

‘Columbia Sunrise’ Thornless Trailing Blackberry

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‘Columbia Sunrise’ is a new, very early ripening, 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 Oregon State University’s Agricultural Experiment Station. ‘Columbia Sunrise’ is introduced as a very early ripening, thornless trailing blackberry with large, firm fruit with a very good flavor and good yields that will be suited for hand-harvested fresh and machine-harvested processed markets. ‘Columbia Sunrise’ should

be adapted to areas where other trailing blackberries can be grown successfully. A U.S. Plant Patent has been applied for (USPPAF 15/330,508).

Origin

‘Columbia Sunrise’, tested as ORUS 3448-2, was selected in Corvallis, OR, in 2008 from a cross made in 2005 of NZ 9629-1 and ORUS 1939-2 (Fig. 1). ‘Columbia Sunrise’ is a half-sibling of ‘Columbia Star’ and ‘Columbia Giant’ (Finn et al., 2014; Finn et al., 2018). As with its half-siblings, ‘Columbia Sunrise’ has the ‘Lincoln Logan’ source of thornlessness (botanically “spineless” but commonly referred to as “thornless” in industry and research communities) through NZ 9629-1 (Hall et al., 1986). The parent ORUS 1939-2 was thorny, productive, and vigorous with medium large, glossy, uniformly conic-shaped fruit with very good flavor but the fruit color was too purple as opposed to black, which when combined with its thorniness, made it commercially not viable. The other parent, NZ 9629-1, was thornless, very productive, and vigorous with small- to medium-sized outstanding flavored, uniformly shaped, conic fruit. Both parents were early ripening but neither was as early in comparison with standards as is ‘Columbia Sunrise’. Very early ripening along with medium-sized fruit are the primary factors that distinguish ‘Columbia Sunrise’ from ‘Columbia Star’ and ‘Columbia Giant’.

‘Columbia Sunrise’ was evaluated most extensively in trials at Oregon State University’s

North Willamette Research and Extension Center (OSU-NWREC; Aurora, OR), U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS; Corvallis, OR), and Enfield Farms Inc. (Lynden, WA). In the Oregon trial plantings, standard cultural practices for trailing blackberry production were used, including annual pre- and postemergent herbicide applications, spring nitrogen fertilization (78 kg N/ha), postharvest removal of floricanes, training of primocanes to a two-wire-trellis, and application of 2.5–5.0 cm of irrigation per week 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 (*Septoria rubi* Westend), purple blotch [*Sphaerulina westendorpii* (Westendrop) Verkley, Quaedvlieg & Crous (formerly *S. rubi* Westend)], rust [*Kuehneola uredinis* (Link) Arth.], and anthracnose [*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 even though plants were spaced and trained similarly to those in the Oregon trials, they were irrigated and received nitrogen fertilizer rates that were standard for red raspberry but greater than typical for blackberry. At OSU-NWREC, ‘Columbia Sunrise’ was planted in a replicated trial in 2012, along with other selections and the standards ‘Marion’ and ‘Black Diamond’, in a randomized complete block design with three replications. Each experimental unit consisted of three plants. Each replication was harvested once a week to determine harvest season, yield, and average fruit weight (based on a randomly selected subsample from each harvest) (Finn and Strik, 2014; Finn et al., 1997, 2005a). ‘Marion’ accounts for the largest blackberry acreage in the Pacific Northwest, ‘Black Diamond’ accounts for the greatest number of plants established in the Pacific Northwest since 2005, and ‘Columbia Star’ has been the second most planted cultivar since 2014 (USDA-National Agricultural Statistics Service, 2016; P.P. Moore, personal communication). A weighted mean fruit weight was calculated that adjusts the average mean fruit weight based on the proportion of the total yield that harvest represents. These data, collected from 2014 to 2016, were analyzed as a split-plot in time with a fixed effect model with cultivar as the main plot and year as the subplot with mean separation by least significant difference (LSD) (SAS PROC GLM, Cary, NC). Least significant differences were only applied when there were significant differences for the trait. Of the multiple genotypes harvested from this replicated trial, only the data from ‘Columbia Sunrise’ and the named cultivars were included in the analysis. The cultivar × 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).

