Crop Reports

Currants

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Additional index words. *Ribes*, genetic resources, germplasm, *Ribes nigrum*, *Ribes rubrum*, *Ribes sativum*, *Ribes sanguineum*, *Ribes hudsonianum*

We appreciate University of Idaho Agricultural Experiment Station, and USDA, ARS, CRIS 5358-21000-029-00D for supporting this paper.

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Black currants (*Ribes nigrum* L.) and red and white currants (*R. rubrum* L., synonym = *R. vulgare* Jancz., *R. sativum* Syme.) are little known crops in the United States but are economically significant in Russia, Poland, Germany, Scandinavia, Great Britain, New Zealand, and many eastern European countries (Fig. 1). The nutritious fruit of these plants are rich sources of antioxidants (such as vitamin C), phenolics, and flavenoids. Some of these fruit are eaten fresh, while others are processed into juices, jams, jellies, bakery, and dairy products. Currants have great potential for expansion into American juice and fruit markets.

Classification

Currants are botanically classified in the genus *Ribes* L., which includes more than 150 described species of shrubs native throughout Northern Europe, Asia, North America, and in mountainous areas of South America and northwest Africa (Brennan, 1996). At least eighteen species have contributed genes to domestic, edible fruited currants (Harmat et al., 1990). This paper describes four sections of economically important species within the genus: black currants (section *Botrycarpum*, formerly *Coreosma*), red and white currants (section *Ribes*), ornamental currants (section *Calobotrya*), and golden currants (section *Symphocalyx*) (Table 1).

Ribes were previously classified in the family Saxifragaceae, but recent taxonomic treatments place them in Grossulariaceae because of wholly inferior ovaries, totally syncarpous gynoecium, and fleshy fruit (Cronquist, 1981; Sinnott, 1985). Although early classifications recognized separate genera for currants and gooseberries (Berger, 1924; Coville and Britton, 1908; Komarov, 1971) prevalent monographs recognize a single genus, *Ribes*, for these crops (Janczewski, 1907; Sinnott, 1985). Crossability between gooseberry and currant species supports this single genus concept (Keep, 1962).

Origin and development

Centers of diversity. The centers of diversity for black currants and red currants include Northern Europe, Scandinavia and the Russian Federation (Jennings et al., 1987; Rehder,

Fig. 1. Fruit of (top) black currant *Ribes nigrum* 'Titania,' (middle) red currant *R. rubrum* 'Rovada,' and (bottom) white currant *R. rubrum* 'White Versailles.'

1986). In addition, several species of black currants with sessile yellow glands are native to South America. The center for diversity of ornamental and golden currants is North and Central America. The principal evolutionary pressure in these groups appears to be geographical adaptation (Sinnott, 1985). Messinger et al. (1999) consider two possible, not mutually exclusive, evolutionary scenarios for *Ribes*: 1) long periods of stasis is interrupted by sudden radiation of species and 2) gene flow due to hybridization as a force for diversification.

ENDANGERED SPECIES. Currant species are robust. Most are broadly distributed and are not in danger of extinction. The World Conservation Monitoring Centre (2002) Red List of Threatened Plants includes 18 *Ribes* species. *Ribes kolymense* (Trautv.) Komarov ex Pojark is extinct from the former Soviet states; three American and one Sardinian species are endangered; six American are vulnerable, two from the Pacific northwestern North America; another Sardinian and a Chilean species are rare; and three Russian species are indeterminate. *Ribes ussuriense* Jancz., one of the Russian species listed as indeterminate, contains the dominant gene, Cr that provides immunity from white pine blister rust (*Cronartium ribicola* J. C. Fisch) (Brennan, 1996). Genes from this species have allowed the cultivation of black currants in white pine blister rust restricted zones of the U.S. The Oregon National Heritage Program lists *R. cereum* var. *colubrinum* Hitchc. as a species to be watched (Kagan, 2001).

HISTORY OF DEVELOPMENT. The word currant is derived from the ancient Greek city, Corinth, and was first used to describe small dried grapes from that region (Hedrick, 1925). These grapes are now referred to and are commercially sold as Zante currants. Early English texts described the cultivated species of *Ribes* with word variations such as corinthes, corans, currans, and bastarde corinthes (Hedrick, 1925). The most commonly used early English reference is attributed to Lord Bacon (1561-1626), who called them corans. The Italians refer

Table 1. Common and scientific names for the currants, genus *Ribes* L., family Grossulariaceae.

Common English name	Foreign names	Scientific name
Black currant	zwarte bes (Dutch)	(Section Botrycarpum, formerly, Coreosma)
	cassissier (French)	*R. americanum* Mill.
	schwarze johannisbeere (German)	*R. bracteosum* Dougl.
	solbaer (Danish)	*R. dikuscha* Fisch. ex Turcz.
	svarta vinbar (Swedish)	*R. fontaneum* Bokarn.
	grosellero negro (Spanish)	*R. hudsonianum* Rich.
		R. janczewski Pojark.
		R. nigrum L.
		R. nigrum var. *sibericum* Wolf.
		R. pauciflorum Turcz ex Pojark.
		R. procumbens Pall.
		R. ussuriense Jancz.
		R. viburnifolium A. Gray
Red currant	aalbes, rode bes (Dutch)	(Section Ribesia)
	groseillier (French)	*R. multiflorum* Kit. ex Schult.
	johannisbeere (German)	*R. petraeum* Wulf.
	ribs (Danish)	*R. rubrum* L (synonym = *R. sativum* Syme.)
	vinbar (Swedish)	(synonym = *R. vulgare* Jancz.)
	grosellero rojo (Spanish)	*R. triste* Pall.
White currant	wittebes (Dutch)	*R. rubrum* L.
	groseille blanc (French)	
	weiss johannisbeere (German)	
	vit vinbar (Swedish)	
	grosellero blanco (Spanish)	
Ornamental currant		(Section Calobotrya)
		R. ciliatum Humb. & Bonpl. ex Schult.
		R. howellii Greene
		R. malvaceum Sm.
		R. nevadense Kellogg
		R. sanguineum Pursh
		R. s. var. *glutinosum* Benth.
		R. viscosissimum Pursh
		R. wolfii Rothr.
Golden currant		(Section Symphocalyx)
		R. aureum Pursh
		R. aureum Pursh var. villosum D.C.
		(synonym = *R. odoratum* Wendl.)

to this fruit as uvetta or little grape. Common name translations of several languages are presented (Table 1).

