

plantations in Russia consisted mainly of *R. rugosa*, *R. majalis* and *Rosa webbiana* Royle.

In spite of being known for its beneficial properties for centuries, rosehip is still considered as a fairly new crop. There are many useful genotypes in nature that need to be collected and evaluated. In plant breeding programmes based on controlled crosses, it is important to consider the implications of the odd meiosis. The main breeding objectives are to produce plants that are suitable for machine harvesting, have a high content of vitamin C and carotenoids, together with a desired flavour. Previous studies show that this could be obtained with interspecific and intersectional crosses. Also, the recent studies on the medicinal effects of rosehips must not be neglected. This is a multipurpose plant with a great potential and a very interesting future.

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Rubus spp. blackberry

Blackberries, *Rubus* spp. (Rosaceae), have probably always been part of humans' diets as they are commonly found as an early colonizer of disturbed areas throughout the northern hemisphere and in Andean South America. Theophrastus in the 3rd century BCE was the first to mention blackberries; they were reportedly used as hedges to keep out invading forces as long as 2000 years ago. Blackberries began to be mentioned in gardening books in the late 1600s. Breeding to improve the blackberries as a crop began to occur in the late 1800s in Europe and North America. By the early 1900s, blackberry cultivars and cultivars derived from crosses between blackberry and raspberry such as 'Logan' and 'Boysen', were planted on over 1000 acres in California and Oregon on the west coast of North America. For many years blackberries were canned or frozen and shipped around the world. However, in the late 1990s as the worldwide market for fresh berries in general expanded dramatically, consumers grew to expect year-round availability of fresh fruit. Blackberries, as with other berries, began to be grown in the southern hemisphere to provide off-season fruit in the northern hemisphere. New cultivars, production techniques and new production areas have led to year-round availability of fresh and processed blackberries. Blackberries have an extremely high content of antioxidants due to compounds that give them their intense colour. As consumers entering the 21st century are increasingly aware of health benefits of berries beyond their basic nutrition there is an even greater interest in blackberries.

World production

The leading producer of blackberries in the world is the USA. While there are many small plantings scattered throughout eastern North America that supply fruit for local sales, the largest plantings are in California and Oregon, where over 15,000,000 kg are produced on 2900 ha. California and Oregon are the major fresh-market suppliers during the northern hemisphere summers. Oregon dominates world production for the processing market although Mexico has become a major producer as well.

European blackberry production is scattered throughout the continent with major production areas in Italy and Germany, primarily for fresh market sale. For off-season consumption in the northern hemisphere, Chile and Mexico are the major producers, although New Zealand has been a major producer in the recent past. As production expands worldwide, China is likely to play a major role in the processing market in the future.

Uses

Blackberries are harvested and sold in fresh and processed markets. For the fresh market, they are sold pick-your-own, for local sales, as well as on the international wholesale fresh market. In the processing market, the fruit are typically frozen whole, puréed or juiced and from these basic 'industrial' products, hundreds of products are made for sale to consumers in every section of a grocery store. Bakery products, jams and jellies, dairy and cereal products are some of the more common consumer products that contain

blackberries. The juice is often fermented to make wines or liqueurs. The leaves are commonly used to make herbal teas. Native people ate the fruit fresh and dried it, often in combinations with fish or meat, for winter stores.

Blackberries are a rich source of anthocyanin pigments (red, purple), other phenolics and ellagic acid. The intense colour due to the anthocyanins has been used as a source of natural dyes and food colourants from ancient to modern times. Anthocyanins, phenolics and ellagic acid are powerful antioxidants that recently have received a great deal of attention from the medical community and consumers. Antioxidants inhibit oxidation that is known to have a damaging effect on tissues. Studies now suggest that consuming fruits and vegetables with high levels of antioxidants may slow the physical and mental ageing process. The nutrient composition of blackberry is shown in Table R.70.

Specific medical studies have confirmed that blackberry fruit and their relatives can hinder the development of oesophageal and colon cancer. Traditionally, the roots, berries, leaves and stems, individually or in combination have been used to treat diarrhoea, gastrointestinal problems, rheumatism, haemorrhoids, colds, headaches, venereal disease, sore eyes and as a treatment to prevent miscarriages.

