

‘Twilight’ Thornless Semi-erect Blackberry

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‘Twilight’ is a thornless, semi-erect, high-quality blackberry (*Rubus* subg. *Rubus* Watson) that has very firm, large, dark, and sweet fruit suited for the fresh market; it ripens in the early midseason for a semi-erect type of blackberry. ‘Twilight’ was released by the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) breeding program in Corvallis, OR in cooperation with Oregon State University’s Agricultural Experiment Station. This cultivar is an offspring of blackberries similar in pedigree to Eclipse and Galaxy, that combine germplasm from the eastern and western North American blackberry germplasm pools (Finn et al., 2020a, 2020b). ‘Twilight’ produces good yields of very firm fruit with tough skin and an excellent, sweet flavor. ‘Twilight’ fruit should be well suited to fresh market production in the early-midseason because it was earlier than ‘Triple Crown’, had a similar appealing flavor as ‘Triple Crown’, but was much firmer and with a tougher skin. ‘Twilight’ is expected to be adapted to areas where other semi-erect blackberries (e.g., ‘Chester Thornless’, ‘Triple Crown’) can be grown successfully. A U.S. Plant Patent has been granted (USPP 30,879) (Finn, 2019).

Origin

‘Twilight’, tested as ORUS 4370-1, was selected in Corvallis, OR in 2012 from a cross made in 2009 of ‘Ouachita’ and ORUS 2867-4 (‘Triple Crown’ × ORUS 1393-1) (Fig. 1). ‘Twilight’ is seven-eighths eastern U.S. blackberry and one-eighth western blackberry ancestry. ‘Ouachita’ is an erect thornless blackberry developed at the University of Arkansas (Clark and Moore, 2005). ORUS 2867-4 shares similar parents with ‘Galaxy’ (Finn et al., 2020b); and while a mixed pedigree, its growth habit most closely resembles semi-erect blackberries like ‘Triple Crown’ (Galletta et al., 1998b). ‘Ouachita’ and ORUS 2867-4 trace their thornlessness to ‘Merton Thornless’ (Crane, 1943; Jennings, 1986). ‘Ouachita’ and ‘Triple Crown’ are tetraploid ($2n = 4x = 28$), while the grandparent hybrid ORUS 1393-1 is a pentaploid (Meng and Finn, 2002; Thompson, 1995). Based on flow cytometry, ‘Twilight’ is a tetraploid.

‘Twilight’ was evaluated most extensively in trials at Oregon State University’s North Willamette Research and Extension Center (OSU-NWREC, Aurora, OR), Oregon

State University’s Lewis Brown farm (Corvallis, OR), and Enfield Farms Inc. (Lynden, WA). In the Oregon trial plantings, standard cultural practices for semi-erect blackberry production were used, including annual pre- and post-emergent herbicide applications, spring nitrogen fertilization ($78 \text{ kg} \cdot \text{ha}^{-1} \text{ N}$), post-harvest removal of floricanes, cutting of primocanes at 1.0 m to encourage branching, training of primocanes to a two-wire-trellis, and application of 2.5 to 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* (Westendorp) Verkley, Quaedvlieg & Crous (formerly *Septoria 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, ‘Twilight’ was planted in a replicated trial in 2013, along with other selections and reference cultivars Chester Thornless and Triple Crown in a randomized complete block design with three replications (Galletta et al., 1998a, 1998b). 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 sub-sample from each harvest) (Finn et al., 2005; Finn and Strik, 2014). ‘Chester Thornless’ accounts for the largest area planted of semi-erect blackberry grown for the wholesale fresh market in the Pacific Northwest (Galletta et al., 1998a). ‘Triple Crown’ is commonly grown for roadside and farmers’ market sales where its large fruit size and outstanding flavor are prized, but its softness and tender skin prevent it from being shipped a significant distance. A weighted mean fruit mass was calculated that adjusts the average mean fruit mass based on the proportion of the total yield harvested on each pick (Finn et al., 2005, 2014). These data, collected from 2015 to 2017, 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). LSD are only presented when there were significant differences for the trait. Of the multiple genotypes harvested from this replicated trial, only the data from ‘Twilight’ and the reference cultivars were included in the analysis (Table 1). The cultivar × year interaction was significant for yield, but not for fruit weight.