Black currants have been cultivated for about 400 years. They were originally collected from the wild by herbalists, and were imported from Holland to the United Kingdom by Tradescant in 1611 (Brennan, 1996). Gerarde (1636) described these plants and their medicinal qualities. As late as the 1890s, Stuartevant's Notes (Hedrick, 1919) report this species as "cultivated for its fruit which is valued for jelly-making." Beginning about World War II, the high vitamin C content was recognized and now black currant juice represents a broad global economic market. World advertising is expanding black currant use in Asia.

Black currants have the greatest economic importance in this genus and are native throughout northern Europe and central and northern Asia. Botanical subgeneric taxa include *R. nigrum* subsp. *europaeum*, *R. nigrum* subsp. *scandinavicum*, and *R. nigrum* var. *sibiricum* (Brennan, 1996). By 1826, five black currant cultivars appeared on the Royal Horticultural Society's recommended plant list (Hedrick, 1925). The cultivars Black Naples and Black Grape, both of unknown origin, were most widely grown. During the 1800s the number of black currant cultivars increased with the introduction of open pollinated seedlings from early cultivars. Hatton (1920) divided the named sorts into four groupings of similar genotypes: 'French Black,' 'Boskoop Giant,' 'Goliath,' and 'Baldwin.' Bunyard (1925) described more than 15 cultivars in England while Hedrick (1925) described 61 cultivars (with 15 synonyms) in the U.S.

In the late 1800s, white pine blister rust was introduced into North America on infected white pine (Pinus strobus L.) nursery stock imported from Europe. In Canada during the 1940s and 1950s, A.W. Hunter (1955) made crosses to develop rust-resistant *Ribes* cultivars. He combined the Cr gene for rust immunity from *R. ussuriense* with the black currant cultivar Kerry and released three cultivars: Crusader, Coronet, and Consort. Fungal uredia do not form on these cultivars under laboratory or field conditions. Unfortunately these cultivars are low yielding and susceptible to powdery mildew, a disease caused by Sphaerotheca mors-uvae (Schw.) Berk.

Red currants were first cultivated as common garden plants in the sixteenth century in Holland, Denmark, and the coastal plains around the Baltic Sea (Brennan, 1996; Hedrick, 1925). The French word for red currant, "grosseillier d'outre mer" (currant from over the sea) implies a Dutch origin. Red currant species grow wild in northern France, Germany, and Austria, but these fruit do not attain the size and quality of those of the more northern species.

German descriptions of red currants date to 1484, while the first French mention is 1536 (Hedrick, 1919; 1925). References to red currants first appeared in English agricultural literature in the sixteenth century (Gerarde, 1636). Currants appear on a memorandum of the Massachusetts Company in 1629 in a list of plants destined for a new world colony. John Rea (1665) described at least five different types of currans: small black, small red, great red, greatest dark red Dutch, and white. The cultivars Red Dutch and White Dutch, became widely distributed, were first introduced into North America by the earliest English settlers in Massachusetts, and remain popular today. In 1925, Bunyard described 31 distinct genotypes that he classified into five groups. Notable *Ribes* breeding programs were active in the first half of the 1900s at agricultural experiment stations in Illinois, Minnesota, Oregon, New York, North Dakota, and South Dakota (Darrow, 1937).

As settlers moved across the U.S. during the mid- and late 1800s, native golden currants were cultivated as flowering shrubs or as rootstocks upon which to graft imported currants and gooseberries (Hedrick, 1925). In 1888, R.W. Crandall of Newton, Kansas selected the large fruited *R. aureum* var. *villosum* 'Crandall'. The selection of ornamentals, such as the pink flowering currant (*R. sanguineum*) occurred in the latter half of the 1900s. For example, the University of British Columbia patented pink flowering currant 'White Icicle' in 1985.

Production statistics

Total world black currant production averaged about 620,000 t (683,000 tons) during the 1990s. Production tends to fluctuate from 500,000 to 600,000 t (551,000 to 661,000 tons) and increased to above 650,000 t (716,000 tons) in 2001 (Table 2). The large production has caused low fruit prices globally. The Russian Federation, Poland, and Germany lead the world in production of black currants. Red currants are valued for fresh markets and for the production of preserves. The main red currant producers are Poland, Germany, Holland, Belgium, France, and Hungary. Germany and the Slovak Republic are the leading producers of white currants.

North American black and red currant production is small and unreported on the world market. *Ribes* were grown widely in the U.S. and Canada during the late 1800s and early 1900s. Hedrick (1925) reported that 2,952 ha (7,379 acres) of *Ribes* (a value of more than $1.4 million, not adjusted for inflation) were grown in the U.S. in 1919. This production was halted in the 1920s when quarantines and regulations in the U.S. prohibited *Ribes* cultivation because of white pine blister rust. Now some North American small fruit growers are beginning to diversify by planting small blocks of black currants, and North American acreage is increasing.

Botanical description

Black currants. This plant is an unarmed, strongly aromatic shrub, growing as tall as 2 m (6.5 ft) (Rehder, 1986). The leaves are lobed, up to 10 cm (4 inches) per side, glabrous above,

Table 2. World production of currants for 1990, 1995, 2000, and 2001 in metric tons (t).[z]

Year	1990	1995	2000	2001
Russia	70,000[y]	175,000	208,000	212,000
Poland	130,409	154,591	33,522	180,485
Germany	146,538	169,300	140,000	140,000
Elsewhere	131,810	126,255	118,316	126,213
Total	478,757	625,146	499,838	658,698

[z]Information from United Nations, Food and Agriculture Organization (2002).
[y]1 t = 1.1 tons.