Fruit evaluations were made during the 2014–16 fruiting seasons using a 1 to 9 scale

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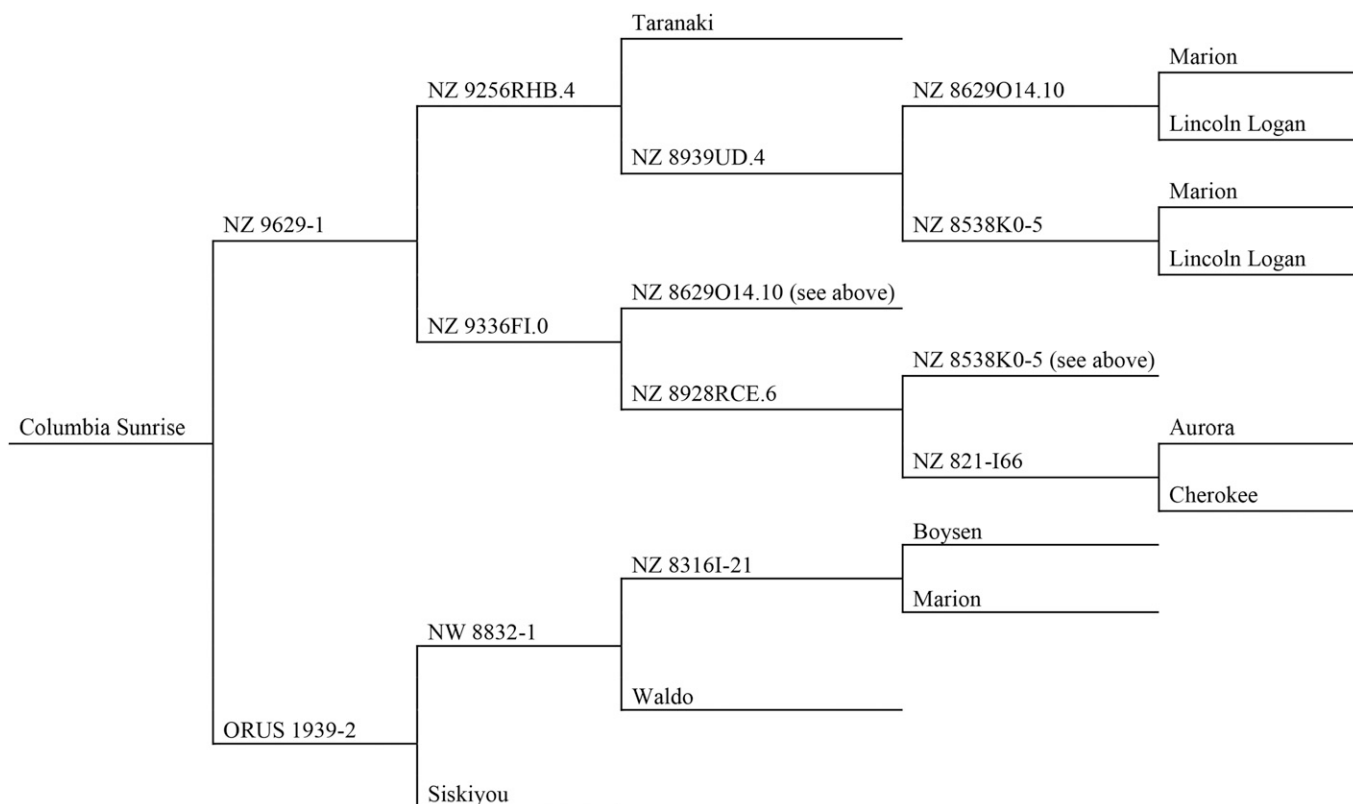


Fig. 1. Pedigree for 'Columbia Sunrise'. The female parent is shown on top.

Table 1. Berry weight and yield in 2014–16 for 'Black Diamond', 'Columbia Sunrise', and 'Marion' blackberries at Oregon State University's North Willamette Research and Extension Center; planted in replicated trial (three plots of three plants each) in 2012.

Cultivar	Berry wt (g)	Yield (kg/plant)			
	2014–16	2014	2015	2016	2014–16
Black Diamond	5.5 b ^a	8.37 a	3.81 a	11.32 a	7.83 a
Marion	5.1 b	5.16 a	4.56 a	6.10 b	5.27 b
Columbia Sunrise	6.5 a	5.06 a	3.74 a	6.53 b	5.11 b

^aMeans within a column followed by the same lowercase letter are not significantly different, $P > 0.05$, by least significant difference test.

