destroy all fruit on the ground to reduce SWD populations from building. Either dispose of the fruit in your municipal trash, as appropriate, or place a bag of infested fruit in the sun for a period of time. The best results for solarizing infested fruit occurs during hot weather and when fruit are held in clear bags. Solarized contents can then be composted (Dreves 2014a).

There are registered insecticides for the control of adult SWD flies. Rotate insecticides to prevent resistance and always follow label recommendations.

Raspberry crown borer (Figure 40) larvae tunnel in the bases of the canes, leading to an overall lack of plant vigor. Remove infested plants and apply a registered insecticide to the base of the remaining canes to protect them from further infestation of crown borer.



Figure 40. Crown borer feeding within the stem of the raspberry cane. Photo: Ralph Byther.

## Blackberries

With proper selection, blackberry gardeners can enjoy harvesting sweet, juicy fruit all across the state. Gardeners can select from a number of different cultivated types of blackberry, which offer different harvest seasons and levels of cold hardiness. Cultivated types offer superior fruit size and yield over the wild Himalayan blackberry (*Rubus armeniacus*), which is considered an invasive plant.

### Nutritional Value

The U.S. Department of Agriculture states that a one-cup serving (144 grams) has 62 calories, 2 grams of protein, and provides 50% of the daily intake of vitamin C (National Nutrient Database 2011) for a 2,000 calorie diet. Blackberries are also high in potassium and dietary fiber, providing 6% and 32% of the recommended daily intake per serving, respectively.

## The Blackberry Plant

Blackberries are related to raspberries (*Rubus* genus). They are perennials with extensive root systems and a biennial growth and fruiting habit. As with raspberries, they produce first year canes known as primocanes, with second year canes known as floricanes. After the floricanes have finished fruiting, they naturally die. Once established, blackberries consist of both primocanes and floricanes growing simultaneously. There are also primocane-fruiting blackberries.

Blackberry fruits consist of an aggregate of drupelets, just like raspberry fruits. However, the internal receptacle of the fruit (torus) is included and consumed when the berry is picked.

There are three different types of blackberries, which differ based upon their cane architecture: trailing, semi-erect, and erect (Strik and Finn 2012).

The bulk of the commercial acreage in Oregon and Washington consists of the trailing-types, which ripen in late-June through early-July and have superior fruit quality. These cultivars bear primocanes that will grow along the ground, hence the name trailing-types. The canes of trailing blackberries can be long, which requires a trellising system. Trailing-types are hardy to 13°F (Zone 8a) if they are fully acclimated, but can be injured at 20°F (Zone 8b) in late winter if they have deacclimated due to fluctuating winter temperatures. More than half of the commercial blackberries raised in the northwest consist of the trailing-types.

The semi-erect types are floricanes-fruiting and produce thick, arching canes that need to be trained to a trellis system in order to be picked. They were developed in the mid-Atlantic regions and are considered generally hardy to zone -20°F (Zone 5a), which will make them suitable for eastern Washington.

The erect-types are less common in Washington and have inferior fruit quality, in part due to their grassy flavor and large seeds. Canes of erect blackberries are stiff, upright and are hardy to 10°F (Zone 8a).

Hybrids of red raspberry and blackberry are managed like trailing blackberry and include the cultivars “Logan” and “Boysen.”

### Flowering

Blackberry flowers are larger than raspberry flowers and are self-fertile. The flowers produce copious amounts of nectar, making them highly attractive to pollinators (Figure 41), especially honey bees. Flowering commences in May, thus reducing the chances for spring frost injury.

## ***Fruiting***

Blackberries thrive in western Washington, where summer and winter temperatures are milder. Yields are reduced when summer temperatures exceed 90°F during harvest. Plan to harvest 10–13 lb of fruit per plant from trailing types, 25–55 lb per plant from semi-erect types, and 4–6 lb per plant from erect types (Strik 2008d).

## ***Winter Chilling***

In the Pacific Northwest, the trailing-types only need 300 hours of winter chilling to satisfy their winter dormancy requirements (Strik 2009). If temperatures fluctuate in late winter or early spring, the plants can de-acclimate and become prone to winter injury when cold temperatures return. The erect-types have higher chilling requirements, thus reduced chance for winter injury.

## ***Cultivar Selection***

Home gardeners have a wide range of cultivars from which to select (Table 5). No one cultivar can be universally recommended for all parts of the state. There is an active breeding program in Oregon, developing both new processing and fresh market cultivars adapted to the Pacific Northwest.

## ***Trailing-Types***

The trailing-types have received the most attention by regional plant breeders in order to meet the needs of the commercial processing trade. Trailing types also tend to have superior flavor than other types of blackberry.

Much of the efforts in plant breeding have gone into developing new cultivars that could replace the older “Marion” cultivar (Figure 42), which is still highly regarded in terms of flavor, but lacks fruit firmness. The newer “Obsidian” cultivar is known for earlier maturity, excellent fruit quality, and slightly better cold hardiness levels than “Marion.”

## ***Semi-erect and Erect-Types***

Breeding efforts for the semi-erect cultivars has largely been conducted on the east coast of the United States for the hand-picked, fresh market trade. The fruit quality of the cultivars “Chester Thornless” (Figure 43), “Triple Crown,” “Hull Thornless,” and others is generally regarded as lower than the trailing types. The fruit are not as sweet and may have lower acidity levels, leaving them with a flat taste.

The erect types have been developed in Arkansas. In comparison to the trailing types, the erect types have only fair flavor, as the fruit is seedy and lacks sweetness (Finn and Strik 2014c), however the fruit are very large.



Figure 41. European honey bee gathering nectar from a “Marion” blackberry flower. Photo: Charles Brun.



Figure 42. “Marion” blackberry is one of the more popular trailing cultivars. Photo: Charles Brun.



Figure 43. Chester Thornless blackberries. Photo: Charles Brun.

Cultivar	Origin	Harvest period <sup>1</sup>	Fruit and plant characteristics	Fruit Flavor	Resistance to root rot, and virus susceptibility
Siskiyou	1999 USDA/ Oregon State University	Early	Trailing type. Thorny canes are more vigorous than "Marion." Yields slightly less than "Marion." Fruit size is greater than "Marion" (Finn 1999).	Excellent	Resists root rot; excellent virus resistance.
Obsidian	2005 USDA/ Oregon State University	Early	Trailing type. Thorny canes are vigorous. Similar to "Marion." High yielding cultivar with large attractive fruit (Finn 2005a).	Excellent	Resists root rot; excellent virus resistance.
Marion	1957 Oregon State University	Mid	Trailing type. Very thorny and vigorous canes. Medium sized fruit. Second most widely raised blackberry in the Northwest (Finn et al. 2014b)	Excellent (Waldo 1957)	Resists root rot; susceptible to viruses (Martin 2013).
Black Diamond	2005 USDA/ Oregon State University	Mid	Trailing type. Thornless and vigorous canes. Berries are attractive and firmer than "Marion."	Good (Finn et al. 2005b)	Resists root rot; excellent virus resistance.
Columbia Star	2014 USDA/ Oregon State University	Mid	Trailing type. Thornless and vigorous canes. Higher yielding than "Marion" or "Black Diamond" (Finn et al. 2014d). Firm fruit.	Excellent	Resists root rot; excellent virus resistance.
Triple Crown	1996 USDA/ Rutgers University	Late	Semi-erect type. Thornless canes (Galletta et al. 1998). Fruit has large seeds.	Excellent	Resists root rot; no major virus issues.
Chester Thornless	1998 USDA/ Rutgers University	Late	Semi-erect type. Thornless canes. Medium size fruit. Sunburn prone (Galletta et al. 1998).	Fair	Resists root rot; no major virus issues.
Prime-Ark 45	2009 University of Arkansas	Very late	Primocane fruiting, erect type. Very large fruit size. Fruit is black and glossy, but seedy. Short harvest season in mid-September.	Fair (Clark and Perkins-Veazie 2011)	Resists root rot; no major virus issues.

<sup>1</sup> Trailing type blackberry cultivars begin bearing late June in southwest Washington, with harvest extending for approximately 3 weeks. Semi-erect types begin fruiting in mid-August and may produce to the first frost. Erect type cultivars begin ripening in early September.

Bury the last 6" of primocanes during late summer. A root system and a new shoot will then develop in the fall for mid-January transplanting. Perform this operation only with healthy, disease-free propagating stock.

All three different types of blackberries are established in rows 8–10' apart. The in row plant spacing for trailing, semi-erect, and erect types is 5–6', 3–5', and 3–6', respectively. Maintain trailing blackberry plants in the hill system for the life of the planting. Relatively few new primocanes will emerge from each of the hills, so it is best to retain all primocanes for later training. Limit the row width to 18".

The trailing type blackberries grow all through western Washington, given the mild winters and dry summers. New primocanes emerge in early April from the crowns and can grow to 12' in length along the surface of the ground. Semi-erect types produce long arching canes that can grow 10' in length. Erect types send out new primocanes from the crown, as well as from buds on roots (suckers), which enable them to form a thicket of shorter growing, stiff canes.

## Fertilization

Base fertilizer application rates on the length of primocane growth made each year. Plants perform best with ½ to 1 oz of nitrogen per plant from a balanced fertilizer (16–16–16) in the planting year. Split the application into thirds with 1/3 two weeks after planting, 1/3 one month later, and the final 1/3 one month after the second application. For established plants, apply 1 to 1 ½ oz of nitrogen per plant and also split the applications into thirds, with 1/3 applied when primocanes start to grow, 1/3 at the end of May, and the last 1/3 at the end of June.

## Irrigation

In western Washington, trailing types blackberries are grown commercially with supplemental irrigation. Home gardeners can utilize drip tape to irrigate their plantings during the summer. Apply water until the top 8" of the soil profile is wet. Irrigation should be provided during fruit development and harvest, but can be stopped post-harvest.