Table 3. Nutritional composition of raw currant, gooseberry, apple, strawberry and orange fruit (per 100-g edible portion).[z]

Fruit	Water (%)	Calories[y]	Protein (g)	Fat (g)	Carbohydrate (g)	Vitamins A (I.U.)[x]	B_1 (mg)	B_2 (mg)	Niacin (mg)	C (mg)
Black currant	81.96	63	1.4	0.41	15.38	230	0.05	0.05	0.3	181
Red currant	83.95	56	1.4	0.2	13.8	120	0.04	0.05	0.1	41
Gooseberry	87.87	44	0.88	0.58	10.18	290	0.04	0.03	0.3	27.7
Apple	83.93	59	0.19	0.36	15.25	90	0.017	0.014	0.077	5.7
Strawberry	91.57	30	0.61	0.37	7.02	27	0.02	0.066	0.230	56.7
Orange	82.3	40	1.3	0.3	15.5	250	0.10	0.05	0.5	71

[z]Source: U.S. Department of Agriculture, National Agriculture Library (2002).
[y]Food calorie = 1000 g calories of heat.
[x]I.U. = international units; 28.35 g = 28,350 mg = 1.0 oz.

slightly pubescent with numerous sessile, aromatic glands beneath. The racemes droop and bear four to ten flowers with reddish- or brownish-green campanulate hypanthia, recurved sepals, and whitish petals about two-thirds as long as the sepals. The fruit are globose, up to 10 mm (0.4 inch) in diameter, and are generally shiny black when ripe, although green- and yellow-fruited forms exist (Liberty Hyde Bailey Hortorium, 1976).

RED AND WHITE CURRANTS. These plants are unarmed shrubs that grow to 2 m (6.5 ft) tall (Rehder, 1986). These Scandinavian natives are grow as far north as 70 °N latitude (Brennan, 1996). The shoots are glabrous or have glandular hairs, and young growth bears crystalline glands (Brennan, 1996). Older stems are covered with a smooth pale yellow bark. The leaves are deeply cordate, 3- to 5- lobed, 6 to 7 cm (2 to 2.75 inches) in diameter. Flowers, which occur on long racemes, are greenish tinged with purple. The hypanthium is almost flat and the petals are very small. The fruit is globose, 6 to 10 mm (0.25 to 0.4 inches) in diameter, and glabrous with a translucent skin. Selections of *R. sativum* (synonym of *R. rubrum*) were initially made from native stands in northwestern Europe. *Ribes petraeum*, a European montane species, was also selected from the wild. *Ribes triste*, the North American red currant, has fruit quality similar to European red currants, but is lower yielding and has not been domesticated. Two additional species, *Ribes spicatum* in Norway and *R. multiflorum* in England, are used in red currant genetic improvement programs. White and pink currants are color forms of *R. rubrum*.

GOLDEN AND ORNAMENTAL CURRANTS. Golden and ornamental species have a broad range of bloom colors. The golden currants, *R. aureum* Pursh and *R. aureum* var. *villosum* (synonym = *R. odoratum*), have fragrant yellow flowers with tubular hypanthia that bloom in spring (Rehder, 1986). The fruit ripen black but do not have the black currant aroma. The flowering currant, *R. sanguineum*, a member of the ornamental currant section, has a range of flower color variants from white to dark red-purple, and is used in landscape plantings for spring bloom and wildlife habitat (Brennan, 1996).

CYTOLOGY. The basic chromosome number of currants is x = 8 (Zielinski, 1953), and species and cultivars are diploid (2x = 2n = 16). Natural polyploidy is extremely rare (Brennan, 1996). Chromosome complements and karyotypes are highly uniform (Sinnott, 1985) and the chromosomes are 1.5 to 2.5 mm (5.91 to 9.85 $\times$ 10^{-5} inches) (Darlington, 1929). Mitotic and meiotic processes are also highly uniform (Zielinski, 1953).

REPRODUCTIVE BEHAVIOR, MODE OF POLLINATION. Most black currant cultivars are partially self-sterile and cross-pollination is essential for optimum yields. In Europe, about 20% of the plants on a plantation are usually pollinizer cultivars. Pollinizers are selected to have the same bloom times and durations as the main cultivars. High temperature can reduce the bloom duration. Basal flowers can bloom up to 20 days earlier than terminal flowers on the same strig (Harmat et al., 1990). Red and white currants are generally self-fruitful, but location and weather influence pollination and fertilization. Harmat et al. (1990) recommend that 1 to 2% of the plants in a field be pollinizer cultivars. Insects are the primary pollinators, although wind plays a minor role in red and white currant pollination. In many locations, the main pollinators are wild bees and bumble bees. Placing 2.5 beehives per ha (one per acre) is recommended (Harmat et al., 1990). Apomixis is rare in currants although it can be induced by application of auxin or gibberellin (Zatyko, 1962).

Uses

Currants are cultivated for edible fruit and ornamental characteristics. Black currants are primarily grown for juice. They are also valued for jams, jellies, pie fillings, dessert toppings, yogurts, ice cream, mineral waters, teas, candies, perfumes, liqueurs (such as creme de cassis in France), for the conversion of white wines to rose, and as flavorings and colorants for dairy products (Brennan, 1996; Dale, 2000). Black currant juice has intense flavor. Also the high color, ascorbic acid, and other antioxidant levels are recognized as being of nutraceutical value. Red, white, and pink currants are eaten fresh and used for jams, and jellies. White currants produce the greatest yields, and are used fresh and for baby food (Harmat et al., 1990). *Ribes* seeds contain gamma-linolenic acid and are used for health extracts. Ornamental and species currants are sold in the nursery trade for landscaping and are produced in mass for river bank stabilization and vegetation reclamation or restoration. Ornamental pink flowering currants are planted to attract humming birds (family Trochilidae).

