

# ‘Columbia Star’ Thornless Trailing Blackberry

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‘Columbia Star’ is a new thornless, trailing blackberry (*Rubus* subg. *Rubus* Watson) cultivar from the U.S. Department of Agriculture–Agricultural Research Service (USDA-ARS) breeding program in Corvallis, OR, released in cooperation with the Oregon State University’s Agricultural Experiment Station. ‘Columbia Star’ is the

first thornless blackberry to be released with the ‘Lincoln Logan’ source of thornlessness other than the original ‘Lincoln Logan’ and ‘Waimate’ that have ‘Logan’-type fruit and ‘Marahau’ that has ‘Boysen’-type fruit (Hall et al., 1986; Hall and Stephens, 1999; Fig. 1). ‘Columbia Star’ is introduced as a very high-quality, high-yielding, machine-harvestable, thornless trailing blackberry with firm, sweet fruit that when processed are similar in quality to or better than fruit from the industry standards ‘Marion’ and ‘Black Diamond’. ‘Columbia Star’ should be adapted to areas where other trailing blackberries can be grown successfully. The name recognizes the importance of the Columbia River in the geography and history of the Pacific Northwest.

## Origin

‘Columbia Star’, tested as ORUS 3447-1, was selected in Corvallis, OR, in 2008 from a cross made in 2005 of NZ 9629-1 and ORUS 1350-2 (‘Black Butte’ × ORUS 828-43) (Fig. 1). ‘Columbia Star’ inherited its thornlessness (botanically “spineless” but commonly referred to as “thornless” in industry and research communities) from NZ 9629-1, which is a selection made in Oregon from a population produced by H.K. Hall then with the New Zealand Crown Research Institute “HortResearch” (Now The New Zealand Institute for Plant and Food Research

Ltd.). The background of ‘Columbia Star’ is extremely diverse (Fig. 1). ‘Marion’ accounts for 20% of the background of ‘Columbia Star’ based on pedigree. The two immediate parents represented elite selections from the New Zealand and Oregon breeding programs. ORUS 1350-2 is thorny, very productive, and vigorous with very large, uniformly shaped barrel fruit that were prone to heat damage and had only fair flavor. NZ 9629-1 was thornless, very productive, and vigorous with small to medium-sized outstanding flavored, uniformly shaped, conic fruit that tended to have visually noticeable pubescence on the fruit that consumers mistake for fruit rot (*Botrytis cinerea* Pers.:Fr.). ‘Columbia Star’ is the first named commercial blackberry-type (vs. ‘Logan’- or ‘Boysen’-type) cultivar to be released using the ‘Lincoln Logan’ source of thornlessness, which was developed originally by The New Zealand Institute for Plant and Food Research Ltd. from a somaclonal selection derived from a thornless sport of ‘Logan’ (Hall et al., 1986; H. Hall, personal communication, J. Stephens, personal communication).

‘Columbia Star’ was evaluated most extensively in trials at Oregon State University’s North Willamette Research and Extension Center (OSU-NWREC; Aurora, OR), USDA-ARS (Corvallis, OR), and at Enfield Farms Inc. (Lynden, WA). In each of the Oregon trial plantings, standard cultural practices for trailing blackberry production were used, including annual pre- and post-emergent herbicide applications, spring nitrogen fertilization (78 kg N/ha), post-harvest removal of floricanes, training of primocanes to a two-wire trellis, and application of 2.5 to 5.0 cm of irrigation during the growing season, depending on rainfall. Delayed dormant applications of liquid lime sulfur and copper hydroxide were made to control leaf and cane spot caused by *Septoria rubi* Westend, purple blotch caused by *Septocytia ruborum* (Lib) Petr., rust caused by *Kuehneola uredinis* (Link) Arth., and anthracnose caused by *Elsinoe veneta* [Burkholder] Jenk. as a standard practice without any knowledge of the susceptibility of the selections in trial to these diseases. The cooperating grower in Washington is primarily a red raspberry (*Rubus idaeus* L.) grower and although plants were spaced and trained similarly to those in the Oregon trials, they were irrigated and received N fertilizer rates that were standard for red raspberry but greater than that typical for blackberry. At OSU-NWREC, ‘Columbia Star’ was planted in 2009 along with other selections and the standards ‘Marion’ and ‘Black Diamond’ in a randomized complete block design with four three-plant replications used for fresh fruit characteristics and three replications harvested once a week to determine harvest season, yield, and average fruit weight (based on a randomly selected subsample from each harvest) (Finn et al., 2005; Waldo, 1957). ‘Marion’ accounts for the greatest amount of producing blackberry acreage in the Pacific Northwest and ‘Black Diamond’ accounts for the greatest number of plants planted in the Pacific Northwest since

