‘Prime-Ark® Traveler’ Primocane-fruited Thornless Blackberry for the Commercial Shipping Market

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‘Prime-Ark® Traveler’ (to be U.S. plant patented as ‘APF-190T’), is the world’s first commercially released, thornless primocane-fruited blackberry (*Rubus* L. subgenus *Rubus* Watson) with shipping-quality fruit. This development is intended primarily as a commercial cultivar to be grown for fruit production for either shipping or local sales. It likely will have value as a home-garden plant also. This is the fifth in the University of Arkansas Prime-Ark® Brand Primocane-Fruited Blackberry cultivar line following the release of ‘Prime-Jan®’ and ‘Prime-Jim®’ in 2004 (Clark et al., 2005), ‘Prime-Ark® 45’ in 2009 (Clark and Perkins-Veazie, 2011), and ‘Prime-Ark® Freedom’ in 2013 (Clark, 2014). This unique type of blackberry fruits on current-season canes (primocanes) and on second-season canes (floricanes), potentially providing for two cropping seasons, both traditional summer fruits in addition to late-summer to fall production. In addition to having thornless canes, this new introduction produces high-quality berries of medium-large size with good flavor, and potential for shipping and postharvest storage. It is anticipated that ‘Prime-Ark® Traveler’ will complement ‘Prime-Ark® 45’ in the expansion of production of primocane-fruited blackberries in the United States and potentially worldwide.

Origin

‘Prime-Ark® Traveler’ resulted from a cross of A-2293T × APF-49T (Fig. 1) made in 2004 at the University of Arkansas Fruit Research Station (FRS), Clarksville, AR. The original plant was selected in June 2008 from a population of 619 plants in a seedling field

at the same location during evaluation of floricane fruits. It was tested as selection APF-190T. At the time of selection during the floricane-fruited season, it was noted to have medium-large fruit of good quality, and thornless canes with excellent primocane health. Primocane flower buds were observed on canes at selection confirming the primocane-fruited characteristic.

The primocane fruiting and thornlessness traits are recessive, and the combination of these two traits in this new cultivar took substantial time and effort to produce the expression of these traits in a tetraploid plant combined with high fruit quality for shipping. ‘Prime-Ark® Freedom’, a prior release, combined thornlessness and primocane fruiting, but did not have shipping-quality fruit characteristics (Clark, 2014). The origin of the primocane-fruited trait is the thorny genotype “Hillquist,” which was first used in crossing in the Arkansas program in 1967 (Fig. 1). Crossing among elite thornless, floricane-fruited selections to bring enhanced fruit size and quality into the primocane-fruited germplasm culminated in this cultivar.

Description and Performance

After selection, two 6.1-m plots of ‘Prime-Ark® Traveler’ were established at FRS [west-central Arkansas, lat. 35°31′58″N and long. 93°24′12″W; U.S. Department of Agriculture (USDA) hardiness zone 7a] in the summer of 2008. Plots were established by moving the original plant along with planting root cuttings collected from the original plant. Observational data were collected on the selection in these plots at the time of floricane fruiting in 2010 and continued through 2015. Observational data were also collected from single plots of the primocane-fruited cultivar Prime-Ark® 45 along with the floricane-fruited cultivars Natchez, Osage, and Ouachita in the selection field during this same evaluation period for comparison. In all plantings, standard cultural practices for erect blackberry production were used including annual preemergence and postemergence herbicide applications, and annual spring nitrogen fertilization (56 kg·ha⁻¹ N) using ammonium nitrate. The primocane genotypes received another application (23 kg·ha⁻¹ N) after the floricane crop production was completed, which was in early July. All genotypes had

primocanes tipped at 1.1 m height two times each season, usually in mid-June and late July or early August. All primocane-fruited genotypes were allowed to produce floricane and primocane crops in these plots. All plants received dormant pruning, which consisted of removing dead floricanes and pruning lateral branches to ≈0.4 m in length. Additionally, the primocane-fruited plants had areas of primocanes removed that fruited the prior growing season. All plantings received a single application of liquid lime sulfur (94 L·ha⁻¹) at budbreak for control of anthracnose [*Elsinoë veneta* (Burkh.) Jenkins]. This was the only fungicide applied to any plantings in any year. Raspberry crown borer (*Pennisetia marginata* Harris) was controlled by a single application of a labeled insecticide in October of each year. All plots were irrigated as needed using overhead sprinkler irrigation.

Floricane fruit ratings were performed for all genotypes based on a rating scale of 1 to 10, where 10 = best, for 6 years (2010–15). Fruit ratings were measured subjectively on 5–10 berries for size (10 = very large), firmness (with rating of 10 indicating very firm), and flavor (subjectively rated by tasting berries in the field, with 10 being exceptional flavor). Plant ratings were performed using the same scale, with highest ratings for excellent health and very erect canes. Vigor ratings were also performed using the same scale, but the highest potential value of 10 was near excessive vigor.