Composition

Currant fruit are rich in nutritional content (Table 3). They are low in calories and sodium, but high in vitamin A, ascorbic acid (vitamin C), and potassium. They are moderate sources of thiamin (vitamin B_1), niacin (vitamin B_3), and calcium. The vitamin C content of black currant cultivars is very high relative to other fruit, ranging from 50 to 250 mg/100 g fresh weight (0.05%

Minerals				
Ca (mg)	P (mg)	Fe (mg)	N (mg)	K (mg)
55	59	1.54	2	322
33	44	1.0	1	275
25	27	0.31	1	198
7	7	0.18	0	115
14	19	0.38	1	166
70	22	0.8	2	196

to 0.25%) (Brennan, 1996), but samples of wild fruit can contain concentrations of 800 mg/100 g fresh weight (0.8%). The amount of vitamin C in the fruit depends on cultivar, site, and weather conditions. Black currants are high in anthocyanins, total phenolics and antioxidant capacity (Moyer et al., 2002a, 2002b).

Cultivars

Recent breeding efforts have doubled fruit size compared to fruit from wild species. Breeders have crossed *R. nigrum* with *R. ussuriense*, *R. dikuscha*, and *R. nigrum* var. *sibiricum* for disease resistance, and with *R. bracteosum* for longer racemes that produce higher yields (Brennan, 1996). *Ribes hudsonianum*, the North American black currant, and *R. americanum*, the American black currant, have desirable traits that may be useful for broadening the gene pool.

Black currant breeding or selection programs are significant in Belgium, the Czech Republic, Denmark, Finland, France, Germany, Hungary, Latvia, New Zealand, Poland, Russia, Sweden, The Netherlands, Ukraine, and the United Kingdom. Recently, a resurgence of interest in black currant development in North America has occurred in British Columbia, Canada, and California, Oregon, Idaho, Maryland, Minnesota, New York, and Pennsylvania. New European releases, such as 'Ben Hope' and 'Ben Gairn,' have resistance to black currant gall mite (*Cecidophyopsis ribis* Westw.) or reversion disease, which are problems that do not presently exist in North America. Cultivars with different traits, such as resistance to white pine blister rust and powdery mildew, are needed for North American production.

Breeding methods and objectives. *Ribes* breeders have made crosses to improve crops for varying climatic conditions, drought, disease, and pest resistance, and fruit quality. The objectives of both black and red currant breeding programs are to maximize yield, maintain crop stability and fruit quality, and improve pest and disease resistance. The need for mechanical harvesting of fruit also requires breeding for upright branching habits. Black currants have been bred for flavor and quality characteristics specifically to satisfy needs of large companies in the juice market. Recent research documenting antioxidant compounds in currants (Moyer et al., 2001, 2002) may encourage breeders to select cultivars rich in these compounds.

Currants are perfect-flowered, with the exception of the dioecious subgenera Berisia and Parilla (Berger, 1924). Cross pollination is normal, although some self-pollination can occur, particularly where the anthers and stigma reside at the same level. Currant flowers are emasculated at the bud stage in preparation for breeding. The entire calyx is removed along with the anthers. A fine brush can be used to apply the pollen to the stigma. Pollen stored at 20 to 24 °C (68 to 75 °F) in diffuse light loses viability within 2 weeks (Brennan, 1996). Pollen viability may be extended with desiccation, but that trait is genotype dependent (Brennan, 1996). Fruit ripen within 1 to 2 months. Seeds can be extracted using a blender with protected blades but the risk of seed damage can be greatly reduced if the fruit are mashed with pectinase. The mixture is flocculated and floating seeds (generally nonviable) are discarded. Seeds are air dried, placed within a desiccator, and stored in paper or aluminum foil envelops at –20 °C (–4 °F). Seeds remain viable for several years in frozen storage (Brennan, 1996).

For optimal germination, seeds are stratified at 4 °C (39 °F) for 3 months before sowing (Goodwin and Hummer, 1993). After stratification, daily alternating temperatures increase germination rates and percentages. Seedlings are grown out and selected for desirable characteristics.

Breeding across subgenera can be difficult. The interspecific cross, 'Josta,' a selection of an F_2 open pollinated amphidiploid of a black currant (*R. nigrum* 'Langtraubige Schwarze') and a gooseberry (*R. diacantha*), was made through mutational breeding using colchicine.

In North America, genetic resources for currants are preserved at the U. S. Department of Agriculture, Agricultural Research Service, National Clonal Germplasm Repository in Corvallis, Ore., and at the Canadian Clonal Genebank in Harrow, Ont., Canada. Cultivated and wild germplasm is preserved clonally as plants in fields, screenhouses, in vitro cultures, and meristems in cryogenic preservation (Hummer and Finn, 1998). Wild species are also preserved as seeds. Germplasm is available for research upon request from the curators of the two facilities.

Major cultivars and characteristics. Limited space precludes mention of the many cultivars available in North America and only a few cultivars are mentioned (Table 4). The best currant cultivars for Europe are not necessarily adapted for North America. For example, fruit growers in Europe and other currant growing regions need black currant cultivars resistant to black currant gall mite and reversion virus. North American growers need currant cultivars resistant to powdery mildew and white pine blister rust. Canada and the U.S. have stringent quarantines to prevent the entry of foreign pests and diseases. Before their release into the U.S., cultivars from outside North America require several years of testing at the U.S. National Plant Germplasm Quarantine Office in Beltsville, Md. While older cultivars remain in the public domain, European cultivars released since 1990 are generally protected by Plant Breeder's rights in the originating country. In the U.S., three black currant cultivars, Ben Tirran [U.S. Plant Patent (USPP) 11,330], Ben Connan (USPP 9,975), and Ben Alder (USPP 9,889) have USPPs (U.S. States Patent and Trademark Office, 2002). Other black currants (e.g., 'Titania') have propagation rights protected by contractual arrangements between breeders and growers.

Environmental limitations

Currants are adapted to temperate conditions. They are noted for their cold hardiness and can survive minimum mid-winter temperatures of –40 °C (–40 °F) or lower (Harmat et

Table 4. Selected black, red, white, and ornamental currant cultivars with their origins, and descriptions.

