Comprehensive Crop Reports

Worldwide Blackberry Production

Bernadine C. Strik[1,5], John R. Clark[2], Chad E. Finn[3], and M. Pilar Bañados[4]

ADDITIONAL INDEX WORDS. *Rubus*, cultivars, area planted, statistics, production systems, erect, semi-erect, trailing, primocane-fruiting blackberry

SUMMARY. A survey of worldwide blackberry (*Rubus* spp.) production was conducted in 2005. Results indicated there were an estimated 20,035 ha of blackberries planted and commercially cultivated worldwide, a 45% increase from 1995. Wild blackberries still make a significant contribution to worldwide production, with 8000 ha and 13,460 Mg harvested in 2004. There were 7692 ha of commercially cultivated blackberries in Europe, 7159 ha in North America, 1640 ha in Central America, 1597 ha in South America, 297 ha in Oceania, and 100 ha in Africa. Worldwide production of cultivated blackberries was 140,292 Mg in 2005. Of the blackberry area worldwide, 50% was planted to semierect cultivars, 25% to erect, and 25% to trailing types. 'Thornfree', 'Loch Ness', and 'Chester Thornless' were the most important semierect types, and 'Brazos' and 'Marion' the most common erect and trailing types, respectively. In general, erect and semierect cultivars are grown for fresh market and trailing cultivars for processing. Fresh fruit are usually picked into the final container in the field, whereas 75% of trailing blackberries for processing are picked by machine. Common production problems are reported. Production systems for field-grown blackberry differ with type grown and region. For example, in Mexico, production systems are modified to extend the production season for 'Tupy' and other erect-type cultivars from mid-October to June. Organic blackberry production is expected to increase from the 2528 ha planted in 2005. An estimated 315 ha of blackberries were grown under tunnels, mainly to protect against adverse weather and target high-priced markets. Based on this survey, there may be 27,032 ha of commercial blackberries planted worldwide in 2015, not including production from harvested wild plants.

[1]Professor and Extension berry Crops Specialist, Department of Horticulture, Oregon State University, 4017 ALS, Corvallis, Oregon 97331-7304

[2]Professor, Department of Horticulture, Plant Science 316, University of Arkansas, Fayetteville, Arkansas 72701

[3]Research Geneticist, USDA-ARS, Horticultural Crops Research Lab, 3420 NW Orchard Ave., Corvallis, Oregon 97330

[4]Profesora, Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile, Casilla 306-22, Santiago, Chile

The authors appreciate the contributions of the following research and extension personnel and industry members: (see footnote, bottom of next page).

[5]Corresponding author. E-mail: strikb@hort.oregonstate.edu.

Blackberries have long been a favorite wild fruit, as many species are native to several countries worldwide and are picked for personal or commercial use. Natural hybrids of wild species provided several of the first named cultivars including, for example, 'Eldorado' (*Rubus allegheniensis* × *R. frondosus*) introduced in the mid-1850s in the United States (Hall, 1990; Moore, 1984).

Blackberries are often classified according to their cane architecture into three types: erect, semierect, and trailing (Strik, 1992). Erect-caned cultivars include the thorny 'Brazos', 'Tupy', and 'Cherokee'; and the thornless 'Navaho' and 'Arapaho'. Semierect cultivars include 'Chester Thornless', 'Thornfree', 'Loch Ness', and 'Čačanska Bestrna'. Trailing cultivars include 'Marion', 'Silvan', and 'Thornless Evergreen' and the blackberry-raspberry hybrids 'Boysen' and 'Logan'. The new primocane-fruiting cultivars 'Prime-Jan' and 'Prime-Jim' (Univ. of Ark., Fayetteville) are erect, thorny types. Erect blackberries produce primocanes from buds at the base of floricanes at the crown or from buds on roots, whereas trailing and semierect types only produce new primocanes from buds on the crown. With the exception of the primocane-fruiting erect types, primocanes are vegetative the first year and fruit the second year on the entire length of the floricane.

In 1990, results of a survey conducted in North America reported 3180 ha of blackberries in the northwestern United States (Strik, 1992) and 1205 ha in the eastern United States (Clark, 1992), for a total of 4385 ha. In 1990, most of the blackberry production in the eastern United States was pick-your-own or prepicked for on-farm or local sales, and less than 2% was processed (Clark, 1992). In contrast, over 90% and 50% of the trailing blackberry crop in Oregon and California, respectively, was processed in 1990. Over 80% of the production from the 55 ha of erect and semierect blackberries in northwestern United States was marketed fresh in 1990 (Strik, 1992).

In the 1990s, blackberries were not found on grocery store shelves in

Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
0.3048	ft	m	3.2808
28.3495	oz	g	0.0353
0.9072	ton(s)	Mg	1.1023
2.2417	ton/acre	$Mg \cdot ha^{-1}$	0.4461

the eastern United States and only rarely in the western United States (Clark, 2005). Late in the 1990s, 'Chester Thornless' became a major shipping blackberry, as it was found to have good fruit firmness. 'Navaho' was found to have excellent shelf life and could be shipped. These and other cultivars contributed to a major shift in the production outlook for shipping of blackberries from that of a local-marketed crop to one shipped for retail marketing (Clark, 2005).

In the mid- to late 1990s, shipping of blackberries from Chile, Guatemala, and Mexico into the United States provided fresh blackberries during the "off-season" autumn, winter, and spring months, increased consumer awareness of this berry crop, and consequently increased sales of U.S.-produced fruit in season also. Production of blackberries was apparently on the increase worldwide; however, there was relatively little factual information on area planted, cultivars grown, and most common production systems.

This review is based on a survey of worldwide blackberry production conducted in 2005. To our knowledge, no prior survey had been done on worldwide blackberry production; we were thus surprised at some of our findings, particularly the large area planted in Serbia and the high production in China. Included in the many questions asked in our survey were an estimate of area planted in 1995 and projections for 2015. We appreciate the contributions of the many research and extension colleagues and industry members who provided additional information (see Acknowledgments).

Table 1. Worldwide area and production of blackberries, 2005.

Region	Area planted (ha)[z]	Production (Mg)[z]
Europe	7,692	43,000
North America	7,159	59,123
Central America	1,640	1,590
South America	1,597	6,380
Asia	1,550	26,350
Oceania	297	3,650
Africa	100	200
World total	20,035	140,292

[z]1 ha = 2.4711 acres, 1 Mg = 1.1023 ton.