(9 = the best expression of each trait). The subjective fruit ratings included sterility (rating of drupelet set), firmness (as evaluated 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 rated when chewed while tasting berries in the field), separation (how easily the ripe fruit were separated from the plant), and flavor (rated by tasting fruit in the field) (Table 2). Fruit glossiness (ideal is glossy), skin toughness (while holding fruit, thumb was rubbed across the fruit surface and ideally the skin surface did not break and "bleed"), and tolerance of heat/ultraviolet light damage (when fruit were fully ripe the incidence of bleached or sunburned fruit was scored where 9 = no evidence of injury) were rated in 2016. The number of fruit per lateral was determined based by counting the fruit on five typical fruiting laterals in each plot once during the ripening season in 2016. Some of the fruit harvested in 2013 were frozen, pureed, sweetened, and assessed in a blind evaluation by a blackberry panel

composed of growers, packers, processors, and researchers as described in Yorgey and Finn (2005) (Table 3). Titratable acidity, percent soluble solids, and pH were determined from harvested fruit (Table 4).

In separate trials, fruit were also evaluated informally as a thawed, individually quick frozen (IQF) product by growers, processors, and researchers.

In 2009, 'Columbia Sunrise' was planted along with several other genotypes in plots at Enfield Farms Inc. to assess cold hardiness and suitability for machine harvest. An over-the-row harvester with a horizontal (Christy) head (Littau Harvester Inc., Stayton, OR) was used in 2010–11 at Enfield Farms Inc. to test harvest plots to determine machine harvestability. While observations were made on these plants from 2010 to 12, the winters were relatively mild (minimum temperature -9.0 to -8.9 °C in Dec. 2009, Nov. 2010, and Feb. 2011). Although the winters in Oregon from Fall 2009 through late Winter 2016 were relatively mild, an unusual cold event in Dec. 2013 provided some insight into what conditions can cause

damage in 'Columbia Sunrise' as the OSU-NWREC experienced temperatures of -13.3 to -12.7 °C over two nights and on those same two nights, it was -16.6 to -16.0 °C in Corvallis.

The fruit ripening season in Oregon was characterized by the dates on which 5%, 50%, and 95% of the total fruit were harvested (Table 5). Plant ratings were conducted once 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 due to winter injury (9 = no injury; 1 = dead) (Table 6).

Description and Performance

'Columbia Sunrise' was moderate yielding with means comparable to 'Marion' and usually numerically less than 'Black Diamond' (Table 1). There was year-to-year variability for yield, with the highest mean cultivar yield in 2016 (9.61 kg/plant) and lowest in 2015 (4.2 kg/plant).

There were cultivar effects but no significant year effects or an interaction between fruit weight and year. 'Columbia Sunrise' consistently had larger fruit than 'Black Diamond' and 'Marion' (Table 1). Although not directly compared in this planting, 'Columbia Giant' and 'Columbia Star' had larger fruit than 'Columbia Sunrise' (Fig. 2). 'Columbia Sunrise' had an excellent size for clamshell packaging as it looks large but was not so large that packers would have difficulty making their stated unit weight. 'Columbia

Table 2. Subjectively evaluated fruit quality traits for ‘Black Diamond’, ‘Chester Thornless’, ‘Columbia Star’, ‘Columbia Sunrise’, and ‘Marion’ blackberries in a replicated trial (three plots of three plants each) planted in 2012 and evaluated in 2014–16 for sterility, firmness, color, shape, texture, separation, and flavor and only in 2016 for number of fruit per lateral, fruit glossiness, heat/ultraviolet light injury symptoms, and skin toughness at Oregon State University’s North Willamette Research and Extension Center.²

Cultivar	Sterility ¹	Firmness	Color	Shape	Texture	Separation	Flavor	Fruit/lateral	Glossiness	Heat/ultraviolet damage	Skin toughness
Black Diamond	6.5 c	7.0 c	8.3 b	7.3 b	6.8 c	8.3 a	6.1 c	12.3 b	7.5 a	6.0 bc	6.0 c
Chester Thornless	5.9 d	8.3 a	9.0 a	6.0 c	5.6 d	7.3 b	5.6 d	21.5 a	7.3 a	5.0 c	8.5 a
Columbia Star	8.7 a	7.9 b	7.5 c	8.7 a	8.6 a	8.5 a	8.5 a	8.3 c	7.0 a	6.8 b	8.0 ab
Columbia Sunrise	7.5 b	7.6 b	8.0 bc	7.6 b	7.8 b	8.4 a	7.6 b	9.0 c	7.0 a	8.5 a	7.5 b
Marion	6.3 d	4.6 d	7.3 c	5.4 d	8.4 a	8.4 a	8.2 a	9.8 bc	8.0 a	5.5 c	4.2 d

¹A 1 to 9 scale was used where 9 = the best expression of each trait and 1 = the worst for all traits except for fruit/lateral, which was a count.