Black currant, section *Botrycarpum*, formerly *Coreosma*

'Ben Alder'
Breeder Malcolm Anderson, Scottish Crop Research Institute, Invergowrie, Scotland in 1988.
Parentage 'Ben More' x 'Ben Lomond'
Fruit is similar to 'Baldwin' in size and produces high-quality juice. Canes vigorous, can be dense. More mildew resistance than 'Ben Lomond' or 'Baldwin.' Yields better than 'Baldwin.' Can be harvested mechanically. Very susceptible to white pine blister rust.

'Ben Lomond'
Breeder Malcolm Anderson, Scottish Crop Research Institute, Invergowrie, Dundee, Scotland. The cross was made in 1961, and the plant was introduced in 1975 under British Plant Variety Rights.
Parentage ('Consort' x 'Magnus') x ('Brodtorp' x 'Janslunda')
Fruit large, have tough skins, and ripen evenly on the strig. Blooms later than 'Baldwin' and tolerates lower temperatures during bloom. Yields are greater and more consistent than for 'Baldwin.' Canes are compact, spreading, moderately vigorous, and moderately tolerant of powdery mildew. Recommended for commercial production for both fresh and processing markets. Potential for U-pick markets. Susceptible to white pine blister rust.

'Consort'
Breeder A.W.S. Hunter, Agriculture Canada, Ontario, in 1944. Tested as Ottawa 396 and introduced in 1952.
Parentage *Ribes ussuriense* x 'Kerry'
Fruit quality is fair to poor and berry size small to medium. Yields low. Has the Cr gene for immunity to white pine blister rust but, unfortunately is very susceptible to powdery mildew.

'Titania'
Breeder Pal Tamas, Sweden. Introduced in 1984.
Parentage 'Altajskaja Desertnaja' x ('Consort' x 'Kajaanin Musta')
Mid-season ripening, high yielding, large fruited cultivar. Plant is resistant to mildew, gray mold, leaf fungal diseases and has the Cr gene for immunity to white pine blister rust. Recommended for u-pick and commercial production.

Golden currant, section *Symphocalyx*

'Crandall'
Discovered by R.W. Crandall, Newton, Kansas, and introduced by Frank Ford & Sons, Nursery, Ravenna, Ohio, in 1888.
This cultivar is a selection of the North American native species, *Ribes aureum* var. *villosum*, also known as the clove currant.
Bright yellow spring flowers. Plant height to 3 m (10 ft). Late black fruit. Fruit of this clone is mild, sweet, pleasant, and very different from European black currants. Performs well in hot summers, is resistant to white pine blister rust, and showed little or no damage from powdery mildew in Idaho and Oregon trials.

Red currant, section *Ribes*

'Jonkheer van Tets'
Introduced by J. Maarse, Schellinkout, The Netherlands in 1941.
Seedling of 'Fay's Prolific.'
Berries are variable in size, of average quality, and have a tendency to split in wet weather. Canes are erect, vigorous, susceptible to wind damage, and only moderately resistant to mildew.

'Red Lake'
Introduced by W.H. Alderman, University of Minnesota, Excelsior, Minn., in 1933.
Parentage unknown
Berries are medium to large, uniform, juicy, flavorful, and ripen during mid- to late season. Canes are moderately vigorous, erect, and moderately resistant to powdery mildew. Clusters are long and easy to pick. Recommended for commercial and home production. Susceptible to white pine blister rust.

'Rondom'
Introduced by J. Rietsema, Breda, The Netherlands in 1946.
Backcross of *R. multiflorum* to red currant cultivars.
High yielding late cultivar. Fruit form in tight clusters and hang well after ripening. Canes are erect and vigorous. Resistant to powdery mildew and white pine blister rust

al., 1990). Darrow (1922) stated that 'Fay' 'Perfection' 'Cherry' 'Red Cross' and 'London' (synonym = 'London Market') were hardy in North Dakota and should be hardy anywhere in the U.S. Red currants are cultivated in the

Red currant, section *Ribes* (continued)

'Rovada'
Introduced by L.M. Wassenaar, Institute for Horticultural Plant Breeding, Wageningen, The Netherlands, in 1980.
Parentage 'Fay's Prolific' x 'Heinemanns Rote Spatlese'
Late ripening. High yielding. Long, loose fruit clusters, good for hand picking. Susceptible to powdery mildew and somewhat susceptible to white pine blister rust.

'Viking' (synonyms 'Hollandische Rote,' 'Norwegian Red Dutch,' 'Rod Hollandsk')
Probably originated in The Netherlands and was introduced into Norway. Introduced into the United States from Norway in 1945 by Glen Gardner Hahn
The berries are small. The canes are less vigorous than other cultivars and are only moderately resistant to powdery mildew. This cultivar demonstrates a hypersensitive response to white pine blister rust (Hahn, 1935). Uredia do not form on 'Viking' leaves under most field conditions throughout the United States although laboratory tests have indicated susceptibility under high infection pressure.

White currant, section *Ribes*

'Blanka'
Introduced by J. Cvopa and I. Hricovsky, Fruit Research Breeding Institute, Bojnice, Slovakia in 1977.
Parentage 'Heinemann's Rote Spatlese' x 'Red Lake'
Late-ripening large berries produced on long strigs. High-yielding, with upright growth. Susceptible to powdery mildew, leaf spot, and white pine blister rust.

'White Currant 1301'
Introduced by the Swedish University of Agricultural Sciences, Division of Fruit Breeding, Balsgaard, Sweden, in 1986.
Selection of *R. rubrum*
Berries medium-sized. Medium vigor. Susceptible to powdery mildew. Resistant to white pine blister rust under field conditions but can develop uredia under high spore inoculation in the laboratory.

'White Dutch'
Introduced into Europe in the early 1600s. Introduced into the United States in the early 1800s. This cultivar is the oldest named white currant.
Parentage unknown
Berries are small to medium with uneven sizes but have excellent quality. Early ripening. Fruit darker than other white cultivars. Canes are medium-sized, vigorous, erect to slightly spreading, dense, very productive. Resistant to powdery mildew. Susceptible to white pine blister rust.

