'Westbrook', 'Bradley', and 'Arrington' Nectarines

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'Westbrook', 'Bradley', and 'Arrington' are the first nectarine cultivars released from the Univ. of Arkansas peach and nectarine [*Prunus persica* (L.) Batsch] breeding program. The program was begun in the 1960s (Clark et al., 1999) and included as an objective development of adapted cultivars for both on-farm and shipping sales of nectarines.

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'Westbrook' is a very early ripening, melting flesh, high skin color nectarine with very good flavor for the early season. 'Bradley' and 'Arrington' have non-melting flesh, and enhanced fruit firmness and potential handling characteristics associated with this flesh type. All three cultivars have good bacterial spot resistance [caused by *Xanthomonas campestris* pv. *pruni* (Smith) Dye]. These cultivars should expand options for nectarine growers in the mid- to upper-southern United States and other areas of the world with similar climatic conditions.

Origin

'Westbrook' resulted from a cross of Ark. 172 x Ark. 176 made in 1977 at the Univ. of Arkansas Fruit Substation, Clarksville (Fig. 1). Both male and female parents of 'Westbrook' have 'Nectared 4' (Okie, 1998) in their back-ground. Seedling trees were planted at the

Fruit Substation in 1978 and the original tree was selected in 1980 by J.N.M and R.C.R. and tested thereafter as Ark. 236. 'Westbrook' is named for Cole J. Westbrook, resident director of the Fruit Substation from 1948 through 1976.

'Bradley' resulted from open-pollinated seed gathered from a population of a cross of Ark. 190 x Ark. 178 made in 1980 at the Fruit Substation (Fig. 2). It also has 'Nectared 4' in its background. The source of non-melting flesh is the cling peach selection Ark. 190. Seedling trees from this cross were planted at the Fruit Substation in 1981, open-pollinated seeds were collected from seedling trees in 1984, and these open-pollinated seeds were germinated and planted in the field in 1985. The original tree was selected in 1988 by J.N.M and R.C.R. and subsequently was tested as Ark. 402. 'Bradley' is named for Dr. George A. Bradley, head of the Horticulture Dept. at the Univ. of Arkansas from 1968 through 1991.

'Arrington' resulted from a cross of Ark. 178 x Ark. 232 made in 1984 at the Fruit Substation (Fig. 3). It too has 'Nectared 4' in its background, but the source of non-melting flesh is the cling peach selection Ark. 24. Seedling trees were field-planted in 1985 and the original seedling tree selected in 1989 by J.N.M. and later tested as Ark. 417. 'Arrington' is named for Gene Arrington, resident director of the Univ. of Arkansas Peach Substation, Nashville, from 1948 through 1987.

Testing of these cultivars was at the Fruit Substation [west-central Arkansas, lat.

Fig. 1. Pedigree of 'Westbrook' nectarine; NJ = New Jersey.

Table 1. Production characteristics of nectarine cultivars, Univ. of Arkansas Fruit Substation, Clarksville, 1997–99 (planting established 1995).

	10% Bloom	Harvest	Yield/tree	Fruit	Bacterial spot rating ^z	
Cultivar	date	date	(kg)	wt (g)	Leaves	Fruit
1997						
Westbrook	11 Mar.	13 June	12.4 bc ^y	83.7 b	1.0 c	0.0 c
Bradley	11 Mar.	9 July	22.8 a	139.1 a	1.3 bc	1.3 ab
Arrington	11 Mar.	19 June	14.9 ab	80.1 b	2.8 a	2.3 a
Red Gold	12 Mar.	31 July	2.9 d	140.6 a	2.3 ab	2.3 a
Summer Beaut	11 Mar.	15 July	4.4 cd	73.2 b	2.0 ab	1.0 bc
1998						
Westbrook	23 Mar.	16 June	4.2 c	99.3 d	1.0 b	0.0 c
Bradley	20 Mar.	4 July	31.4 a	169.2 ab	1.0 b	0.0 c
Arrington	17 Mar.	25 June	22.3 b	121.5 c	1.0 b	0.5 c
Red Gold	23 Mar.	20 July	11.1 c	176.9 a	2.3 a	3.3 a
Summer Beaut	21 Mar.	11 July	10.4 c	155.9 b	2.5 a	1.5 b
1999						
Westbrook	11 Mar.	8 June	26.3 cd	95.0 b	1.0 b	0.0 c
Bradley	13 Mar.	2 July	51.5 a	124.9 a	1.3 b	0.5 c
Arrington	6 Mar.	22 June	43.5 ab	101.8 b	1.5 b	1.8 b
Red Gold	8 Mar.	28 July	16.7 d	142.5 a	3.3 a	4.3 a
Summer Beaut	11 Mar.	3 July	30.8 bc	135.1 a	1.5 b	2.0 b