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Mention of trade names or commercial products in this manuscript is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

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Fig. 1. 'Columbia Star' pedigree.

2005 (USDA-National Agricultural Statistics Service, 2013; P.P. Moore, personal communication). A weighted mean fruit weight was calculated. These data, collected from 2011–13, were analyzed as a split plot in time with cultivar as the main plot and year as the subplot with mean separation by least significant difference. Of the dozen genotypes harvested from this replicated trial, only the data from 'Columbia Star' and the named cultivars were included in the analysis. The cultivar  $\times$  year interaction was significant for yield but not for fruit weight and the means for yield in each year are presented and compared (Table 1). Subjective fruit evaluations were made during the 2011–13 fruiting seasons using a 1 to 9 scale (9 = the best expression of each trait). The fruit ratings included sterility (subjective rating of drupelet set), firmness (as measured subjectively by hand in the field on six to eight fruit), color (ideal is a solid, dark black), shape (with a uniform, long conic berry being ideal), texture (as measured subjectively when chewed while tasting berries in the

field), separation (subjective rating of how easily the ripe fruit were separated from the plant), and flavor (subjectively rated by tasting fruit in the field) (Table 2). Some of the fruit harvested in 2011 and 2013 was frozen, puréed, and assessed in a blind evaluation by an expert panel as described in Yorgey and Finn (2005) (Table 3). Titratable acidity, percent soluble solids, and pH were determined at each harvest date in each year from harvested fruit (Table 4). Fruit samples of 'Black Diamond', 'Columbia Star', and 'Marion' were analyzed for the concentration of anthocyanins using previously described procedures (Lee and Finn, 2007) with a longer high-performance liquid chromatography column (Synergi Hydro-RP 80Å, 250 mm  $\times$  2 mm, 4  $\mu$ m; Phenomenex, Inc., Torrance, CA) (Table 5). Fruit were also evaluated informally as a thawed, individually quick frozen (IQF) product by growers, processors, and researchers each off season. The fruit ripening season in Oregon was characterized by the dates on which 5%, 50%, and 95% of the total fruit were harvested (Table 6). A

Littau Harvester (Stayton, OR) was used in 2012 and 2013 at OSU-NWREC and in 2010 and 2011 at Enfield Farms Inc. to test harvest plots. Plant ratings were conducted one time each year during the fruiting season for primocane and florican vigor, spines (9 = spineless; 1 = numerous, large spines), flowering or fruiting lateral length (1 = very short; 5 = very long) and strength (1 = weak, droopy; 5 = stiff, sturdy), and damage resulting from winter injury (9 = no injury; 1 = dead) (Table 7). In 2009, 'Columbia Star' was planted along with a number of other genotypes in plots at Enfield Farms Inc. to assess cold-hardiness and suitability for machine harvest. Although observations were made on these plants from 2009–11, the winters were relatively mild (minimum temperature  $-8.9$  to  $-9.0$  °C in Dec. 2009, Nov. 2010, and Feb. 2011). Although the winters in Oregon from Fall 2009 through late Winter 2013 were relatively mild, an unusual cold event in Dec. 2013 provided some insight into what conditions can cause severe damage in 'Columbia Star' as the OSU-NWREC

experienced -12.7 to -13.3 °C over two nights and on those same two nights it was -16.0 to -16.6 °C in Corvallis.