Fruit evaluations were made weekly during the harvest seasons using a 1 to 9 scale

(9 = the best expression of each trait). The subjective fruit ratings included drupelet fertility (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 2015–17. The number of fruit per lateral was determined based on counting the fruit on five typical fruiting laterals in each plot once during the season in 2015–17.

Titrate acidity, percent soluble solids, and pH were determined from harvested fruit (Table 3). Fruit samples of ‘Black Diamond’, ‘Chester Thornless’, ‘Columbia Star’, ‘Hall’s Beauty’, ‘Marion’, and ‘Twilight’ were analyzed for the concentration of anthocyanins, using previously described separation and identification procedures (Finn et al., 2014; Lee and Finn, 2007) (Table 4). In separate trials, fruit were also evaluated informally as a thawed, individually quick frozen (IQF) product by growers, processors, and researchers.

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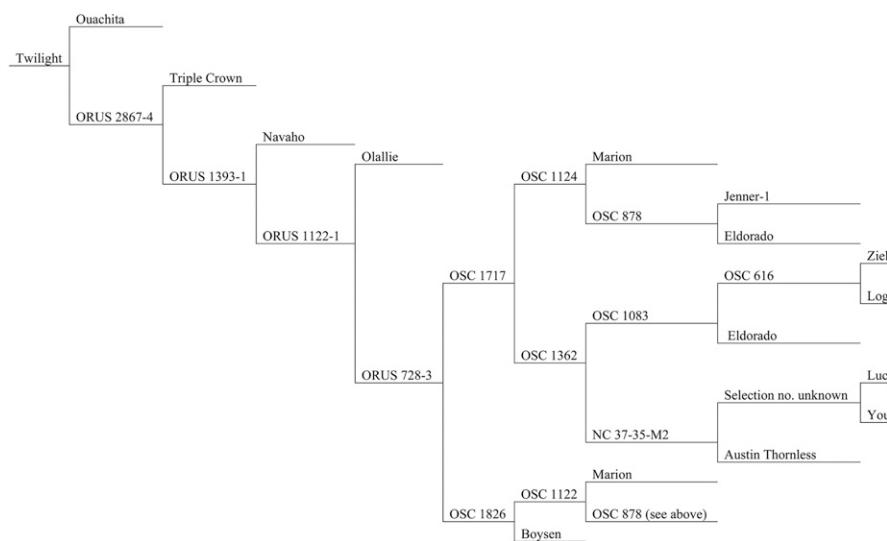


Fig. 1. Pedigree for ‘Twilight’. The female parent is shown on top.

Table 1. Berry weight and yield in 2015–17 for ‘Chester Thornless’, ‘Twilight’, and ‘Triple Crown’ blackberries at Oregon State University’s North Willamette Research and Extension Center (Aurora, OR); planted in replicated trial (three plots of three plants each) in 2013.

Cultivar	Berry wt (g) 2015–17 ^z	Yield (kg/plant) ^z			2015–17
		2015	2016	2017	
2015	7.1 a				8.69 b
2016	7.1 a				9.29 b
2017	8.0 a				13.61 a
Chester Thornless	6.3 b	8.40 b	10.45 a	14.97 a	11.16 a
Triple Crown	8.1 a	11.44 a	9.14 a	14.39 a	11.66 a
Twilight	8.7 a	8.26 b	9.31 a	11.76 b	9.98 b

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

In 2016 and 2018, ‘Twilight’ was planted with other genotypes in plots at Enfield Farms Inc. (Lynden, WA) to assess cold hardiness. While observations were made on these plants from 2016 to 2019, the winters were relatively mild (minimum temperature was -10.0 to -7.2 °C in Feb. 2017, Dec. 2017, and Feb. 2019). The winters in Oregon from Fall 2014 through late Winter 2019 were relatively mild, with annual minimum temperature ranging from -9.9 to -5.2 °C.

The fruit ripening season in Oregon was characterized by the dates on which 5%, 50%, and 95% of total yield was harvested (Table 5). Plant ratings were conducted once each year during the fruiting season for primocane and florican vigor, 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 (1 = dead; 9 = no injury) (Table 6).