## Trellising

In order to raise clean, disease-free fruit, and make picking easier, a trellis will be required for both the trailing and semi-erect blackberry types. It is easier to build the trellis before putting in the plants.

The standard trellis consists of two, 8', treated-end posts, set 2' in the ground, with concrete for support. Treated wood posts typically have a twenty-year life span. Use 12-gauge galvanized wire and wire tighteners to construct a 2-wire trellis (Figure 44). If the distance between the end posts exceeds 40', use metal line posts every 20' to support the trellis wires. The top wire should be placed at 6' above the ground, while the lower wire should be set at 4 ½' above the ground. If the end posts were properly set in concrete, one should be able to keep the trellis wires tight with wire tighteners as the wire stretches over time.

## Training

During the first year of planting, primocanes should be allowed to grow within the row and along the ground, which may require some guidance by the gardener. Wire guides can help gardeners guide primocane growth along the ground and within the row, thereby preventing growth in the alleyways. Wire guides are especially helpful when both floricanes and primocanes are present.

In the planting year, primocanes should be lifted and tied with binder's twine along the lower or upper wires. Separate canes along the wires to ensure good air circulation. Wear heavy gloves and a long sleeve shirt when working with the thorny, trailing types. During succeeding years, the floricanes will be wrapped and draped on the trellis wires, while the next flush of primocanes are allowed to run beneath the floricanes (Figure 44).

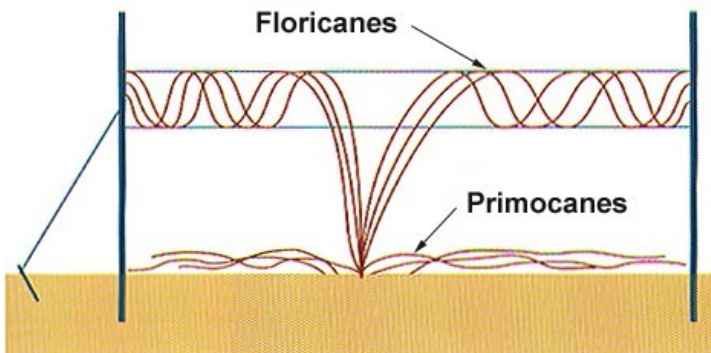


Figure 44. Trellis and training system for trailing-type blackberries where floricanes are woven upon the trellis wires and primocanes are allowed to run guided upon the ground. Illustration: Charles Brun.

In western Washington, gardeners should train their trailing-type primocanes in late summer (August-September), as opposed to waiting until the leaves have fallen in the winter (Strik and Finn 2012). Disease and insect problems are usually worse if one delays training until the following spring.

In eastern Washington, the vines are more susceptible to winter injury. By leaving them on the ground, they are less exposed and less susceptible to winter injury. Train canes in March, after all chances of low winter temperatures have passed.

For semi-erect types, gently lower the arcing primocanes down to the top wire and secure them with binder's twine (Figure 45).

For erect types, consider a cross arm trellis (Figure 46) to confine the primocanes within two parallel training wires.



Figure 45. Trellis design for the semi-erect "Chester Thornless" blackberry. The normally upright-growing primocanes are gently lowered down to the trellis wires and secured. Photo: Charles Brun

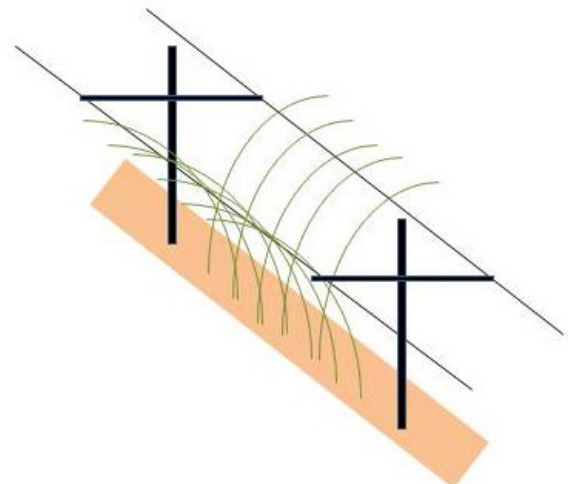


Figure 46. Cross arm trellis with two wires to capture erect type blackberries. Illustration: Charles Brun.

Many different types of training systems exist for blackberries. One could train the primocanes to one side and the floricanes to the other (Fernandez and Ballington 1999).

### Pruning

On all three types of blackberries, prune out the dead floricanes at ground level in October or later. Spent canes can be cut into smaller pieces and simply tilled into the alleyway between the rows. Semi-erect types need tip pruning (removal of the terminal 2") in early summer, when the canes have grown to a height of 5'. For the erect types, the same practice should be employed when the primocanes have attained a height of 3' (Figure 47).

Tip pruning will encourage branching and higher yields the following year. During the following winter, cut back the branches to 18". To raise only the fall crop on erect-types (such as Prim-Ark 45, Prime-Ark Freedom, others) cut down the entire planting in the fall after fruiting.

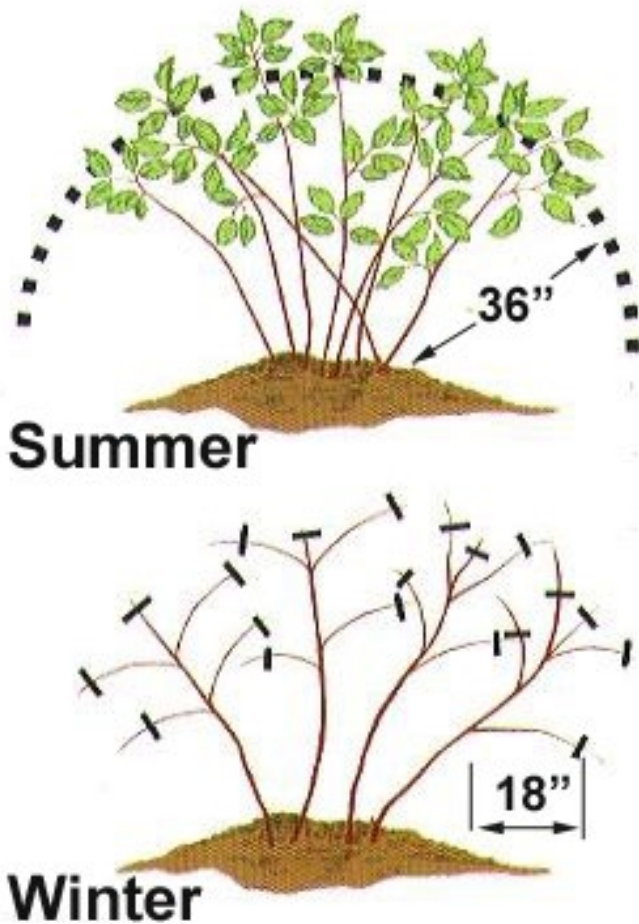


Figure 47. When pruning erect blackberries, tip back primocanes in the summer to 36". During the following winter, cut back floricanes to 12" to 18" in total length. Illustration: Charles Brun.

### Harvesting and Storage

Pick blackberries promptly as they ripen throughout the summer. They won't ripen further after being picked. Hot summer temperatures can lead to sunburn (ultraviolet ray damage), causing white drupelets to form on the exposed surface. By harvesting and promptly freezing the fruit every day, gardeners can reduce the potential damage from spotted wing drosophila (SWD).

### Pests

Although blackberries are prone to many of the same pathogens that attack red raspberries, the symptoms are generally less severe.

### Diseases

Root rot is less of a problem on blackberries since the canes are more tolerant of heavier soil types. Fruit rot is also less severe because the berries mature during the drier portion of the summer. Minimize fruit rot by keeping the primocanes well separated during training to ensure good air movement through the canopy and by picking regularly.

The most notable disease on trailing blackberries is Septoria leaf and cane spot (Figure 48). The disease causes 1/8" leaf spots that vary from light to dark brown and take on whitish centers with brown-to-red borders.

In the spring, canes of both the trailing and semi-erect types display irregular, elongated purple blotches that can develop into cankers and girdle the canes, causing defoliation. Promptly remove spent fruiting canes, train primocanes in the fall, and apply a fungicide in the spring and fall to control the disease.

Other cane diseases of blackberries are anthracnose and crown gall. Refer to the raspberry section for further details.



Figure 48. Septoria leaf spot. Photo: Charles Brun.

## Insects

Spotted wing drosophila can be a serious problem on blackberries (Figure 49), especially the later ripening types, including the semi-erect and erect types. By midsummer, as blackberries start to ripen, populations of SWD will begin to increase. Manage SWD with frequent picking and prompt freezing to maintain the quality of the berries. Also, practice good sanitation by removing and destroying fruit that has fallen on the ground.

There are registered insecticides (HortSense 2015) that can be used to kill the adult flies, but not the larval or pupae stages (Dreves 2011). Gardeners might consider building a temporary framework out of 3/4-inch PVC pipe and covering it with a fine mesh (e.g., organza fabric) from a sewing store. Be sure to keep the entire plant covered so that the SWD adults can't come in contact with the fruit.

Later in the summer, brown marmorated stink bug (BMSB, *Halyomorpha halys*; Figure 50) is also potentially a problem on late maturing blackberries and fallbearing raspberries, as the population of adults peaks in September. All members of the plant genus *Rubus* spp. are susceptible to this invasive pest (Bergmann et al. 2015).



Figure 49. SWD adult on the surface of blackberry fruit. Photo: Bev Gerdeman.



Figure 50. Brown marmorated stink bug. Photo: Steven Valley, Bugwood.org.

When a BMSB feeds on berries (Figure 51), it leaves them with puncture wounds and collapsing (Rodriguez-Saona et al. 2013). The physical barrier approach suggested for SWD will also protect the plants from BMSB.