Replicated trials were established at FRS in May 2011 and 2012. These trials consisted of two replications. Plots in these trials were 3.1 m in length containing five plants produced from adventitious shoots produced from root cuttings spaced at 0.6 m intervals. Row spacing was 3.7 m. This resulted in a planting density of 4346 plants/ha. The cultivars Prime-Ark® 45, Natchez, and Ouachita were included for comparison in the trials, and plants of these cultivars were propagated by a commercial tissue culture nursery. Cultural management of this trial was the same as described previously, with the exception of drip irrigation being used in these trials, and fertilization through the drip system. In 2013–15, insecticides labeled for commercial use in Arkansas were used for spotted-wing drosophila (*Drosophila suzukii* Matsumura) control. Data for median budbreak date (middle of budbreak period, not the first nor last budbreak date), 10% and 50% floricane bloom date, and floricane first and peak harvest dates including floricane average berry weight (25 berries measured at three to five harvest dates for each replication) and yield were recorded for 2012–14 for the 2011-established trial and 2013–15 for the 2012-established trial (‘Natchez’ data were not collected in 2015 for the 2012 trial). For primocane-fruited cultivars, primocane first bloom date along with primocane first ripe date were also recorded each year. The primocane-fruited cultivars were “double cropped” (flori- and primocane crops produced), in that in addition to floricane fruit, primocane yields and berry weights (25 berries measured

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Fig. 1. Pedigree of 'Prime-Ark® Traveler' blackberry.

on three to five primocane harvest dates for each replication) were measured. Additionally, on these same 25 floricanes berries, soluble-solid content (SSC), pH, and titratable acidity (TA; expressed as percent citric acid) were measured two to five times per season in 2012–15, and SSC was measured only in 2012. Primocane berries (25 on three to five harvest

dates) from the 2012 replicated trial were also measured for SSC, pH, and TA in 2013–15. Data for replicated trials were analyzed for each year and fruiting season (floricanes and primocane for primocane-fruiting cultivars) separately as a randomized complete block by the GLM procedure of SAS, and mean separated by *t* test ($P < 0.05$) for each year.

Postharvest evaluations were done on floricanes fruits of 'Prime-Ark® Traveler' and several other cultivars for 2012–15 using fruit from the replicated trials. The procedures used were developed over a multiyear period in the 1990s where various measurements were taken to develop a system for genotype evaluation for potential shipping (Clark and Perkins-Weazie, 2011). Dry, shiny-black berries (not treated with pre-harvest fungicides) were collected in the morning of harvest days into hinged, clear, vented, polyethylene 260-g clamshell containers (Century Corrugated Container, Kilgore, TX). Each clamshell contained on average 20 berries. Two clamshells were gathered from each genotype usually at two consecutive harvest dates (resulting in four replications). The berries were then stored at 5 °C, 80% relative humidity for 7 d. Subjective evaluations were made for firmness, presence or absence of visible mold, leak, or reddening (color reversion). After storage, each berry was removed from the container, determined to be firm (1) to very soft (5) by using finger pressure between thumb and forefinger, and placed in rows for each firmness rating. Percent soft berries were those in the 4 and 5 rating categories. Each berry was rolled gently on a white paper towel and counted as leaky if juice spots appeared. The berries were rated on a yes/no scale for presence of red drupelets in clusters of three or more in 2012. In 2013–15, berries were rated as having red drupelets if only a single drupelet showed red development. All ratings were converted to percentages based on the total number of fruit in the clamshell. The variables of percent berries decayed, with leakage, and soft were used in a calculation for marketability. The overall performance value was calculated as follows: $100 - [\text{sum} (\% \text{ decayed} + \% \text{ soft (3-, 4-, and 5-rated berries)} + \% \text{ leaky})]$. Postharvest data were analyzed by analysis of variance by year, and mean separated by least significant difference. Additionally, in 2014 and 2015, fruit firmness for 'Prime-Ark® Traveler' and four other cultivars was measured as the force (newton, N) necessary to compress an individual fruit 5 mm after the probe made contact with the fruit. In 2014, fruit firmness was measured before and after being in cold storage for 7 d at 5 °C, and in 2015 fruit firmness was measured only after 7 d cold storage. For this procedure, each fruit was placed horizontally on a flat surface, and a 7.6-cm-diameter cylindrical and plane probe compressed each fruit 5 mm using an iCon Texture Analyzer (Texture Technologies Corp. Hamilton, MA). In 2014, 35 to 43 individual berries were used for firmness measurements, and in 2015, 10 to 29 individual berries were used for this procedure. Mean and standard deviation were calculated.