Production regions

In 2005, an estimated 20,035 ha of blackberries were planted and commercially cultivated worldwide (Table 1), a 45% increase from estimated area in 1995 (Fig. 1). Worldwide blackberry production was 140,292 Mg (Table 1). In the following sections, we will provide more information on blackberry area and production systems in the major producing regions of the world. We include little information on production in countries with less than 100 ha planted (Table 2).

EUROPE. There were 7692 ha of commercially cultivated blackberries in Europe in 2005. Serbia accounted for 69% (5300 ha) of Europe's blackberry area and had the greatest area in the world (Fig. 1). Serbia produced 25,000 Mg, the fourth highest production in the world (Fig. 2), with 90% of their production processed and exported.

Hungary was the next largest producer in Europe with 1600 ha or 21% of the total area and 12,000 Mg, most of which was processed and exported. Countries in Europe with 100 ha or more were the United Kingdom, Romania, and Poland (100 ha each), Germany (110 ha), and Croatia (180 ha). In the United Kingdom and Germany, most of their production was for fresh, domestic use. Area in Poland has doubled in the last 10 years; 500 Mg were produced with 80% processed and most of this was exported as was most of their fresh production.

NORTH AMERICA. There were 7159 ha of commercially cultivated blackberries in North America in 2005 with the United States accounting for 67% of the area planted (4818 ha), the second highest in the world. The area planted in the United States increased 28% from 1995 to 2005. The United States had the highest production in the world with 31,841 Mg (Fig. 2).

Sixty-five percent of the blackberries cultivated in the United States were in Oregon (Table 3). Area in this state increased 25% from 1995 to 2005. Over 95% of the total production of 22,848 Mg was processed with the remaining marketed fresh, all for domestic use. Most of the blackberries in Oregon were trailing types, particularly the cultivars 'Marion' (61%), 'Boysen' (15%),

USA: Alabama (Bobby Boozer, Auburn Univ.); Arkansas (John Clark, Univ. of Arkansas); California (Rick Harrison, Driscoll Strawberry Assoc., Inc.; Mark Bolda and Ed Perry, Univ. of California); Delaware (Harry Swartz, Univ. of Maryland); Florida (Jeff Williamson, Univ. of Florida); Illinois (Bob Skirvin, Univ. of Illinois); Iowa (Gail Nonnecke, Iowa State Univ.); Indiana (Bruce Bordelon, Purdue Univ.); Georgia (Gerard Krewer, Univ. of Georgia); Kansas (Sorkel Kadir, Kansas State Univ.); Kentucky (John Strang, Univ. of Kentucky); Louisiana (John Pyzner, Louisiana State Univ.); Maryland (Harry Swartz, Univ. of Maryland); Massachusetts (Sonia Schloemann, Univ. of Massachusetts); Michigan (Eric Hanson, Michigan State Univ.); Mississippi (John Braswell, Mississippi State Univ.); Missouri (Michele Warmund, Univ. Missouri; Patrick Byers, Missouri State Univ.); New Jersey (Joseph Fiola, Univ. of Maryland); New Mexico (Ron Walser, New Mexico State Univ.); New York (Marvin Pritts, Cornell Univ.); North Carolina (Gina Fernandez and James Ballington, North Carolina State Univ.); Ohio (Shawn Wright, The Ohio State Univ.); Oklahoma (Penny Perkins-Veazie, USDA-ARS, SCARL, Lane); Oregon (Bernadine Strik, Oregon State Univ.); Pennsylvania (Kathy Demchak, Penn. State Univ.); South Carolina (Walker Miller); Tennessee (David Lockwood, Univ. of Tennessee); Texas (James Kamas, Texas A&M Univ.); Virginia (Jeremy Pattison, Virginia Tech.); Washington (Tom Walters, Washington State Univ.; Tom Peerbolt, Peerbolt Crop Management); West Virginia (Richard Zimmerman, W.Va. Univ. [retired]). **Canada:** British Columbia (Mark Sweeney, BCMAFF); Ontario (Pam Fisher, OMAF); Québec (Luc Urbain, Extension Service); Nova Scotia (Andrew Jamieson, Agriculture and Agri-Food Canada). **Mexico:** Jose Lopez-Medina (Facultad de Agrobiología, U.M.S.N.H., Uruapan, Mich.); Mark Hurst (Hurst's Berry Farm, Sheridan, Ore.); Marcela Zúñiga and Victor Valencia (Hortifrut Mexico, Michoacán); Mark Erickson (Erickson's Blueberry Hill, Mazamitla); Rick Harrison (Driscoll Strawberry Assoc., Inc., Watsonville, Calif.). **Europe:** Austria (Manfred Wiesenhofer, Landwirtschaftskammer Steiermark, Graz); Belgium (Philip Lieten, Proefbedrijf der Noorderkempen, Meerle); Croatia (Boris Duralija, Univ. Zagreb); France (Jean-Claude Navatel, Ctifl Centre de Balandran, Bellegarde); Germany (Klaus Olbricht, Gunhild Muster, Staatliche Lehr- und Versuchsanstalt für Wein- und Obstbau); Holland (Jacinta Balkhoven-Baart, Applied Plant Research—Fruit, Wageningen Univ. and Res.; Sil Moonen); Hungary (Ferenc Denes, Small Fruit Res. Stn., Fertöd); Ireland (Eamonn Kehoe, Teagasc Soft Fruit Spec. Enniscorthy); Italy (Lara Giongo, Istituto Agrario, Centro Sperimentale, San Michele all'Adige); Poland (January Danek, Institute of Pomology and Floriculture, Skierniewice); Romania (Paulina Mladin, Research Institute for Fruit Growing Pitesti-Maracineni); Serbia (Miloljub Stanisavljevic, IPTCH WILLAMETTE, Cacak); Spain (Marta Ciordia, Area de Cultivos Hortofruticolas y Forestales, Asturias; Juan Jesus Medina, IFAPA, Huelva); United Kingdom (David Northcroft, KG Fruits Ltd.; Derek Jennings); **Asia:** China (Luo Fei and Zhang Qinqua; Chinese Academy of Forestry, Beijing; Anonymous); **Africa:** South Africa (Trevor McKenzie). **Oceania:** Australia (David Bardon, Blueberry Farms of Australia, Corindi Beach, NSW; Graeme McGregor [deceased]); New Zealand (Harvey Hall, HortResearch, Inc., Motueka); **South America:** Argentina (Jorge Antonio, Gergal S.A., Buenos Aires, Anibal Caminitti, INTA, El Bolson, Patagonia); Brazil (Luis Antunes and Emerson Gonçalves, EMBRAPA Clima Temperado, Pelotas); Chile (Pilar Bañados, Univ. Católica de Chile, Santiago); Ecuador (Javier Fernandez Salvador); Peru (Victor Luque, El Taller Asociación de Promoción y Desarrollo, Arequipa); Uruguay (Cristina Monteiro, Berries del Uruguay, Montevideo, Mercedes Arias, Univ. de la Republica, Montevideo); Venezuela (Sylvio Miron, Hacienda Altos de Casa Vieja, Mérida). **Central America:** Costa Rica (Roberto Valverde, Univ. de Costa Rica, San José, Marvin Orozco, APROCAN); Guatemala (John Clark, Univ. of Arkansas).