### Description and Performance

'Columbia Star' was higher yielding than current standards 'Black Diamond' and 'Marion' based on a 3-year mean (Table 1). In each individual year, 'Columbia Star' always had the highest yield but it was not always significantly higher than the other two

cultivars. There was year-to-year variability for yield with the largest yield in 2011 and the smallest in 2012 with 2013 being intermediate (data not shown).

There was no significant interaction among fruit weight and year and 'Columbia Star' consistently had larger fruit than 'Black Diamond' and 'Marion' (Table 1). Although we have no strong evidence, blackberry breeders believe that a berry between 7 and 9 g is ideal because it looks large but can be consumed in one bite and does not cause

problems with making the stated unit weight when packing fresh fruit in clamshells (Fig. 2). 'Columbia Star' had excellent drupelet fertility, better than 'Marion' and 'Black Diamond', and this helped contribute to its overall attractive and uniform appearance that was rated similar to 'Black Diamond' but better than 'Marion', which can be lumpy (Table 2; Fig. 2). Fresh fruit of 'Columbia Star' were rated as having better firmness than either of the current industry standards. Although not yet evaluated in commerce, 'Columbia Star' fruit should have sufficient firmness for local fresh market sales, but it is not certain whether firmness would be sufficient for wholesale fresh shipping. Fruit color was rated similarly to 'Black Diamond' fruit and more black than those of 'Marion'. 'Columbia Star' and 'Marion' were rated similarly for fruit texture and flavor as fresh fruit and both were considered better than 'Black Diamond'. Fruit from an adjacent field of 'Chester Thornless' were scored to have better firmness but poorer shape, texture, flavor, and color than 'Columbia Star' (data not shown).

Plots of 'Columbia Star', 'Marion', and 'Black Diamond' in Lynden, WA, and at OSU-NWREC were harvested with a Littau harvester (Fig. 3A). 'Columbia Star' was suited to machine harvest because it had high yields and fruit quality with no obvious plant injury (Fig. 3A–B).

'Columbia Star' fruit looked outstanding the first year it was harvested in replicated trials in 2011 and enough fruit was harvested to do a blind evaluation of purée in Dec. 2011. Purée was again evaluated by another blind panel of experts in Feb. 2014. A main goal of the breeding program has been to develop a thornless blackberry with high yields and with fruit quality similar to 'Marion' blackberry (Hall et al., 2002). Blackberry experts (growers, packers, processors, and growers) can visually distinguish thawed 'Marion' IQF fruit from other genotypes. Puréeing the fruit sample not only removes this ability to identify fruit by its appearance, but purée also accounts for a significant proportion of the commercial processed product. As a purée in the 2011 evaluation, 'Columbia Star' had the highest scores of the cultivars tested for all traits except fruit color, was not significantly different from 'Marion' for any traits, and was rated better than 'Black Diamond' for flavor and overall quality (Table 3). Having a thornless selection score comparable or better than 'Marion' for fruit quality including flavor represents a major accomplishment. In 2014, 'Columbia Star' purée was rated similar to 'Black Diamond' and 'Marion' for aroma,

Table 1. Berry weight and yield in 2011–13 for 'Black Diamond', 'Columbia Star', and 'Marion' blackberries at Oregon State University's North Willamette Research and Extension Center (Aurora, OR) planted in replicated trial (three, three plant plots) in 2009.<sup>z</sup>

Cultivar	Berry wt (g)		Yield (kg/plant)		
	2011–13	2011	2012	2013	2011–13
Black Diamond	6.0 b	7.32 a	2.18 b	3.03 b	4.27 c
Columbia Star	7.6 a	7.80 a	6.17 a	8.52 a	7.49 a
Marion	5.5 b	6.71 a	4.95 a	5.12 b	5.59 b

<sup>z</sup>Mean separation within columns by least significant difference,  $P \leq 0.05$ .

