‘Caddo’ Thornless Blackberry

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‘Caddo’ (pronounced kad-oh) is the 14th release in a series of erect-growing, high-quality, productive floricanefruiting blackberry (*Rubus* L. subgenus *Rubus* Watson) cultivars intended for the fresh market developed by the University of Arkansas Division of Agriculture. Recent years have had increased focus on the improvement of flavor in blackberries in the Arkansas program, and ‘Caddo’ was developed with the intention of advancing flavor to a higher level in an additional thornless blackberry cultivar. ‘Caddo’ ripens mid-early season, near ‘Osage’ and slightly before ‘Ouachita’ (Clark, 2013; Clark and Moore, 2005), and just after ‘Natchez’ (Clark and Moore, 2008). ‘Caddo’ produces large berries, larger than that of ‘Osage’ and ‘Ouachita’. ‘Caddo’ has excellent postharvest quality for the shipping market in addition to local market use. It is expected that ‘Caddo’ will complement ‘Osage’ and ‘Ouachita’ in the mid-early to midseason harvest period.

Origin

‘Caddo’ resulted from a cross of ‘APF-45’ (‘Prime-Ark® 45’) × Ark. 2108T made in 2004 (Fig. 1). The original plant was selected in 2008 from a seedling field at the University of Arkansas Fruit Research Station, Clarksville, AR (FRS), and tested as selection Ark. 2428T. The most thorough testing of ‘Caddo’ has been at this location.

A single, 6.1-m, untrelled observational plot was established at FRS [west-central Arkansas, lat. 35°31′58″N, long. 93°24′12″W; U.S. Department of Agriculture (USDA) plant hardiness zone 7a (U.S. Department of Agriculture, 2013), with soil type Linker fine sandy loam (Typic Hapludults)], in Summer 2008, and observational data were acquired on ‘Caddo’ on this plot for the fruiting seasons of 2010–18. Plots of ‘Natchez’,

‘Osage’, and ‘Ouachita’ were also present in this planting for comparison, and observational data were collected on these cultivars during this evaluation period. In this planting, standard cultural practices for erect blackberry production were used, including annual preemergence and postemergence herbicide applications, annual spring nitrogen (N) fertilization (56 kg·ha⁻¹ N) using ammonium nitrate (NH₄NO₃), summer tipping of primocanes at 1.1 m, sprinkler irrigation applied as needed, and dormant pruning. A single application of liquid lime sulfur (94 L·ha⁻¹) was applied each spring at budbreak for control of anthracnose [*Elsinoë veneta* (Burkh.) Jenkins], and this was the only fungicide applied to this planting in any year. Raspberry crown borer (*Pennisetia marginata* Harris) was controlled by a single application of a labeled insecticide in October of each year. Ratings for a range of characteristics were taken for 9 years (2010–18). Fruit ratings were taken based on a rating scale of 1 to 10, where 10 = best, including size (10 = largest), firmness (as measured subjectively by hand in the field on 8 to 10 berries, with a rating of 10 indicating very firm), and flavor. Flavor ratings were conducted by the senior author and were subjective, with higher ratings indicating sweet berries with a desirable balance of acidity with sweetness. Plant ratings for vigor (scale, 1–10; with a rating of 7–10 acceptable; vigor rating based on both floricanes and primocanes), health (scale, 1–10, where 10 indicates excellent health; components of this rating include freedom from diseases and uniform leaf color and size), and erectness (scales, 1–10, where 10 is very erect) were conducted once each year. Winter injury was evaluated (seen as bud or cane injury) each year at the time of fruiting.