An additional site of evaluation was of two observational 10-plant plots (6.1 m) of 'Prime-Ark® Traveler' located in Watsonville, CA (lat. 36°54'37"N and long. 121°45'20"W; USDA hardiness zone 9) with floricanes- and primocane-fruiting observations recorded in

2012–14 on plants established in 2011. One plot was “double-cropped,” where both floricanes and subsequent primocanes were allowed to fruit. The other plot was “single-cropped,” where primocanes were mowed to the ground each winter. Under both cropping strategies, canes were managed with primocanes double-tipped, first at 50 cm and then subsequent branches tipped at ≈ 50 cm. Data were collected for average yield per plant, average berry weight, soluble solids, and post-harvest performance (for 2013 and 2014 only; using a similar system as described previously except that decay was not recorded) from these plots in 2012–14.

Floricanes yields of ‘Prime-Ark® Traveler’ were statistically similar to ‘Prime-Ark® 45’ in 2014 in the 2011-established planting as well as in 2013–15 in the 2012-established planting. ‘Prime-Ark® 45’ yielded higher in 2012 and 2013 in the 2011 planting (Tables 1 and 2). The floricanes-fruiting cultivars Osage, Ouachita, and Natchez were usually higher yielding than ‘Prime-Ark® Traveler’ in the replicated trials (Tables 1 and 2). Although the floricanes yields of ‘Prime-Ark® Traveler’ were generally less (either statistically significant or numerically) than those of the comparison cultivars, the floricanes yield was substantial and commercially acceptable. Primocane yields varied greatly at FRS for both primocane-fruiting cultivars. For instance, in 2012 there was no measurable crop on primocanes on either cultivar due to the extremely high heat experienced from June to September. There were some flowers produced on the plants, and a few small berries noted on ‘Prime-Ark® Traveler’, but none on ‘Prime-Ark® 45’, and the yield was not enough to be measured. It has been shown in prior field observations in Arkansas, and in a controlled-environment study in Ohio, that

high temperatures reduce bud and bloom development and result in low productivity, small berries, and low-quality fruit in primocane-fruiting blackberries (Clark and Perkins-Veazie, 2011; Stanton et al., 2007). Thus, ‘Prime-Ark® Traveler’ did not exhibit substantial heat tolerance over that of ‘Prime-Ark® 45’. Primocane yields for both cultivars were similar in 2014 for the 2011-established planting as well as in 2013–15 for the 2012-established planting (Tables 1 and 2). ‘Prime-Ark® Traveler’ was lower in yield in 2013 compared with ‘Prime-Ark® 45’ in the 2011 planting. In 2013–15, more moderate daytime high temperatures in July and August compared with 2012 provided better conditions for the primocane-fruiting trait to be expressed. The very moderate conditions of 2015 resulted in the highest yields of primocane-fruiting cultivars ever recorded at FRS, and likely are the best reflection on potential comparative primocane yields for these two cultivars. Also, the yield data for primocanes had similar trends for the two plantings for 2013 and 2014 showing consistency in performance. As has been observed for ‘Prime-Ark® 45’, growers in locations with high summer temperatures (generally above 32 °C for 1 week or longer periods) in July to September, such as in the southern United States, should be aware of heat impacts on ‘Prime-Ark® Traveler’. One positive aspect of the reduced primocane production is that this results in substantial yield potential if the canes are retained for the floricanes crop the following year. ‘Prime-Ark® 45’ and ‘Prime-Ark® Traveler’ both had their highest floricanes yields in 2013 in the 2011-established planting following the lack of primocane fruiting on the canes that grew in 2012. ‘Prime-Ark® 45’ has been found to have substantial commercial production potential when fruited by growers on floricanes, and has

some potential use as a floricanes-fruiting cultivar especially in years when the primocane crop the year prior was very light (reflected in the data and from grower reports). Further, although ‘Prime-Ark® Traveler’ yields were not higher, and in some years lower than ‘Prime-Ark® 45’, it is believed that the thornless canes of ‘Prime-Ark® Traveler’ will contribute to easier plant management and thus make this cultivar desirable to growers.

Yield data from the California trial indicated substantial promise for ‘Prime-Ark® Traveler’ (data not shown). In 2012, the double-cropped plot averaged 1.3 kg/plant (cumulative data for floricanes and primocanes) (5650 kg·ha⁻¹ based on Arkansas spacing of 4346 plants/ha), whereas the single-crop (primocane only) plot yielded 1.0 kg/plant. In 2013, when the plots were more mature, yields averaged 5.0 and 3.7 kg/plant (21,730 and 16,080 kg·ha⁻¹) for the double- and single-cropped plots, respectively. In 2014, a very low-chill year on the California coast (≈ 306 chill units accumulated; one chill unit is equivalent to 1 h below 7.2 °C), yields were similar for double- and single-cropped plots, averaging 4.5 and 4.4 kg/plant (19,557 and 19,122 kg·ha⁻¹), respectively. In contrast, ‘Prime-Ark® 45’, established on-site in 2012 (1 year after ‘Prime-Ark® Traveler’), averaged 7.5 and 5.2 kg/plant (32,595 and 22,599 kg·ha⁻¹) on mature double- and single-cropped plots in 2014, respectively. For both cultivars, there was an overall annual yield increase gained by double cropping, yet the bulk of the crop was borne on primocanes. Furthermore, the cropping of floricanes tended to delay the subsequent primocane crop by 4–5 weeks in coastal California. This site has very moderate temperatures, usually with midday highs from 22 to 25 °C in August for example,

Table 1. Floricanes yield and berry weight (average weight of 25 berries measured three to five harvest dates per cane type each year) of two primocane-fruiting and two floricanes-fruiting blackberry genotypes in a replicated trial that was established in 2011 at the University of Arkansas Fruit Research Station, Clarksville.