Botany

TAXONOMY AND NOMENCLATURE Blackberries (*Rubus* spp.) are in the same genus as red raspberries, black raspberries, mora, cloudberry and arctic raspberry. Blackberries are distinguished from raspberries by whether the receptacle picks with the fruit (blackberries) or stays with the plant when picked (raspberries). Blackberry taxonomy is very uncertain. While distinct species existed at one time, and many can still be identified today, human activities to clear forests and open up ground for farming in many areas such as eastern North America and Europe have allowed blackberry populations to

Table R.70. Nutritional composition of blackberry per 100 g individually quick frozen fruit (Source: Oregon Raspberry and Blackberry Commission, 2007).

Proximal analysis	%
Energy (kcal)	54.7
Lipids	0.1
Total carbohydrates	12.0
Sugar	5.6
Protein	1.5
Dietary fibre	3.1
Minerals	mg
Calcium	25.5
Iron	0.8
Sodium	4.9
Ellagic acid	5.8
Anthocyanins	150.0
Catechins	1.4
Quercetin	0.5–3.5
Vitamins	mg
Vitamin C	1.5
Vitamin A	67.8 IU

mix and interbreed blurring the differences between species. Many blackberries such as *Rubus laciniatus* and *Rubus armeniacus* (syn. *Rubus procerus*) in Europe also predominantly produce apomictic seed that are genetically identical to their maternal parent rather than a result of a sexual combination between a male and female parent. As a result, vast areas of blackberries may appear to be a separate species but may in fact all be genetically identical.

In modern times, based on commercial production, the blackberries have been grouped by growth habit. The erect and semi-erect cultivars, which account for much of the fresh market industry, are largely derived from several eastern US species (i.e. *Rubus allegheniensis*, *Rubus argutus*, *Rubus frondosus*). The trailing cultivars, which account for much of the processing industry, are largely derived from the western dew berry (*Rubus ursinus*) but have several other species in their background.

Rubus laciniatus, the evergreen blackberry, originally from Europe is still an important commercially grown species where the original species background can be clearly defined. In some regions of the world, blackberries from native species are commercially harvested but there are no breeding programmes in place to develop improved cultivars. One of the best examples of this is the Andean blackberry or mora (*Rubus glaucus*) that is commonly harvested from plantings in the highlands of Peru, Ecuador and Colombia.

MORPHOLOGY Blackberries have perennial crowns and root systems with biennial canes. Canes grow vegetatively the first year (primocanes). In the second year, the canes (floricanes) produce flowers and fruit and then die. In any given year, the plant will have primocanes and floricanes. Blackberry species all have spiny canes. Using the occasional, chance, thornless mutants, cultivars have been developed in breeding programmes that are spineless ('thornless').

Blackberry canes are vigorous and can grow more than 6 m long in a growing season. The leaves are pinnately or palmately compound with three to five leaflets. The leaf colour is typically dark green. In mild climates, the leaves will often remain on the plant from one year to the next.

Many *Rubus* spp., particularly the blackberries, will commonly spread through tip layering. In the autumn, the vegetative canes develop a 'rat tail' appearance and grow towards and into the ground. Then the tip roots and a new plant will develop from this tip. While this can be beneficial to propagation, it is also one of the reasons that blackberries can become such nuisance weeds.

REPRODUCTIVE BIOLOGY The flowers are typical for the *Rosaceae*. Most cultivated blackberries produce between five and 15 flowers per lateral, although some species may have dozens of small flowers on each lateral. The showy, white to pink petals surround a ring of stamens, which in turn surround a receptacle covered with pistils arranged in whorls (Fig. R.18). The flowers are very attractive to pollinating insects. If pollination and fertilization are successful, a drupelet is produced by each ovule. Collectively the drupelets form the edible fruit, which is called an aggregate fruit. Flowering usually takes place in mid-spring and the fruit ripen 40–70 days later depending on the cultivar and the environment.