'White Versailles'
Selected by M. Bertin in 1883, from Versailles, France.
Selected white-fruited mutant of cultivated red currant.
Early ripening translucent-white berries on medium long strigs. Very sweet and aromatic berries. The yield is medium to high. Plants are generally healthy with an upright growth habit. The plant has a medium level of resistance to diseases.

Ornamental currant, section *Calobotrya*

'King Edward VII'
Introduced in the United States before 1980.
Selection of *R. sanguineum* from California
Deciduous shrub growing to 2.7 m (9 ft) tall and 1.8 m (6 ft) wide (without pruning). Crimson red flowers are profuse on the inflorescence and have white tips at maturity. Draws humming birds.

'White Icicle'
Introduced by the University of British Columbia in 1985
White form of *R. sanguineum*
Deciduous shrub growing to 2.7 m tall and 1.8 m wide. Drooping pure white racemes of flowers appear in early spring just as the new leaves are emerging. This cultivar flowers about 2 weeks earlier than most red forms. Lobed pale green leaves are attractive all summer and emit a spicy fragrance when touched.

vicinity of Fairbanks, Alaska, where winter minimum temperatures of –40 °C are common and have reached –55 °C (–66 °F).

Cultivated currants require 800 to 1600 h between 0 and 7 °C (32 and 45 °F) to meet chilling requirements (Westwood, 1993). Cultivated currants do not tolerate high mid-summer temperatures well, especially in combination with intense sunlight. Foliar damage can occur at 30 °C (86 °F) (Harmat et al., 1990). North facing slopes are usually recommended for planting sites. In southern climates,

these crops usually perform best at high elevations. Bloom requires 160 to 200 growing degree days [5 °C (41 °F) base] and fruiting requires 120 to 140 frost-free days (Harmat et al., 1990). The plants perform best on deep, organic, well-drained soils, with good water-holding capacity. The soil pH should be between 5.5 and 7.0.

Before planting, growers should consult with their state department of agriculture, or corresponding agency, concerning the most recent *Ribes* regulations. Although laws are changing in the U.S., some states or regions prohibit *Ribes*. Where currants are permitted, rust-immune or rust-resistant cultivars should be planted, whenever possible. Also, foliar application of mineral oil to currants during the growing season (Hummer and Picton, 2001), pruning white pine branches to heights of 6 m (20 ft), or planting currants no closer than 305 m (1000 ft) to white pine, may reduce white pine blister rust incidence.

Culture and management

PROPAGATION. Currants root readily from dormant stem cuttings collected in the fall, or softwood cuttings taken in the spring. Black currants typically root well from any type of cutting, but red currants can be more difficult to root (Brennan, 1996). Nurseries in milder climates, such as the Pacific northwestern U.S., cut 15 cm (6 inch) long stems of black currant cultivars in late October and immediately plant the stems into outdoor propagation beds, covering the lower two to three nodes with soil. The cuttings remain in the field throughout the winter. Rooted cuttings are dug and shipped in early spring. Propagation stock for currants is available from nurseries in the Pacific northwestern North America, nidwestern and eastern U.S.

PLANTING. *Ribes* are usually planted from October through March using dormant planting stock or cuttings. Planting bare root stock in late spring is not recommended because the plants break dormancy and bloom early, often even if kept in refrigerated storage. Acclimated, containerized plants may be transplanted at any time the ground can be worked. Early autumn planting allows for root formation and plant establishment before winter.

Containerized currants and gooseberries are marketed primarily to home gardeners. To reduce production and shipping costs, most commercial growers purchase fall-dug, 1- or 2-year-old, bare root plants. Some authorities have expressed a strong preference for vigorous 1-year-old plants, believing that they are easier to transplant (Shoemaker, 1948). In either case, the plants will have several canes that are pencil thick and 30 to 45 cm (12 to 18 inches) long. Planting stock should have dense, fibrous roots.

Plant spacing depends on the planned training system and field maintenance equipment. Currants trained as individual bushes require greater spacing than for plantations with mechanically-harvested hedgerows. Unrooted cuttings may be stuck into the soil at 30 cm (1 ft) intervals to form hedgerows (Harmat et al., 1990).

FERTILIZATION. Healthy, productive currant plants require regular fertilization, usually beginning the spring after fall planting. Some growers fertilize spring- or summer-planted stock lightly the year of planting. Young bushes need less fertilization than do mature plants. Mature currant plantings annually need about 100 $kg \cdot ha^{-1}$ (90 lb/acre) of nitrogen, 20 $kg \cdot ha^{-1}$ (18 lb/acre) of phosphorus, and 40 $kg \cdot ha^{-1}$ (36 lb/acre) of potassium (Harmat et al., 1990). Fertilizers containing about 10% each of N, P_2O_5, and K_2O (10N–4.4P–8.3K) are commonly recommended in North America. Standards for leaf tissue nutrient concentrations based upon work done with currant and other fruit crops were presented by Bould (1968) and Bradfield (1969). Nutrient levels fluctuate throughout the growing season and the recommendations are based on leaves collected about the first of August.

WEED CONTROL. Mechanical cultivation is often used to control weeds in currant fields. Because currant roots are shallow, mechanical cultivation should be no deeper than about 5 cm (2 inches). Older currant production guides sometimes recommended deep cultivation around the bushes in hot, dry areas to encourage development of deep root systems. Scientific support for this practice is lacking and deep cultivation is more likely to be detrimental than beneficial. Shallow cultivation under the bushes by hand or machine helps control currant fruit fly (*Epochra canadensis* Loew) by exposing and killing the pupae.

Most commercial farmers, particularly those in Europe, have replaced or supplemented tillage with herbicides. Pre- and postemergent herbicides are used. While herbicides are used on many North American fruit crops, relatively few are registered for *Ribes*. In 1991, 12 contact and preemergent herbicides were recommended for gooseberry and currant growers in the northwestern U.S. By 1999, the number of available materials had decreased to three pre-emergent and one post-emergent grass herbicide (William et al., 1999).