In addition, replicated trials were established at FRS in 2013 and 2016, and at the Southwest Research and Extension Center, Hope, AR [southwest Arkansas, lat. 33°42′30″, long. 93°33′0″; USDA hardiness zone 8a (U.S. Department of Agriculture, 2013)], with soil type Bowie fine sandy loam (Fragic Paludults)], in 2014. These trials consisted of three replications with only two replications used for data collection at FRS; the other plots were used for observation and sampling for postharvest evaluations. At Hope, all three replications had data collected. Plots in both trials were 3.1 m in length and contained five plants per replication spaced at 0.6-m intervals, and were planted on raised

beds covered with black plastic (which remained in the plantings the first 2 years) at FRS, and on a raised bed with woven black landscape cloth at Hope. These trials were trellised using a T-type trellis, with two lower wires spaced horizontally about 0.6 m apart and 0.5 m from the soil line and two additional wires spaced horizontally 1.0 m apart and 1.3 m from the soil. The cultivars Natchez, Ouachita, and Osage were included for comparison in all trials. For Hope and the FRS replicated plantings, fertigation was used as the source of fertilization with a similar N rate (56 kg·ha⁻¹ N). In addition, in 2017 and 2018, the FRS replicated trial received two additional fungicide sprays, about 5 and 3 weeks before first harvest, for control of anthracnose, botrytis fruit rot (*Botrytis cinerea* Pers.: Fr), and cane and leaf rust [*Kuehneola uredines* (Link) Arthur]. The additional fungicide applications were added because of the severe level of cane and leaf rust in 2016, and to parallel commercial production practices more closely. Insecticides labeled for commercial use in Arkansas were used for spotted-wing drosophila (*Drosophila suzukii* Matsuura) control and raspberry crown borer in the FRS and Hope replicated trials. Both locations received chilling in excess of 800 h (hours less than 7 °C) during the years of evaluation. Data for 10% and 50% bloom; and first, peak, and last harvest dates were recorded for 2014–16 for the 2013-planted trial; and 2017 and 2018 for the 2016-planted trial at FRS. Data for average berry weight (average for 25 berries/replicate at each harvest date at FRS and at Hope, with the average for each replicate for the season being used in the analysis) and total yield data from the individual replicated plantings were collected. In addition, at FRS, soluble solids content, pH, and titratable acidity were determined from one harvest each week from a 10-berry sample collected from each replicate. Soluble solids content was calculated using a refractometer. Titratable acidity and pH were measured using a Metrohm 800 Dosino 862 Compact Titrator (Metrohm AG, Herisau, Switzerland) and an electrode standardized to pH 2.00, 4.00, 7.00, and 10.00 buffers. Titratable acidity was determined from 6 g of juice diluted with 50 mL deionized, degassed water by titration of 0.1 N sodium hydroxide to an endpoint of pH 8.2 and expressed as percentage of citric acid.

Postharvest evaluations were done on floricanefruit for ‘Caddo’, ‘Natchez’, ‘Osage’, and ‘Ouachita’ from 2012 to 2018 for fruit from the replicated trial plots at FRS. The procedures used have been described previously (Clark and Perkins-Weazie, 2011). Briefly, dry, shiny-black berries (not treated with preharvest fungicides) were harvested in the morning into hinged, clear, vented, polyethylene 260-g clamshell containers (Century Corrugated Container, Kilgore, TX). Each clamshell contained 20 berries on average. Two clamshells were gathered from each genotype at two consecutive harvest dates (resulting in four replications). The berries were then stored at 5 °C and 80% relative

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Fig. 1. Pedigree of 'Caddo' thornless blackberry.

humidity for 7 d. Subjective evaluations were made for firmness, presence or absence of visible mold, leak, or reddening (also referred to as reversion in the industry). In 2012, the berries were rated on a yes/no scale for presence of red drupelets in clusters of three or more. In 2013–18, 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 to calculate marketability. The marketability value was calculated as $100 - \{ \text{Sum}[\% \text{ Decayed} + \% \text{ Soft} (4\text{- and } 5\text{-rated berries, which are the two classes of the softest berries on a 1-to-5 scale with 1 being very firm)} + \% \text{ Leaky}] / 3 \}$. A minimum score of 85 was desired for a genotype to be considered likely acceptable for shipping based on the variables measured. Comments were recorded (no ratings) for flavor retention and berry gloss after 7 d. In addition, postharvest samples were held for an additional week (14 d total storage), but only observations (no ratings) on mold, flavor, leaking, and reddening were noted.