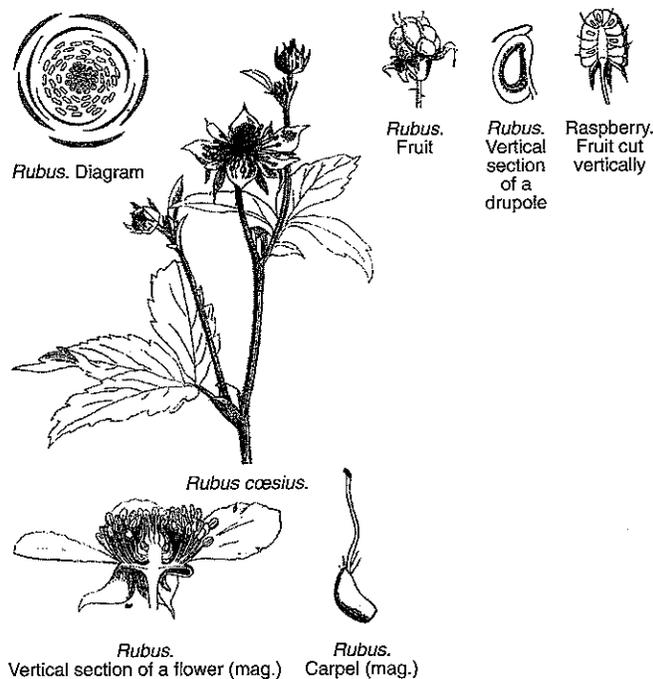


Fig. R.18. Leaves, flower and fruit of *Rubus* spp. (Source: Le Maout, 1877).

Some blackberry species, such as *R. ursinus*, are dioecious, meaning a plant produces either staminate or pistillate flowers. Dioecy has been eliminated through modern breeding practices.

ECOLOGY Blackberries are naturally rapid colonizers of any open ground. Their fruit and seeds are well adapted to dispersal by birds. Combining this method of dispersal with their habit of spreading quickly through tip layering, means that they will aggressively move into any areas opened by natural (e.g. flood, fire) or human (e.g. ranching, farming, home or road building) disturbance of the ground and removal of competing plants. They will often dominate the early stages of succession after such a disturbance until trees begin to establish themselves and cause excessive shading. Within the various species ranges, they often are common or the dominant species along forest edges, railroad tracks, fence lines and roadways.

Horticulture

PROPAGATION Blackberries propagate readily from cuttings. The type of cutting that works best depends on the species or type of blackberry. The crown-forming blackberries propagate readily from mature softwood cuttings taken in the summer, by hardwood cuttings taken in the autumn or tip layers, whereas the blackberries that 'sucker' (produce underground rhizomes) propagate best from root suckers or root cuttings. Blackberries are easy to propagate in tissue culture and commercial nurseries commonly use this method of propagation.

PLANTING, TRAINING AND PRUNING For commercial plantings, the plants are established 1–2 m apart within rows and

usually a two-wire trellis system is used. Each type of blackberry requires different pruning and training practices, which in turn are dependent on how vigorous they are in the environment they are growing in.

The trailing blackberries are trained in one of two general methods either for 'every year' (EY) production or for 'alternate year' (AY) production. In either case, they are trained on to a two-wire trellis. In AY production, all canes are cut to the ground initially and then the new primocanes are trained vertically onto the trellis as they grow. When they reach the top wire, they are trained in a single direction to facilitate machine harvesting the following year. The following spring, new primocanes are chemically or mechanically removed prior to harvest. In the dormant season, all canes are removed and the cycle begins again. In this system, there is a crop in the field every other year. Over 2 years' time this system produces about 80% of the fruit that would be harvested if the plants were cropped every year, however, the labour costs of pruning and training are greatly reduced. In EY production, the floricanes that have finished fruiting and are dead are removed after fruiting or during the dormant period and the primocanes that grew that year are trained vertically to the top wire and horizontally along the wire in one direction. The following year the floricanes fruit, the new primocanes grow along the ground and after fruiting the cycle begins anew.

The erect and semi-erect blackberries have the same general practices followed with EY training above. However, the new erect and semi-erect blackberry primocanes are tipped when they reach 1.2 and 1.5 m, respectively. This tipping encourages branch formation where most of the fruit will be borne. In many climates, no support system is needed for erect blackberries as between their suckering characteristic and interlocking branches the hedges are self-supporting. However, in climates where they are more vigorous, the primocanes are tied to a two-wire trellis. Semi-erect blackberries are extremely vigorous and are often grown in a T-trellis. They are tipped 20–30 cm below the wires and the resulting branches are trained to the two wires. In both types, the dead floricanes are removed after harvest.

FERTILIZATION AND IRRIGATION Blackberries are generally vigorous and require less irrigation and fertilization than most crops. However, they are typically fertilized in late spring with two or three split applications of nitrogen. If soils are low in potassium or phosphorus these may be included in the fertilization programme. In many temperate climates, blackberries can be successfully grown without irrigation, however to ensure high quality berries and high yields, if rain is not adequate, 3–5 cm of water/week is applied.