## Weeds

As with other small fruits, prepare the planting site carefully to eliminate all perennial weeds and grasses before planting blackberries. As with raspberries, there is a registered granular herbicide that can be applied in the winter months to manage perennial weeds, as well as broadleaf and annual weeds.

## Strawberries

Gardeners across Washington State can readily raise sweet, brightly colored strawberries (*Fragaria x ananassa*) for fresh eating, freezing, and preserves. The plants are easy to grow and bear abundantly.

## Nutritional Value

The U.S. Department of Agriculture states that a one-cup serving of strawberries (152 grams, for halves) has 49 calories, and 1.0 grams of protein. This serving size will supply 84.7 milligrams of vitamin C (National Nutrient Database 2011), representing 149% of the suggested daily value for vitamin C for a 2,000 calorie diet.

## The Strawberry Plant

The strawberry plant is classified as an herbaceous perennial. New leaves emerge from the crown of the plant (Figure 52), which consists of a compressed stem (crown) with a central core (pith) surrounded by a vascular tissue. This tissue gives rise to above-ground leaves, fruiting stalks (pedicels), and stolons (runners) that form new plants (Strand 2008). The crown also produces roots that help anchor the plants and



Figure 51. Adult BMSB clustered on blackberries. Photo: Hollingsworth 2015.

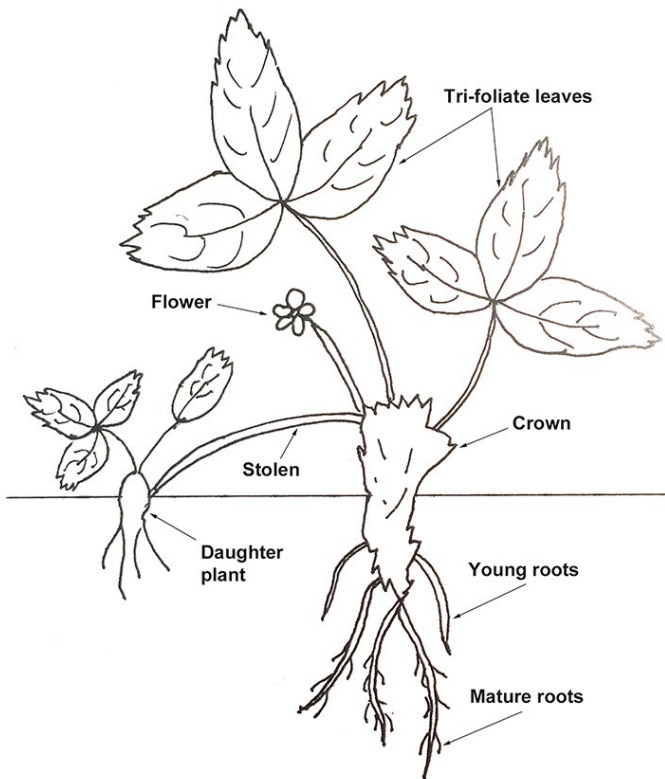


Figure 52. Strawberry plant terminology.  
Illustration: Charles Brun.

allow absorption of water and nutrients. New leaves form in the spring from the crown and live for three to six months before they die. Roots develop in the spring and live for one to two years.

There are three different types of strawberries. These types of strawberry plants differ based on their sensitivity to day length and temperature, which is involved in flower bud formation.

The first type are June-bearers, which are short-day plants that form flower buds in the late summer/early fall when the day length drops below fourteen hours per 24 hour cycle. Fruit will subsequently be produced the following spring, typically in late/May and into June, hence the name “June-bearer” (Strand 2008). June-bearing production can even extend into July, depending on cultivar and growing season. In the Northwest, most of the commercial production is from June-bearing cultivars. June-bearers produce many stolons (runners) that result from vigorous plant growth (Figure 53), which is why they are typically grown in matted row production systems.

The second type are called ever-bearers, as they initiate flowers under long days. Ever-bearers tend to produce the highest yields in June and the latter part of September. During the summer, they produce few runners. Two of the more popular cultivars sold as ever-bearers include “Quinault” and “Ft. Laramie.”



Figure 53. Stolons spread out to form new plants.  
Photo: Charles Brun.

The third types are known as day-neutrals. Day neutrals are insensitive to day-length and initiate and bear fruit all summer long when the temperatures are between 40°F–90°F. Day neutrals produce few runners and are commercially important for the fresh-market strawberry industries based in California and Florida (Hoashi-Erhardt and Walters 2014).

### Flowering

June-bearers can begin flowering in late April to early May in western Washington. June-bearers are self-fertile, with honey bees and other pollinators transferring pollen between flowers.

Flowers can be damaged or killed by spring frosts. Injured flowers exhibit black, as opposed to yellow centers, surrounded with white petals. Frost injury can result in reduced fruit production and deformed (puckered) fruit at harvest.

Protect the flowers from frost when clear nights and below-freezing temperatures are forecast in spring. Protection can be provided by row covers made of spunbonded polyethylene. Apply row covers at night to protect the flowers and remove it during the day to allow pollinators to visit the flowers. Day-neutral cultivars flower later and generally don’t experience frost injury.

### Fruiting

June-bearers thrive in western Washington with the mild weather that commonly occurs during harvest. Yields are reduced with hot weather (> 90°F) during harvest. Fruit may also be lost to rot if rain occurs during ripening.

Plan to pick 1–2 lb of fruit per plant for June-bearers beginning in year two. After three years of fruiting, the original plants will yield less and should be replaced with new, virus-free nursery stock. June-bearers can also be

rejuvenated each year by renovation (described below). Ever-bearers and day-neutral cultivars will yield less and are often replaced after only two fruiting cycles as the plants lose vigor.

### **Winter Chilling**

June-bearers require in excess of 400 hours of winter chilling in order to resume growth in the spring (Lantz et al. 2010). June-bearers can de-acclimate in the winter and suffer from winter injury if the temperature fluctuates too much. Ever-bearers and day-neutral types don't have the same chilling requirements, ranging from 240 to 500 hours.

### **Cultivar Selection**

Most of the efforts in plant breeding for strawberries in the Northwest has gone into the development of June-bearing cultivars for the processing industry (Martin et al. 2013). Desirable traits include high yields, good internal color for ice cream and yogurt, and disease resistance. Over the relatively short harvest window of three weeks, the berries are handpicked and transported to food processing plants where the fruit is frozen for later use. Processing cultivars as listed in EC 1618 (Finn, Strik, and Moore 2014) are typically not available in retail stores visited by home gardeners.

For fresh consumption, plant breeders have developed cultivars based on fruit color, shape, firmness, and flavor. Table 6 lists a number of different fresh market cultivars that are available to the home gardener. Use caution when purchasing Junebearers from outside of the Northwest through mail order sources, as they generally do not perform as well as ones developed in Washington, Oregon, or British Columbia.

### **Day-Neutral Cultivars**

Gardeners can extend the strawberry season into the fall by planting day-neutral cultivars (Table 7). The California strawberry industry has led the way in promoting fresh market strawberries with day-neutral cultivars that have large fruit size, attractive appearance, and high fruit firmness.

The cultivar "Albion" (Figure 54) is frequently found at farmers markets in western Washington, as it has an extended production season, good flavor, and very attractive fruit appearance. Some find the older "Tristar" cultivar has better flavor than the California cultivars, but it lacks fruit size. Day-neutral cultivars are generally best grown in raised beds, as they benefit from warmer soils, under plastic mulch. A guide to raising day-neutral strawberries in Washington is available (Hoashi-Erhardt and Walters 2014).



Figure 54. 'Albion' day-neutral strawberries.  
Photo: Charles Brun.

### **Site Selection and Preparation**

Strawberries perform best on well-drained soils and with exposure to full sun throughout the day. Avoid frost-prone areas where a freeze can occur during mid-to-late April through early May. Also, avoid sites that previously were used for tomatoes, eggplants, peppers, potatoes, or red raspberries. All of these plants are hosts for *Verticillium* wilt, which is a serious and devastating disease for strawberries. Currently, there are no strawberry cultivars that offer resistance to *Verticillium* wilt (Bolda 2013).

Carefully remove all perennial weeds from the planting site. Consider the use of a non-selective herbicide on sites with perennial weeds. Gaining control of weeds at the site preparation stage is important for successful production, as strawberries are poor competitors with weeds. Raising a cover crop in the fall, prior to spring planting will help lessen the impact of weeds during the establishment year (Cogger et al. 2014) and improve soil quality.

Incorporate compost or aged animal manures the fall prior to planting to improve physical attributes of the soil. The optimum soil pH for strawberries is 6.0 to 6.5, which can be determined with a pre-plant soil test. After the strawberry plants have been planted, use a combination of hoeing and mulching to manage weed growth.

### **Establishment and Cultivation**

In order to ensure the long lifespan of a planting, use certified virus-free planting stock available from nurseries from late-winter through early-spring. Plants are often sold as bare-root stock, which needs to be set into the ground soon after purchase. Container stock is also sold.

When planting strawberries, ensure that the crown is set at the soil level (Strik 2008c). Avoid planting the crown too deep or too shallow. June-bearers are normally grown in a matted row system where plants are set 15–24" apart

Table 6. June-bearing strawberry cultivars.