Table 2. Subjectively evaluated fruit quality traits for 'Black Diamond', 'Columbia Star' and 'Marion' blackberries in a replicated trial (three, three plant plots) planted in 2009 and evaluated in 2011–13 at Oregon State University's North Willamette Research and Extension Center (Aurora, OR).<sup>z</sup>

Cultivar	Sterility <sup>y</sup>	Firmness	Color	Shape	Texture	Flavor
Black Diamond	7.4 b	6.7 b	8.0 a	8.3 a	6.8 b	6.4 b
Columbia Star	8.5 a	7.6 a	8.3 a	8.5 a	8.3 a	8.1 a
Marion	5.8 c	4.1 c	7.4 b	5.3 b	8.1 a	8.4 a

<sup>y</sup>A 1 to 9 scale was used where 9 = the best expression of each trait and 1 = the worst.

<sup>z</sup>Mean separation within columns by least significant difference,  $P \leq 0.05$ .

Table 3. Evaluation of 'Black Diamond', 'Columbia Star', and 'Marion' blackberries in 2011 and 2014 as purées in a blind evaluation by an expert panel (blackberry growers, processors, and fieldmen).

Cultivar	Aroma <sup>z</sup>	Flavor	Color	Overall quality
2011 Evaluation (n = 46)				
Black Diamond	5.57 a	5.23 b	6.02 a	5.51 b
Columbia Star	6.17 a	6.19 a	6.38 a	6.23 a
Marion	5.41 a	5.94 a	6.50 a	5.83 ab
2014 Evaluation (n = 58)				
Black Diamond	5.78 a	5.48 b	6.40 a	5.92 a
Columbia Star	5.87 a	6.39 a	6.68 a	6.49 a
Marion	5.53 a	6.08 ab	6.29 a	6.19 a

<sup>z</sup>Ranked using a 9-point hedonic scale (1 = dislike extremely 5=neither like nor dislike, and 9 = like extremely). Mean separation within columns by Tukey's honestly significant difference,  $P \leq 0.05$ .

Table 4. Fruit chemistry characteristics for four blackberry cultivars grown at Oregon State University's North Willamette Research and Extension Center and harvested in 2011–13.

Cultivar	Soluble solids		Titratable acidity (g·L <sup>-1</sup> as citric acid)
	(°Brix) <sup>z</sup>	pH	
Black Diamond	10.28 c	3.38 a	12.18 b
Chester Thornless	11.69 b	3.28 b	10.51 c
Columbia Star	12.74 a	3.19 c	15.43 a
Marion	12.57 a	3.21 bc	15.64 a

<sup>z</sup>Means within a column followed by the same lowercase letter are not significantly different,  $P > 0.05$ , by least significant difference test.

Table 5. Anthocyanin concentrations (mg of cyanidin-3-glucoside/100 g) of 'Columbia Star', 'Marion', and 'Black Diamond' blackberries harvested in 2013 from trials at Oregon State University's North Willamette Research and Extension Center (Aurora, OR).<sup>z</sup>

Cultivar	Cyanidin-3-glucoside	Cyanidin-3-rutinoside	Cyanidin-3-xyloside	Cyanidin-3-glucoside-malonate	Cyanidin-3-dioxyalylglucoside	Total
Columbia Star	135.3 (68)	54.2 (27)	4.0 (2)	4.8 (2)	Not detected	198.3
Marion	140.0 (67)	51.6 (25)	4.4 (2)	4.9 (2)	7.7 (4)	208.6
Black Diamond	106.5 (73)	27.4 (19)	5.9 (4)	5.2 (4)	Not detected	145.0

<sup>z</sup>Anthocyanin listed in the order of high-performance liquid chromatography elution. Values in italic font are percent proportions of the total anthocyanins. Non-acylated anthocyanin levels and percent proportions can be obtained by summing values of cyanidin-3-glucoside-malonate and cyanidin-3-dioxyalylglucoside.