All replicated trial data were analyzed by analysis of variance (ANOVA) as a split plot in time, with cultivar as the main plot and year as the subplot using PROC Glimmix in SAS 9.4 (SAS Institute, 2012). All analyses had significant year-by-cultivar interactions for all variables. All postharvest data were analyzed separately for each year by ANOVA as a randomized complete block using PROC Glimmix in SAS 9.4 (SAS Institute, 2012). Mean separation for both replicated trial and postharvest data were

performed with Tukey's honestly significant difference test ($P \leq 0.05$).

Description and Performance

'Caddo' originated from a cross designed to produce enhanced flavor between the male parent Ark. 2108 (also a parent of 'Osage') and the highly flavored female parent 'APF-45' ('Prime-Ark® 45'). Consistent excellent flavor was noted during repeated observations of fruit of this cultivar over the years of evaluation, including after rain events, which can reduce flavor and overall fruit quality. 'Caddo' had an average flavor rating of 8.1 in the observational plot, the same as 'Ouachita' and very similar to 'Osage' and 'Natchez' (8.0) (Table 1). Berry sweetness as reflected in average soluble solids ranged from 9.8% to 10.6%, with an average of 9.8% in the 2013 replicated trial for 3 years, and 9.8% to 11.1% (average, 10.5%) in the 2016 trial for 2 years (Tables 2 and 3). Titratable acidity was 1.01% for all years of data collection for the 2013 trial (Table 2), and was 1.11% in 2017 and 0.93% in 2018 (not significantly different) for the 2016 trial (Table 3). Values for pH showed several differences among cultivars and years, but value differences were small and usually 0.2 to 0.3 pH units (Tables 2 and 3).

Fruit of 'Caddo' are oblong and have even drupelet fill. Drupelets are usually visually larger than 'Ouachita', 'Osage', and 'Natchez'. Berries of 'Caddo' are glossy with a uniform black finish. White drupelets have rarely been observed for 'Caddo'. Occasionally, the calyx was observed to be retained on berries for 'Caddo' on some harvest dates.

Fruit firmness is a noteworthy characteristic of 'Caddo', as the field firmness rating in

the observational plots was 7.9, similar to other thornless cultivars (Table 1). Firmness was consistent whether in rainy or dry periods of fruit maturity. Average berry weight of 'Caddo' ranged from a high of 9.5 g (2015) to a low of 7.0 g (2016) (average, 8.0 g) in the FRS 2013-planted replicated trial (Table 2); and 9.6 (2018) to 9.7 g (2017) in the 2016-planted trial (Table 3). At Hope, berries ranged from 6.7 g (2015) to 7.5 g (2016 and 2017) (data not shown). 'Caddo' was usually 2 g or more larger than its similar-season comparison cultivar Osage (Tables 2 and 3), and 1.0 to 1.5 g larger than 'Ouachita' (Table 2). 'Caddo' was smaller than 'Natchez' by 1.8 g, averaged for years in the 2013 trial (Table 2). 'Caddo' retained high fruit weight during the harvest season, averaging only 0.8 g lower from 2014 to 2016 from first to last harvest in the 2013-planted trial (Table 1), whereas fruit weight increased from 7.9 to 9.9 g during the harvest season on average in the 2016-planted trial (data not shown). 'Caddo' produced a limited number of basal inflorescences in some years after the primary crop, which exhibited large berry weight.

Postharvest evaluations done in 2012–18 indicated that 'Caddo' demonstrated excellent storage potential, with marketability greater than 84% every year, with an average of all years of 91.7%. This was comparable in most years to 'Ouachita', 'Natchez', and 'Osage', and in only one year (2013) 'Caddo' was not in the top statistical group (Table 4). Decay averaged 6.2% across all years and in 2013 was significantly greater than other cultivars. This was a year before the two postbloom fungicide applications were added to the management of the planting; there is no explanation to this occurrence and, being