²Means within a column followed by the same lowercase letter are not significantly different, $P > 0.05$, by least significant difference test.

Sunrise’ had excellent drupelet fertility (as evidenced by uniform fruit shape), better than ‘Marion’, ‘Black Diamond’, and ‘Chester Thornless’ but not as good as ‘Columbia Star’ (Table 2; Figs. 2 and 3A and B). Fruit shape was affected by the genetic background with the semierect cultivars such as Chester Thornless tending to have rounder and less uniformly shaped fruit, whereas the trailing cultivars Columbia Star and Black Diamond tended to be more conical and uniformly shaped. The combination of good drupelet fertility and genetic background affects fruit shape scores. ‘Columbia Sunrise’ was rated as having a fruit shape comparable to ‘Black Diamond’, not as symmetrical and uniform as ‘Columbia Star’, but more attractive than ‘Chester Thornless’ or ‘Marion’ (Fig. 3A and B). Fresh fruit of ‘Columbia Sunrise’ were rated as having better firmness than ‘Marion’ and ‘Black Diamond’, comparable to ‘Columbia Star’, but not as firm as ‘Chester Thornless’ (Table 2). Since the release of ‘Columbia Star’, it has proven to be firm and have few problems with “bleeding” in the local fresh market (Finn et al., 2014). Bleeding is largely due to poor skin drupelet toughness. ‘Columbia Sunrise’ was rated similarly to ‘Columbia Star’ for skin toughness, although not as good as for ‘Chester Thornless’ (Table 2). Although not in the same trial, in the same years of evaluation, ‘Columbia Sunrise’ was rated firmer and with a tougher skin than the early ripening ‘Obsidian’ and ‘Metolius’ (Finn et al., 2005b, 2005c). When eaten, ‘Columbia Sunrise’ fruit texture was rated very good but poorer than ‘Columbia Star’ and ‘Marion’, and much more desirable than ‘Chester Thornless’ (Table 2). ‘Columbia Sunrise’ was picked easily by hand and, in commercial trials, picked well with a machine harvester (Littau Harvester Inc.) (Table 2; Fig. 3B). When eaten fresh in the field, ‘Columbia Sunrise’ fruit flavor was not as outstanding as ‘Columbia Star’ or ‘Marion’ but higher rated than ‘Black Diamond’ or ‘Chester Thornless’ (Table 2). ‘Columbia Sunrise’ was rated outstanding for heat tolerance as it had almost no heat/ultraviolet light injury symptoms. We do not believe that ‘Columbia Star’ fruit are physiologically better able to handle heat/ultraviolet light without showing injury, but rather that with its early ripening, it escapes the conditions that trigger these symptoms.

In Dec. 2014, ‘Columbia Sunrise’ fruit were included in a blind evaluation of

Table 3. Evaluation of ‘Black Diamond’, ‘Columbia Star’, ‘Columbia Sunrise’, and ‘Marion’ blackberries in 2014 as sweetened purées in a blind evaluation by a blackberry evaluation panel (untrained panelists who are blackberry growers, packers, processors, and researchers; $n = 60$).

Cultivar	Aroma	Flavor	Color	Overall quality
Black Diamond	5.78 ab ²	5.48 b	6.40 ab	5.92 a
Columbia Star	5.87 a	6.39 a	6.68 ab	6.49 a
Columbia Sunrise	5.08 b	5.72 ab	6.95 a	5.96 a
Marion	5.53 ab	6.08 ab	6.29 b	6.19 a

²Ranked 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. Soluble solids, pH, and titratable acidity for ‘Black Diamond’, ‘Chester Thornless’, ‘Columbia Star’, ‘Columbia Sunrise’, and ‘Marion’ blackberries grown at Oregon State University’s North Willamette Research and Extension Center and harvested in 2014–16.