Table 6. Ripening season was estimated as the date at which yield passed the given percentage of total yield for four blackberry cultivars in trials planted in 2009 and evaluated in 2011–13 at Oregon State University's North Willamette Research and Extension Center (Aurora, OR).

Cultivar	Harvest season		
	5%	50%	95%
Columbia Star	3 July	12 July	24 July
Marion	8 July	15 July	24 July
Black Diamond	3 July	17 July	26 July
Chester Thornless	5 Aug.	28 Aug.	25 Sept.

Table 7. Subjectively evaluated plant traits for 'Black Diamond', 'Columbia Star', and 'Marion' blackberries in a replicated trial (three, three plant plots) planted in 2009 and evaluated in 2011–13 at Oregon State University's North Willamette Research and Extension Center (Aurora, OR).

Cultivar	Primocane		Floricanes vigor	Lateral		Winter injury
	Vigor <sup>z</sup>	Spine		Length	Strength	
Black Diamond	7.8 b	7.6 b	6.7 b	2.1 c	3.3 a	8.2 a
Columbia Star	8.4 a	9.0 a	8.0 a	4.4 b	2.6 b	8.2 a
Marion	8.0 ab	3.9 c	6.5 b	5.1 a	2.4 b	7.1 b

<sup>z</sup>A 1 to 9 scale was used where 9 = the best expression of each trait and 1 = the worst for all traits except lateral length and strength, which were on a 1 to 5 scale where 1 = short, weak and 5 = long, strong. Means within a column followed by the same lowercase letter are not significantly different,  $P > 0.05$ , by least significant difference test.



Fig. 2. Ripe fruit cluster of 'Columbia Star'.

color, and overall quality (Table 3). For flavor, 'Columbia Star' had the highest rating, comparable to 'Marion' and better than 'Black Diamond'. 'Black Diamond' has become the industry favorite for its yield, machine harvestability, and generally good fruit quality but many are of the opinion that its flavor could be better. Having 'Columbia Star' rate better than or similar to 'Black Diamond' in all traits in both trials and to have noticeably better flavor is remarkable.

Over the 3 years of evaluation, 'Columbia Star' fruit consistently had percent soluble solids, pH, and titratable acidity levels comparable to 'Marion' (Table 4). Fruit percent soluble solids was consistently higher than that for 'Black Diamond' and 'Chester Thornless'. Mean pH and titratable acidity



Fig. 3. Machine-harvested fruit of 'Columbia Star'. (A) On sorting belt. (B) In harvest tote.

were lower for 'Columbia Star' than for 'Black Diamond' and 'Chester Thornless'. Of these three fruit chemistry parameters, all had significant year effects but only soluble solids had a cultivar  $\times$  year interaction (data not shown). The three trailing blackberries had their highest percent soluble solids in 2012, whereas 'Chester Thornless' had its lowest in 2012.

The three cultivars were evaluated for anthocyanin content and profile and contained

similar anthocyanins with the exception that 'Marion' contained small levels of cyanidin-3-dioxyglucoside, which was not present in 'Black Diamond' or 'Columbia Star' (Table 5). For the other four anthocyanins detected and for the total anthocyanin level, 'Columbia Star' and 'Marion' were fairly similar and 'Black Diamond' tended to have lower amounts except for cyanidin-3-xyloside and cyanidin-3-glucoside-malonate where the levels in 'Black Diamond' fruit were higher. 'Columbia Star' contained a slightly higher proportion of non-acylated anthocyanin (98% of total) than for 'Black Diamond' (96%) or 'Marion' (94%).