Cultivar	Yield (kg·ha ⁻¹)			Wt/berry (g)		
	2012	2013	2014	2012	2013	2014
<i>Floricanes harvest</i>						
Prime-Ark® Traveler	11,015 c ^z	22,420 c	9,826 b	7.0 ab	6.7 bc	7.5 b
Natchez	29,195 a	36,443 ab	20,060 a	7.5 ab	8.3 ab	9.7 a
Ouachita	18,370 b	30,775 b	14,981 ab	6.5 b	6.2 cd	7.9 b
Prime-Ark® 45	20,366 b	31,803 b	11,924 b	6.6 ab	7.1 bc	7.6 b
<i>Primocane harvest</i>						
Prime-Ark® Traveler	—	4,306 b	7,479 a	—	5.2 a	7.2 a
Prime-Ark® 45	—	6,525 a	6,493 a	—	6.3 a	5.7 a

^zMeans in the same column within cane type followed by the same letter are not significantly different by *t* test, *P* ≤ 0.05.

Table 2. Floricanes yield and berry weight (average weight of 25 berries measured three to five harvest dates per cane type each year) of two primocane-fruiting and three floricanes-fruiting blackberry genotypes in a replicated trial that was established in 2012 at the University of Arkansas Fruit Research Station, Clarksville.

Cultivar	Yield (kg·ha ⁻¹)			Wt/berry (g)		
	2013	2014	2015	2013	2014	2015
<i>Floricanes harvest</i>						
Prime-Ark® Traveler	13,057 cd ^z	13,283 b	8,961 b	6.7 bc	7.3 b	8.7 a
Natchez	38,342 a	21,725 a	—	8.3 a	10.9 a	—
Ouachita	23,052 bc	12,456 b	17,332 a	6.2 bc	7.4 b	7.5 ab
Prime-Ark® 45	20,845 bc	10,234 b	8,283 b	7.1 b	7.9 b	6.6 b
<i>Primocane harvest</i>						
Prime-Ark® Traveler	4,963 a	7,568 a	10,287 a	4.7 a	6.4 a	5.3 a
Prime-Ark® 45	7,798 a	4,978 a	10,540 a	6.3 a	7.3 a	5.1 a

^zMeans in the same column within cane type followed by the same letter are not significantly different by *t* test, *P* ≤ 0.05.

much lower than that experienced in Arkansas. The moderate temperatures allowed for much better expression of the primocane-fruiting trait, and thus resulting in higher primocane yields in California. In commercial plantings in California, planting densities are often higher, and per hectare yields can be substantially higher than those stated based on Arkansas spacing.

Average florican berry weight of 'Prime-Ark® Traveler' ranged from 6.7 to 8.7 g in the replicated trials, similar to 'Prime-Ark® 45', 'Ouachita', and 'Osage' in all comparisons, although 'Prime-Ark® Traveler' was larger in 2015 (Tables 1 and 2). It was usually smaller than 'Natchez'. Although not statistically

compared, primocane berry average weights in Arkansas were usually lower for 'Prime-Ark® Traveler' and 'Prime-Ark® 45' when compared with floricanes fruits. The weights of berries from different cane types showed more similarity in 2014 than 2013, again likely due to more moderate summer temperatures in 2014. The average primocane berry weight in 2015 for both cultivars was numerically lower than floricanes for both cultivars, but this could be due to the substantially larger primocane crop in 2015 compared with 2014. In California, primocane berry weight for 'Prime-Ark® Traveler' averaged 6.4 g in 2012, 7.7 g in 2013, and 7.6 g in 2014. No substantial differences were observed in berry weights between double- and single-cropped plots. By comparison, 'Prime-Ark® 45' in 2013 and 2014 had an average berry weight of 12.1 and 9.7 g, respectively.

Fruit of 'Prime-Ark® Traveler' is semi elongated to blocky, and attractive with a glossy, black finish (Fig. 2). Fruit shape is usually uniform, with fewer double and/or misshapen fruits than that seen on 'Prime-Ark® 45' and 'Prime-Ark® Freedom' (Clark, 2014), an occurrence thought to be related to summer heat on primocane bud and flower differentiation. This is a significant observation, as loss of berries due to doubling or other fruit shape inconsistencies has been a concern in primocane production by growers in high-temperature areas for 'Prime-Ark® 45'.