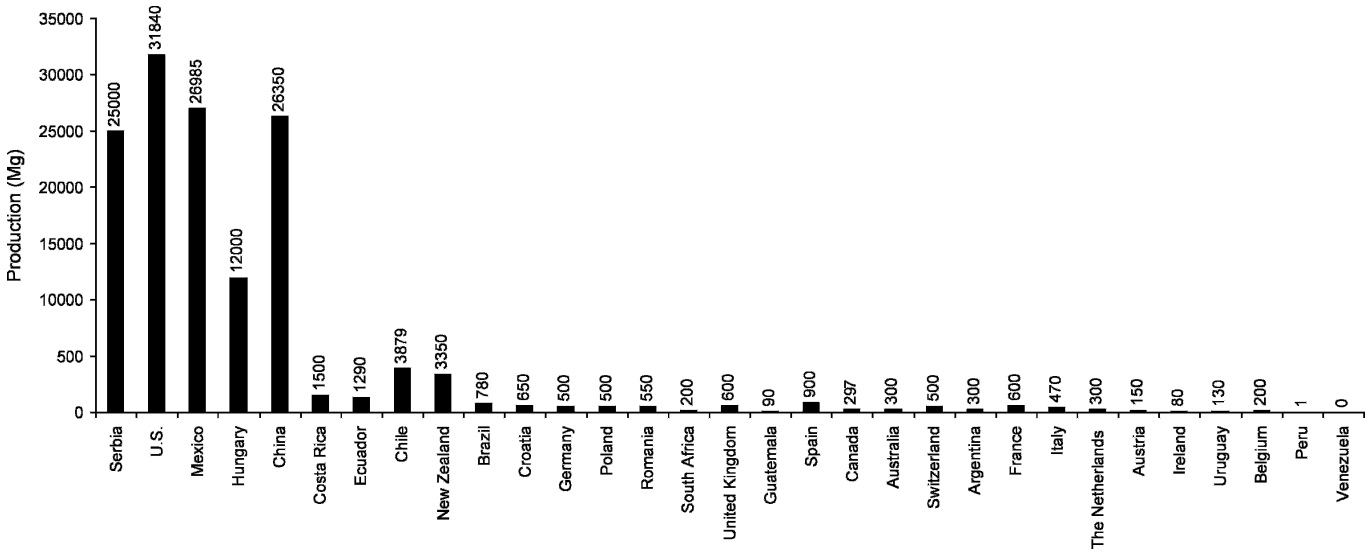

Fig. 1. Worldwide cultivated blackberry area in 1995, 2005, and 2015 (projected); 1 ha = 2.4711 acres.

Table 2. Countries, by region, that reported from 1 to 99 ha of planted blackberries in 2005 (countries with greater area are reported in the text).

Region/country	Area planted (ha)[z]	% Change 1995–2005	% Change 2005–2010
Europe			
Austria	20	0	0
Belgium	5	0	0
France	30	200	0
Ireland	10	20	100
Italy	26	28	92
Spain	55	450	0
Switzerland	35	0	0
The Netherlands	21	5	0
North America			
Canada	41	36	67
Central America			
Guatemala	90	–63	33
South America			
Argentina	35	106	49
Peru	2	1900	650
Uruguay	9	100	0
Venezuela	1	0	200
Oceania			
Australia	38	90	32

[z]1 ha = 2.4711 acres.

'Thornless Evergreen' (11%), and 'Silvan' (7%). An estimated 125 ha of semierect types were present in Oregon, mainly 'Chester Thornless' grown primarily for late-season fresh market from early August through October. Only 1% of the blackberries in Oregon were erect types, mainly 'Cherokee' and 'Navaho', hand-picked for fresh market in July.

The next largest blackberry producing state in the United States was California with 2359 Mg in 2005. The fruiting season is from mid-May through August. Over half of the area was planted to semierect cultivars. The production of 'Boysen' for processing in the central valley of California has declined steadily, as predicted (Strik, 1992), to only 40 ha. Most of the blackberry production in California was now located on the north-central coast, near Watsonville, and has a fresh-market focus.

Texas reported 275 ha and 726 Mg in 2005. Only erect blackberries are planted, with 'Kiowa', 'Brazos', and 'Rosborough' accounting for 85% of the area. Only 10% of the production is processed, with 40% sold on-farm and 50% marketed to domestic, U.S. markets in the months of May–July. Arkansas had 243 ha, a 60% increase in planted area from 1995. A broad range of erect cultivars are being grown, including 'Arapaho', 'Navaho', 'Ouachita', 'Apache', 'Chickasaw', and 'Kiowa'. Eighty percent of this production is marketed fresh, and the rest is sold on-farm from 20 May to 20 July. The area in Georgia has tripled in the last 10 years to 127 ha. Erect types are mainly grown with 'Arapaho' and 'Navaho' accounting for 60% of the area planted.

In the United States, other than the aforementioned five states, four states reported 50–100 ha planted. An additional 26 states reported from 2 to 50 ha of blackberries. Of note is Washington, which had less than 50 ha in 1995; this area had doubled by 2005 and is projected to grow to 140 ha by 2015.

