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‘Columbia Giant’ Thornless Trailing Blackberry

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‘Columbia Giant’ is a new thornless trailing blackberry (*Rubus* subg. *Rubus* Watson) cultivar with very large fruit 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 Giant’ is introduced as a high quality, high yielding, thornless trailing blackberry with good flavor and firm fruit that are suited for local fresh market sales but can be machine harvested for the processing market with very good frozen quality. ‘Columbia Giant’ should be adapted to areas where other trailing blackberries can be grown successfully. A U.S. Plant Patent has been granted (USPP18,369).

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Origin

‘Columbia Giant’, tested as ORUS 3447-2, was selected in Corvallis, OR in 2008 from a cross made in 2005 of NZ 9629-1 and ORUS 1350-2. ‘Columbia Giant’ is a full sibling of ‘Columbia Star’ with an identical pedigree (Fig. 1) and a description of the parents are given in Finn et al. (2014). As with its sibling ‘Columbia Star’, ‘Columbia Giant’ has the ‘Lincoln Logan’ source of thornlessness (botanically “spineless” but commonly referred to as “thornless” in industry and research communities) from NZ 9629-1. ‘Marion’, the standard from the 1970s to recent times in the Pacific Northwest, accounts for 20% of its ancestry (Finn et al., 1997; Hall et al., 1986; Waldo, 1957). The parents represented elite selections from the New Zealand Institute for Plant & Food Research Ltd. and the USDA-ARS, HCRU Oregon breeding programs (Finn et al., 2014). ORUS 1350-2 is thorny, productive, and vigorous with very large, uniformly barrel-shaped fruit that has only fair flavor. NZ 9629-1 is thornless, very productive, and vigorous with small- to medium-sized outstanding flavored, uniformly shaped, conic fruit. The gigantic fruit of ‘Columbia Giant’ are the primary distinguishing factor between it and ‘Columbia Star’ (Figs. 2 and 3A).

‘Columbia Giant’ 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 at 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 weekly 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 [*Septocyta ruborum* (Lib) Petr.], 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 that typical for blackberry.

‘Columbia Giant’ was planted along with other selections and the standards ‘Marion’ and ‘Black Diamond’ in a randomized complete block design with three replications at OSU-NWREC in 2011. 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 et al., 2005; Finn and Strik, 2014; Waldo, 1957). ‘Marion’ accounts for the greatest amount of producing blackberry area in the Pacific Northwest and ‘Black Diamond’ accounts for the greatest number planted in the Pacific Northwest since 2005 (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 2013 to 2015, 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 (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 Giant’ and the named cultivars were included in the analysis. The cultivar × year interaction was significant for yield but not for

Fig. 1. 'Columbia Giant' pedigree.

fruit weight and the means for yield in each year are presented and compared (Table 1).

Subjective fruit evaluations were made during the 2013–15 fruiting seasons using a 1 to 9 scale (9 = the best expression of each trait) (Table 2). 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). Some of the fruit harvested in 2013 was frozen, puréed and sweetened, and assessed in a blind evaluation by a panel composed of industry members 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). Fruit samples of 'Black Diamond', 'Columbia Star', 'Columbia Giant', and 'Marion' were analyzed for the concentration of anthocyanins using previously described separation and identification procedures (Finn et al., 2014; Lee and Finn, 2007) with a longer high-performance liquid chromatography column (Synergi Hydro-RP 80Å, 250 mm × 2 mm, 4 μm; Phenomenex, Inc., Torrance, CA) (Table 5). 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).

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

A harvester (Littau Harvester Inc., Stayton, OR) was used in 2011 at Enfield Farms Inc. to test harvest plots to determine machine harvestability.

Fig. 2. Ripe fruit clusters of 'Columbia Giant'.

Table 1. Berry weight and yield in 2013–15 for 'Black Diamond', 'Columbia Giant', and 'Marion' blackberries at Oregon State University's North Willamette Research and Extension Center in replicated trial (three, three plant plots) planted in 2011.[z]

	Berry wt (g)	Yield (kg/plant)			
Cultivar	2013–15	2013	2014	2015	2013–15
Black Diamond	5.7 b	6.51 b	2.90 bc	4.63 a	4.68 b
Columbia Giant	12.0 a	9.23 a	4.49 a	4.07 a	5.93 a
Marion	5.2 b	5.30 b	3.01 ab	3.15 a	3.82 c