Soluble-solid concentration for florican fruits measured from the 2012 replicated trial ranged from 9.4% in 2013 to 11.1% in 2014 (Table 3), and from 11.1% to 12.0% among 2012–14 for the 2011 trial (data not shown).

The SSC values were similar to 'Prime-Ark® 45' in all comparisons (including from the 2011 trial) except in 2013 when 'Prime-Ark® 45' was higher. Soluble-solid content was usually similar to slightly lower compared with the florican-fruited cultivars. For primocane berries measured in 2013–15, 'Prime-Ark® Traveler' SSC ranged from 11.6% to 12.5% and was similar to 'Prime-Ark® 45' in all but one year when 'Prime-Ark® 45' achieved 13.5% (data not shown). Soluble-solid values for 'Prime-Ark® Traveler' primocane fruits from the California test site ranged from 10.4% to 12.4%, and were also similar to 'Prime-Ark® 45' (data not shown). Juice pH and TA variables were added to data collection in 2013–15 to better identify genotypes that exhibit reduced acidity that can result in sweeter-tasting berries. Titratable acidity values for florican fruits of 'Prime-Ark® Traveler' ranged from 0.8% to 0.9% and were consistent among years and usually lower than the values for other cultivars in several years and plantings (Table 3; 2011 trial data not shown). Primocane berries ranged from 0.6% to 1.0% TA for 'Prime-Ark® Traveler', similar to 'Prime-Ark® 45' (data not shown). The pH for florican berries of 'Prime-Ark® Traveler' ranged from 3.2 to 3.4 among years and plantings, often higher (less acid) than other cultivars, particularly compared with 'Natchez'. Primocane berries had the same range of pH values (data not shown).

Flavor ratings for 'Prime-Ark® Traveler' averaged 7.8, the same as for 'Prime-Ark® 45', slightly higher than for 'Natchez' (7.7) but lower than 'Ouachita' (8.4) and 'Osage' (8.2) (Table 4). Flavor observations over the years indicated that berries were routinely sweet in

Fig. 2. 'Prime-Ark® Traveler' fruit.

Table 3. Florican berry soluble-solid content (%), titratable acidity (%), and pH of four blackberry genotypes collected in 2013–15 from a replicated planting that was established in 2012 at the University of Arkansas Fruit Research Station, Clarksville.

Characteristic	Cultivar				
	Prime-Ark® Traveler	Natchez	Osage	Ouachita	Prime-Ark® 45
<i>2013</i>					
Soluble solids	9.4 c ²	9.5 c	10.0 bc	11.8 a	11.2 ab
Titratable acidity	0.8 a	1.1 a	1.0 a	1.0 a	0.9 a
pH	3.2 a	2.8 b	3.2 a	3.1 a	3.2 a
<i>2014</i>					
Soluble solids	11.1 a	10.9 a	—	11.2 a	11.4 a
Titratable acidity	0.8 b	1.1 a	—	1.1 a	0.8 b
pH	3.3 a	3.1 b	—	3.1 b	3.3 a
<i>2015</i>					
Soluble solids	9.5 a	—	—	10.5 a	10.1 a
Titratable acidity	0.9 b	—	—	1.1 a	0.8 b
pH	3.2 a	—	—	3.1 a	3.2 a

²Means in the same row followed by the same letter are not significantly different by *t* test, *P* ≤ 0.05.

Table 4. Ratings for fruit firmness and flavor and plant vigor, health, and cane erectness for five blackberry genotypes at the University of Arkansas Fruit Research Station, Clarksville with ratings from observational plots collected from 2010 to 2015.

Characteristic	Cultivar				
	Prime-Ark® Traveler	Prime-Ark® 45	Natchez	Osage	Ouachita
<i>Fruit</i>					
Firmness	8.0 (0.0) ²	8.2 (0.4)	7.5 (0.5)	8.0 (0.6)	8.6 (0.5)
Flavor	7.8 (0.5)	7.8 (0.8)	7.7 (0.5)	8.2 (0.4)	8.4 (0.5)
<i>Plant</i>					
Vigor	8.3 (0.5)	7.7 (0.5)	7.2 (0.4)	7.2 (0.4)	7.0 (0.0)
Health	9.0 (0.8)	7.5 (0.5)	7.3 (0.8)	7.5 (0.5)	7.5 (0.5)
Erectness	8.0 (0.9)	9.0 (0.0)	6.0 (0.0)	7.5 (0.5)	8.2 (0.2)

²Mean (standard deviation) for each of the characteristics for each cultivar averaged across years.

flavor and often noted to taste subacid, an observation supported by the pH and TA values, which were often lower than other cultivars. Field firmness ratings averaged 8.0 for ‘Prime-Ark® Traveler’, the same as for ‘Osage’ (8.0) but slightly lower than for ‘Prime-Ark® 45’ (8.2), and ‘Ouachita’ (8.6) (Table 4).