^zScale of 0–5: 0 = no disease; 5 = severe disease.

^yMean separation by LSD, $P < 0.05$.

35°31'58"N and long. 93°24'12"W; U.S. Dept. of Agriculture (USDA) hardiness zone 7a; soil type Linker fine sandy loam (Typic Hapludult). In all testing, trees were trained to an open-center system and pruned annually, spaced 5.5 m between trees, fertilized annually with either complete or nitrogen fertilizers, irrigated as needed, and pests managed using a pest management program typical for commercial orchards of the area, including the applications of fungicides and insecticides. No bactericides were applied to evaluation plantings during testing of these cultivars. Fruit thinning was done prior to pit hardening but after shuck split each year that a crop was present, with thinning to a distance of 12 to 15 cm between fruit.

Trials consisting of two-tree observational plots on 'Lovell' rootstock were maintained at Clarksville, and data were collected from these trees or the original tree. 'Westbrook' was tested from 1980 through 1999; 'Bradley' was tested from 1988 through 1999; and 'Arrington' was tested from 1989 through 1999. Data are reported here only for a maximum of 7 years for any data point except as noted for any cultivar (1992 through 1999, except for 1996 when crop loss occurred on all cultivars due to spring frost damage). Fruit ratings were taken for shape, firmness, skin color, flesh color, finish, and flavor. Trees were rated for vigor, crop, and health, with an emphasis on bacterial spot on leaves or fruit. Rating scale for these variables was 1 to 10 with a rating of 10 most desirable, with the exception of vigor, in which a rating of 10 indicated excessive vigor. A rating of 7 to 8 would be most desirable for vigor in this rating scale. Additionally, a five-fruit sample was collected for each cultivar for the same 7 years and average fruit weight, firmness [using a model FT327 fruit pressure tester, 11-mm-diameter probe (McCormick Fruit Tree Co., Yakima, Wash.)] and soluble solids using a bench refractometer were determined. A five-fruit sample was collected in 1998 and on this

sample fruit skin (blush and ground color) and flesh color were measured [using a Minolta model CR-200 chroma meter (Minolta, Ramsey, N.J.)].

A replicated trial of these cultivars and the standard cultivars Red Gold (Okie, 1998) and Summer Beaut (Okie, 1998) was established at the Fruit Substation in 1995 and data were collected for bloom and harvest date, yield, average fruit weight, and bacterial spot on fruit and leaves in 1997–99. Bacterial spot ratings in this planting were based on a six-point scale, with 0 = no bacterial spot and 5 = severe bacterial spot infection. Four single-tree replications arranged in a randomized complete-block design were utilized in this planting, and data were analyzed separately for each year by analysis of variance and means separated by LSD (SAS Institute, 1989).