Cultivar	Soluble solids		Titratable acidity (g-L ⁻¹ as citric acid)
	°Brix ²	pH	
Black Diamond	11.04 c	3.32 b	12.66 b
Chester Thornless	12.52 b	3.30 bc	10.22 c
Columbia Star	13.38 b	3.24 bc	14.35 ab
Columbia Sunrise	14.27 a	3.55 a	8.10 d
Marion	13.32 b	3.13 c	15.90 a

²Means within a column followed by the same lowercase letter are not significantly different, $P > 0.05$, by least significant difference test.

Table 5. Ripening season estimated as the date at which yield passed the given percentage of total yield for ‘Black Diamond’, ‘Chester Thornless’, ‘Columbia Sunrise’, ‘Marion’, and ‘Prime-Ark[®] Freedom’ and ‘Prime-Ark[®] Traveler’ blackberries in trials planted in 2012 and evaluated in 2014–16 at Oregon State University’s North Willamette Research and Extension Center.

Cultivar	Harvest season		
	5%	50%	95%
Columbia Sunrise	11 June	18 June	2 July
Black Diamond	18 June	29 June	3 July
Marion	23 June	2 July	12 July
Chester Thornless	18 July	3 Aug.	24 Aug.
Prime-Ark [®] Freedom	20 Aug.	27 Aug.	19 Sept.
Prime-Ark [®] Traveler	24 Aug.	3 Sept.	24 Sept.

Table 6. Subjectively evaluated plant traits for ‘Black Diamond’, ‘Chester Thornless’, ‘Columbia Star’, ‘Columbia Sunrise’, and ‘Marion’ blackberries in a replicated trial (three, three plant plots) planted in 2012 and evaluated in 2014–16 at Oregon State University’s North Willamette Research and Extension Center.

Cultivar	Primocane		Florican	Lateral		Winter
	Vigor ²	Spine	Vigor	Length	Strength	Injury
Black Diamond	7.9 b	7.8 b	7.0 d	2.4 d	4.1 a	8.4 a
Chester Thornless	8.7 a	9.0 a	8.6 a	5.0 a	1.8 c	8.6 a
Columbia Star	8.7 a	9.0 a	7.7 bc	3.6 c	3.1 b	7.9 b
Columbia Sunrise	8.3 b	9.0 a	8.0 b	4.5 b	3.0 b	7.2 c
Marion	8.3 b	4.0 c	7.2 cd	5.0 a	2.1 c	6.1 d

²A 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, and winter injury where 9 = no observable injury and 1 = killed to the ground. 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 clusters of ‘Columbia Sunrise’.

sweetened purées of several genotypes by a blackberry evaluation panel to determine how they compared with industry standards (Table 3). As a purée, ‘Columbia Sunrise’ was rated with ‘Marion’ for aroma, flavor, and overall quality and was rated similar to ‘Columbia Star’ for flavor, color, and overall quality but was scored as having poorer fruit aroma. In informal evaluations of thawed IQF fruit by members of the industry and research communities, ‘Columbia Sunrise’ was regularly noted for its pleasant and very sweet flavor.

The perception of very sweet flavor that was regularly noted in the informal evaluations likely reflected the fruit chemistry measurements (Table 4). In three years of evaluation, ‘Columbia Sunrise’ had significantly higher percent soluble solids and pH, and significantly lower titratable acidity than the other cultivars. Although this combination of levels is highly desirable for fresh consumption, it can be problematic for berry processing where a higher level of acidity is often desired for balance in a sweetened product and to help maintain anthocyanins in their most intense red form (Wrolstad et al., 2008).

The most important reason for the release of ‘Columbia Sunrise’ is that it is very early ripening (Table 5). The first ripe fruit of ‘Columbia Sunrise’ were harvested 7 d before ‘Black Diamond’, 11 d before ‘Marion’, and 37 d before ‘Chester Thornless’. The midpoint of harvest was 11 d before that for ‘Black Diamond’, 14 d before ‘Marion’, and 55 d before that for ‘Chester Thornless’. Although not harvested in the same years, observational notes indicate that ‘Columbia Sunrise’ ripens in a similar season to the early ripening, but thorny, ‘Obsidian’ and ‘Metolius’ (Finn et al., 2005b, 2005c). The last pick for ‘Columbia Sunrise’ was similarly much

A



B



Fig. 3. Flats of harvested fruit (A) hand-harvested ‘Columbia Sunrise’ (l) vs. ‘Columbia Star’ (r) and (B) first pick of machine-harvested (Littau Harvester Inc.) ‘Columbia Sunrise’ fruit.

earlier than that for the other cultivars and, of course, the primocane crop on the primocane fruiting cultivars (Prime-Ark® Freedom, Prime-Ark® Traveler) was in a completely different season 2 months later (Table 5). We believe that ‘Columbia Sunrise’ is the earliest ripening thornless blackberry commercially available. This earliness allows growers to extend their season for fresh and processed markets. Perhaps as important, ‘Columbia Sunrise’ will need fewer insecticide sprays for spotted winged drosophila (*Drosophila suzukii* Matsumura) as this pest only begins to build to problematic levels toward the end of ‘Columbia Sunrise’s harvest season.