Mexico accounted for 32% of the planted area in North America in 2005 with 2300 ha, a very large increase from 230 ha in 1995. Most of the blackberries are planted in the state of Michoacan, but there is also some production in the state of Jalisco and a new planting of semierect types in state of Chihuahua. The predominant type of blackberry grown was erect, particularly 'Brazos' and 'Tupy' with relatively little (5%) semierect types, mainly proprietary

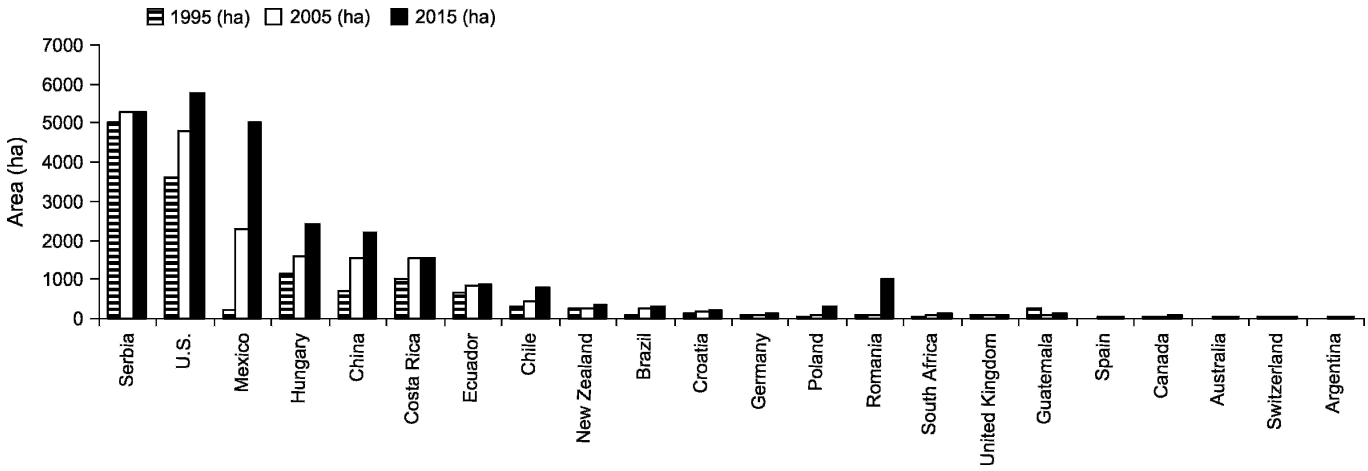

Fig. 2. Worldwide cultivated blackberry production in 2005; 1 Mg = 1.1023 ton.

Table 3. Production of blackberries, in the United States in 2005, by state.

State	Area (ha)[z]	% Change 1995–2005	Production (Mg)[z]
Oregon	3,138	25	22,848
California	283	100	2,359
Texas	275	20	726
Arkansas	243	60	1,400
Georgia	127	300	600
Washington	96	100	363
Virginia	81	—	300
Ohio	71	350	159
North Carolina	61	50	650
Kentucky	45	30	280
Pennsylvania	45	70	109
Illinois	40	–25	100
Missouri	40	0	308
New York	40	–50	140
Tennessee	34	35	300
Louisiana	25	0	14
South Carolina	20	80	227
West Virginia	20	40	170
Michigan	16	0	40
Oklahoma	16	5	80
Indiana	14	90	120
Alabama	12	100	91
Maryland	12	0	50
Massachusetts	12	40	109
Kansas	10	20	50
Delaware	8	0	30
New Jersey	8	30	25
Iowa	4	100	13
Mississippi	4	900	27
New Mexico	4	50	45
Connecticut	4	40	33
Maine	3	40	25
New Hampshire	2	40	22
Rhode Island	2	40	18
Vermont	1	40	11
United States	4,818	34	31,840

[z]1 ha = 2.4711 acres, 1 Mg = 1.1023 ton.

cultivars. Most of the Mexican production targets fresh export markets to the United States. In 2004, Mexico exported 7480 Mg to the United States, more than double their export volume in 2002.

CENTRAL AMERICA. There were 1640 ha of commercially cultivated blackberries in Central America in 2005 with 1590 Mg produced. The two countries that reported commercial production were Costa Rica and Guatemala. There were 1550 ha of blackberries (mainly 'Brazos' and *R. glaucus*) in Costa Rica located predominantly in the Provinces of Cartago and San José. Most grow *R. glaucus* like a shrub without a trellis in organic production systems. Of the 1500 Mg produced in 2004, <15% was exported. Presently, most is used for local processed and fresh consumption.

The blackberry production area in Guatemala declined 63% from 1995 to 90 ha in 2005 but is expected to increase 33% in the next 10 years, provided this country can compete with Mexican production. Guatemala is the main country in Central America that ships fresh blackberries to the United States.

SOUTH AMERICA. There were 1597 ha of commercially cultivated blackberries in South America in 2005 with 6380 Mg produced.

Ecuador accounted for about half of the planted area with 850 ha. 'Brazos' and *R. glaucus* are the main types planted in organic production systems with average yields of 15 and 2.5 $Mg \cdot ha^{-1}$, respectively. There was an estimated 30% growth in planted area from 1995 to 2005, but little growth is projected for the next 10 years. Only 15% of their estimated 1290 Mg of production are exported for fresh market, mainly due to the soft fruit of *R. glaucus* and the Mediterranean fruit fly (*Ceratitis* spp. and *Anastrepha* spp.).

Chile had 450 ha of commercial blackberries in 2005 with a total production of 3879 Mg. The area planted increased 50% from 1995 to 2005. In 2004, Chile exported 9679 Mg of processed fruit (55% to 65% was harvested from introduced wild species) and 190 Mg of fresh fruit. Their fruiting season is from November to March using trailing, erect, and semierect cultivars and wild species. Production systems for cultivated types are similar to those reported for the United States.

Brazil had 250 ha and 780 Mg of production with only 15% exported. All of their area is planted with erect blackberries, mainly 'Tupy' and 'Guarani'. Most of the production is processed for domestic use.

No other countries in South America reported more than 100 ha of area planted.

Asia. China accounted for all of the reported production in Asia with 1550 ha and 26,350 Mg in 2005. Over 90% of the area was planted with semierect blackberry, mainly seedlings of 'Hull Thornless' and 'Chester Thornless'. The remaining area was planted with 'Shawnee' and the trailing cultivars 'Boysen', 'Marion', and 'Siskiyou'. Most of the production in China is processed with 70% of processed fruit, and 10% of the fresh production exported. Most blackberries were planted in the Jiangsu Province, but the newest regions, in the Liaoning, Shandong, and Hebei provinces, are projected to grow most in the next 10 years when China is expected to have 2200 ha.