Postharvest evaluations for florican fruits stored for 7 d at FRS indicated good performance for ‘Prime-Ark® Traveler’ (Table 5). The data indicated substantial variation among cultivars and years for most variables. Two cultivars in particular are most important to compare with, the most widely Arkansas-developed cultivar Ouachita, and the most

widely planted primocane-fruiter ‘Prime-Ark® 45’. In all years, overall postharvest score for ‘Prime-Ark® Traveler’ was statistically similar to ‘Ouachita’ and ‘Prime-Ark® 45’ in 2013–15. Percent of berries with red drupes and percent soft berries among these three cultivars were also similar among years, and percent of leak and decay was usually similar as well. ‘Prime-Ark® Traveler’ was rated lower for red drupe development but higher for percent leaky berries compared with ‘Prime-Ark® 45’ in postharvest evaluations in California in 2013 (data not shown). These findings indicate that ‘Prime-Ark® Traveler’ would have good potential for postharvest handling in the commercial shipping

industry. Further, ‘Prime-Ark® Traveler’ overall performed better than ‘Tupy’, the most widely grown cultivar for the shipping industry, produced in central Mexico.

Additionally in 2014 and 2015, fruit firmness for ‘Prime-Ark® Traveler’ and four other cultivars was measured as the force (N) necessary to compress an individual fruit 5 mm after the probe made contact with the fruit. The compression data indicated that ‘Prime-Ark® Traveler’ had the highest values before and after 7 d of cold storage in 2014 (12.4 and 9.4 N, respectively) and also in 2015 (7.0 N after cold storage), compared with the other cultivars (Table 6). These data reinforce the potential for berries to stay firm,

Table 5. Postharvest evaluations of ‘Prime-Ark® Traveler’ florican berries compared with other blackberry cultivars from 2012 to 2015 at the University of Arkansas Fruit Research Station, Clarksville (7 d in cold storage at $\approx 5^{\circ}\text{C}$).

Cultivar	Overall ^z	Red (%) ^y	Leak (%) ^x	Decay (%) ^w	Soft (%) ^v
2012					
Prime-Ark® Traveler	55.8 bc ^u	9.0 abc	30.8 a	4.0 a	0.0 a
Natchez	75.5 ab	10.0 ab	20.5 ab	0.0 b	0.0 a
Osage	70.3 ab	0.8 c	21.5 ab	2.5 ab	3.3 a
Ouachita	52.5 bc	5.8 abc	21.0 ab	0.0 b	2.3 a
Prime-Ark® 45	79.8 a	1.3 bc	14.8 b	0.0 b	0.0 a
Tupy	35.0 c	10.5 a	32.5 a	0.0 b	6.3 a
2013					
Prime-Ark® Traveler	52.5 a	17.8 ab	30.0 abc	1.5 b	3.5 c
Natchez	58.5 a	43.0 ab	6.3 c	0.0 b	9.5 c
Osage	–28.0 bc	15.0 b	45.0 ab	8.5 b	45.8 ab
Ouachita	11.0 ab	38.5 ab	21.0 bc	6.0 b	35.8 abc
Prime-Ark® 45	16.8 ab	16.8 b	27.0 abc	4.8 b	20.0 bc
Tupy	–63.5 c	47.5 a	50.3 a	26.8 a	61.5 a
2014					
Prime-Ark® Traveler	55.5 ab	19.3 b	16.8 ab	0.0 a	1.3 a
Natchez	67.7 ab	50.5 a	1.8 b	2.0 a	2.5 a
Osage	89.5 a	19.3 b	3.8 b	1.5 a	0.0 a
Ouachita	42.3 b	18.8 b	22.0 a	3.5 a	1.3 a
Prime-Ark® 45	73.3 ab	26.3 ab	6.3 b	1.3 a	1.3 a
2015					
Prime-Ark® Traveler	–21.3 a	45.3 a	48.3 a	3.5 a	36.3 a
Natchez	4.5 a	72.0 a	23.3 a	0.0 a	42.0 a
Osage	–17.5 a	31.5 a	39.3 a	3.0 a	28.8 a
Ouachita	–32.8 a	65.0 a	42.5 a	4.8 a	33.0 a
Prime-Ark® 45	6.0 a	45.0 a	26.5 a	3.5 a	18.8 a
Tupy	–14.0 a	60.7 a	32.3 a	5.7 a	24.7 a

^zOverall ratings are used as indicator of performance after 7 d in the cooler. Overall rating is calculated as follows: $100 - \{\text{sum } [\% \text{ decayed} + \% \text{ soft (3-, 4-, and 5-rated berries)} + \% \text{ leaky}]\}$.

^yThe berries were rated on a yes/no scale for presence of red drupelets in clusters of three or more in 2012. In 2013–15, berries were rated as having red drupelets if only a single drupelet showed red development.