only 1 year, is not thought to indicate greater susceptibility to fruit rot (Table 4). Average leak was 12.4%, very similar to ‘Osage’ and ‘Natchez’, and less than ‘Ouachita’. In only one year (2016) was ‘Caddo’ not in the more desirable statistical group for leakage. Development of red drupelets on berries was very low in most years for ‘Caddo’, averaging 26.4% and close to that of ‘Ouachita’, greater than for ‘Osage’ (12.7%), and less than ‘Natchez’ (45.0%) (Table 4). The values for soft fruit percentage indicate the percentage of berries rated soft (a rating of 4 or 5 on a 5-point scale), with a lower value being more desirable. ‘Caddo’ had an average of 6.4% soft fruit, less than the average for the comparison cultivars (Table 4). ‘Caddo’ was also in the most desirable statistical grouping in each year for percentage of soft fruit. Flavor was consistently noted to be retained after 7 d of storage, indicating that in most stored samples, the aromatic component of flavor remained present. Berry gloss was

retained in the majority of the 7-d stored samples as well. For postharvest samples held for 14 d, there was quite good success in the storage of ‘Caddo’. In 6 of 7 years, the 14-d stored samples were considered overall adequate in storage, and flavor was usually retained, but in some years mold was noted as well as substantial softening, leakage, and some development of red drupelets. ‘Caddo’ is expected to perform well in commercial shipping use based on these comparisons.

‘Caddo’ produced yields of more than 20,000 kg·ha⁻¹ in all years except 2016 in the FRS replicated trials, with an average for the 5 years of 21,535 kg·ha⁻¹. Averaged across 5 years, the yield for comparison cultivar ‘Osage’ was 21,664 kg·ha⁻¹, and for 3 years the average for ‘Ouachita’ was 20,468 kg·ha⁻¹ and ‘Natchez’ was 24,863 kg·ha⁻¹. ‘Caddo’ was in the highest statistical yield group in 4 of 5 years of comparisons (Tables 2 and 3). The lower yield in 2016 in the 2013-planted trial was attributed to a

missing plant in one plot and one lower vigor plant in two plots for that year; it was not determined what contributed to the loss of one plant or lower vigor. At Hope, the 3-year average yield for ‘Caddo’ was 11,394 kg·ha⁻¹, whereas ‘Osage’ averaged 14,961 kg·ha⁻¹ and ‘Natchez’ averaged 13,810 kg·ha⁻¹, although there were no statistical differences in yield for the cultivars (data not shown).

The ‘Caddo’ 10% bloom date averaged 27 Apr. and the 50% bloom was 2 May for the two replicated trials over 5 years (Table 2 for the 2013 trial and data not shown for the 2016 trial), and was very near that of ‘Osage’ and ‘Ouachita’, but later than ‘Natchez’ by 8 d. The first harvest date for ‘Caddo’ for the 5 years was 8 June compared with 10 June for ‘Osage’. The average for only the 2013-planted trial indicated ‘Caddo’ first harvest averaged 10 June, 3 d before ‘Osage’, 5 d before ‘Ouachita’, and 2 d after ‘Natchez’ (Table 1). In the 2016-planted trial, the ‘Caddo’ first harvest date was earlier, with an average of 5 June compared with 7 June for ‘Osage’ (data not shown). Similar trends in harvest for peak and last harvest were usually found among the cultivars (Table 1). A primary consideration in planting ‘Caddo’ will be the near-identical season as ‘Osage’ and also the substantial overlap in harvest period with the highly successful ‘Ouachita’. The hope is that ‘Caddo’ will complement the ‘Osage’ and ‘Ouachita’ harvest period and diversify cultivar choices for growers.

Canes of ‘Caddo’ are thornless and erect. Average erectness ratings for ‘Caddo’ were 7.6, similar to ‘Osage’, ‘Ouachita’, and ‘Natchez’ (Table 1) in the untrellised plots. In the replicated trials with T-type trellis support, the canes were observed to have a very upright stature and this cultivar was well suited to this support system. The rotatable cross-arm/shift trellis (Takeda et al., 2003) has not been evaluated for ‘Caddo’. The average vigor rating of ‘Caddo’ was 7.1, exhibiting balanced vigor similar to other cultivars in the observational plots (Table 1). Plants of ‘Caddo’ usually produce one to three canes per crown, which is not as prolific as some cultivars.

Table 1. Plant and fruit characteristics of four thornless blackberry cultivars at the University of Arkansas Fruit Research Station, Clarksville, AR, from a 2013-planted replicated trial and single-plot observational trial.