Oceania. Most of the blackberry area in Oceania is planted in New Zealand, which had 259 ha and 3350 Mg in 2005. The fruiting season in New Zealand is from November through April with almost all of their blackberry production consisting of trailing types, mainly 'Boysen'. Almost all of their production is processed with 55% of that exported.

Africa. South Africa was the only country in 2005 reporting commercial blackberry production with 100 ha. About 60% of their area was planted to 'Young' trailing blackberry that was all processed and 60% exported. 'Hull Thornless', 'Loch Ness', 'Choctaw', and 'Arapaho' were grown also, with 50% of their production being marketed fresh. However, it was not cost-effective to export fresh fruit from South Africa to Europe. They reported problems with plant importation due to phytosanitary restrictions and the need for cultivars that are firmer for long-distance shipping. They will try to produce the new primocane-fruiting types in South Africa.

Cultivars

Wild or feral blackberries still make a significant contribution to worldwide production and although accurate data are hard to obtain, survey respondents estimated that 3600 ha of wild blackberry (*R. glaucus*) in Ecuador, 2400 ha in Romania (*R. armeniacus*, *R. laciniatus*), 2000 ha in Chile (derived from introduced *R. ulmifolius*), a small area of unknown size in Mexico, and 100 ha *R. glaucus* in Venezuela were harvested in 2005. The 8000 ha of wild blackberries harvested in 2005 had a total reported production of 13,460 Mg. About one-third of worldwide wild production (5800 Mg) was processed and exported in Chile. In some regions, like northwestern North America, fruit harvested from wild blackberries, even though for personal use, may negatively impact sales of commercially grown fruit.

Respondents reported the cultivars grown on 15,412 ha of the 20,035 ha of blackberries grown worldwide. On this reported area, 50% of the area was planted to semierect cultivars, 25% to erect, and 25% to trailing types.

In general, erect and semierect cultivars are grown predominantly for fresh market; these types produce fruit that is more firm, has a longer shelf life, and is better suited to shipping. Trailing types, however, are mainly used for processing. These cultivars, like Marion, are known for having highly flavored, aromatic fruit, with small seeds. Fruit of most trailing cultivars available today are not firm enough for long-distance shipping. Still, there are a few cultivars of trailing blackberry that are relatively new and are suited for fresh market; 'Siskiyou' and 'Obsidian' are examples.

Semi-erect. The cultivars 'Thornfree', 'Loch Ness', and 'Chester Thornless' accounted for 58% of the semierect blackberry area and 'Dirksen Thornless', 'Hull Thornless', and 'Smoothstem' for 28%. Only semierect blackberry types were grown in Serbia with the predominant cultivars being 'Thornfree', 'Dirksen Thornless', and 'Smoothstem' that are harvested in July and August. 'Loch Ness' accounted for 75% of the blackberry area in Hungary and is the main cultivar in Germany and Romania. In Oregon, 'Chester Thornless' and other semierect cultivars are primarily for the late-season, early-August through October, fresh market with an average yield of 30 $Mg \cdot ha^{-1}$.

The only other cultivar grown on more than 5% of the worldwide semierect area was 'Čačanska Bestrna', a newer cultivar from the Investigation, Production, and Trade Center of Horticulture, Čačak, Serbia. This cultivar produces as high as 45 $Mg \cdot ha^{-1}$ and 22-g fruit and is being widely planted in Serbia.

'Gazda', from the Institute of Pomology and Floriculture in Skierniewice, Poland, accounted for 80% of the area planted in Poland. Typical yields are 5 to 8 $Mg \cdot ha^{-1}$.

Erect. 'Brazos' was by far the most common erect blackberry grown worldwide in 2005 accounting for 46% of the erect area. However, 'Brazos' is being rapidly replaced by 'Tupy' in Mexico. Other cultivars accounting for 5% or more of the erect area planted worldwide were 'Tupy' (18%), 'Navaho' (9%), 'Kiowa' (5%), and 'Cherokee' (5%). These cultivars are all hand-picked mainly for the fresh market. In Texas, 'Kiowa' now accounts for over one-third of the area planted; the superior fruit quality of this cultivar coupled with its extended harvest season, has doubled retail sales of blackberries there.

The first cultivars of primocane-fruiting blackberry to be released were 'Prime-Jan' and 'Prime-Jim' in 2004. In 2005, primocane-fruiting blackberry were not yet commercially grown, although test plantings had been established in Arkansas and Oregon.

Trailing. 'Marion' is the most important trailing blackberry grown, accounting for 51% of the worldwide area of trailing types; more than 90% of the worldwide 'Marion' area is located in Oregon. 'Boysen' accounted for 24%, 'Thornless Evergreen' 9%, and 'Silvan' 5% of the worldwide area of trailing blackberry. However, in 2004 and 2005, plant sales of the new thornless 'Black Diamond' were greater than all other

cultivars. The fruiting season for this type of blackberry ranges from late June through August, depending on cultivar.

Production systems

Blackberry plantings generally have a life of 5–20 years, depending on the production region, type of blackberry grown, and productivity. Plantings are established in the spring using plants propagated by tissue culture or root cuttings, depending on type of blackberry grown. Plantings may be established with bareroot or potted plants.

SEMIERECT. The planting density for semi-erect blackberries varies with production region and cultivar. In Serbia, plants are generally established at an in-row spacing of 1.0–1.5 m with 2.5–3.0 m between rows. In the United States, plants are typically 1.5–1.8 m apart in rows that are 3.0–3.6 m apart. In most fields in China, the planting density is very high with 0.3–0.4 m between plants and 1.0 m between rows.

In almost all regions, primocanes are tipped during the growing season, at ≈1.5–1.6 m high to encourage branching. In the winter, the dead floricanes are removed and the branches of the new canes are pruned to about 0.5 m in length or left unpruned. Canes are either trained on a multiple wire trellis with a nondivided canopy or are trained to a "double T" system. In most regions, plantings are irrigated using drip, overhead, or microjet systems. However, in China fields are commonly flood irrigated.