Cultivar	Origin	Harvest period <sup>1</sup>	Fruit and plant characteristics	Fruit Flavor	Resistance to root rot and virus susceptibility
Honeoye	1979 Cornell University	Very early	Good appearance and glossy red color. Firm texture. Low to medium yields and poor shelf life (Hokanson and Finn 2000). Best grown on lighter soils. May become tart on heavier sites.	Fair	Highly prone to root rot; virus susceptibility unknown.
Sweet Sunrise	2014 Oregon State University	Very early	A new high yielding cultivar with medium to large fruit size. Plants are very vigorous (Finn et al. 2014a).	Excellent	Unknown resistance to root rot; good virus resistance.
Hood	1965 Oregon State University	Early	Attractive, bright fruit of average size. Excellent for preserves. Medium yield. Plants are short lived (Barritt 1973).	Excellent	Prone to root rot; highly susceptible to viruses.
Shuksan	1970 Washington State University	Mid-season	Large fruit size with bright and attractive berries. Best cultivar for freezing. Plants have good winter hardiness (Barritt 1971).	Excellent	Resistant to both root rot and viruses.
Puget Reliance	1995 Washington State University	Mid-season	Bright glossy fruit that are large-sized. High yields and good plant vigor (Moore, Sjulín, and Shanks 1995).	Good	Resistant to both root rot and viruses.
Rainier	1972 Washington State University	Late	A sibling of "Shuksan." Large fruit size. Produces few runners. Fruit can lack firmness and be soft.	Good	Good resistance to root rot and viruses.
Puget Crimson	2011 Washington State University	Very late	Large fruit size with medium-firmness. Vigorous plant growth (Moore et al. 2011).	Excellent	Moderate resistance to viruses.

<sup>1</sup> In the southwest part of the state, the earliest cultivars ripen in late May, while the later season cultivars ripen in the last half of June and into July.

Table 7. Day-neutral strawberry cultivars.

Cultivar	Origin	Harvest period <sup>1</sup>	Fruit and plant characteristics	Fruit Flavor	Resistance to root rot and virus susceptibility
Albion	2004 University of California	June -October	The most widely grown California day-neutral cultivar. Firm fruit with better flavor than "Aromas," but lower yield than "Aromas" (Shaw 2006). Plants lack durability in northern zones (Finn et al. 2014b).	Good	Good resistance to root rot; susceptible to viruses.
Tristar	1981 USDA Beltsville Maryland	June -October	Small to medium sized fruit with good internal and external color and fruit firmness. Yield is low. Sister cultivar of "Tribute." Larger fruit size than "Tribute" (Weber 2012c).	Excellent	Fair to good resistance to both root rot and viruses.
Seascape	1991 University of California	June -October	Good yield and plant vigor, though fruit size is smaller and flavor is less preferred when compared to "Albion" (Bringhurst and Voth 1991).	Good	Lacks resistance to root rot; good resistance to viruses (Finn, Strik, and Moore 2014).
Aromas	1998 University of California	June -October	A late season cultivar with high yield capacity, good plant growth, and durability. Larger fruit size than "Seascape" (Shaw 1998).	Fair to good (Hoashi-Erhardt and Walters 2014)	Excellent resistance to viruses (UC Davis 2015).

<sup>1</sup> Day-neutral cultivars beginning bearing in early June, followed by small crops on a regular basis until frost, unless summer temperatures exceed 90°F.

in a row, with rows 36–42” apart. Runners and daughter plants are allowed to fill in the row until the row is 14–18” wide (Figure 55).

Day-neutral cultivars often are grown in a hill system on raised beds and under mulch. Because they produce few runners, they will need to be planted closer together. They can be planted 8–12” apart, both within and between rows. Consider double or triple rows for higher yields on a per area basis, while still offering convenient harvesting.

After planting, remove all runners to encourage the plant to become established and have good fruit production. Remove the first blossoms appearing on day-neutrals for six weeks to encourage strong leaf and root development. After this period of flower removal, they may be allowed to develop fruit until temperatures get too cold.

### **Fertilization**

Strawberries are not heavy nutrient feeders. Apply two lb of a 10–20–20 fertilizer or four lb of 5–10–10 per 100 square feet prior to planting. It is best to apply fertilizer in the late summer for established June-bearing plants, particularly at the time of renovation. Fertilizing in the spring is not advised, because it can lead to excessive runner and leaf development at the cost of fruit production.

To do this, apply two oz of nitrogen fertilizer for every 10’ of row. Gardeners often use a balanced fertilizer such as 16–16–16. If this mixture is used, apply 12.5 oz of product ( $2/.16 = 12.5$ ). Be sure to brush off any fertilizers that land on leaves to avoid fertilizer burn and water fertilizers into the soil.

Day-neutrals and ever-bearers can be fertilized at the same rate as June-bearers. However, these types of strawberries perform best when fertilizer applications are provided during the growing season and split among three to four applications, from spring to early August.

Manures may be used for fertilizing strawberries, but apply in late fall to early winter and reduce the nitrogen fertilizer rate by half. Visually assess growth to assess the fertility program. Tissue testing may also be performed if deficiencies are suspected.

### **Watering**

Supplemental watering during dry summer months will help encourage a vigorous, productive strawberry planting. Most of the plant roots are in the top 18” of the soil. Irrigate June-bearers as they enter the harvest period, if the soil is dry. Continue irrigating during renovation and again early to mid-September to ensure good plant vigor and flower bud formation.

Avoid over-head irrigation during fruit production, as this practice can encourage fruit rot. A drip/trickle system works best for irrigation. Use a shovel to ensure that the soil is wet to a 6” depth.



Figure 55. Matted row strawberries. Photo: Charles Brun.



Figure 56. Re-growth on renovated strawberries in late August. Photo: Charles Brun.

## Renovation

Renovation is an important yearly production practice that helps rejuvenate Junebearing plantings. After Junebearers finish fruiting, cut or mow the plant foliage to stimulate new growth (Figure 56). Avoid damaging the crown of the plants in the process.

For small beds, use a set of hedge clippers to cut off the tops of the plants. Growers may wish to dig up and replant rooted runners in bare areas. Then narrow the row width to 12". Finally, apply fertilizers, manage weeds, and irrigate adequately. Weak plantings or plantings with high weed pressure are best removed and replanted elsewhere.

## Harvest and Storage

Fruit is generally ready for harvesting when the entire surface becomes bright red. The color usually indicates berries have reached their maximum flavor, sweetness, and aroma. However, some cultivars benefit from additional time on the plant through improved flavor (e.g., "Albion"). Strawberries don't ripen further after being picked.

Pick strawberries with their green calyxes, or cap, left on. Handle them carefully to reduce bruising. Do not wash fruit at harvest time, as this will increase incidence of fruit rot. Wash and remove caps just before eating or processing. Unless the berries are cooled promptly after picking, they will last little more than overnight at room temperature. If they are placed in the refrigerator (at or below 40°F), will last 24 to 48 hours. Freeze berries in a home freezer set at 0°F.

## Pests

### Diseases

Viral diseases are an important factor limiting the life span of strawberries. The presence of viruses leads to a gradual loss in vigor, as well as a marked reduction in yield. Leaves become cupped, yellow, or streaked, depending upon which virus has infected the plant (Figure 57).

Aphids spread viruses when they feed on plant sap. Planting non-certified nursery stock can also spread viruses.

The most common control measure is to dig out infested plants and replace them with certified virus-free nursery stock. Gardeners can use the same area of the garden, since the virus requires strawberry plants as a living host to survive. Management of aphid populations with insecticides or predatory insects can reduce the transmission of insect vectored viruses. Applying insecticides for aphid control has not been found to be effective.



Figure 57. Uneven row vigor is suggestive of virus decline in these "Hood" strawberries. Photo: Charles Brun.

Root rot can be a problem in poorly drained soils or in sites previously infested with root rot causing organisms. Several different soil fungi and molds, some of which can survive in the soil for many years, are responsible for root rot. Leaf reddening, as well as stunted and discolored root systems (Figure 58) are suggestive of root rot.

There are no registered fungicides available to home gardeners for the control of root rot on strawberries. Commercial growers typically manage root rot through preplant soil fumigation. However, brassica/mustard seed meal mixes and/or pre-plant cover crops of mustards may reduce populations of root rot causing organisms. Mustard seed meals can be accessible to home gardeners and are considered safer to use than fungicides and fumigation.

If a planting is infected, it should be removed. Re-establish new plantings on different ground that is



Figure 58. Strawberry roots with red internal discoloration suggests infection by a root rot causing organism. Photo: Ralph Byther.

well-draining. Raised beds that are 12" in height or taller can also reduce incidence and severity of root rot.

Verticillium wilt spreads by a soil-borne pathogen, similar to the one that causes wilt and decline in tomatoes and potatoes. Older, outer leaves wilt, and newer, inner leaves remain green and erect (Figure 59). Eventually, wilt can kill the entire plant and even an entire planting. Pre-plant soil tests can indicate if verticillium could be problematic.

Botrytis gray mold is a perennial threat to flowers and fruits. Infected blossoms can brown and wither without producing fruit. Over-ripe fruit affected by fruit rot exhibit the characteristic gray, fungal growth (Figure 60).

Manage fruit rot by planting strawberries in sunny, breezy locations with good air flow. Avoid overhead irrigation from bloom through harvest and fertilization in the spring. Mulch beds with clean straw (not hay); be



Figure 59. Strawberry plants suffering from Verticillium wilt. Note the browning of the outer leaves. Photo: Steven T. Koike.



Figure 60. Strawberry gray mold fungus. Photo: Scott Bauer, USDA Agricultural Research Service, Bugwood.org.

sure straw is weed free to keep fruit off of the ground and reduce further rot. Harvest fruit every day to ensure they don't become over-ripe and susceptible to gray mold.

There are registered gray mold fungicides (HortSense 2015), including both synthetic and organic products. Like any fungicide or pesticide product, read the label and rotate to avoid resistance development.

### ***Insects***

Root weevils (*Otiorhynchus sulcatus*, *O. rugosostriatus*, and *O. ovatus*) are common insect pests of strawberries. Adult weevils notch leaves when they feed (Figure 61). The larvae, or grubs, however, are the most damaging stage of the weevil life cycle (refer back to Figure 14). Larvae feed on plant roots and cause the plant to wilt and die.



Figure 61. Leaf notching indicates a root weevil infestation. Photo: Lynell Tanigoshi.

Home gardeners don't have any insecticides for the management of the larvae, but do have a foliar-applied insecticide available for management of the adults (HortSense 2015), as well entomopathic nematodes for the larvae (Miles et al. 2012).