^xPercentage of leaky berries is reported.

^wThe berries were rated on a yes/no scale for presence of decay and the percent of berries with decay is reported.

^vThe berries were rated on a 1 to 5 scale for softness, where 1 = firm and 5 = very soft berry, very leaky. Means represent the percentage of berries that scored a 4 or 5.

^uMean in the same column within year followed by the same letter are not significantly different by least significant difference, $P \leq 0.05$.

Table 6. Fruit firmness evaluations of ‘Prime-Ark® Traveler’ compared with other blackberry genotypes in 2014 and 2015 at the University of Arkansas Fruit Research Station, Clarksville after 7 d in cold storage at $\approx 5^{\circ}\text{C}$.

Cultivar	2014		2015	
	Day 0 ^z	Day 7 ^y	Day 7 ^y	
	No. ^x	Firmness (N)	No.	Firmness (N)
Prime-Ark® Traveler	41	12.4 (3.9) ^w	31	9.4 (3.8)
Natchez	28	9.6 (3.0)	25	7.2 (3.3)
Osage	28	8.7 (3.1)	43	6.1 (2.8)
Ouachita	40	6.5 (1.5)	41	6.2 (2.4)
Prime-Ark® 45	39	9.0 (2.4)	34	6.8 (2.4)

Fruit firmness was measured as the force (newton) necessary to compress an individual fruit 5 mm after the probe made contact with the fruit.

^zFruit firmness was measured the same day of harvest.

^yFruit firmness was measured on fruits after storage 7 d in the cooler.

^xNo. = number of total berries measured.

^wMean (standard deviation) of fruit firmness is presented.

Table 7. Bloom and harvest dates of four blackberry genotypes collected in 2013–15 from a replicated planting that was established in 2012 at the University of Arkansas Fruit Research Station, Clarksville.

Characteristic	Cultivar			
	Prime-Ark® Traveler	Natchez	Ouachita	Prime-Ark® 45
		<i>Floricanes bloom date</i>		
10% bloom	30 Apr. (6.2) ^a	26 Apr. (4.7)	2 May (5.8)	25 Apr. (7.5)
50% bloom	5 May (5.9)	30 Apr. (5.2)	5 May (4.9)	1 May (7.9)
		<i>Floricanes harvest date</i>		
First	9 June (4.9)	12 June (0.7)	16 June (4.9)	8 June (1.5)
Peak	21 June (6.1)	27 June (5.7)	3 July (6.7)	22 June (7.0)

^aMean (standard deviation) for each of the characteristics for each cultivar averaged across years.

a key component to postharvest handling potential.

Median budbreak for ‘Prime-Ark® Traveler’ averaged 24 Feb. (2013–15) in the 2012 trial and 18 Feb. in the 2011 trial (2012–14 data) (data not shown). Budbreak was 8 d later than ‘Prime-Ark® 45’, 1 to 7 d later than ‘Natchez’, and 1 to 4 d earlier than ‘Ouachita’ among the years and plantings. This indicates that the later budbreak could be an advantage, particularly compared with ‘Prime-Ark® 45’, in risk of freeze damage to developing buds when floricanes are retained. On average, floricanes bloom dates (10 and 50% bloom) for ‘Prime-Ark® Traveler’ were 4 to 5 d later than ‘Prime-Ark® 45’ and ‘Natchez’, and similar to ‘Ouachita’ (Table 7, 2012 planting; 2011 planting data not shown). Thus, ‘Prime-Ark® Traveler’ does not bloom unusually early, and so could be less susceptible to cold damage to flowers in late spring frosts than earlier blooming cultivars. Primocane first bloom date for ‘Prime-Ark® Traveler’ ranged from 12 June in 2012 to 28 June in 2013, 6–10 d earlier than ‘Prime-Ark® 45’ (data not shown).

Floricanes mean first harvest date for ‘Prime-Ark® Traveler’ was 9 June (average of 2013–15 of the 2012 planting) (Table 7) and 6 June for 2012–14 (for the 2011 planting; data not shown), similar to ‘Prime-Ark® 45’. The first harvest date in the 2012 planting for 2013–15 for ‘Prime-Ark® Traveler’ indicated a slightly earlier first harvest date than for ‘Natchez’ while the 2011 planting had a similar harvest date of 6 June (2012–14; data not shown). The first harvest date of ‘Ouachita’ was 7 d later than ‘Prime-Ark® Traveler’ in all plantings. The early harvest date for ‘Prime-Ark® Traveler’ is of potential importance, as ‘Prime-Ark® 45’ has been used as an early ripening floricanes cultivar to complement ‘Natchez’, and ‘Prime-Ark® Traveler’ could further serve as a complement for early harvest. Peak harvest dates had similar trends for all cultivars in all years and plantings (Table 7; 2011 planting data not shown). The floricanes harvest period was observed to be on average ≈40 d.