Description and Performance

‘Twilight’ yield was moderate and comparable to the other commercial cultivars evaluated in the same trial (Table 1). Over the 3 harvest years, ‘Twilight’ was lower yielding than ‘Chester Thornless’ and ‘Triple Crown’; however, in individual years, it was statistically like one or the other. In this and

other trials (Table 1, data not shown), ‘Twilight’ plants seem slower to establish, and yields during the first harvest years are less than when plants are well established (data not shown).

There were statistically significant differences between cultivar fruit-weight means, but no significant year or cultivar $\times$ year effects. ‘Twilight’ fruit are comparable in weight to ‘Chester Thornless’ and lighter than those for ‘Triple Crown’ (Table 1). ‘Twilight’ had an excellent size for clamshell packaging. The number of fruit per lateral for ‘Twilight’ was comparable to ‘Triple Crown’ and much fewer than for ‘Chester Thornless’ (Table 2). ‘Twilight’ has a more uniform and attractive, somewhat blocky shape than either ‘Chester Thornless’ or ‘Triple Crown’, which tend to be lumpier (Figs. 2 and 3). Fruit shape can be impacted by drupelet fertility; and while ‘Twilight’ had the highest rating for fertility, it was not statistically different from the other two cultivars (Figs. 2 and 3; Table 2) (Strik et al., 1996). ‘Twilight’ has excellent black color that was comparable with ‘Chester Thornless’; and while statistically darker than ‘Triple Crown’ (Fig. 4), the color was not meaningfully different from ‘Triple Crown’. ‘Twilight’ has been rated as having comparable firmness and skin toughness to ‘Chester Thornless’, and it has rated much

Table 2. Subjectively evaluated flowering date, fruiting traits, and fruit per lateral count in 2015–17 for ‘Chester Thornless’, ‘Twilight’, ‘Eclipse’, and ‘Triple Crown’ blackberries at Oregon State University’s North Willamette Research and Extension Center (Aurora, OR); planted in replicated trial (three plots of three plants each) in 2013.^z

Cultivar	Date 10% flowering ^y	Date 10% ripe	Fruit/lateral	Drupelet fertility	Shape	Firmness	Color	Glossiness	Heat/ultraviolet damage	Separation	Skin toughness	Texture	Flavor
Chester Thornless	20 May a	13 July a	19.3 a	6.0 a	6.0 b	8.4 b	9.0 a	7.8 b	4.9 b	7.6 a	8.3 b	5.1 b	5.2 b
Eclipse	10 May c	4 July c	10.0 b	6.9 a	6.9 a	8.6 ab	9.0 a	8.8 a	6.8 a	6.1 b	8.4 b	5.9 a	7.3 a
Triple Crown	20 May a	13 July a	9.9 b	6.5 a	6.1 b	6.1 c	8.8 b	7.9 b	7.1 a	8.1 a	5.5 c	5.5 ab	7.2 a
Twilight	13 May b	8 July b	7.5 b	6.4 a	6.6 a	8.9 a	9.0 a	9.1 a	6.5 a	7.8 s	9.1 a	6.0 a	7.1 a

^zA 1 to 9 scale was used where 9 = the best expression of each trait and 1 = the worst for all traits except for flowering date, which was an estimate of when 10% of the flowers were opened, and fruit/lateral, which was a count.

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

Table 3. Soluble solids, pH, and titratable acidity for the fruit of ‘Twilight’, ‘Eclipse’, ‘Triple Crown’, and ‘Chester Thornless’ semi-erect and ‘Black Diamond’, ‘Columbia Star’, ‘Hall’s Beauty’, and ‘Marion’ trailing blackberries from plants grown at Oregon State University’s North Willamette Research and Extension Center (Aurora, OR) and harvested in 2015–17.

Cultivar	Soluble solids (%) ^z	pH	Titratable acidity (g·L ⁻¹ as citric acid)
Black Diamond	11.83 a	3.38 a–c	11.68 b
Chester Thornless	12.09 a	3.29 c	11.08 bc
Columbia Star	13.13 a	3.27 c	13.81 a
Eclipse	13.20 a	3.51 ab	9.09 d
Hall’s Beauty	13.56 a	3.33 bc	12.49 ab
Marion	13.13 a	3.28 c	14.18 a
Triple Crown	15.23 a	3.54 a	9.18 cd
Twilight	13.08 a	3.51 a	8.58 d