Description and performance

Average 10% bloom date for 'Westbrook' ranged from 11 to 23 Mar. for 1997–99, while 'Bradley' 10% bloom occurred from 11 to 20 Mar., and 'Arrington', 6 to 11 Mar. in the replicated trial (Table 1). 'Arrington' had earlier 10% bloom in 2 of the 3 years compared to 'Bradley' or 'Westbrook'. 'Red Gold' and 'Summer Beaut' 10% bloom dates were within those of the three Arkansas-developed cultivars (Table 1). Full bloom dates averaged 26 Mar. for 'Westbrook', 22 Mar. for 'Bradley', 20 Mar. for 'Arrington', 21 Mar. for 'Summer Beaut', and 22 Mar. for 'Red Gold' (data not shown). Flowers of 'Westbrook', 'Bradley', and 'Arrington' are non-showy and self-fertile. Leaf glands of 'Westbrook' and 'Bradley' are reniform, while those of 'Arrington' are globose. Tree vigor was similar for 'Westbrook' and 'Arrington', but 'Bradley' vigor was slightly lower by comparison (Table 2); this difference was minimal and would not affect canopy management decisions. Crop load ratings (taken at the time of fruit maturity) were highest for 'Bradley' and 'Arrington' but still

Table 2. Fruit and plant characteristics of Arkansas nectarine cultivars. Data are means of 7 years (1992–99). Ratings are based on a 1–10 scale, with a rating of <6 considered unacceptable.

	Westbrook	Bradley	Arrington
Fruit			
Shape ^z	8.1	7.9	7.9
Firmness ^y	7.7	8.9	9.0
Skin color ^x	8.0	8.1	8.7
Flesh color ^w	7.9	8.6	8.3
Finish ^v	8.1	8.6	8.3
Flavor ^u	8.0	7.1	7.6
Soluble solids (%)	10.7	11.6	12.2
Plant			
Vigor ^d	8.9	7.7	9.0
Crop ^s	8.4	9.3	9.2
Health ^r	9.6	9.3	9.6

^z10 = round or mostly round or uniform and free of bulging suture and blossom-end tip.

^yBased on hand pressure applied to whole, unpeeled fruit, with 10 = very firm fruit.

^xPreferred is 50% or more blush or overcolor with a yellow or orange ground color with an absence of green in the groundcolor at maturity; 10 = the preferred balance of these colors.

^wPreferred is a yellow to orange flesh with red in the flesh acceptable, although a predominantly red flesh was rated lower; 10 = slight to moderate red in flesh along with orange to yellow predominant flesh color.

^vPreferred is bright finish free of any blemish or skin cracks or inconsistencies with 10 = bright red color with skin free of all surface blemishes/freckles and skin cracks.

^uRatings based on fresh samples and higher values indicate good sweetness and expression of nectarine flavor, and low in astringency or other undesirable flavor components.

^dRatings based on good shoot growth, but not overly vegetative; optimum is a rating of 7 to 8 with a rating of 10 considered excessive vigor.

^s10 = full crop; 9 = 90% crop, etc.

^rFreedom from poor health due largely from disease with 10 = no disease or health concerns. The most important disease involved in this rating is bacterial spot, and a higher rating indicates a lower occurrence of this disease. Non-disease factors could involve poor health due to mineral deficiencies or insect damage.

high (8.4) for 'Westbrook' (Table 2), although these ratings were taken at the time of fruit maturity and do not reflect the fruit set prior to thinning. However, consistent cropping was achieved in all years of fruiting except for years when frosts near bloom (either prior to, during, or post-bloom) eliminated the crop. Ratings for tree health for all three cultivars were very good, indicating excellent health for all three cultivars on the observational trees (Table 2). A major component of the tree health rating is resistance to bacterial leaf spot. 'Westbrook' was observed to be completely free of bacterial spot infection on fruit in all years, and had slight bacterial spot on leaves in only 3 of 19 years of observation on the two-tree plot observational trees (data not shown). Likewise, in the replicated trial 'Westbrook' had no fruit bacterial spot lesions, and only very slight leaf infections (Table 1). 'Bradley' had no bacterial spot lesions noted in 12 years of observation on the two-tree plots (data not shown), while trees in the replicated trial had very few infections on either leaves or fruit (Table 1). 'Arrington' also was free of bacte-