Characteristic	Cultivar			
	Caddo	Osage	Ouachita	Natchez
Bloom date ^z				
10% bloom	28 Apr.	24 Apr.	26 Apr.	20 Apr.
50% bloom	3 May	30 Apr.	2 May	25 Apr.
Harvest date ^z				
First	10 June	13 June	15 June	8 June
Peak	23 June	22 June	3 July	18 June
Last	14 July	20 July	20 July	7 July
Berry weight ^z (g/berry)				
First	8.4	5.9	7.1	10.0
Peak	7.9	6.2	6.3	11.5
Last	7.6	5.9	6.7	8.9
Fruit ^{yxw}				
Firmness	7.9 ± 0.4	7.8 ± 0.4	7.9 ± 0.4	7.8 ± 0.4
Flavor	8.1 ± 0.4	8.0 ± 0.0	8.1 ± 0.4	8.0 ± 0.0
Plant ^{yxw}				
Vigor	7.1 ± 0.8	7.0 ± 0.0	7.1 ± 0.8	7.0 ± 0.0
Health	7.6 ± 0.5	7.4 ± 0.5	7.6 ± 0.5	7.4 ± 0.5
Erectness	7.6 ± 0.5	7.8 ± 0.4	7.6 ± 0.5	7.8 ± 0.4

^zMeans of 3 years (2014, 2015, and 2016) from a 2013-planted replicated trial.

^yMeans of 9 years, 2010–18, with data collected from the observational plots ± sd.

^xRating scale of 1 to 10, where 10 = best.

^wMissing 2010, 2011, and 2012 data for ‘Osage’, and 2010 data for ‘Natchez’.

Table 2. Yield, berry weight, soluble solids, titratable acidity, and pH of four blackberry cultivars established in 2013 with data collected in 2014, 2015, and 2016 at the University of Arkansas Fruit Research Station, Clarksville, AR.^z

Cultivar	Yield (kg·ha ⁻¹)			Avg berry wt (g)			Soluble solids (%)			Titratable acidity (%)			pH		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
Caddo	23,231 abAB	25,032 aA	15,815 aB	7.5 bB	9.5 bA	7.0 aB	10.6 aA	9.9 cA	9.8 abA	1.01 aA	1.01 aA	1.01 aA	3.2 abA	3.0 aAB	2.9 aB
Osage	18,714 bA	13,539 bA	20,157 aA	5.7 cAB	6.9 cA	4.7 cB	10.8 aB	11.6 aA	9.6 bC	0.75 bA	0.77 bA	0.86 aA	3.4 aA	3.3 aAB	3.2 aB
Ouachita	28,385 aA	11,141 bB	21,878 aA	6.6 bcA	7.1 cA	6.0 cA	10.7 aA	11.3 abA	10.7 aA	1.05 aA	0.96 abA	1.01 aA	3.1 abA	3.1 aA	3.1 aA
Natchez	26,411 abA	23,717 aA	24,461 aA	9.8 aB	10.9 aA	8.7 aB	11.4 aA	10.5 bcB	10.6 aAB	1.0 aA	1.09 aA	1.08 aA	3.1 bA	2.9 aA	3.0 aA

^zMeans followed by the same lowercase letters within each column and followed by the same uppercase letters within a row of each parameter are not significantly different at the 5% level by Tukey’s honestly significant difference test.

Table 3. Yield, berry weight, soluble solids, titratable acidity, and pH of two blackberry cultivars established in 2016 with data collected in 2017 and 2018 at the University of Arkansas Fruit Research Station, Clarksville, AR.^z

Cultivar	Yield (kg·ha ⁻¹)		Avg berry wt (g)		Soluble solids (%)		Titratable acidity (%)		pH	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Caddo	20,511 bA	22,908 aA	9.7 aA	9.6 aA	9.8 aB	11.1 aA	1.11 aA	0.93 aA	3.2 bB	3.5 aA
Osage	25,962 aA	25,754 aA	5.4 bA	6.2 bA	10.0 aB	11.6 aA	0.90 aA	0.69 aA	3.4 aB	3.6 aA

^zMeans followed by the same lowercase letters within each column and followed by the same uppercase letters within a row of each parameter are not significantly different at the 5% level by Tukey’s honestly significant difference test.