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

Table 4. Anthocyanin concentrations (mg of cyanidin-3-glucoside/100 g) of ‘Twilight’ and ‘Chester Thornless’ semi-erect along with ‘Black Diamond’, ‘Columbia Star’, ‘Hall’s Beauty’, and ‘Marion’ trailing blackberries harvested in 2017 from trials at Oregon State University’s North Willamette Research and Extension Center (Aurora, OR).^z

Cultivar	Cyanidin-3-glucoside	Cyanidin-3-rutinoside	Cyanidin-3-xyloside	Cyanidin-3-malonylglucoside	Cyanidin-3-dioxalylglucoside ^y	Total
Black Diamond	139.1 (79)	33.0 (19)	2.7 (1)	2.3 (1)	Not detected	177.1
Chester Thornless	266.7 (89)	1.4 (0)	11.1 (4)	7.6 (3)	11.7 (4)	298.6
Columbia Star	168.3 (75)	53.4 (24)	1.0 (0)	2.1 (1)	Not detected	224.8
Hall’s Beauty	242.2 (73)	78.8 (24)	1.0 (0)	3.3 (1)	5.6 (2)	330.9
Marion	261.5 (80)	54.9 (17)	2.2 (1)	3.0 (1)	5.1 (2)	326.7
Twilight	147.9 (90)	1.5 (1)	12.6 (8)	1.7 (1)	Not detected	163.6

^zAnthocyanin listed in the order of high-performance liquid chromatography elution. Values in parentheses are percent proportions of the total anthocyanins.

^yPossibly cyanidin-hydroxymethylglutarylglucoside (Jordheim et al., 2011), but need confirmation by an additional independent research group.

Table 5. Ripening season estimated as the date at which yield passed the given percentage of total yield in 2015–17 for the semi-erect ‘Chester Thornless’, ‘Eclipse’, ‘Triple Crown’, ‘Twilight’, and ‘Von’, the trailing ‘Black Diamond’, ‘Columbia Star’, ‘Hall’s Beauty’, and ‘Marion’, and the primocane-fruiting ‘Prime-Ark®45’ at Oregon State University’s North Willamette Research and Extension Center (Aurora, OR); planted in 2013.

Cultivar	Harvest season			Days from 5% to 95%
	5%	50%	95%	
Chester Thornless	17 July	2 Aug.	21 Aug.	35.0
Eclipse	15 July	17 July	7 Aug.	22.3
Triple Crown	17 July	31 July	9 Aug.	23.3
Twilight	10 July	21 July	9 Aug.	30.0
Von	10 July	17 July	4 Aug.	25.3
Black Diamond	20 June	30 June	17 July	27.0
Columbia Star	20 June	26 June	7 July	17.7
Hall’s Beauty	22 June	26 June	10 July	18.3
Marion	24 June	30 June	15 July	20.7
Prime-Ark 45	25 Aug.	13 Sept.	29 Sept.	35.0

better than the softer, more tender-skinned ‘Triple Crown’ (Table 2). This combination of firmness, uniformity of shape, medium- to large size, and excellent skin toughness make

‘Twilight’ an excellent candidate for shipping in clamshells in the wholesale fruit market. When eaten fresh, ‘Twilight’ fruit texture was comparable with ‘Triple Crown’

and more pleasant than ‘Chester Thornless’ (Table 2). ‘Twilight’ fruit were harder to pick than the other cultivars in the trial (Table 2). When eaten fresh, ‘Twilight’ fruit flavor was as good as the highly regarded ‘Triple Crown’ and better than ‘Chester Thornless’ (Table 2). In general, the semi-erect and erect blackberries show more symptoms of heat damage than do the trailing types. While this may be under control of a genetic component, we suspect it is largely due to the earlier ripening of the trailing types when there are fewer high temperature events. All of the semi-erect blackberries compared showed symptoms of heat injury, however the symptoms were much more severe on ‘Chester Thornless’ than they were for ‘Twilight’ or ‘Triple Crown’ (Table 2). In California, ‘Twilight’ held up well and was still sweet and firm after hot (43 °C) temperatures (Willems Family Farm, personal communication).