rial spot infection on leaves or fruit on the observational trees for 11 years (data not shown). More bacterial spot infection was seen for 'Arrington' in the replicated trial but ratings indicated only minimal levels of infection (Table 1). In the replicated trial, 'Westbrook' and 'Bradley' were usually rated significantly higher for bacterial spot resistance compared to 'Red Gold' and 'Summer Beaut', and 'Arrington' was more bacterial spot resistant than 'Red Gold' but slightly more susceptible than 'Westbrook' and 'Bradley'. No other disease problems have been seen on any of these cultivars, although a commercial fungicide program was used that controlled brown rot [caused by *Monilinia fructicola* (G. Wint.) Honey] and peach scab (caused by *Cladosporium carpophilum* Thuem.). Chilling requirement of 'Westbrook', 'Bradley', and 'Arrington' has not been measured but is probably near 750 h below 7 °C based on observations of budbreak and bloom in comparative plantings with test cultivars of known chill requirement.

Fruit of 'Westbrook' ripened very early, on average 9 June in 12 years of maturity recorded on the observational trees (data not shown), and ripened from 8 to 16 June in the replicated trial (Table 1). This maturity date is on average 3 weeks earlier than 'Redhaven' peach (Okie, 1998) at this location. 'Bradley' ripened on average 29 June in 9 years of observation and from 2 to 9 July in the replicated trial, near that of 'Redhaven' peach, thus averaging 5 d before 'Summer Beaut' and 21 d before 'Red Gold'. 'Arrington' ripened between 'Westbrook' and 'Bradley', on average 24 June in 8 years of observation. These three nectarines would provide a near continuous supply of fruit from early June to the first third of July at this location.

Yield data, collected in the replicated trial 1997–99, indicated 'Bradley' was the highest yielding entry in the trial in all years, although 'Arrington' was statistically similar in 2 of 3 years. 'Westbrook' had lower yields than 'Bradley' and 'Arrington', and it is not known what contributed to the decline in yield for 'Westbrook' for 1998 compared to that of 1997. Yields in 1999 were higher for 'Westbrook', however, indicating more yield potential on older trees. Crop load ratings (discussed earlier) for 'Westbrook' averaged 8.4 on a 1 to 10 scale, with 10 = very heavy crop (Table 2), so yield performance in the replicated trial should not be the sole reflection of yield potential for this cultivar.

Average fruit weight for 'Westbrook' over 7 years in the observational trees was 109.6 g. In the replicated trial, average fruit weight ranged from 83.7 to 99.3 g and was usually the smallest-fruited cultivar among those reported here (Table 1). Fruit are round without a pronounced tip or suture bulge. Fruit measurements for 'Westbrook' from the five-fruit sample for 1998 averaged 5.9 cm in length and 6.3 cm in diameter. Average fruit weight for 'Bradley' over 7 years was 146.4 g for the observational trees, ranging from 124.9 to 169.2 g in the replicated trial, and was among the larger-fruited cultivars in this comparison

(Table 1). Fruit are also round, with a length of 7.5 cm and diameter of 7.7 cm (based on the five-fruit sample measured in 1998). 'Arrington' fruit averaged 125.1 g for 1992–99 from the observational trees, and in the replicated trial ranged from 80.1 to 121.5 g (Table 1). Also with a round fruit shape, fruit diameter was measured to be 5.9 cm in length and 6.3 cm in diameter (1998 fruit only). Split pits were observed in some years on 'Arrington' and 'Westbrook', but were not seen on a large percentage of the fruits. Split pits on 'Bradley' were very rarely observed.