Table 4. Postharvest evaluations of ‘Caddo’, ‘Osage’, ‘Ouachita’, and ‘Natchez’ blackberries from 2012 to 2018 collected at the University of Arkansas Fruit Research Station, Clarksville, AR, compared with named cultivars (7 d in cold storage at $\approx 5^{\circ}\text{C}$).

Cultivar	Marketability (%) ^z	Decay (%) ^y	Leak (%) ^x	Red (%) ^w	Soft (%) ^v
2012					
Caddo	94.9 a ^u	4.8 a	9.6 b	0.7 a	1.0 a
Osage	95.5 a	3.5 a	10.1 b	0.0 a	0.0 a
Ouachita	91.1 a	0.0 a	25.3 a	4.5 a	1.3 a
Natchez	95.9 a	0.0 a	12.4 b	1.4 a	0.0 a
2013					
Caddo	86.2 b	24.7 a	16.7 ab	30.0 ab	0.0 b
Osage	76.4 c	7.1 b	26.8 a	17.6 b	36.7 a
Ouachita	79.2 bc	5.8 b	21.1 a	38.4 a	35.6 a
Natchez	94.8 a	0.0 b	6.1 b	43.0 a	9.6 b
2014					
Caddo	95.9 a	1.4 a	6.6 b	36.4 b	4.5 a
Osage	98.3 a	1.5 a	3.8 b	19.0 c	0.0 a
Ouachita	91.0 b	3.6 a	22.1 a	18.7 c	1.3 a
Natchez	97.9 a	2.1 a	1.8 b	50.5 a	2.5 a
2015					
Caddo	89.3 a	2.6 a	12.3 b	28.0 b	17.2 a
Osage	82.0 ab	3.0 a	28.7 ab	31.4 b	28.6 a
Ouachita	73.3 b	4.7 a	42.5 a	64.9 a	33.0 a
Natchez	86.5 ab	0.0 a	23.4 ab	62.6 a	22.7 a
2016					
Caddo	84.5 a	4.1 a	25.3 a	33.1 b	17.2 b
Osage	88.8 a	7.5 a	10.6 ab	2.3 c	20.6 ab
Ouachita	87.8 a	2.2 a	6.0 b	15.1 bc	28.6 a
Natchez	88.3 a	1.5 a	12.0 ab	74.3 a	21.8 ab
2017					
Caddo	92.2 a	5.6 a	12.9 a	11.1 a	4.9 b
Osage	88.0 a	0.9 a	14.5 a	6.1 a	20.7 a
Ouachita	85.9 a	3.3 a	19.8 a	27.7 a	19.3 a
Natchez	94.7 a	1.6 a	7.0 a	16.5 a	7.3 ab
2018					
Caddo	98.9 a	0.0 a	3.3 b	45.6 b	0.0 b
Osage	100.0 a	0.0 a	0.0 b	11.7 d	0.0 b
Ouachita	97.6 a	2.4 a	3.6 b	30.0 cd	1.1 b
Natchez	83.0 b	0.0 a	26.8 a	66.7 a	24.2 a
Means $\pm$ sd ^t					
Caddo	91.7 $\pm$ 5.3	6.2 $\pm$ 8.4	12.4 $\pm$ 7.2	26.4 $\pm$ 15.4	6.4 $\pm$ 7.6
Osage	89.9 $\pm$ 8.6	3.4 $\pm$ 2.9	13.5 $\pm$ 10.9	12.7 $\pm$ 11.0	15.2 $\pm$ 15.2
Ouachita	86.6 $\pm$ 8.1	3.1 $\pm$ 1.9	20.0 $\pm$ 12.9	28.5 $\pm$ 19.5	17.2 $\pm$ 15.7
Natchez	91.6 $\pm$ 5.6	0.7 $\pm$ 0.9	12.8 $\pm$ 9.2	45.0 $\pm$ 27.0	12.6 $\pm$ 10.2

^zPercent marketability ratings are used as an indicator of performance after 7 d in the cooler. Percent marketability is calculated as $100 - \{\text{Sum}[\% \text{ Decayed} + \% \text{ Soft (4- and 5-rated berries)} + \% \text{ Leaky}]/3\}$. A minimum of 85 is desired. Marketability is calculated using the per-replication data for decayed, soft, and leaky berries, not the mean values presented here. This can result in differences between marketability presented and what would be calculated using the mean values presented here in the formula.