DISEASES AND PESTS Blackberries are generally less susceptible to disease and insect pests than many fruit crops due to their vigour. Each production region and type of blackberry has fungal, bacterial or viral diseases that can be important. Grey mould (*Botrytis cinerea*) on fruit; anthracnose (*Elsinoe veneta*), cane blight (*Leptosphaeria coniothyrium*), cane and leaf rust (*Kuehneola uredinis*), cane and leaf spot (*Septoria rubi*) on canes and leaves; and crown gall (*Agrobacterium tumefaciens*) on crowns and canes can be universal problems. In the south-eastern USA,

orange rust (*Gymnoconia peckiana*) and rosette or double blossom (*Cercospora rubi*) are particular problems. The viral diseases (raspberry bushy dwarf virus, rubus stunt, tomato ringspot, tobacco streak), which can be pollen, leafhopper or aphid borne, are increasingly recognized as problems.

Insects and other arthropods are not particularly a problem in the western USA, however, in the eastern USA red necked caneborer (*Asgrilus ruficollis*) and raspberry crown borer (*Obera bimaculata*) can be particularly troublesome.

MAIN CULTIVARS AND BREEDING The most widely grown blackberry cultivars and some of their characteristics are provided in Table R.71.

'Marion', a trailing type, is the most important cultivar in the world with at least 2500 ha in Oregon alone. Other important trailing cultivars include: 'Thornless Evergreen', 'Kotata', 'Waldo', 'Siskiyou' and 'Olallie'. The breeding programme in Oregon (USA) is actively working to develop cultivars that are thornless, machine harvestable, more winter tolerant and that have fruit that are firmer and maintain the intense flavour and aroma that characterizes the trailing blackberry.

The most important erect or semi-erect cultivars include 'Chester Thornless', 'Navaho', 'Cherokee' and 'Brazos'. Breeding programmes are actively working to develop a broader range of thornless cultivars, including ones whose fruit are more uniform and have a better flavour and plants that are more disease tolerant. New, primocane-fruiting (fruit on first-year growth) blackberries are rapidly being developed. The most active breeding programmes are in Arkansas and California (USA).

Many cultivars have multiple species in their background and are known as hybridberry cultivars. A few are either direct offspring of crosses between the wild western trailing blackberry (*R. ursinus*) and the red raspberry (*Rubus idaeus*) or offspring of these hybrids. The most important of these cultivars are 'Boysen', 'Logan' and 'Tayberry'. 'Boysen' is still a major cultivar worldwide with about 1000 ha planted.

'Logan' at one time accounted for over 10,000 ha in the USA but is now grown on fewer than 40 ha. 'Tayberry' is primarily grown as a novelty by homeowners, but there is scattered, small-scale commercial production. Breeders in New Zealand are actively working to develop improved 'Boysen' type cultivars. Chad Finn

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Rubus spp. red and black raspberry

Raspberries, *Rubus* spp. (*Rosaceae*), are fragile, fragrant, highly flavoured and perishable high-value fruit (Plate 74). They are distributed worldwide, but best adapted to temperate areas of both the northern and the southern hemispheres. Red raspberries were harvested from the wild by Greeks 2000 years ago, described by Pliny in the first century and cultivated by Romans by the fourth century. Flowers and leaves have

Table R.71. Most widely grown blackberry cultivars, their growth type, whether they are spiny or spineless, the primary market where the fruit is sold and where they were developed or discovered.

Type	Cultivar	Spines?	Primary market	Where developed or discovered
Trailing	'Boysen' (blackberry × raspberry hybrid)	Yes	Processing	California
	'Kotata'	Yes	Processing	Oregon
	'Logan' (blackberry × raspberry hybrid)	Yes	Processing	California
	'Marion'	Yes	Processing	Oregon
	'Olallie'	Yes	Fresh - local sales	Oregon
	'Siskiyou'	Yes	Fresh	Oregon
	'Thornless Evergreen' ('Everthornless')	No	Processing	Oregon
Semi-erect	'Waldo'	No	Processing	Oregon
	'Chester Thornless'	No	Fresh	Illinois-Maryland ^a
	'Hull Thornless'	No	Fresh	Illinois-Maryland
Erect	'Triple Crown'	No	Fresh	Illinois-Maryland
	'Apache'	No	Fresh	Arkansas
	'Brazos'	Yes	Fresh and processing	Texas
	'Cherokee'	Yes	Fresh	Arkansas
	'Kiowa'	Yes	Fresh	Arkansas
	'Navaho'	No	Fresh	Arkansas

^a Cross and/or selection made by US Department of Agriculture (USDA) Agriculture Research Service (ARS) in Illinois. Final testing and release by USDA ARS in Maryland.