Primocane first ripe fruit date ranged from 25 July to 4 Aug. among 2012–15, and was consistently 8 to 12 d earlier than ‘Prime-Ark® 45’ in Arkansas. Fruiting was observed to continue until mid-October in some years in Arkansas. This trend was not observed in California. ‘Prime-Ark® 45’ began fruiting on floricanes on 17 and 19 May in 2013 and 2014, respectively, with ‘Prime-Ark® Traveler’

Fig. 3. ‘Prime-Ark® Traveler’ showing extended primocane fruiting.

fruit consistently ripening 10 d later in both years. Primocanes in the double-cropped plot of ‘Prime-Ark® Traveler’ and ‘Prime-Ark® 45’ subsequently began fruiting on 9 and 23 Aug. (2013) and 12 and 11 Aug. (2014), respectively. On single-cropped plots (primocane only), ‘Prime-Ark® Traveler’ and ‘Prime-Ark® 45’ harvest began on 24 and 15 July (2013) and 30 and 16 July (2014), respectively. Bloom dates were not recorded; however, ‘Prime-Ark® Traveler’ generally required 50–60 d from bloom to shiny-black fruit in central coastal California. It is not known why the ripening dates differed between the two locations.

Canes of ‘Prime-Ark® Traveler’ are erect (rating of 8.0), similar to most comparison cultivars and more erect than ‘Natchez’ (rating 6.0) (Table 4). However, the plants should be grown with supporting trellis wires placed on either side of the plant row at ≈1.3 m height to help support the canes, as the primocane crop can be produced on the more distal portion of the canes (Fig. 3). It will be very important in management of ‘Prime-Ark® Traveler’ that canes be double tipped to maximize yield and maintain primocane height (double-tip the primocanes first at 50 cm and then subsequent branches tipped at ≈50 cm). Vigor rating of ‘Prime-Ark® Traveler’ was slightly higher than the comparison cultivars (Table 4); however, this

vigor level is not excessive and contributes to rapid row fill of canes. Plant health was rated very high (9.0), higher than the comparison cultivars (Table 4). In some years the leaves of ‘Prime-Ark® Traveler’ exhibited upward curling, but no disease symptoms were seen. No orange rust [caused by *Gymnoconia nitens* (Shwein.) F. Kern & H.W. Thurston] was observed on ‘Prime-Ark® Traveler’ in any evaluations, even though infected plants were seen within 30–50 m of data collection plots in each year of evaluation. ‘Prime-Ark® Traveler’ berries or canes have not been observed to be susceptible to anthracnose at FRS where a single spray of lime sulfur was applied. Reaction of ‘Prime-Ark® Traveler’ to rosette/double blossom [*Cercospora rubi* (Wint.) Plakidas] has not been conducted as this disease did not occur at any of the test sites. This cultivar likely has resistance to this disease as exhibited by other Arkansas thornless blackberry cultivars.

The chilling requirement for floricanes for ‘Prime-Ark® Traveler’ has not been measured and it has not been tested fully in environments of less than 800 h of chilling (hours below 7 °C during dormancy). Budbreak date is often used as a potential indicator of chilling, and as indicated earlier ‘Prime-Ark® Traveler’ breaks buds later than ‘Prime-Ark® 45’, was near to or later than that of ‘Natchez’, and earlier than ‘Ouachita’.

These cultivars have not been fully defined for chilling requirement, but 'Prime-Ark® 45' and 'Natchez' have been observed to have requirement of 200 to 300 h and 'Ouachita' of ≈400 h (J.R. Clark, personal observation). Therefore, this suggests 'Prime-Ark® Traveler' may have a chilling requirement of 300 to 400 h, but further observation is needed to more precisely define this characteristic. However, 'Prime-Ark® Traveler' also fruits on primocanes with no chilling, so in this aspect no chilling is required for fruit production. Winterhardiness of overwintering canes has not been fully defined for 'Prime-Ark® Traveler'. It fruited consistently in Arkansas in USDA hardiness zone 7a, but has not been tested in colder locations. However, if grown only for primocane fruit, and overwintering canes were not required for fruit production, then cane hardiness is not critical for fruiting. In that instance only

plant/crown survival would be critical for fruit production, and hardiness in much colder zones will likely be experienced.

'Prime-Ark® Traveler' is an exciting development as it is the first thornless plant of this blackberry type recommended for fruit production for the commercial shipping market. It also has fruit flavor and overall quality that would contribute to the growth in the fresh market blackberry industry in the United States and other locations in the world. 'Prime-Ark® Traveler' is recommended for the commercial shipping market as well as for local market use and home gardens.

Availability

An application for a U.S. plant patent (to be U.S. plant patented as 'APF-190T') has been filed for 'Prime-Ark® Traveler'.

Nurseries will be licensed in the United States and other countries for propagation; a list of these can be attained from John R. Clark (jrclark@uark.edu).

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