The primocanes of ‘Columbia Sunrise’ were as vigorous as those of ‘Marion’ and ‘Black Diamond’ but were less vigorous than those of ‘Columbia Star’ or ‘Chester Thornless’ (Table 6; Fig. 4). Since the source of thornlessness in ‘Columbia Sunrise’ is from ‘Lincoln Logan’, the canes are entirely thornless,



Fig. 4. Fruiting plants of ‘Columbia Sunrise’.

whereas those for ‘Black Diamond’, with the ‘Austin Thornless’ source, have thorns at the base of the canes, whereas ‘Marion’ has many large thorns along the entire cane length (Table 6) (Hall et al., 1986). Floricane vigor of ‘Columbia Sunrise’ scored similarly to that of ‘Columbia Star’, less vigorous than that of ‘Chester Thornless’, and more vigorous than that of ‘Marion’. The fruiting laterals of

'Columbia Sunrise' were medium long, not as long as for 'Marion' or 'Chester Thornless', but longer than for 'Columbia Star' and much longer than for 'Black Diamond' (Table 6; Fig. 4). The lateral strength was similar to those for 'Columbia Star' and not nearly as pendulous as for 'Marion' and 'Chester Thornless' (Table 6). With a minimal spray program, no significant incidence of foliar or cane diseases occurred in Oregon, although, in 2014, when the conditions apparently were ideal for purple blotch, the symptoms were much more severe on 'Marion' than on 'Columbia Sunrise' and were comparable to those on 'Black Diamond' (data not shown). With a commercial raspberry fungicide program in Lynden (WA), there were no foliar or cane disease symptoms. Over the years tested in Lynden (WA) and in Corvallis (OR) when potentially injurious temperatures were experienced the previous winters, 'Columbia Sunrise' experienced injury; however, the winter injury scores were consistently better than those for 'Marion' (data not shown). At OSU-NWREC, in replicated trial, 'Columbia Sunrise' was rated as having similar winterhardiness to 'Columbia Star', better hardiness than 'Marion', but not as outstanding hardiness as 'Black Diamond' or 'Chester Thornless'.

'Columbia Sunrise' is introduced as a very early ripening, thornless trailing blackberry with large, firm fruit with a very good sweet flavor and good yields. The early ripening characteristic is expected to reduce the exposure of developing fruit to spotted winged drosophila. 'Columbia Sunrise' fruit are well suited for processing or local fresh market sales. 'Columbia Sunrise' should be adapted

to areas where other trailing blackberries can be successfully grown.

'Columbia Sunrise' nuclear stock has tested negative for *Apple mosaic virus*, *Arabidopsis mosaic virus*, *Cherry leaf roll virus*, *Cherry rasp leaf virus*, *Prunus necrotic ringspot virus*, *Raspberry bushy dwarf virus*, *Raspberry ringspot virus*, *Strawberry necrotic shock virus*, *Tobacco ringspot virus*, *Tobacco streak virus*, *Tomato black ring virus*, *Tomato ringspot virus*, and *Xylella* by enzyme-linked immunosorbent assay. It has also indexed negative on grafting to *Rubus occidentalis* L. and has tested negative for *Blackberry chlorotic ringspot virus*, *Blackberry virus Y*, *Blackberry yellow vein associated virus*, *Black raspberry necrosis virus*, *Raspberry latent virus*, *Raspberry leaf mottle virus*, and *Strawberry latent ringspot virus* in real-time polymerase chain reaction assays for phytoplasmas in polymerase chain reaction assays.

An application for a U.S. Plant Patent has been submitted for 'Columbia Sunrise'. 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 Sunrise' is available on written request to Chad E. Finn. 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 2694.001 (PI 674102), where it will be available for research purposes, including development and commercialization of new cultivars.

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