'Columbia Star' ripened in the early mid-season for trailing blackberries and over 1 month earlier than 'Chester Thornless' semi-erect blackberry (Table 6). Within the trailing cultivars, 'Columbia Star' harvest started as early as 'Black Diamond', a few days ahead of 'Marion', but reached the midpoint of harvest 5 d ahead of 'Black Diamond' and 3 d ahead of 'Marion'. The harvest season of 'Columbia Star' ended with 'Marion' and ahead of 'Black Diamond' giving it a longer harvest season than 'Marion' and a slightly shorter season than 'Black Diamond'.

'Columbia Star' was vigorous, comparable to 'Marion', and the floricanes and primocanes were more vigorous than 'Black Diamond' (Table 7; Fig. 4). The floricanes of 'Columbia Star' scored higher for vigor than those of 'Marion' despite having comparable primocane vigor scores, likely a result of observed higher percent budbreak and less foliar and cane disease in 'Columbia Star' than in 'Marion' (Table 7). The laterals of 'Columbia Star', although shorter than those of 'Marion', were more comparable to those of 'Marion' than the short laterals of 'Black Diamond'. The laterals on 'Columbia Star' and 'Marion' have similar strength and are not as stiff as those of 'Black Diamond' (Table 7). The scores overall reflect a definite difference in plant architecture between 'Columbia Star' and 'Black Diamond'. 'Black Diamond' had very short fruiting laterals with less foliage and therefore there was excellent air circulation around the fruit and the fruit were visible for hand picking but the exposed fruit were more susceptible to sunburn. The fruit of 'Columbia Star' were more hidden and, although not observed, potentially more susceptible to fruit diseases promoted by wet fruit but much less susceptible to ultraviolet light/heat damage. With a minimal spray program, no significant incidence of foliar or cane diseases occurred in Oregon and with a commercial raspberry fungicide program, there were no foliar or cane disease symptoms in Lynden, WA. In 2011–13, 'Black Diamond' and 'Columbia Star' had less winter injury than 'Marion' in Oregon (Table 7) and in Lynden, WA (data not shown). Winter injury for 2013–14 will not be scored until May to June 2014, but locations in Oregon experienced an extreme weather event in Dec. 2013 where trailing blackberries were damaged. Buds and canes were cut in the field in late January to assess



Fig. 4. Plants of 'Columbia Star'.

the damage from the December freeze events. At the OSU-NWREC, where the temperature was  $-12.7$  to  $-13.3$  °C over two nights, there was almost no cane damage or bud damage seen on 'Black Diamond' or 'Columbia Star' and although 'Marion' had more damage, the expectation is that the yield will not be reduced. In Corvallis, it was a very different story because the two nights at  $-16.0$  to  $-16.6$  °C appear to have killed many of the canes to the ground as well as many buds for 'Marion' with 'Columbia Star' appearing to have less injury and 'Black Diamond' the least, albeit severe, injury. The plants should recover in Corvallis but there will probably be a major to complete crop loss for all three cultivars. Although these locations were  $\approx 100$  km apart, the environmental conditions (e.g., wind, preceding acclimating temperatures, duration of the coldest temperatures), other than absolute low temperatures, were similar suggesting that 'Columbia Star' will probably tolerate  $\approx -14$  °C and still have a crop but if the temperature drops to  $\approx -16$  °C, the crop will be threatened; however, temperature thresholds would likely differ depending on whether cold temperatures occur during the acclimation, dormant, or deacclimation phase.