Fall plowing the future planting site protects the newly established plants as it kills the existing larvae. Controlling root weevil adults on adjacent ornamentals is also beneficial. Adult weevil populations can reside in an area for a long period of time. Manage weevils before replanting strawberries.

Lygus bug, also known as tarnished plant bug (*Lygus lineolaris*) can feed on buds, blossoms, and developing fruit resulting in deformed fruit (Figure 62). Damage occurs most frequently later in the summer, when they feed on day-neutral strawberries.

Spittlebug infestations are characterized by masses of foam that cover developing fruit and stunt its growth (Figure 63). Apply foliar insecticides shortly before bloom to control spittlebugs. Control is more difficult when masses of foam have appeared. Use a garden hose to spray a stream of water onto the berries to wash off the spittle.

Slugs also feed on leaves and fruit, especially during cool, moist weather. Manage slugs by destroying adults. Insecticidal baits may also be set out between the rows, but do not apply the bait to foliage or fruit.

### **Weeds**

Weeds can severely reduce plant growth and vigor. A registered herbicide exists for managing annual grasses in strawberries (HortSense 2015). It should be applied to annual grasses in the spring, when they are less than 6" tall. This product is effective against crabgrass, foxtail, and quackgrass (a perennial), but not as effective on annual bluegrass.



Figure 62. Lygus bug feeding damage. Photo: Surendra Dara.



Figure 63. Spittlebug masses on immature strawberry fruit. Photo: Charles Brun.

A 3" layer of straw applied between the rows will prevent annual bluegrass seed germination, which requires light for germination. Straw mulch that is weed free can also be effective at reducing weed populations, as can plastic mulches in day-neutral strawberry production.

### **Kiwi**

There are over 50 species of kiwi (*Actinidia* spp.), including several species that are grown commercially for fruit. Kiwi is a relative newcomer to the Pacific Northwest. It originated in the Yangtze River Valley of China. Seeds were taken to New Zealand, where commercial plantings were developed.

The first introduction into the United States occurred in the early 1930s, with the introduction of the "Hayward" fuzzy kiwi (LaRue 1994). By the 1970s, the first commercial plantings began to develop in California. Currently, California provides 98% of the kiwi fruit sold in supermarkets over a period of six months (October through April). The southern hemisphere supplies fruit the remaining months.

## Nutritional Value

The U.S. Department of Agriculture states that a one-cup serving of fuzzy kiwi (177 grams) has 108 calories and 2.0 grams of protein. This serving size will supply 273% of the daily intake needs for vitamin C (National Nutrient Database 2011) for a 2,000 calorie diet.

## The Kiwi Plant

There are three different types of kiwi that can be raised in Washington. The popular fuzzy kiwi (*Actinidia deliciosa*) is a subtropical deciduous vine that grows up to 30' long and produces numerous, fuzzy brown, berry-like fruit the size of large eggs (Figure 64). The fruit has tough skin that is usually peeled off before eating. The flavor resembles a combination of citrus, melon, and strawberry. When cut in cross section, the emerald-green flesh has a ring of small, black, edible seeds.

The popular "Hayward" cultivar is winter-hardy to 10°F (Zone 8a), depending upon degree of plant dormancy (Beutel 1990). The lower trunk is the most sensitive part of the plant with respect to winter injury (Strik 2005). Consider wrapping the lower trunk with plastic-coated foam insulation during the winter to protect the vines from freeze damage. The newer cultivar, "Saanichton," is hardy to 0°F (Zone 7).

Hardy kiwi (*Actinidia arguta*), also a vigorous growing vine, can grow to 40' in length unless it is pruned. The stems are red. The fruit are smaller than fuzzy types (Figure 65), resembling table grapes, and are sometimes called "kiwiberries." They may also be referred to as "Chinese gooseberry."

The third type of kiwi is known as Arctic Beauty kiwi (*Actinidia kolomikta*), also known as Kolomikta, which resembles the hardy types, but produce narrower fruit. Arctic Beauty kiwi plants are often used as ornamentals, as the fruit can have a bitter taste (Maughan and Black 2015). The vines are hardy to zone -40°F (Zone 3a).

## Flowering

The plants are dioecious, meaning that they have male and female flowers produced on separate plants. To cross-pollinate kiwi and ensure fruit production, intersperse male pollinizer vines with the female fruit-producing vines. Pollen from one male vine can pollinate up to eight surrounding female vines. Note that male vines flower profusely, but do not produce fruit.

Male flowers (Figure 66) are characterized as having numerous stamens (pollen producing organs), while female flowers only bear stigmas (pollen receptors) and associated female organs necessary for producing seed and fruit.

Open flower clusters are not very attractive to bees. A shortage of pollinator activity results in small, misshapen fruit. European honey bees are the preferred pollinators, but other insects can pollinate kiwi.

A spring frost in April, when flowering begins, can significantly reduce yield.



Figure 64. Fruit of the "Hayward" kiwi, ready for harvest.  
Photo: Charles Brun.



Figure 65. Hardy kiwi fruit (*Actinidia arguta*).  
Photo: Charles Brun.



Figure 66. Kiwi flowers: Male on the left, female on the right.  
Photo: Jerry Payne, USDA ARS, Bugwood.org.

## **Fruiting**

Vines do not begin to bear fruit until they have grown for four years and are established. Fuzzy kiwi needs long, warm summers with a growing season of more than 225–240 days in order to ripen the fruit sufficiently (Beutel 1990). Maximum production is not attained until eight years after planting.

Growers in the north Willamette Valley of Oregon report vine yields of up to 100 lb of fruit per plant for the fuzzy types. Hardy kiwi only needs 150 frost-free days to ripen, making them ideal in areas that do not have long growing seasons. Hardy kiwi can produce up to 150 lb of fruit per vine. Kolomikta kiwis require the shortest growing season to ripen, but yields tend to be lower than hardy kiwi types.

## **Winter Chilling**

Fuzzy kiwi cultivars require 600–700 hours of winter chilling, while the hardy kiwi types require only 300 hours. If temperatures fluctuate in late winter or early spring, the vines can de-acclimate quickly and thus suffer from late spring frosts.

## **Cultivar Selection**

Gardeners have several choices of kiwi cultivars (Table 8). Base cultivar choices on winter hardiness levels, the length of the growing season needed to ripen the fruit, and the type of fruit desired.

The common fuzzy-types are well known, as they are found in the grocery stores. The Arctic Beauty types and hardy types may occasionally be found at local farmer's markets. The Arctic Beauty types do poorly in full sun conditions or sites with poor drainage.

## **Site Selection and Preparation**

Plant both the fuzzy and hardy types on sun exposed, north facing slopes or in protected spots to reduce the chance of spring frost injury. The foliage is extensive and requires trellising. Kiwi does best on well-drained, loamy soils, with a pH of 5–7.

Kiwi is susceptible to Verticillium wilt (a soil borne pathogen), so avoid planting it where the previous crop consisted of strawberry, black raspberry, or potatoes/tomatoes. Eliminate all vegetation from the planting site prior to establishment and plan to keep the newly planted vines weed free over the life of the planting.

## **Establishment and Cultivation**

Kiwi plants are available at retail garden centers in the winter months or from mail order nurseries.

Consider building a trellis system for the vines before purchasing plants. In California, the fuzzy-types are grown on a pergola trellis. The standard plant spacing is 15' between the plants, with rows spaced 15' apart.

A wire trellis system is constructed using 8', treated posts, set 2' into the ground. Galvanized, high-tensile, 12-gauge wire is run down the rows, as well as across the ends of multiple rows (Reil 1994; Figure 67). While the foliage is concentrated at 6' above the ground, the fruit will hang lower.

## **T-Bar Trellis**

In the Northwest, the T-bar trellis (Figure 68) is most commonly utilized for training kiwi. The trellis consists of 8–9' uprights and 5–6' cross arms (use 2x6', treated wood). It is easier to construct and prune vines on a T-bar trellis. Space three to five trellis wires (12 gauge) along the length of the T-bar.

After planting, allow the vine to grow straight up to the middle wire. Pinch the terminal bud to stop its growth. Select two buds that will grow to become two permanent cordons in opposite directions along the length of the middle wire (Figure 69).



Figure 67. Hayward kiwi on pergola trellis.  
Photo: Charles Brun.



Figure 68. Hardy kiwi grown on a T-bar trellis in southwest WA. Photo: Charles Brun.

Table 8. Kiwi cultivars.

Cultivar	Origin	Harvest period <sup>1</sup>	Fruit and plant characteristics
September Sun	Moscow University	Early	Arctic Beauty (Kolomikta) hardy-type. Fruit as long as “Anna,” but narrower. Plants need afternoon shade (Berkheimer and Hanson 2001). Leaves have white, green, and pink variegation.
Pasha	Moscow University	No fruit	Arctic Beauty (Kolomikta) hardy-type. Male plant serves as a pollinizer for “September Sun.” Leaves have white, green, and pink variegation.
Ananasnaja (Anna)	1972 Moscow University	Mid	Hardy-type. Female plant. Produces hairless, cherry-sized fruit that don’t require peeling. Barrel shaped fruit that has a reddish-blushed skin and green center. Good flavor (Maughan and Black 2015).
Hardy male	Unknown	No fruit	Un-specified hardy-type. Male plant with bright white flowers in May. Pollinates eight hardy female hardy vines.
Issai	Japan	Mid	Hardy-type. Self-fertile female. Sweeter in flavor than “Hayward” fuzzy kiwi. Fruit ripen un-evenly.
Saanichton 12	Agriculture Canada	Late	Fuzzy-type. Female plant; use “Matura” for pollination. Bright red skin. Better winter hardiness than “Hayward.” Ripens two weeks prior to “Hayward.”
Matua	Unknown	No fruit	Fuzzy-type. Male pollinator for “Saanichton 12.”
Hayward	1934 USDA Chico California	Late	Fuzzy-type. Female plant. Standard cultivar grown principally in California (Vossen and Silver 2015). Fruit are sold widely in grocery stores (LaRue 1994). Marginal hardiness for eastern Washington.
California male	1934 USDA Chico California	No fruit	Male plant used to pollinate female “Hayward.” No specific cultivar is recommended (LaRue 1994).