Average yield is 8–45 $Mg \cdot ha^{-1}$ with all fruit hand-picked every 3–5 d for fresh market. The fruiting season, in the northern hemisphere, ranges from July to October, depending on cultivar and production region. Excess fruit are processed, usually as a seedless puree.

ERECT. In most production regions, plants are established 0.8–1.2 m apart in rows 3 m apart. During the growing season, primocanes are tipped at a height of 0.9–1.2 m, depending on production region, to encourage branching. After fruit harvest or in winter, dead floricanes are removed by pruning. In some production regions, like Oregon, dead floricanes are left in the planting to save labor costs; they will eventually break off and fall into the row middles. In Texas, growers often do not prune out dead floricanes in winter, and see increased problems with anthracnose (*Elsinoe veneta*). In winter, the primocane branches are usually shortened to ≈0.5 m by hand. However, in Oregon, use of a machine to hedge plantings in winter results in variable branch length.

Erect blackberries are grown without a trellis in some regions; however, the use of a trellis is becoming very common as planting area increases. Reasons to trellis include the reduction in cane breakage due to wind along with keeping all fruiting canes upright within the row to limit yield loss at fruit maturation. Usually a simple two- or four-wire trellis is used, but canes are usually not tied to the wire. In Georgia, U.S., hydrogen cyanamide (Dormex; SKW Trostberg AG, Trostberg, Germany) is applied in some years to improve budbreak. Drip irrigation systems are most common.

Fruit are harvested by hand, primarily for fresh market, every 3–5 d. The fruiting season of erect floricane-fruiting cultivars is about 4 weeks long, from May to August, depending on production region. Yields range from 3 $Mg \cdot ha^{-1}$ (Texas) to 11 $Mg \cdot ha^{-1}$ (Ore.).

In Mexico, the area planted to blackberry has increased 10-fold since 1995 and growth continues to be strong. Specialized production systems have been developed through on-farm research by growers and private companies to extend the season for 'Brazos', 'Tupy', and other erect cultivars. About 5–7 months after primocane emergence, a chemical defoliant (a combination of urea or ammonium sulfate, copper sulfate, and mineral oil) is applied two to three times. The plants are then pruned by topping canes and shortening laterals to about 0.3 m. Gibberellic acid (GA) and thidiazuron (TDZ) are used about 3 weeks after defoliation to improve flowering and promote budbreak. Fruit harvest begins ≈90–100 d after defoliation. After the first crop is finished, many growers prune again, removing the portion of the cane that fruited, and repeat the defoliation process to obtain multiple crops. Growers then mow the canes to ground level to repeat the cycle. Often plants are grown in tunnels to protect fruit from adverse weather conditions. Using these methods, the Mexican fruiting season extends from mid-October to early May for the export market and from May through June for local markets.

Primocane-fruiting blackberries can be double-cropped (floricane in early summer plus primocane in late-summer through autumn) or single-cropped (primocane only). These blackberries were too new to be grown to any significant extent commercially in 2005. It appears that primocane-fruiting blackberries must be tipped during the growing season for maximum fruit production (Strik et al., 2007). Primocane-fruiting blackberries show great promise for improving the availability of fresh market blackberries worldwide using off-season production systems.

TRAILING. Trailing types are typically grown in every-year production systems at an in-row spacing of 0.9–1.8 m with 3 m between rows. Most are grown on a trellis with the canes wrapped around two wires (top at 1.7 m second at 1.2 m).

Trailing blackberries can be grown in every-year (EY) or alternate-year (AY) production systems. In EY production, new primocanes are trained along the ground, under the canopy, while the floricanes are on the wire producing the current season crop. After fruit harvest, the dead floricanes are removed and the primocanes trained onto the trellis wires in August or February. Most growers in Oregon train primocanes in February, leaving canes more protected from cold, potentially injurious temperatures as compared with August-training where canes are more exposed to cold injury on the trellis.

In AY production systems, plants fruit every other year. In the "on-year" floricanes produce a crop and primocanes are not managed. In October, the dead floricanes and the primocanes are pruned off at the crown. The following "off-year" primocanes are trained to the trellis as they grow. The yield of an AY field is about 85% of an EY field over a 2-year period (Eleveld et al., 2001). Research has demonstrated that primocanes following an off-year in an AY system are more cold-hardy than

primocanes that grew in the presence of floricanes in an EY system (Bell et al., 1995; Cortell and Strik, 1997). There is also less cane disease in AY production systems than in EY systems. Over 60% of the trailing blackberry acreage in Oregon is grown in AY production systems.

In New Zealand, a three-wire trellis is typically used with canes trained in a fan and looped over to the middle wire. Plants are grown in EY production systems.

Most plantings are irrigated with overhead systems, but in Chile, furrow irrigation is very common.

Trailing types for the processed market are machine-harvested on more than 75% of the area in the United States and New Zealand. Typical yields range from 8 to 15 $Mg \cdot ha^{-1}$.

Wild species. *R. glaucus* is harvested from native plantings and established fields in Central and South America. In Venezuela, plants are collected from the wild or grown from seeds and are established at 1.5 m in the row with 2.0 m between rows. There is limited use of pruning and fertilizer, and most are unirrigated. All are hand harvested.

In Costa Rica, harvested area of blackberries has increased 55% in the last 10 years to 1550 ha. Much of this area is thought to be *R. glaucus*. The average farm size is 2.5 ha. Most growers are using organic production systems but have trouble getting sufficient quantities of approved organic fertilizers. Weeds and native grasses that grow around plants are kept short using machetes or mowers. In this tropical region, fruiting can occur all season long; however, peak fruiting seasons occur from September to December and January to May. Typical yield is 1.5 $Mg \cdot ha^{-1}$.

In Romania and Chile, fruit are harvested from wild or feral plants in fence rows, for example, with fruit brought to processing companies in small quantities at a time.

Harvest

In general, most fruit for fresh market is hand harvested directly into the final container, often clear plastic clamshells. Flats are usually supported on specially constructed wire or wooden stands and are not allowed to contact the ground. Pickers are monitored to ensure high quality. In ideal situations, fruit are harvested in the early morning, after the dew is off the berries and temperatures are cooler, for best quality.