Fruit shape, skin color, and finish ratings were generally similar among 'Westbrook', 'Bradley', and 'Arrington', and all were rated very good (Table 2). 'Westbrook' has the highest amount of red skin color of the three, with the red blush estimated to cover over 80% of the fruit surface. The ground color (background color) for 'Westbrook' was determined to have the following values: L = 56.70 (the lower the L value, the darker the sample), a = 29.24 (the higher the a value, the redder the sample), b = 37.83 (the higher the b value, the more yellow the sample); while the red blush or over color of the skin was: L = 32.56, a = 28.70, b = 8.59. 'Bradley' has a blush covering ≈60% of the fruit skin surface. The ground color (background color) for 'Bradley' was determined to have the following values: L = 68.02, a = 19.34, b = 55.91; while the red blush or over color of the skin was: L = 39.88, a = 38.80, b = 19.94. 'Arrington' has a blush also covering ≈60% of the fruit skin surface. The ground color (background color) for 'Arrington' was determined to have the following values: L = 68.62, a = 13.58, b = 54.68; while the red blush or over color of the skin was: L = 34.96, a = 39.74, b = 15.75. Finish ratings reflect the uniformity of the surface of the fruit, and higher ratings indicate smooth fruit surface free of cracking, freckling, and bacterial spot lesions. These cultivars exhibited consistently good characteristics in this area. The only concern with fruit skin was with 'Westbrook', in that skin breakdown (sloughing) was observed in some years on fully mature fruits (fruits that were softened) when rainfall occurred. This skin concern should be considered in harvesting fully mature fruit for local sales, particularly if significant rainfall is anticipated.

Fruit firmness for 'Westbrook' had an average rating of 7.9 and a 7-year average pressure test value of 4.6 kg on early-mature fruits (rating data in Table 2 but pressure data not shown). The flesh of 'Westbrook' is melting, so softens more quickly compared to the non-melting 'Bradley' and 'Arrington'. 'Bradley' average firmness rating was 8.9 and pressure test value average was 5.2 kg, while 'Arrington' was rated 9.0 and had a 5.3 kg pressure test value (rating data in Table 2 but pressure data not shown). 'Westbrook' exhibits a cling to semi-clingstone flesh adherence to the pit, while 'Bradley' and 'Arrington' are both cling-stones.

Flesh color ratings were high for all cultivars. However, the cultivars differ in flesh color characteristics. 'Westbrook' has a more

conventional nectarine flesh, in that some red pigment is found in the flesh. 'Westbrook' flesh color values for 1998 samples were: L = 58.31, a = 11.41, b = 42.23. 'Bradley' and 'Arrington' however both have completely yellow to yellow-orange flesh with no red in the flesh. Flesh color values for 1998 were for 'Bradley': L = 68.03, a = 10.57, b = 53.31; and for 'Arrington' were: L = 66.63, a = 8.49, b = 51.72.

Flavor ratings were high for all cultivars, with the highest rating for 'Westbrook'. Its flavor is very good for a very early ripening cultivar, a season in which good flavor is difficult to achieve. 'Westbrook' has a mild nectarine flavor. Soluble solids of 'Westbrook' averaged 10.7% (Table 2). 'Bradley' was the lowest rated cultivar of the three, and the flavor of 'Bradley' is more similar to a processing peach flavor. 'Arrington' does not exhibit the same processing peach flavor as 'Bradley', and it has a mild nectarine flavor and aroma. Soluble solids for 'Bradley' and 'Arrington' averaged 11.6% and 12.2%, respectively.

The outstanding characteristics of 'Westbrook' are its very early maturity date, excellent flavor, attractive skin color, good firmness for melting flesh, and good resistance to bacterial spot; weaknesses are only medium fruit size and occasional skin breakdown on very mature fruits after rainfall. The outstanding characteristics of 'Bradley' are large, attractive fruits with outstanding firmness for good shipping and storage performance, good yield potential, and good resistance to bacterial spot; weaknesses include a processing peach rather than typical nectarine flavor. 'Arrington' has the outstanding traits of early maturity, firm flesh with good shipping and storage potential, moderate resistance to bacterial spot, and good yield potential. A weakness of 'Arrington' is somewhat early bloom. All three cultivars are recommended for trial where other eastern U.S.-developed, medium- to high-chill nectarines are grown.

Availability

Applications for U.S. plant patents have been filed for all three cultivars. A list of nurseries licensed to propagate and sell these cultivars can be obtained from J.R.C., 316 Plant Science, Dept. of Horticulture, Univ. of Arkansas, Fayetteville, AR 72701. A limited amount of budwood is available for research and evaluation purposes and requests can be sent to J.R.C., 316 Plant Science, Dept. of Horticulture, Univ. of Arkansas, Fayetteville, AR 72701.

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