<sup>1</sup> Arctic Beauty types ripen in August; hardy types ripen in early to mid-September; fuzzy types ripen in mid-to-late October (in southwest Washington).

During the second growing season, select fruiting canes spaced at 2’ intervals along the established cordons. These developing fruiting canes will grow at right angles to the permanent cordons and will bear for two to three years. Fruit will develop on shoots from these canes and hang down below the trellis wires.

### Fertilization

Mature kiwi plants (seven years and older) can receive up to one lb of actual nitrogen applied as broadcast, granular application under the vines. Split the application between bud break (March) and early summer (June). If using 16–16–16, apply approximately 6 lb of product ( $6 \times 16=1$ ). Don’t over apply granular fertilizer as it can burn the root systems, which is evidenced by leaf edge burning (Strik 2005).

### Pruning

Kiwi vines need annual pruning in order maximize production and fruit quality. Vines that are not pruned gradually stop producing fruiting shoots. Pruning should start in December, when the plants are dormant and after the leaves have dropped.

Remove nearly all of the fruiting canes that bore fruiting shoots in the fall (Figure 70). Leave one strong

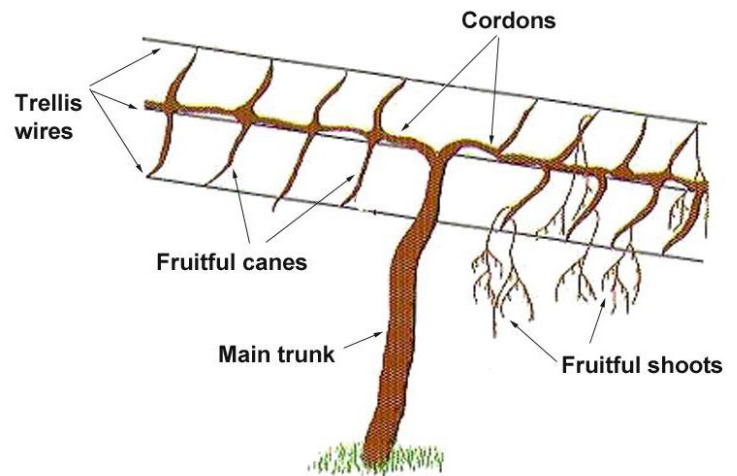


Figure 69. New Zealand Renewal System for training kiwi vines. Illustration: Charles Brun.

replacement cane for next year’s fruiting. Limit the total number of replacement canes to 30–40 canes, split evenly between the two cordons. When more than 40 canes are left on each vine, fruit size and quality will diminish.

Replacement canes should be separated a foot apart along the cordons. Head back replacement canes to a length of 4–5’ in order to produce an adequate number of fruiting shoots for next year’s crop. With a T-bar trellis and 6’ cross arms, replacement canes will extend 1–2’ beyond the length of the cross arm.

## Harvesting and Storage

The optimum harvest time for kiwi depends upon the season and type of fruit raised. The Artic Beauty types ripen in late August—harvest them when they are sweet to the taste.

The hardy types, such as the cultivar Issai, ripen in early to mid-September in southwest Washington. Ripening can occur earlier in August, depending on the cultivar and location. If allowed to fully ripen on the vine, they become too soft and will lose their stems when plucked from the vines. Damaged fruits have short postharvest lives and do not store well.

For the fuzzy types, determining maturity is a challenge. The fruit don't display any visual changes as they approach maturity. They don't ripen off the vine. In research trials in northwest Oregon, the cultivar "Saanichton 12" ripened in early-October, while the "Hayward" cultivar ripened in mid-October. Pick the fuzzy-types ("Hayward") before they start to soften on the vine. The fruit can tolerate a light frost. Ripe fruit will have black seeds, when cut in half.

As for storage, the hardy types may last only two months under ideal storage conditions of 32°F. The fruit are sensitive to ethylene, so reduce their exposure to this plant hormone by storing away from ethylene-producing fruit, including apples, bananas, melons, and tomatoes fruits (Crisosto et al. 2013).

Pick fruit and placed them in one-gallon freezer bags, but don't seal the bags. Place the fruit-filled bags into cardboard boxes with layers of newspaper to cushion the fruit from each other. Set the boxes in an un-heated garage and away from apples. Over the next four to six months bring the bags into the home and ripen the fruit at room temperature. Set them near apples to speed up the conversion of starch to sugar.

## Pests

Neither home nor commercial growers of kiwi in the Pacific Northwest have reported any serious insect or disease problems. Root rot (*Phytophthora* spp.) is a problem in California and could be a problem in the Northwest if the fuzzy-types are grown on heavy poorly drained sites. Manage weeds by applying herbicides or a thick layer of mulch.

## Currants and Gooseberries

Currants (*Ribes sativum*), black currants (*Ribes nigrum*), and gooseberries (*Ribes grossularia*) are considered shrubby, deciduous plants that bear colorful spring flowers and abundant berries that are generally processed into juices and preserves. They do well in almost any Northwest soil of average fertility, whether it is slightly acidic or alkaline.

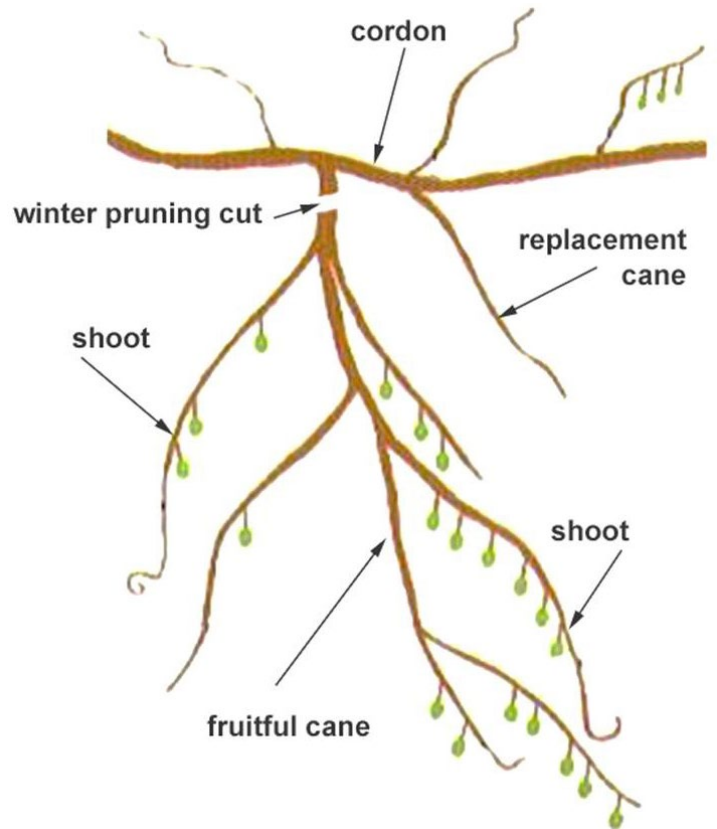


Figure 70. Winter pruning cuts on kiwi vines.  
Illustration: Charles Brun.

In addition, they can be raised in soil that does not drain well enough for strawberries or raspberries. Both currants and gooseberries flourish in areas of partial shade and where the soil stays moist. Currants and gooseberries are excellent sources of antioxidants, which are being increasingly shown to be very important diet constituents.

## Nutritional Value

The U.S. Department of Agriculture states that a one-cup serving of currants (112 grams) has 63 calories and 1.6 grams of protein. This serving size will supply 76% of the daily intake needs for vitamin C (National Nutrient Database 2011) for a 2,000 calorie diet. A one-cup serving of gooseberries (150 grams) has 66 calories, 1.3 grams of fat, and will supply 69% of the daily intake needs for vitamin C.

## The Currant and Gooseberry Plant

Currants and gooseberries are members of the genus *Ribes*. They are native to western Europe and have long been used there for preserves and other processed foods.

The biggest challenge to growing *Ribes* in the U.S. arose in the early 1900s when rust-infected white pine seedlings were re-imported from European nurseries to

replant deforested areas on both the eastern and western coasts. Five-needle pines, including western white pine (*Pinus monticola*), eastern white (*Pinus strobus*), sugar pine (*Pinus lambertiana*), limber pine (*Pinus flexilis*), and bristlecone pine (*Pinus aristata*), are susceptible to that disease, known as white pine blister rust (WPBR, *Cronartium ribicola*), which can eventually kill the trees (Maloy 2003).

As with many rust fungi, WPBR has an alternative host: *Ribes*. Infected *Ribes* plants will develop chlorotic spots on their upper leaf surfaces and orange pustules on the lower surfaces (Figure 71). Susceptible cultivars of *Ribes* will shed their leaves (defoliate).

During the 1930s, the United States federal government hosted a program of *Ribes* eradication across the nation in order to reduce the threat to the native white pines (Barney and Fallahi 2009). Even though the program was unsuccessful, a federal ban on raising *Ribes* existed until 1966, after which it was dropped. There are still states in the nation where *Ribes* are banned (predominantly the northeastern ones); Washington is not one of them.

Rust-susceptible *Ribes* should not be planted within half a mile of native five-needle pines or ornamental cultivars of five-needle pines. Breeding efforts have produced *Ribes* that have resistance to WPBR, as well as powdery mildew (Table 9).

Gooseberry plants (Figure 72) can reach a height of 5–7' at maturity and can live for more than 15 years. They generally have thorny, arching canes. Currants and gooseberries are hardy in protected areas of eastern Washington to winter temperatures of -30°F (Zone 3b). The plants are not well adapted to high temperatures, so consider planting them in a site with a northern exposure or under the shade of a deciduous tree.