Field-heat is often removed using forced-air cooling to lower fruit temperature to 0–1 °C within 2 h of picking. Relative humidity within the refrigerated rooms is maintained at 85% to 95%, although free moisture on the berries or in the containers must be kept to a minimum. Fresh-market berries are not washed before shipment to enhance shelf life and reduce fruit rot.

In Hungary, semierect blackberries (1600 ha) are harvested by hand for the processing market. Most of the trailing blackberry production worldwide for processing is harvested by machine. Growers begin machine harvest when the primary fruit are fully mature. Fruit are gently shaken from the plants using self-propelled, over-the-row machines. Frequency of harvest is about every 5 d depending on cultivar and temperature, and harvest is typically at night when fruit are more easily removed. Machine-harvested fruit are more uniform in maturity, having higher aroma, flavor, and percent soluble solids than hand-harvested fruit.

In addition to the possible insect contaminants, thorns can be a serious contaminant in thorny cultivars that are machine harvested. Research has helped growers minimize this risk by using machine harvesters equipped with brushes in winter to remove potential contaminants (Strik and Buller, 2002). Plant breeders consider the development of high-quality, thornless trailing blackberry cultivars a high priority and have recently released several thornless cultivars for processing, including the popular new trailing 'Black Diamond' (Finn et al., 2005).

Blackberries are processed as individually quick frozen (IQF), bulk frozen, puree (with or without seeds, depending on cultivar), freeze-dried, canned, or juice/concentrate.

Changes in production systems

In the United States, the major changes over the last 10 years include a trend toward higher-density plantings and increased use of machine harvest for processed markets. In New Zealand, growers have adopted Eurogap and ISO 22,000 and other standards, use more foliar fertilization, sweep cane prunings into the row to provide a mulch, and packing lines now have a water bath. Organic and tunnel production systems are becoming more common worldwide.

Organic production. There were 2528 ha of organic blackberry production reported in the world in 2005: 1550 ha in Costa Rica, 893 ha in South America (most in Ecuador), 73 ha in North America (most in the United States), and 11 ha in Europe. Most production regions expected an increase in organic area in the next 10 years.

Tunnels. An estimated 315 ha of blackberries grown under tunnels were reported worldwide, with tunnels mostly being used to protect against adverse weather (150 ha in Mexico; 20 ha in Oregon; and 12 ha in Washington). Tunnels or greenhouses to advance or delay the fruiting season in addition to protection against the elements were used in Spain (50 ha), The Netherlands and Italy (20 ha each), Romania (10 ha), and South Africa (10 ha). Essentially, all of the blackberries grown in The Netherlands are in either a tunnel, a greenhouse, or are covered with plastic (less expensive structure) to protect fruit from rain. The use of tunnels is expected to increase, particularly in Mexico, Oregon, and Washington.

Although tunnels may cost over USD 25,000 per hectare, growers report advantages including protection against rain and heat, relative freedom from insects and some diseases, and the ability to manipulate microclimate and thus plant growth to target high-priced markets. Research on tunnel production of blackberries began in Belgium and The Netherlands in the early 1980s. Tunnels can be used to delay the fruiting season, simply by protecting the crop against adverse weather or to advance the season by placing plastic over the tunnel at the end of the dormant period to advance growth. The season can be further advanced 3–4 weeks by heating the tunnel starting in late winter. Often, yield in the tunnel is higher than in the open field, as less fruit are lost to disease, winter cold damage is reduced, and the entire crop can be harvested (Bal and Meesters, 1995). Blackberries produced in tunnels have been reported to have a better shelf

life than open field-grown fruit (Bal and Meesters, 1995; L. Giongo, personal communication). Off-season production in winter can be accomplished by growing blackberries in containers (10 L most commonly) and bringing plants into a heated greenhouse after chilling has been satisfied. Yields are generally lower than for field-grown plants in this production system.

Production problems

Most blackberries are grown using a combination of cultivation and herbicides for weed management and pesticides for disease and insect control.

CULTURAL. Although semierect blackberries are considered relatively cold-hardy, cold injury is still considered the most important production problem in Serbia, Romania, and Poland, and in Oregon for their most important trailing cultivar, Marion. Damage from low winter temperatures can occur in Arkansas, in some years. In China, in all production regions except Nanjing Province, canes are buried in winter to avoid cold injury. Other cultural production problems mentioned included: managing weeds (almost all production regions), rainfall at harvest (Arkansas, Georgia, Costa Rica), white drupelets, thought to be due to UV (ultraviolet) light damage (United States), and color reversion from black to red (Brazil, Mexico, and some cultivars in some regions in United States).

DISEASES. Disease problems were listed as prevalent in all production areas; specifically mentioned were downy mildew [*Peronospora sparsa* or *P. rubi* (Germany, Mexico, New Zealand, Oregon, California)]; powdery mildew [*Sphaerotheca macularis* (Mexico)]; fruit rot [*Botrytis cinerea* (Chile, Mexico, New Zealand, Germany, Poland, Romania, Serbia, southeastern United States)] particularly in years with rain occurring during bloom or fruit development; raspberry bushy dwarf virus (New Zealand, Romania, Oregon); cane blight [*Leptosphaeria coniothyrium* (Georgia)]; crown gall [*Agrobacterium tumefaciens* (Brazil, Germany)]; anthracnose [*Elsinoe veneta* (Mexico, United States)]; rosette or double blossom on thorny, erect cultivars [*Cercosporella rubi* (Arkansas, Georgia., Texas)]; yellow rust [*Phragmidium violaceum* (Serbia, Romania, Oregon on 'Thornless Evergreen' only)]; orange rust [*Arthuriomyces peckianus* (eastern United States)]; cane and leaf rust [*Kuehneola uredinsis* (western United States)]; unknown rust (Costa Rica); cane and leaf spot [*Septoria rubi* (western United States)]; orange felt or orange cane blotch [*Cephaleuros virescens* (Georgia)]; and purple blotch [*Septocyta ruborum* (trailing types in Oregon; semierect types in Serbia and Romania)].