In multiple years of evaluation, ‘Twilight’ had percent soluble solids comparable with most cultivars evaluated (Table 3). The pH of the ‘Twilight’ fruit puree was in the range typically observed for blackberries, though it was higher than that of ‘Chester Thornless’, ‘Columbia Star’, ‘Eclipse’, ‘Hall’s Beauty’, and ‘Marion’. ‘Twilight’ fruit had lower titratable acidity than most of the trailing blackberries including ‘Black Diamond’, ‘Columbia Star’, ‘Hall’s Beauty’, and ‘Marion’. This combination of high soluble solids, moderate pH, and low titratable acidity levels puts ‘Twilight’ in a range that is desirable for fresh consumption, as the fruit are perceived as being sweet.

For all the blackberry cultivars evaluated, cyanidin-3-glucoside was the main anthocyanin (Table 4). The total anthocyanin concentration for ‘Twilight’, ‘Galaxy’ (Finn et al., 2020a), and ‘Black Diamond’ was much lower than the other three trailing blackberries (‘Columbia Star’, ‘Hall’s Beauty’, and ‘Marion’). ‘Twilight’ and ‘Galaxy’ (Finn et al., 2020b) had much lower proportions of cyanidin-3-rutinoside than the trailing blackberries. ‘Twilight’ had no cyanidin-3-dioxalylglucoside; while, at relatively low proportions, ‘Chester Thornless’, ‘Hall’s Beauty’, and ‘Marion’ were the only cultivars with detectable levels.

The trailing cultivars reached 50% ripe 14–18 d ahead of ‘Twilight’ (Table 5). ‘Von’ started and finished harvest a few days earlier than ‘Twilight’, but they had the same 50%

Table 6. Subjectively evaluated plant traits in 2015–17 for ‘Chester Thornless’, ‘Eclipse’, ‘Twilight’, and ‘Triple Crown’ blackberries at Oregon State University’s North Willamette Research and Extension Center (Aurora, OR); planted in replicated trial (three plots of three plants each) in 2013.

Cultivar	Primocane vigor ^a	Floricanes vigor	Lateral		Winter injury
			Length	Strength	
Chester Thornless	8.6 a	8.3 bc	4.9 a	1.6 c	9.0 a
Eclipse	8.3 b	8.5 ab	3.8 b	3.3 a	8.8 a
Triple Crown	8.8 a	8.9 a	5.1 a	2.7 b	8.8 a
Twilight	8.3 b	8.0 c	3.5 c	2.4 b	8.6 a

^aA 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 letter are not significantly different, $P > 0.05$, by least significant difference test.



Fig. 2. Typical fruiting laterals with ripe fruit of ‘Twilight’.

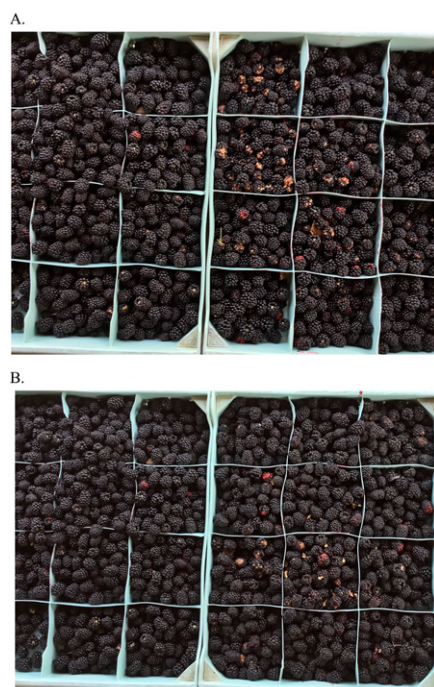


Fig. 3. Flats of hand-harvested fruit. (A) ‘Twilight’ (left) vs. ‘Chester Thornless’ (right); and (B) ‘Twilight’ (left) vs. ‘Triple Crown’ (right).

harvest date. The 50% harvest date for ‘Twilight’ was 14 d ahead of ‘Triple Crown’ and 16 d ahead of ‘Chester Thornless’. Not surprisingly, based on ripening season, ‘Twilight’ began flowering 10 d before ‘Chester Thornless’ and ‘Triple Crown’ (Table 2). All cultivars ripened their crop much earlier than the primocane crop of ‘Prime-Ark®45’.



Fig. 4. Clamshells of fresh ‘Twilight’ (left) vs. ‘Chester Thornless’ (right) fruit after 14 d storage at 1 to 3 °C.