Currants are more erect than gooseberries and are thornless. Fruit are borne in grapelike clusters referred to as strigs. Red-colored currants, such as the “Red Lake” cultivar (Figure 73), are not as tart as gooseberries and are best when used in pies and preserves. They grow to a height of 3–5'.

Black currants (Figure 74) typically grow to a height of 4'. Their piney or resinous flavor makes them best suited to processing into jams, jellies, and pies (Widerholt 2015). Black currant juice is also popular in some European countries.

### **Flowering**

Gooseberries and currants are self-fertile. Thus, single plants can be utilized in a home garden. Honey bees and other insects are responsible for pollen transfer. They bloom fairly early in the spring (early April), so avoid frost-prone sites.



Figure 71. White pine blister rust on currant leaf.  
Photo: Robert L. Anderson, USDA Forest Service, Bugwood.org.



Figure 72. “Hinnomake” gooseberries. Photo: Charles Brun.



Figure 73. “Red Lake” currants. Photo: Charles Brun.

Table 9. Currants and gooseberries.

Cultivar	Origin	Harvest	Fruit and plant characteristics	Disease resistance
<b>Red currants</b>				
Jonkheer van Tets	1941 Holland	June	An early season red currant with good flavor and large fruit size. Fruits may split with wet weather (Bratsch and Williams 2009).	Susceptible to PM <sup>1</sup> ; resistant to WPBR <sup>2</sup> .
Perfection	1887 New York	June	An older cultivar gaining renewed interest (Tepe and Hoover 2015).	Fair resistance to PM.
Red Lake	1933 University of Minnesota	July	Good fruit flavor and moderate plant vigor. Widely available in the trade. Highly susceptible to spring frost in northern latitudes.	Fair resistance to PM; susceptible to WPBR.
Rovada	1980 The Netherlands	July	Considered one of the best red cultivars (Barney 2013). Bears abundantly. The most common commercial cultivar in Europe (Pluta and Hummer 1995) as it produces large fruits and strigs.	Resistant to PM; susceptible to WPBR.
<b>White currants</b>				
White Imperial	1890 New York	July	European cultivar which produces well with long strigs. Wide spreading bush. Fruit low in acids.	Resistant to PM; susceptible to WPBR.
Primus	1977 Slovakia	July	Vigorous upright bush which bears yellow-white fruiting strigs (Carroll et al 2014). Touted as the sweetest of the white currants.	Susceptible to PM.
Blanka	1977 Slovakia	July	High yielding cultivar with very long strigs. Blooms later in the spring, thus avoiding spring frosts.	Resistant to PM; unknown for WPBR.
<b>Black currants</b>				
Ben Sarek	1983 Scotland	July	A popular Scottish black currant with a compact spreading habit. Fruit have tough skin. Tight fruit clusters make hand picking berries difficult.	Resistant to PM and WPBR.
Consort	1950 Canada	July	An early, blister rust resistant cultivar. Fruit quality rates as fair (Barney 2013). Related "Consort" and "Crusader" cultivars are also resistant to WPBR.	Highly resistant to both PM and WPBR.
Ben Lomand	1975 Scotland	July	Compact bush. Very large fruit size. One of the most widely grown English home garden cultivar. The standard European cultivar for processing.	Resistant to PM; susceptible to WPBR.
Titania	1984 Sweden	July	Tall bushes (over 6'). Very large fruit size, but fruit are highly acidic and lack flavor. Initially reported to be WPBR resistant; now found to be susceptible (Ferguson and Crawford 2014).	Highly resistant to PM; susceptible to WPBR.
<b>Gooseberries</b>				
Hinnonmaki Red	Finland	July	Red fruit with tart, sweet flavor. Can be eaten fresh. Medium sized fruit (Pomper 2012).	Resistant to PM and WPBR.
Invicta	1981 East Malling, England	July	European cultivar with large, green fruit with fair flavor. Very large thorns.	Resistant to PM, some resistance to WPBR.
Jeanne	2006 USDA Corvallis	August	Dark red gooseberry with high fruit quality. Better resistance to sawfly defoliation (Hummer and Reed 2008).	Resistant to PM and WPBR.

<sup>1</sup> PM: Powdery mildew (*Podosphaera mors-uvae*)<sup>2</sup> WPBR: white pine blister rust (*Cronartium ribicola*)



Figure 74. Black currants. Photo: Charles Brun.

### ***Fruiting***

Newly established plants should not be allowed to fruit during the first year in order to allow for good plant establishment. Strip flowers off during the planting year and allow a small crop to develop in year two. Full crops should begin by years three and four.

A respectable yield for gooseberries and currants is 8–10 lb of fruit per plant (Bratsch and Williams 2009), with black currants yielding only half as much.

### ***Winter Chilling***

Currants and gooseberries generally require 1,000 to 1,200 hours of winter chilling temperatures in order to successfully break bud in the spring (Bratsch and Williams 2009). Winter cane injury has not been observed to be a problem in Washington.

### ***Cultivar Selection***

Select Ribes cultivars based on their intended use, as well as their potential impact on five-needle pines in the vicinity (Table 9). If gardeners plan to grow Ribes spp. near five-needle pines, they will need to select cultivars with resistance to white pine blister rust. While this disease may affect the growth of the Ribes plant, it will severely weaken and possibly kill the affected five-needle conifer. Red and white currants can be eaten fresh, while black currants are best when processed.

### ***Site Selection and Preparation***

Unlike the majority of berries, Ribes can tolerate partial shade. They can also tolerate heavier soils. The best sites consist of deep, well-drained loam soils with adequate moisture-holding capacity. Avoid any sites that have standing water in the winter. The ideal soil pH is 5.5 to 7.0 (Barney 2013).

As with any other berry crop, be sure to remove all competing vegetation in the future planting site of a Ribes planting. Temperatures above 95°F during harvest can cause ripe fruit to drop from the plants.

### ***Establishment and Cultivation***

Dormant container stock is available for mid-winter planting in January and February in western Washington. Set plants 5' apart. They are considered drought tolerant, but during drought periods, irrigate them well once per week during the summer. A thick layer of mulch or well-rotted manure helps roots surrounding the plants survive during the dry summer months. The root systems are not as shallow as those of blueberries.

### ***Trellising and Training***

Home gardeners should grow gooseberries and currants as free-standing bushes, in hedgerows, or as fan-shaped bushes up against the side of a wall (Bratsch and Williams 2009). The last method allows for easier picking when thorns are present. Diseases usually cause fewer problems because air can circulate through the foliage. Currants can be raised on cordon trellis systems (McKay 2005), but this technique is very labor intensive.

### ***Pruning***

The objective in pruning free-standing bushes is to develop an open vase-shaped bush with equally spaced branches. In general, use more thinning cuts (removal of an entire branch back to the base) than heading cuts (shortening a branch). Failure to keep a bush pruned usually results in a brushy bush and can reduce production. The two-, three-, and four-year-old branches are the most productive. At maturity, a healthy bush has no more than 9–12 canes (Barney and Fallahi 2009).

### ***Harvesting and Storage***

Harvesting currants and gooseberries is a slow process, especially when gooseberry cultivars have thorns. Red and white currants ripen over a two-week period. Once mature, however, they hold on the bushes for a week without spoiling. Do not remove individual red, white, or black currants from the strigs if the goal is to use them in making juice or jelly, because the products are strained.

Gooseberries mature over a four to six week period, with berries at the tops of fruit clusters ripening first. Pick gooseberries individually when the fruit attain full size, but before they start to shrivel. Fully ripe gooseberries can be eaten fresh, but can also be processed.

## Pests

### Diseases

The principal disease problem on both currants and gooseberries, beside blister rust, is powdery mildew (Figure 75). The disease is characterized by a whitish, powdery growth that occurs on leaves, shoots, and fruit. During fruit maturation, heavily infested fruit take on a brown, rough coating that makes them unusable for use. Humid conditions and crowded plantings that reduce air flow through the canopy favor powdery mildew development.

There are registered fungicides than can be applied to protect developing vegetative and floral growth in April.

### Insects

Currant fruit flies (*Euphranta canadensis*), also known as gooseberry maggot (Figure 76), aphids, and imported currant worm (*Pteronous ribesii*) larvae (Figure 77) are the principal insect pests of currants and gooseberries.

Aphids can feed on the plants and leave the fruit with a sticky, undesirable coating, as well as reduced productivity if populations are high. Currant fruit flies emerge as adults from the soil beneath the bushes in April and soon lay eggs in developing berries. Eggs develop into white maggots that feed within the berries, causing them to turn red and drop from the bushes. Imported currant worm can cause significant defoliation of the plants if allowed to feed unmanaged. Monitor for the small green larvae with the distinctive black spots feeding on the leaves.

For all of these insect pests, there are registered pesticides for their management (HortSense 2015). As a non-chemical approach, plants may be protected by building PVC cages with organza fabric draped over to enclose them and provide a physical barrier to these insect pests.

## American Elderberry

Washington State gardeners can grow American black elderberries (*Sambucas nigra* subsp. *canadensis*) all through the state for jam, jelly, vinegar, yogurt, and wine (Stevens and Nesom 2010).

### Nutritional Value

The U.S. Department of Agriculture states that a one-cup serving of elderberries (145 grams) has 106 calories and 1.0 grams of protein. This serving size will supply 87% of the daily intake needs for vitamin C (National Nutrient Database 2011) for a 2,000 calorie diet.

## The Elderberry Plant

Elderberries are broadleaf, deciduous shrubs that can grow to 5–12' in height. They are multi-stemmed plants that grow by producing new canes via above-ground stolons. The foliage consists of pinnately compound opposite leaves that are 6–13" long. Each leaf consists of seven leaflets that are 2–6" long.



Figure 75. Powdery mildew on gooseberry.  
Photo: Charles Brun.