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

Table 2. Subjectively evaluated fruit quality traits for 'Black Diamond', 'Columbia Giant', and 'Marion' blackberries in a replicated trial (three, three plant plots) planted in 2011 and evaluated in 2013–15 at Oregon State University's North Willamette Research and Extension Center.[z]

Cultivar	Sterility[y]	Firmness	Color	Shape	Texture	Flavor
Black Diamond	7.4 b	7.1 b	8.1 a	8.5 a	7.0 b	5.9 c
Columbia Giant	8.8 a	8.0 a	8.0 a	8.6 a	8.2 a	7.3 b
Marion	6.3 c	4.5 c	7.7 a	5.6 b	7.7 ab	8.1 a

[z]A 1 to 9 scale was used where 9 = the best expression of each trait and 1 = the worst.
[y]Means within a column followed by the same lowercase letter are not significantly different, $P > 0.05$, by least significant difference test.

Table 3. Evaluation of 'Black Diamond', 'Columbia Giant', 'Columbia Star', and 'Marion' blackberries in 2014 as sweetened purées in a blind evaluation by a panel composed of industry members and researchers (blackberry growers, processors, and fieldmen; $n = 54$).

Cultivar	Aroma[z]	Flavor	Color	Overall quality
Black Diamond	5.72 a	5.44 b	6.35 a	5.93 a
Columbia Giant	6.20 a	6.57 a	6.42 a	6.59 a
Columbia Star	5.83 a	6.31 a	6.70 a	6.46 a
Marion	5.59 a	6.06 ab	6.25 a	6.20 a

[z]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. Soluble solids, pH, and titratable acidity of fruit for five blackberry cultivars grown at Oregon State University's North Willamette Research and Extension Center and harvested in 2012–15.

Cultivar	Soluble solids (°Brix)[z]	pH	Titratable acidity (g·L^{-1} as citric acid)
Black Diamond	11.79 c	3.37 a	12.23 c
Chester Thornless	12.54 b	3.28 b	10.86 d
Columbia Giant	11.72 c	3.18 bc	18.75 a
Columbia Star	13.18 a	3.20 bc	15.14 b
Marion	13.70 a	3.14 c	15.88 b

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

Fig. 3. Flats of hand-harvested fruit of 'Columbia Giant' vs. (**A**) 'Columbia Star', (**B**) 'Black Diamond', and (**C**) 'Marion' with 'Columbia Giant' on the left in each pairing.

At OSU-NWREC, plant ratings were conducted one time each year during the fruiting season for primocane and floricane 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 7).

In 2009, 'Columbia Giant' was planted along with several other genotypes in plots at Enfield Farms Inc. to assess cold hardiness and suitability for machine harvest. While observations were made on these plants from 2010 to 2012, the winters were relatively mild (minimum temperature –9.0 to –8.9 °C in Dec. 2009, Nov. 2010, and Feb. 2011). Winters in Oregon from Fall 2009 through late Winter 2016 were relatively mild; however, an unusual cold event in Dec. 2013 provided some insight into what conditions can cause severe damage in 'Columbia Giant'. 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, OR.

Description and Performance

'Columbia Giant' was higher yielding than current standards 'Black Diamond' and 'Marion' based on a 3-year mean (Table 1). In each year, 'Columbia Giant' had a higher yield than 'Marion'. For unknown reasons, the 'Black Diamond' plants did not establish as well as would normally be expected and this was reflected in a lower than typical yield. The 'Marion' plants grew as expected and were typical. We are confident that in commercial production, 'Columbia Giant' will have yields greater than 'Marion' but suspect that the yields will be comparable or less than those of 'Black Diamond'. There was year-to-year variability for yield, with the largest yield in 2013 ($P \leq 0.05$). Yield was reduced in 2014 because of winter injury to the plants in Dec. 2013.

There was no significant interaction between fruit weight and year, and 'Columbia Giant' consistently had larger fruit than 'Black Diamond' and 'Marion' (Table 1). We believe that 'Columbia Giant' is the largest fruited,

Table 5. Anthocyanin concentrations (mg of cyanidin-3-glucoside/100 g) of 'Columbia Giant', 'Columbia Star', 'Marion', and 'Black Diamond' blackberries harvested in 2014 from trials at Oregon State University's North Willamette Research and Extension Center.[z]