PRUNING AND TRAINING. Pruning is critical in keeping fruit-bearing currant bushes healthy and productive. Pruning reduces pest and disease problems, stimulates the formation and growth of replacement canes, and facilitates harvest. Most commercially-grown currants in Europe and North America are trained to free-standing bushes. To facilitate machine harvesting, bushes can be trained to hedgerows. In some black currant hedgerow systems, all canes are mowed to the ground in alternate years. While yields are reduced, so are pruning costs. Other than for ornamental cordons, unwanted canes are removed as close to the ground as possible and are normally not shortened or headed back. Most of the fruit for red currants or white currants is borne on short spurs on 2- and 3-year-old canes. The normal practice is to prune dormant bushes during late fall through early spring.

For mature red and white currant bushes, three or four new canes per plant are retained each year. An equal number of the oldest canes are removed. In this way, mature bushes have nine to twelve canes after pruning, three to four each of 1-, 2-, and 3-year-old canes. Canes 4 years old or older are removed.

Pests and pest management

Currants are susceptible to many pest and disease problems that interfere with production worldwide. In North America, the most serious disease problems include white pine blister rust and powdery mildew. Some of the most common and/or serious insect pests presently in North America include: currant aphid (*Cryptomyzus ribis* L.) currant borer (*Synanthedon tipuliformis* Cl.) currant fruit fly (i.e., gooseberry maggot), gooseberry mite

(*Cecidophyopsis grossularae* Coll.), and pacific flat-headed borer (*Chrysobothris mali* Horn.) The reader is referred to Harmat et al. (1990) and Brennan (1996) for additional discussion of diseases and pests. A disease diagnostic website is available at <www.ars-grin.gov/cor/ribes/ribsymp/ribsymp.html> (Hummer and Postman, 2000).

Powdery mildew. The fungus that causes powdery mildew disease over-winters on currant twigs, and infects shoots, leaves, and berries during the spring and summer. This disease is extremely serious on susceptible cultivars and appears as white powdery growths on the surfaces of leaves and green shoots. Affected leaves develop scorch symptoms, become deformed, and dry out. During hot weather, damaged leaves may fall off. On berries, mildew produces a dark brown, felt-like coating that renders the fruit unmarketable. Infected plants are often stunted and severely affected plants can be killed.

Planting resistant cultivars is the best management strategy, although mineral oil sprays (Hummer and Picton, 2001) and fungicides provide some control. European black currants range from highly susceptible to resistant. White and red currants show foliar symptoms during some years, but the berries are generally not damaged.

Good nutrition can provide some protection against mildew. Keeble and Rawes (1948) recommended reducing nitrogen fertilization but increasing potassium applications to develop "hardened foliage and hard, well-ripened growth less liable to attack." These authors also recommended pruning in late fall to remove mildew damaged shoot tips. The tips are removed from the field immediately and burned to prevent them from being a source of infection in the spring. For commercial fields, such pruning may be cost-prohibitive. Sulfur sprays from pre-budbreak through the growing season are the most common control, although other fungicides are registered in some areas.

White pine blister rust. Aecial spores of the fungus that causes white pine blister rust are produced on pines and can travel more than 644 km (400 miles) to infect currants. Most European black currants are more rust-susceptible than are red or white currants. Several black currant cultivars are available that are resistant, highly resistant or immune to blister rust. The wild species of stink currant, flowering currant, and Sierra currant are susceptible. Susceptible five-needled pines in North America include whitebark pine (*Pinus albicaulis* Engelm.), limber pine (*P. flexilis* James), western white pine (*P. monticola* Dougl.), eastern white pine (*P. strobus* L.), sugar pine (*P. lambertiana* Dougl.), and bristlecone pine (*P. aristata* Englem.).

On the undersides of infected currant leaves, small cup-like spots, called uredia, develop, formed from minute, orange, hair-like structures. Uredinial spores from these uredia cause additional infections of currant leaves throughout the summer. Infected plants are weakened and may defoliate prematurely. At the end of the summer, brown telia and then basidia form on the currant leaves. The basidiospores that infect pines seldom travel more than 0.6 to 1 km (1000 to 3000 ft). Currants should be planted further than this distance from the nearest susceptible pines. In North America, growers in five-needle pine areas should plant rust-immune or rust-resistant currant cultivars. The black currant cultivars Consort, Coronet, Crusader, and Titania are rust-immune. Highly resistant black currant cultivars include Doez Siberjoczk, Lowes Auslese, Lunnaja, Polar, Sligo, Willoughby, Rain-in-the-face (*R. americanum*), and Crandall (*R. aureum* var. *villosum*). Red currant cultivars that are highly rust-resistant include: London Market, New York 72, Sabine (selected as O-273), Rondom, and Viking. One white currant cultivar, Gloire de Sablons, is also highly resistant.

Botrytis-related diseases. The gray mold fungus (*Botrytis cinerea* Pers.) causes two problems in susceptible *Ribes*: die-back of the shoots and fruit rot (Brennan, 1996). Regular application of fungicides may help control these problems. Many of the golden currants are susceptible to stem die-back. Die-back is particularly evident at the beginning of the summer growing season. Botrytis has also been implicated as causing premature fruit drop or runoff. Susceptibility to run-off is genotype dependant and can be selected against in breeding programs.

Viruses. About 12 viruses or virus-like diseases have been reported on *Ribes* and were described by Converse (1987). Reversion is the most serious virus disease affecting black currants in Europe and New Zealand (Trajkovski and Anderson, 1992.) The causal agent is black currant reversion virus. Reversion symptoms in black currants appear one year after inoculation and are limited to one or a few shoots. By the second year, one-third to one-half of the bush is affected, and the entire plant becomes affected by the third or fourth year. Infected bushes tend to have more but shorter canes than uninfected plants. Yields are reduced and fields with less than 5% infected plants are uneconomical to harvest (E. Thompson, personal communication).