INSECTS. The importance of insect pests in blackberry production varies by region. Insect problems mentioned included: raspberry bud moth [*Heterocrossa rubophaga* (New Zealand)], fruit fly [*Ceratitis* spp. and *Anastrepha* spp. (Brazil, Ecuador)], two-spotted spider mite [*Tetranychus urticae* (Chile, Mexico)], red berry mite [*Acalitus essigi* (Germany, Hungary, Oregon, California)], aphids [*Amphorophora rubi* (Romania)], rednecked cane borer [*Agrilus ruficollis* (Arkansas, Texas)], raspberry crown borer [*Pennisetia marginata* (United States)], thrips [*Frankliniella* spp. (Mexico, Arkansas)], stink bugs [*Euschistus* spp. (United States)], crickets [*Oecanthus* spp. (Mexico)], leaf rollers including the orange tortrix (*Argyrotaenia franciscana*) and the oblique banded (*Choristoneura rosaceana*) in New Zealand and the United States, and an unknown Lepidopteran (Costa Rica, Mexico).

Birds were mentioned as a problem in Costa Rica, New Zealand, Venezuela, and Texas.

Economic and regulatory concerns

Various economic concerns were raised for blackberry production. Many regions mentioned increasing cost of labor (Chile, New Zealand, Romania, United States). In addition, competition from other production regions and the adverse impact on grower price for fruit was mentioned by several (Chile, Costa Rica, United States). Variability in price growers are paid for fruit as a result of fluctuating supply in years with cold damage (Oregon and Serbia) and low cost to the grower for fruit (Mexico, United States) were also mentioned. The cost of compliance for local environmental legislation is an issue in New Zealand.

Regulatory concerns included impacts of legislation, border security, or immigration reform on the availability of labor in the United States; groundwater issues (New Zealand); chemical or pesticide residues on exported fruit (China, Mexico); ability to meet Eurogap requirements for organic certification (Costa Rica); and requirements for showing traceability or source of fruit in processed markets (Chile).

LIMITS TO EXPANSION. Many areas producing blackberries have some limitations to expansion of the area planted including: lack of and cost of labor (Texas), encroachment of urban area (New Zealand), lack of suitable land and high cost of land (New Zealand), lack of organization, technical support, certified plants, and commercial infrastructure (Costa Rica, Venezuela), lack of processors to handle any increase in production (Brazil, Venezuela), need for fresh market cultivars with better flavor (many regions) or those that are better adapted to the local area (Georgia), and the need for more cold-hardy cultivars with good quality to ensure stability of market (Germany, Hungary, Romania, Serbia). Issues related to markets included: relative lack of consumer awareness of blackberries (South America) and needing markets to expand (China, Mexico, United States).

Despite the above-mentioned limitations, blackberry production is expected to increase in many regions. Projections for the greatest growth in the next 10 years (Fig. 1) are in Romania (900%), Poland (200%), Mexico (117%), Chile (76%, mainly in trailing cultivars for processing), Hungary (50%), China (42%), and the United States (20%).

RESEARCH AND BREEDING PROGRAMS. In the United States, large public breeding and research programs in blackberry exist at Oregon State University and the U.S. Department of Agriculture, Agricultural Research Service (USDA-ARS), Corvallis, Ore. In the southern United States, research is done on postharvest fruit quality (USDA-ARS, Lane, Okla.), and at the University of Arkansas (Fayetteville) there is a strong breeding program as well as research on various cultural and

disease issues. There is no public breeding program for blackberries in California and little public research. Two private breeding companies based in California, Driscoll Strawberry Associates, and Plant Sciences, in Watsonville, have blackberry breeding programs.

There is a new breeding program for blackberry in Mexico (University Michoacan de San Nicolas de Hidalgo) but no production/physiology research. Some private companies, based elsewhere, breed for cultivars adapted to the Mexican climate.

There was an active breeding program along with supporting pathology and horticulture research programs conducted by New Zealand HortResearch, in 2005. In South America, there was very little blackberry research reported other than the breeding program at the Embrapa Clima Temperado Research Center in Pelotas, Brazil, and cultivar trials in Chile. In Europe, breeding programs were reported in Poland, Hungary, Romania, Scotland (N. Jennings), and Serbia and production trials or research in Germany, Romania, Poland, and Italy. Asia has no blackberry breeding programs, but cultivars from other regions are undergoing trials in China.

Conclusion

Worldwide blackberry area increased from 13,958 ha in 1995 to 20,036 ha in 2005, a 44% increase. Most of this growth occurred in Mexico, the United States, China, and Costa Rica. Projections for the greatest growth in the next 10 years are in Romania, Poland, Mexico, Chile, Hungary, China, and the United States. On the basis of this survey, there may be 27,032 ha of commercial blackberries worldwide, not including production from harvested wild plants, in 2015.

Literature cited

Bal, E. and P. Meesters. 1995. Year-round production of blackberries. Proc. North Amer. Bramble Growers Assn., Orlando, Fla., p. 49–61.

Bell, N., B.C. Strik, and L.W. Martin. 1995. Effect of date of primocane suppression on 'Marion' trailing blackberry. II. Cold hardiness. J. Amer. Soc. Hort. Sci. 120:25–27.

Clark, J.R. 1992. Blackberry production and cultivars in North America east of the Rocky Mountains. Fruit Var. J. 46:217–222.

Clark, J.R. 2005. Changing times for eastern United States blackberries. HortTechnology 15:491–494.

Cortell, J. and B.C. Strik. 1997. Effect of floricane number in 'Marion' trailing blackberry. I. Primocane growth and cold hardiness. J. Amer. Soc. Hort. Sci. 122:604–610.

Eleveld, B., B.C. Strik, K. Brown, and B. Lisec. 2001. Marion blackberry economics. The costs of establishing and producing 'Marion' blackberries in the Willamette Valley. Oregon State University Ext. Ser. Corvallis, Publ. EM 8773.

Finn, C.E., B. Yorgey, B.C. Strik, H.K. Hall, R.R. Martin, and M.C. Qian. 2005. 'Black Diamond' trailing thornless blackberry. HortScience 40:2175–2178.

Hall, H.K. 1990. Blackberry breeding. Plant Breed. Rev. 8:249–312.

Moore, J.N. 1984. Blackberry breeding. HortScience 19:183–185.

Strik, B.C. 1992. Blackberry cultivars and production trends in the Pacific Northwest. Fruit Var. J. 46:202–206.

Strik, B. and G. Buller. 2002. Reducing thorn contamination in machine-harvested 'Marion' blackberry. Acta Hort. 585:677–681.

Strik, B., J.R. Clark, C. Finn, and G. Buller. 2007. Management of primocane-fruiting blackberry to maximize yield and extend the fruiting season. Acta Hort in press.