The primocanes of ‘Twilight’ were slightly less vigorous than those of ‘Chester Thornless’ and ‘Triple Crown’. While differences were noted for floricanes vigor, they were not significant; all three of these cultivars grow very well vegetatively. What cannot be captured with a score, is how erect growth was in ‘Twilight’ after cutting the primocanes to 1 m in the summer. The laterals that break grow straight up and typically grow up to 1 m above the trellis. While different management practices were not tried, tipping the primocanes much lower to the ground and having the laterals that break fill the trellised canopy, as opposed to being over it, may increase the area of the fruiting zone and yield. ‘Twilight’ had shorter and stronger laterals than the two other cultivars (Table 6). All cultivars showed excellent winter tolerance wherever they were trialed. While the overall adaptation of ‘Twilight’ to the eastern United States has not been well tested, it has proven to be winter hardy in Arkansas (J.R. Clark, personal communication) and North Carolina (G.R. Fernandez, personal communication), but not in Massachusetts (P. Rizzo, personal communication). In Arkansas, ‘Twilight’ was susceptible to

diseases, such as anthracnose, common in areas with warm summers and high humidity.

With a minimal spray program, no significant incidence of foliar or cane diseases occurred in Oregon. With a commercial raspberry fungicide program in Lynden (WA), no foliar or cane disease symptoms were observed. As with all semi-erect or erect blackberry genotypes growing in the western United States, ‘Twilight’ is susceptible to redberry mite (*Acalitus essigi* Hassan) and spotted winged drosophila (*Drosophila suzukii* Matsumura).

As mentioned, ‘Twilight’ is a thornless, semi-erect blackberry. It has good yields of firm fruit, featuring tough skins (Table 2) and a sweet flavor. The fruit should be well suited to fresh-market production in the early-midseason because it was earlier than ‘Triple Crown’. It had a similar appealing flavor to ‘Triple Crown’ but its skin was firmer and tougher. While ‘Twilight’ is expected to be adapted to areas where other semi-erect blackberries (e.g., ‘Chester Thornless’, ‘Triple Crown’) can be successfully grown, it should be evaluated in colder regions before being widely planted, as one of its grandparents is a winter-sensitive trailing blackberry.

Parentage of ‘Twilight’ was confirmed by microsatellite analysis using a fingerprinting set of eight simple sequence repeat (SSR) markers that we have developed at the USDA–ARS National Clonal Germplasm Repository to genotype our blackberry collection (Zurn et al., 2018). All the alleles amplified in ‘Twilight’ were found in at least one of its parents, ‘Ouachita’ and/or ORUS 2867-4 (Table 7). One to two alleles at five (RH_MEa007aG06, RH_MEa008cF01, ERubLRSQ_07-4_D05, RH_MEa0015cE06, and RH_MEa011dG03a) of the eight SSRs were uniquely shared with ‘Ouachita’; and one to two alleles (at all but RH_MEa0006bG05), could only be inherited from the other parent, ORUS 2867-4. This confirms pedigree of ‘Twilight’ as resulting from the cross between ‘Ouachita’ and ORUS 2867-4.

‘Twilight’ nuclear stock has tested negative for *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*, *Tomato ringspot virus* and *Tomato black ring virus* and *Xylella fastidiosa* by ELISA. It also tested negative for *Apple mosaic virus*, *Blackberry chlorotic ringspot virus*, *Beet pseudo yellows virus*, *Blackberry virus E*, *Blackberry virus X*, *Blackberry virus Y*, *Blackberry yellow vein associated virus*, *Black raspberry necrosis virus*, *Impatiens necrotic spot virus*, *Raspberry latent virus*, *Raspberry leaf mottle virus*, *Rubus yellow net virus*, *Strawberry latent ringspot virus*, *Tomato ringspot virus* in RT-PCR assays and for phytoplasmas, and *Xylella fastidiosa* in PCR assays. It was also negative in bioassays when it was grafted onto *R. occidentalis* ‘Munger’.

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.

Table 7. Genetic profiles of the parents, ‘Ouachita’ and ORUS 2867-4, and the offspring, ‘Twilight’ at each of the eight simple sequence repeat (SSR) markers in the blackberry fingerprinting set (Zurn et al., 2018). Allele composition for all three genotypes is listed for each SSR, and the light-gray highlighted alleles indicate alleles shared only with ORUS 2867-4, and the dark-gray highlighted alleles were inherited from the other parent, ‘Ouachita’.