Although 'Columbia Star' and 'Black Diamond' are thornless from a commercial harvest perspective, they do behave differently for this trait based on the origins of their thornlessness (Table 7). The origins and use in breeding of the various sources of thornlessness have been well reviewed (Clark et al., 2007; Finn and Clark, 2012; Hall and Stephens, 1999). To briefly compare the sources of thornless, the 'Merton Thornless' source, derived from 'John Innes', is recessive and was used in the eastern blackberry tetraploid germplasm (e.g., 'Chester Thornless', 'Triple Crown', and 'Ouachita'), whereas the 'Austin Thornless' source, derived from 'Austin-Mayes' dewberry and the 'Lincoln Logan' source, was used in the higher ploidy (6x–12x) trailing blackberry germplasm. The thornlessness of 'Black Diamond' traces

through the North Carolina selection NC 37-35-M-2 to 'Austin Thornless', a sport of 'Austin-Mayes' found in Oklahoma (Finn, 2008; Finn et al., 2005; Finn and Clark, 2012). Primocanes of blackberry genotypes with 'Austin Thornless' thornlessness often are very thorny when they emerge from the ground; however, after growing 15 to 45 cm, they become thornless and this thorny region is out of the fruiting and harvesting zones and the thorns are not a risk to contaminate the product. 'Waldo', selected in 1973 and released in 1989, was the first thornless trailing cultivar derived from 'Austin Thornless' (Lawrence, 1989). The thornlessness of 'Columbia Star' was derived from 'Lincoln Logan' and Plant and Food Research New Zealand worked extensively to combine this source of spinelessness with high fruit quality (Clark et al., 2007; Finn and Clark, 2012; Hall et al., 1986). Seedling progenies derived from the 'Lincoln Logan' source can be screened when less than 1 cm tall and the spiny progeny discarded and selections from this screening are 100% spineless. Although the germplasm pool derived from 'Austin Thornless' and 'Lincoln Logan' has other positive and negative traits that can be passed onto progeny, the 'Lincoln Logan' material's positive attributes include resistance to downy mildew caused by *Peronospora sparsa* Berk., good aromatic flavor profiles, and excellent flower fertility that leads to well-formed primary, secondary, and tertiary fruit. The main negative aspects to using 'Lincoln Logan' germplasm were the need to select strongly for black rather than purple fruit and for flexible canes that do not break during training.

'Columbia Star' is introduced as a very high-quality, high-yielding, machine-harvestable, thornless trailing blackberry with firm, sweet fruit that, when processed, are similar in quality to or better than fruit from 'Marion'. Although 'Columbia Star' may be sold for local fresh market, it is not expected to have sufficient skin toughness for wholesale shipping and handling. 'Columbia Star' should be adapted to areas where other trailing blackberries can be grown successfully.

'Columbia Star' nuclear stock has tested negative for *Tomato ringspot virus*, *Tobacco ringspot virus*, *Apple mosaic virus*, *Prunus necrotic ringspot virus*, *Cherry leaf roll virus*, *Raspberry ringspot virus*, *Arabidopsis mosaic virus*, *Tomato black ring virus*, *Strawberry necrotic shock virus*, *Raspberry bushy dwarf virus*, and *Tobacco streak virus* by enzyme-linked immunosorbent assay; has indexed negative on grafting to *R. occidentalis* L.; and has tested negative for *Raspberry leaf mottle virus*, *Raspberry latent virus*, *Rubus yellow net virus*, *Blackberry yellow vein associated virus*, *Blackberry virus Y*, and *Blackberry chlorotic ringspot*

*virus* in reverse transcription–polymerase chain reaction assays.

An application for a U.S. Plant Patent has been submitted for 'Columbia Star'. When this germplasm contributes to the development of a new cultivar, hybrid, or germplasm, it is requested that appropriate recognition be given to the source. Further information or a list of nurseries propagating 'Columbia Star' is available on written request to Chad Finn, USDA-ARS Horticultural Crops Research Unit, 3420 NW Orchard Avenue, Corvallis, OR 97330. The USDA-ARS and Oregon State University do not sell plants. In addition, genetic material of this release has been deposited in the National Plant Germplasm System as CRUB 2643, where it will be available for research purposes, including development and commercialization of new cultivars.

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