Reversion is vectored by the black currant gall mite. Swollen globular dormant buds indicate that black currant gall mite is present. Jones (1992) stated that more than 30,000 mites can occupy a single bud, and an infested bush often contains more than 100 infested buds. While neither the gall mite nor reversion disease have been reported in North America (Converse, 1987), both are common in other countries where *Ribes* are grown. Canada and the U.S. have enacted national quarantine regulations to prevent this disease from entering North America.

A range of other virus and virus-like diseases also occur in *Ribes* (Converse, 1987). Aphids vector gooseberry vein banding and cucumber mosaic, and nematodes vector arabis mosaic and others.

Insects. Currant borer (*Synanthedon tipuliformis* Cl.) is present in Europe and North America. This insect infests black, red, and white currants. It lays eggs in the summer. During the winter the larvae feed and develop inside the stems causing the pith to blacken. In the growing season the leaves wilt and the cane lodges over causing the developing fruit to wilt. To control this pest, infected canes must be cut and destroyed as soon as signs of damage appear.

The currant fruit fly (*Epochra canadensis* Loew) infests many *Ribes* species. The female lays her eggs in young fruit. The larvae grow and feed inside of the fruit causing premature fruit drop. The insect can be controlled by insecticide treatment at flowering and with a second preventative spray 10 d later.

Brennan (1996) cites 12 aphid species as infesting currants. These pests cause leaf blistering, reddening and discoloration in black, but particularly in red and white currants. The amount of leaf damage can range from cosmetic to severe. Aphids can also cause economically significant damage as vectors for viruses. Pesticide treatments before flowering and after harvest will help limit the damage caused by these pests.

VERTEBRATE PESTS. As in other small fruit crops, deer (*Cervidae*) and other herbivores damage canes. Deer fencing and bird netting or other bird-control devices may be necessary for some planting sites. Gophers (*Gopherus polyphemus*) can cause root damage and voles (*Microtus*) and mice (*Mus*) can girdle canes. Avoiding straw and similar mulches, and aggressively controlling rodents in currant fields is recommended.

Harvest

Harvesting currants is an intensive process that accounts for 60% to 70% of the crop labor needs. For example, in northern Europe, 'Jonkheer van Tets' is the leading red currant cultivar, with yields of 10.1 to 15.7 $t \cdot ha^{-1}$ (4.5 to 7 tons/acre). By hand, a person can harvest about 4 or 8 kg (9 or 18 lb) per hour of black currants or red currants, respectively (Harmat et al., 1990). At this rate, up to 1962 $h \cdot ha^{-1}$ (778 h/acre) would be required to harvest 'Jonkheer van Tets,' translating to about 25 pickers per ha (10 pickers per acre), assuming a 2-week harvest. To reduce labor costs, tractor-driven or self-propelled mechanical harvesters are usually used for large farms. Because *Ribes* production is very limited in North America, commercial currant harvesters are not manufactured here, but can be imported. For small plantings, battery-powered, hand-held vibrators can be used to shake berries into catchers. In Europe, growers spray fruit to be machine harvested with 240 $\mu L \cdot L^{-1}$ (ppm) ethephon 10 to 12 d before harvest to encourage berry abscission and increase harvest speed and uniformity (Harmat et al., 1990).

Currants ripen over about a 2-week period, depending on the cultivar. They can be harvested in two pickings to get the berries at peak ripeness, although most ripe currants will remain on a bush without falling or becoming over-ripe for up to several weeks. Berries normally begin ripening in July, depending upon location, but cold weather during spring and early summer can delay ripening.

Red and white currants have delicate skins and are hand harvested by removing intact fruit clusters (strigs) by pinching them off at their bases. For fresh use, currants are typically hand picked into 250- to 500-mL (0.5- or 1.0-pt) containers. Baskets and flats designed for raspberries work well for fresh currants, but mesh baskets should be avoided because the currant berries are small enough that some are damaged by being snagged by or pressed through the mesh. Grading of currants is done by pickers in the field.

For currants intended for processing, 1- to 4-L (1- to 4-qt) containers are often used. Collection containers used for machine harvesters depend upon the type of harvester and the intended use of the fruit. Machine-harvested currants are used only for processing. Currants weigh about 0.57 $kg \cdot L^{-1}$ (1.2 lb/qt).

Currants intended for jellies and other preserves are often picked slightly under-ripe because fruit pectin content is highest at that time. In the U.S., however, the tendency has been to pick currant and gooseberry fruit too early because of the misconception that ripe fruit does not jell properly during cooking. Unripe currants are unpalatable. Ripe berries taste better and can be used effectively for processing. For fresh use, berries are allowed to fully ripen before picking.

Ripe red and white currants are quite delicate and require about the same care in shipping as do raspberries and strawberries. When kept refrigerated at 1 to 2 °C (34 to 36 °F), red and white currants maintain acceptable quality for several days after harvest. Black currant skins are tougher and refrigerated berries maintain their quality for 1 to 2 weeks, depending on ripeness and storage conditions. Currants are frozen for long-term storage.

Conclusion

Currant production was popular in North America more than 100 years ago. These crops could become a new berry crop for the U.S. and Canada if markets developed simultaneously with production. There are risks, however. During the late 1990s, black currant production overwhelmed world market demand, driving fruit prices down. Because of the abundant fruit supply, large juice companies are presently able to dictate cultivars to be grown, production techniques, and selling price to growers.

Currant production in the U.S. does not have sufficient acreage to be reported in federal or state agricultural statistical production reports. However, this crop is continuing to develop as a cottage industry. Some fruit growers in southern Canada and the northern U.S. are diversifying their production by adding small blocks of currants. The fruit are sold to local markets through pick-your-own farms, small juicers and wineries, gourmet grocers, restaurants, and other outlets. Fresh fruit, value added food products, dietary supplements, and herbal products each present marketing opportunities. Expansion beyond local and niche markets, however, will require coordinated efforts between grower and marketing organizations, as well as education of the public in the taste and nutraceutical properties of these fine berries.

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