^yThe berries were rated on a yes/no scale for presence of decay.

^xThe berries were rated on a yes/no scale for presence of leakiness.

^wThe berries were rated on a yes/no scale for presence of red drupelets in clusters of three or more in 2012. In 2013–18, berries were rated as having red drupelets if only a single drupelet showed red development; percentage of berries with red drupes is reported.

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

^uMeans followed by the same letters within each column within year are not significantly different at the 5% level by Tukey’s honest significant difference test.

^tMeans of 7 years (2012–18) $\pm$ sd.

The average health rating for the observational plot for ‘Caddo’ was 7.6, which is comparable to comparison cultivars (Table 1). Leaf color was observed to be deep green for ‘Caddo’, and leaf health in the replicated trials was always noted to be very high on both floricanes and primocane leaves. Floricane leaf health was observed to be routinely sustained until after harvest was completed in all years. In 2016 in the 2013-planted replicated trial, a severe infection of cane and leaf rust was seen on many genotypes, with some genotypes experiencing widespread leaf death on floricanes leaves during harvest. ‘Caddo’ was observed to be free of rust infection, reflecting resistance or lower susceptibility to this disease. No orange rust [caused by *Gymnoconia nitens* (Shwein.) F. Kern & H.W. Thurston] has been observed on ‘Caddo’ in any evaluations, even though infected plants

were seen within 50 m of the observational plot of ‘Caddo’. No evidence of infection of anthracnose on berries, canes, or leaves of ‘Caddo’ were seen during its evaluation period. Reaction of ‘Caddo’ to rosette/double blossom [*Cercospora rubi* (Wint.) Plakidas] has not been evaluated. It is expected that ‘Caddo’ is resistant to this disease, as are the other Arkansas thornless cultivars, and ‘Caddo’ should hold promise for production in areas where this disease is limiting.

Winterhardiness can be limiting in blackberry cultivars, particularly in colder climates or areas that experience severe winters. Overall, ‘Caddo’ appears similar in hardiness to other Arkansas-developed cultivars such as ‘Ouachita’ and ‘Osage’. During the evaluation of ‘Caddo’ at FRS in replicated trials, a winter minimum of

-17°C was experienced in Jan. 2018, and no plant or crop damage was noted the following fruiting season. The plants were very well hardened on this date and no warm temperatures were experienced near this minimum temperature event. Other low temperatures experienced were -16°C in Jan. 2015 and Jan. 2017, and -14°C in Jan. 2014. Very slight cane tip damage was noted in 2014 and 2015, but no damage was observed in 2017. Hardiness to temperatures less than these experienced in Arkansas is not known because ‘Caddo’ has not been tested in colder sites.

The chilling requirement for ‘Caddo’ has not been measured and it has not been tested fully in environments of less than 800 h of chilling (hours less than 7°C during dormancy). It is expected that ‘Caddo’ has a chilling requirement similar

to ‘Osage’, which is considered to have a chilling requirement of 300 h.

Outstanding characteristics of ‘Caddo’ include large berries with very good fruit flavor, overall high fruit quality with excellent postharvest fruit-handling potential, consistent high yields, and excellent plant health. Also, diversification of an early midseason cultivar choice beyond ‘Osage’ and ‘Ouachita’ is considered an attribute. ‘Caddo’ should be a commercial cultivar with good potential for shipping, as well as an option for local-market production as well as home gardens. ‘Caddo’ is expected to perform well in areas where ‘Osage’, ‘Apache’, ‘Arapaho’, ‘Ouachita’, ‘Natchez’, or ‘Navaho’ are

adapted, including all areas of the upper South and Southeast United States and into the Midwest, in addition to the West and Pacific Northwest.

Availability

An application for a U.S. plant patent will be filed for ‘Caddo’ and it will be licensed on a nonexclusive basis in the United States.

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