Cultivar	Cyanidin-3-glucoside	Cyanidin-3-rutinoside	Cyanidin-3-xyloside	Cyanidin-3-malonylglucoside	Cyanidin-3-dioxalylglucoside[y]	Total
Black Diamond	69.0 (*76*)	20.6 (*23*)	0.4 (*0*)	1.1 (*1*)	Not detected	91.0
Columbia Giant	78.4 (*66*)	39.5 (*33*)	0.6 (*1*)	0.3 (*0*)	Not detected	118.9
Columbia Star	98.2 (*70*)	39.9 (*29*)	0.3 (*0*)	1.1 (*1*)	Not detected	139.5
Marion	98.2 (*70*)	37.9 (*27*)	0.7 (*0*)	1.2 (*1*)	3.2 (*2*)	141.1

[z]Anthocyanin listed in the order of high-performance liquid chromatography elution. Values in italic font are percentages of the total anthocyanins.
[y]Possibly cyanidin-hydroxymethylglutaroylglucoside (Jordheim et al., 2011).

Table 6. Ripening season estimated as the date at which yield passed the given percentage of total yield for five blackberry cultivars in trials planted in 2011 and evaluated in 2013–15 at Oregon State University's North Willamette Research and Extension Center.

	Harvest season		
Cultivar	5%	50%	95%
Columbia Giant	22 June	3 July	17 July
Black Diamond	24 June	3 July	17 July
Marion	26 June	5 July	15 July
Navaho	26 June	5 July	15 July
Chester Thornless	31 July	12 Aug.	30 Aug.

thornless, trailing cultivar commercially available. The large fruit size makes it particularly attractive for roadside marketing and homeowners but may be problematic for the wholesale fresh market as a very large berry can cause problems with making the stated unit weight when packing fresh fruit in clamshells (Fig. 3). 'Columbia Giant' 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 uneven (Table 2; Fig. 3). Fresh fruit of 'Columbia Giant' were rated as having better firmness than either of the current industry standards. Since its release, 'Columbia Star' has proven to be firm and have few problems with bleeding in the local fresh market (Finn et al., 2014) and 'Columbia Giant' is expected to be equally adapted to this market based on its firmness and shape. Fruit color was rated similarly among all three cultivars in trial (Table 2). When eaten, 'Columbia Giant' was rated as having a comparable texture to 'Marion' which is excellent. Although 'Columbia Giant' is likely to be picked largely by hand for the fresh market, it was harvested as easily as the industry standards by machine (Table 2). When eaten fresh in the field, 'Columbia Giant' fruit flavor was not as outstanding as 'Marion', but much better than 'Black Diamond' (Table 2). 'Columbia Giant' must be picked fully ripe or it may be too tart for fresh market sales.

Plots of 'Columbia Giant', 'Marion', and 'Black Diamond' in Lynden (WA) and at OSU-NWREC were harvested with a harvester. Whereas the fruit was picked easily with good quality in 1 year, in the second year, underripe fruit with unripe tips were often unintentionally harvested. In general, it is expected that very little 'Columbia Giant' will be harvested by machine, but for late season picks of fruit that are not suited for the fresh market, growers should be able to modify their approach to harvest and get a product of desired maturity.

'Columbia Giant' fruit were included in a blind evaluation of several genotypes as sweetened purées in Dec. 2011 to determine how they compared with industry standards (Table 3). 'Columbia Giant' had comparable performance for aroma, flavor, color, and overall quality with its sibling 'Columbia Star' and 'Marion', which are considered industry standards for quality. 'Columbia Giant' was rated better than 'Black Diamond' for flavor (Table 3). In informal evaluations by members of the industry and research communities, of thawed individually quick frozen (IQF) fruit, 'Columbia Giant' was regularly noted for having a good but tart flavor.

Over the 3 years of evaluation, 'Columbia Giant' fruit consistently had soluble solids similar to those for 'Black Diamond' fruit but less than 'Chester Thornless', 'Marion', or 'Columbia Star' (Table 4). 'Columbia Giant' fruit had a pH comparable to the other cultivars in trial except for Black Diamond, which had a higher pH (Table 4). 'Columbia Giant' fruit had the highest titratable acidity of all cultivars in trial. As was noted previously related to perception of sweetness or tartness in the fruit, thawed IQF fruit of 'Columbia Giant' were often more acidic than were desired but when sweetened, as in the tested purée's, the flavor was outstanding.