Name	RH_MEa0006bG05				ERubLRSQ_07-4_D05				RH_MEa0015cE06				RH_MEa011dG03a			
Ouachita	244				250	252	256	259	265	268	273		345	348		357
Twilight	244	243			250	252			265			285	345	348	354	357
ORUS 2867-4	244	243	247			252						285	345		354	

Availability

‘Twilight’ is protected by U.S. Plant Patent PP 30,879 (Finn 2019). Further information or a list of nurseries propagating ‘Twilight’ is available on written request to Mary Peterson (USDA-ARS). Nurseries interested in a license for ‘Twilight’ should contact the Office of Commercialization and Corporate Development (OCCD) at Oregon State University. 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 2802 (PI 682659), where it will be available for research purposes, including development and commercialization of new cultivars.

Literature Cited

- Clark, J.R. and J.N. Moore. 2005. ‘Ouachita’ thornless blackberry. *HortScience* 40:258–260.
- Crane, M.B. 1943. United States Plant Patent: Blackberry plant. USPP 571. Washington, D.C.
- Finn, C.E. 2019. United States Plant Patent: Blackberry plant named ‘Twilight’. USPP 30,879. Alexandria, VA.
- Finn, C.E., B.C. Strik, B.M. Yorgey, M.E. Peterson, J. Lee, R.R. Martin, and H.K. Hall. 2014. ‘Columbia Star’ thornless trailing blackberry. *HortScience* 49:1108–1112.
- Finn, C.E., B.C. Strik, B.M. Yorgey, M.E. Peterson, P.A. Jones, G. Buller, S. Serge, J. Lee, N.V. Bassil, and R.R. Martin. 2020a. ‘Eclipse’ thornless semi-erect blackberry. *HortScience* 55:749–754.
- Finn, C.E., B.C. Strik, B.M. Yorgey, M.E. Peterson, P.A. Jones, G. Buller, J. Lee, and R.R. Martin. 2020b. ‘Galaxy’ thornless semi-erect blackberry. *HortScience* (in press).
- Finn, C.E. and B.C. Strik. 2014. Blackberry cultivars for Oregon (EC 1617-E, revised). Oregon State University Extension Service, Corvallis, OR.
- 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.
- Galletta, G.J., A.D. Draper, J.L. Maas, R.M. Skirvin, A.G. Otterbacher, H.J. Swartz, and C.K. Chandler. 1998a. ‘Chester Thornless’ blackberry. *Fruit Var. J.* 52:118–122.
- Galletta, G.J., J.L. Maas, J.R. Clark, and C.E. Finn. 1998b. ‘Triple Crown’ thornless blackberry. *Fruit Var. J.* 52:124–127.
- Jennings, D.L. 1986. Breeding for spinelessness in blackberries and blackberry–raspberry hybrids: A review. *Acta Hort.* 183:59–66.
- Jordheim, M., K.H. Enerstvedt, and O.M. Andersen. 2011. Identification of cyanidin 3-O-β-(6”-(3-hydroxy-3-methylglutaryl)glucoside) and other anthocyanins from wild and cultivated blackberries. *J. Agr. Food Chem.* 59:7436–7440.
- Lee, J. and C.E. Finn. 2007. Anthocyanins and other polyphenolics in American elderberry (*Sambucus canadensis*) and European elderberry (*S. nigra*) cultivars. *J. Sci. Food Agr.* 87:2665–2675.
- Meng, R. and C. Finn. 2002. Determining ploidy level and nuclear DNA content in *Rubus* by flow cytometry. *J. Amer. Soc. Hort. Sci.* 127:767–775.
- Strik, B., J. Mann, and C. Finn. 1996. Percent drupelet set varies among blackberry genotypes. *HortScience* 121:371–373.
- Thompson, M.M. 1995. Chromosome numbers of *Rubus* cultivars at the National Clonal Germplasm Repository. *HortScience* 30:1453–1456.
- Zurn, J.D., K.A. Carter, M.H. Yin, M.W. Worthington, J.R. Clark, C.E. Finn, and N.V. Bassil. 2018. Validating blackberry seedling pedigrees and developing an improved multiplexed microsatellite fingerprinting set. *J. Amer. Soc. Hort. Sci.* 143:381–390.