Figure 76. Currant fruit-fly-infested gooseberry fruits. Photo: Charles Brun.



Figure 77. Imported currant worm. Photo: Charles Brun.

American elderberries grow naturally on moist, well-drained soils in full sun sites. The plants are hardy to -40°F (Zone 2). Aside from the fruit they produce, they are attractive plants in the landscape and the fruit can attract birds. Leaves, roots, canes, and immature fruit contain poisonous alkaloids and cyanide, so care should be exercised if this plant is to be in an area with children or pets.

### **Flowering**

Elderberry flowers are white with yellow stamens and are borne on 10" wide, domeshaped panicles, called cymes (Figure 78). They have a pleasant, though slightly rancid odor. Flowering typically occurs in June, but will vary depending on location and the genetics of the plant.

While the flowers are bisexual and self-fertile, larger crops can be achieved by planting two different cultivars that permit cross pollination. The flowers are primarily wind pollinated, as the flowers produce no nectar and are not attractive to honey bees and many other pollinators.

### **Fruiting**

Individual elderberry fruit are 1/4" in diameter or less and the color of mature fruit is purple to black. They typically ripen in September. Don't eat immature red fruit, as they contain alkaloids, making them toxic. When fruit are mature, the entire fruit cluster should be picked (Figure 79). Ripe fruit are rarely eaten raw, but are usually processed.

### **Winter chilling**

Elderberries require very few hours of winter chilling in order to successfully overwinter and bloom the following spring, as they can be raised in Florida and Texas. However, their natural distribution is quite large and they can be very winter hardy in the northern areas of their range.

### **Cultivar Selection**

Elderberries have long been gathered from the wild in natural areas. The oldest cultivars (e.g., "Adams" and "Eryoff") were developed in the 1920s and 1930s on the East Coast. The University of Missouri began breeding and selection efforts in 1998 to develop superior plants with uniform ripening, large berry size, and smaller seeds (Byers 2014a; Table 10).

### **Site Selection and Preparation**

Elderberries are not difficult to grow, as they occur naturally across the eastern United States on a wide array of soil types. While they can tolerate light shade, they prefer and perform best when grown under full sun. A neutral soil pH is preferred. Adjust the soil pH prior to planting with either lime or elemental sulfur, if necessary.

### **Establishment and Cultivation**

Elderberries have naturalized in riparian river bottoms. Gardeners can take advantage of this by mimicking sites along aquatic areas by incorporating compost into a cleared site to increase the water-holding capacity.

Plants are available in the late winter at independent garden centers.

They should be established 4' apart, in rows 10' apart, and allowed to spread. It takes 2–3 years for full production to occur, at which point one can expect 10–15 lb of fruit per bush. The plants should live for many years.



Figure 78. American elderberry flowers are borne in cymes. Photo: Charles Brun.



Figure 79. American elderberry fruiting clusters. Photo: Charles Brun.

Table 10. American Elderberries.

Cultivar	Origin	Harvest	Fruit and plant characteristics
Bob Gordon	2011 University of Missouri	Mid July	Newer cultivar from Missouri which produces dark purple berries in pendulous cymes, which may make them less attractive to bird depredation.
Wyldewood	2010 University of Missouri	Late July	A newer cultivar featuring dark purple berries arranged in upright cymes. Fruit ripen over a three-week period (Byers et al. 2012). The bushes can grow up to 7' in height.
York	1964 New York	August	Older cultivar that produces very large berries. Latest ripening cultivar for the Northwest.

### Irrigation

Utilize a drip/trickle system to keep the bushes well supplied with water during the hot and dry summer months.

### Pruning

To promote good growth of elderberry bushes, annually prune any canes older than three years of age and leave a total of 7–9 canes on each bush. Alternatively, gardeners can mow off the canes in the late fall. This will reduce the yield, but can increase the size of the cymes and concentrate the harvest over a two- to three-week period (Byers 2014b).

### Harvesting and Storage

Elderberry flowers can be harvested in the early summer, when all the florets have opened. Use caution when harvesting and do not eat the pedicels (flower stalks) or any vegetative tissue, as they can be toxic. Flowers can be dried or frozen for later use in juices, pies and fritters.

In the fall, clip the mature cymes as they mature and place them, intact, in the freezer. The berries are highly perishable, which is why they should be promptly frozen after harvest. Once frozen, the berries can be shaken off the pedicels.

Elderberries are typically not eaten fresh, but rather processed for use in jams, sauces, vinegars, wines, or for use in food coloring. Dried fruit can be used in cereal bars or fruit leathers.

### Pests

There have not been any reported disease problems in the Pacific Northwest for elderberries. As with other summer-bearing crops, there will be potential issues with SWD, as elderberry is a suitable host. As with other susceptible crops, a PVC cage covered with organza fabric would be the best protection.



Figure 80. Lingonberries ready for harvest.  
Photo: Stephen Ausmus, USDA ARS, Bugwood.org.

### Lingonberry

Lingonberry (*Vaccinium vitis-idaea*) is well suited to sites west of the Cascade Mountains, where summers are mild and the soil is naturally acidic. This groundcover plant produces tasty fruit (Figure 80) that can be used in preserves and syrups, serving as a substitute to cranberries.

Lingonberry is a native plant in the Canadian Pacific Northwest, the northern United States (Alaska, Washington, and Oregon), northern Europe, and Scandinavia (Heidenreich 2010).

### Nutritional Value

A one-cup serving of lingonberries (100 grams) has 76 calories and 1.0 grams of protein. This serving size will supply 36% of the daily intake needs for vitamin C (National Nutrient Database 2011) for a 2,000 calorie diet.

### The Lingonberry Plant

Lingonberries are members of the blueberry and cranberry plant family (Ericaceae). They are often referred to as mountain cranberry or foxberry. The plants are small, evergreen, woody shrubs that spread by underground runners.

Table 11. Lingonberries.

Cultivar	Origin	Harvest	Fruit and plant characteristics
Ernteseugen	1981 Germany	August and November	Double cropping cultivar from Germany. Highest yielding cultivar in Oregon State University trials (Penhallegon 2006). Plants grow 15" tall. Mild-flavored fruit.
Ida	1997 Sweden	September	Second highest yielding cultivar in Oregon State University trials (Penhallegon 2012). Plants grow to 5–7" in height. Large fruit size Yields twice that of "Koralle" (Finn and Mackey 2006).
Koralle	1969 Holland	September	Principle Dutch cultivar for all of Europe. Upright, strongly branched, vigorous plants. Light red to dark red, tart fruit. Fruit hold well on the plants for up to two weeks (Heidenreich 2010).

Plants can grow 2–16" in height and up to 16" in width. The leaves are oval in shape with a distinctive notched tip. The plants are hardy to 2°F (Zone 7b), but should be covered with straw or floating row covers when the temperature is expected to drop below 10°F (Zone 8b).

### Flowering

Lingonberry flowers consist of small, pinkish-white, urn-shaped blossoms that open in tight clusters near the tips of one-year-old shoots (Figure 81). Bumble bees are the primary pollinators. The flowers are self-fertile, but having two different cultivars increases fruit size at harvest. The plants typically bloom twice, once in March-April, and then again in April-August.

### Fruiting

Lingonberries produce bright red, tart berries that mature in August–September from the early flowering period and then in mid-October from the later flowering period. Berries are tart-to-bitter when first picked, but their flavor improves when picked after the first frost. Berries are typically processed into preserves and not eaten fresh.

### Winter chilling

As with other hardy, temperate-grown plants, lingonberries require 700 or more hours of winter chilling to successfully break bud in the spring and resume normal growth (Halloway et al. 1983) .

### Cultivar Selection

Lingonberries have long been gathered from the wild in natural areas in Europe, Alaska, and the Atlantic Provinces (Table 11). There are no breeding efforts currently in the United States for lingonberries.

### Site Selection and Preparation

Like most plants in the Ericaceae family, lingonberries perform best on acidic soils with high organic matter content. Soil pH should be 4.3 to 5.5 and will need to be adjusted a year prior to planting if the pH is outside of this range.



Figure 81. Lingonberry flower. Photo: H. Zell, Botanical Garden KIT, Wikimedia Commons.

Select a sunny site with good soil drainage. Amend the planting site with a 2" layer of peat moss or sawdust and incorporate this material to depth of 6–8". The plants can tolerate partial shade.

### Establishment and Cultivation

Lingonberries thrive on peat-moss–amended soils. Weeds can be managed by hand hoeing and mulching with sawdust, yard-debris compost, wood chips, straw, or peat moss. The plants will produce rhizomes that spread throughout the mulch layer. On weed-free sites, set new plants 14–18" apart in rows 3–4' apart. After a couple of years, the plants will have spread out to form a low, evergreen hedge.

## ***Irrigation***

Lingonberries should not be exposed to hot and dry conditions or they will suffer. They will need an inch of irrigation water per week to perform their best. Amending the site with organic matter before planting and applying liberal amounts of mulch will help preserve soil moisture.

## ***Pruning***

Lingonberries don't require any pruning for the first five years. Older plants can be re-vitalized by mowing the top growth back to stimulate new shoot growth.

## ***Harvesting and Storage***

Fruit are ready for harvest when they have grown to the size of a small blueberry and have turned light to dark red. The color intensifies during refrigerated storage. Mail-order nurseries carry low-bush blueberry rakes that can be used to aid in the harvest of the fruit. Ripe fruit is tart and acidic, but sweeter than fresh cranberries (Penhallegon 2006).

Under refrigeration, fruit can be stored for three to five weeks if they are not overripe. Lingonberries can be processed into jams, liqueurs, and wine, or dried to make fruit leather.

## ***Pests***

New lingonberry plantings will need to be carefully weeded and mulched to keep the plants thriving. Once the plants have grown together into a mat, there will be less weed pressure.

The plants are susceptible to leaf and twig blights. The best way to reduce blight incidence is to site the planting in a sunny location where the foliage can dry out.

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