The total anthocyanin concentration of 'Columbia Giant' fruit was in an intermediate range (118.9 mg/100 g) when contrasted to the other cultivars. 'Columbia Star' and 'Marion' concentrations were higher and fairly similar to each other, whereas 'Black Diamond' had the lowest amount (91.0 mg/100 g) (Table 5). All four cultivars evaluated contained only cyanidin-based anthocyanins. 'Columbia Giant' had cyanidin-3-glucoside as its chief anthocyanin (66% of total), followed by cyanidin-3-rutinoside (33% of total); that proportion of cyanidin-3-rutinoside in 'Columbia Giant' was slightly higher than in the other three cultivars (23% to 29% of total). Cyanidin-3-dioxalylglucoside (possibly cyanidin-hydroxymethylglutaroylglucoside; Jordheim et al., 2011) was not detected in 'Columbia Giant', 'Columbia Star', or 'Black Diamond' fruit, although it was measured in 'Marion' fruit.

'Columbia Giant' ripened in the early midseason for trailing blackberries, similar to 'Black Diamond', a couple of days before 'Marion', and weeks ahead of 'Navaho' erect and 'Chester Thornless' semierect blackberries (Table 6). The harvest interval (5% to 95% ripe) for 'Marion' was ≈19 d. 'Black Diamond' and 'Columbia Giant' had about a 23–25-d-harvest interval, whereas 'Navaho' and 'Chester Thornless' had 40- and 30-d-harvest intervals, respectively.

The canes of 'Columbia Giant' were as vigorous as those of 'Marion' and 'Black Diamond' (Table 7). 'Columbia Giant', with the 'Lincoln Logan' thornlessness, was completely thornless, whereas 'Black Diamond', with Austin Thornless' thornlessness, had basal thorns, and 'Marion' was thorny (Table 7) (Hall et al., 1986). Floricanes of 'Columbia Giant' 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 Giant' than in 'Marion' (Table 7). 'Columbia Giant' fruiting laterals were similar in length to those of 'Marion' and longer than those for 'Black Diamond'. 'Columbia Giant's laterals were held upright and more strongly than those for 'Marion' that tended to droop, but were not as stiff as those of 'Black Diamond' (Table 7). The combination of relatively stiff laterals and very large fruit mean that the fruit were well displayed for easy hand harvest (Fig. 4). Despite well-displayed fruit, no particular susceptibility to ultraviolet light (ultraviolet) damage was noted (symptoms of sunburn or white drupelets). However, this may just reflect the relatively early ripening period for 'Columbia Giant' rather than higher levels of ultraviolet tolerance. 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). Over 3 years (2013–15), 'Black Diamond' had the least winter injury, 'Marion' the most, and 'Columbia Giant' was intermediate. All three cultivars were injured by an unusually early, very cold freeze event in Dec. 2013, when the temperature was –13.3 to –12.7 °C over two nights, and as with the overall mean scores, 'Marion' was noted for the most injury and 'Black Diamond' the least in Spring 2014 (Table 7).

'Columbia Giant' is introduced as a high-yielding, thornless trailing blackberry with very large, firm fruit with very good flavor. Although 'Columbia Giant' fruit are well suited for processing, it is expected that the primary use of this cultivar will be for the fresh market. 'Columbia Giant' should be adapted to areas where other trailing blackberries can be successfully grown.

'Columbia Giant' nuclear stock has tested negative for *Apple mosaic virus*, *Arabis mosaic virus*, *Cherry leaf roll virus*, *Cherry rasp leaf virus*, *Prunus necrotic ringspot virus*,

Table 7. Subjectively evaluated plant traits for 'Black Diamond', 'Columbia Giant', and 'Marion' blackberries in a replicated trial (three, three plant plots) planted in 2011 and evaluated in 2013–15 at Oregon State University's North Willamette Research and Extension Center.

	Primocane			Lateral		
Cultivar	Vigor[z]	Spine	Floricane vigor	Length	Strength	Winter injury
Black Diamond	7.9 a	8.1 b	7.1 a	2.6 b	3.3 a	8.1 a
Columbia Giant	8.1 a	9.0 a	7.1 a	4.8 a	2.6 b	7.3 b
Marion	8.0 a	4.0 c	6.3 b	5.0 a	2.0 c	5.5 c

[z]A 1 to 9 scale was used where 9 = the best expression of each trait (greatest vigor, completely spineless, and least winter injury) and 1 = the worst for all traits (weakest vigor, completely spiny with large spines, and completely dead to the ground after winter) 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. 4. Fruiting plants of 'Columbia Giant'.

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, has indexed negative on grafting to *R. 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*, *Rubus yellow net virus*, and *Strawberry latent ringspot virus* in real-time polymerase chain reaction assays for phytoplasmas in polymerase chain reaction assays.

When this cultivar 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 Giant' 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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