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Rabbiteye Blueberry Cultivar Performance

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Abstract

'Tifblue,' 'Premier,' and 'Powderblue' were the highest producing cultivars tested. Economic analysis showed these three cultivars generate the greatest income per hectare even though fruit from earlier ripening culitvars received higher prices some years. Late spring frosts resulted in more damage and greater reduction in yields of some early flowering and cold-sensitive cultivars such as 'Climax,' 'Woodard' and 'Delite.' Sequence of maturity dates and number of harvests required per year varied by cultivar and year. Fruit size varied by cultivar and year, with the largest fruit being produced by 'Delite,' 'Climax,' and 'Powderblue.' Fruit of 'Climax,' 'Garden Blue,' 'Homebelle,' and 'Menditoo' had the highest percent soluble solids and 'Delite' had the lowest.

Introduction

The rabbiteye blueberry (*Vaccinium ashei* Reade) is native to the Southeastern United States. In recent years, interest has developed in commercial blueberry production and marketing in Alabama, as well as in Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Texas (1, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 17). There has been a large increase in commercial acreage in each of these states, along with the development of marketing organizations. Spears (18) indicated that the most popular rabbiteye cultivars based on the percentage of acreage currently being planted are 'Tifblue' (53%), 'Climax' (23%), 'Brightwell' (6%), 'Woodard' (5%), 'Premier' (4%), 'Beckyblue' (4%), 'Delite' (2%), 'Aliceblue' (2%), 'Southland' (2%), and 'Bonita' (1%).

Rabbiteye blueberries are vigorous, tall-growing, highly productive, long-lived, and have insect and disease resistance (3, 6, 7, 17). Plants perform best on a well-drained, medium-textured soil with a pH of 4.5-5.2. Since frost injury can be a problem, plantings do best when established on an elevated site with good air drainage. Frost injury can occur from the time the flower buds swell in the spring until harvest (14). Spiers (14) reported that as flower bud development advanced in the spring the flowers became more sensitive to cold damage. He reported that 'Climax,' 'Woodard,' 'Southland,' and 'Delite' cultivars had earlier flower bud development than other cultivars in the study and therefore incurred more cold damage from late spring frost.

Establishment of a blueberry planting is expensive; however, the productive life has exceeded 50 years in some states. The success of the planting is dependent upon careful cultivar selection and proper planting schemes. Two or more cultivars must be included in each planting because rabbiteye blueberries are essentially self-sterile and require cross pollination (3, 6, 7, 17). Rabbiteye blueberries are productive, however, yield varies greatly among cultivars. Commercial yields generally range from 1,680 to 16,800 kg/ha (6). Great variation exists among cultivars in fruit quality, size, and concentrated period of fruit ripening (1, 3, 10, 11, 15, 16). Many new cultivars have been released in recent years and their performance in Alabama has not previously been evaluated. This study was conducted to determine yield, fruit size and quality, ripening season and

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sequence, and concentration of fruit maturity of ten cultivars of rabbiteye blueberry.

Materials and Methods

An experimental planting of ten cultivars of rabbiteye blueberry was established in March 1980 in southeast Alabama at the Brewton Experiment Field, Brewton, Alabama. A randomized complete block design was used with blocks of three plants per cultivar in each of the four replications. The planting was established with plants 1.8 in rows 3.7 m apart with 1494 plants per ha.

The soil was a Benndale (Typic Paleudalts) sandy loam with a pH of 4.7 which tested very high in phosphorus and high in potassium prior to planting. Two-year-old bare root plants were used to establish the planting. The planting hole was dug and the soil removed was amended with equal volumes of peat moss prior to planting. After planting, the rows were mulched with pine bark. The mulch was applied down the row 0.9 m wide and 10.2 to 15.2 cm deep. A drip irrigation system was established in May 1983 with a 3.79-1 per hour emitter per plant. Plants that died during the first two years were replanted the following dormant season to maintain the competitive effect of adjacent plants. Recommended practices for fertility and weed control were followed.

Fruit were hand picked once per week from the time the first berries were ripe until all fruit were harvested from each plant. Yield data from each plot were projected to kg/ha. Berry weight (g), the number of berries per kg, fruit length and width (cm), percent soluble solids, and potential gross income per hectare were calculated. These data were then analyzed by analysis of variance procedures (19), and differences among the cultivars were separated at the 5% level using NMRT.

Results and Discussion

Collection of yield data began in the fourth growing season after planting (Table 1). 'Tifblue,' 'Premier,' and 'Powderblue' were the highest yielding cultivars in each of the 7 years (1983-89) that yield data were collected and had the highest cumulative and average yields. In the second (1984), third (1985) and seventh (1989) fruiting seasons, yields of some other cultivars were high but did not equal the three highest yielding cultivars. Yields reported in Table 1 are similar to yields reported for corresponding cultivars from other states (1, 2, 6, 10, 11, 16, 17). However, yields for 'Powderblue' and 'Premier' have not been reported from similar evaluations.

Yields were reduced in 1986, 1987, and 1988 due to late spring frosts that occurred during bloom. In 1986, damaging low termperatures of -3.3°C and -2.2 occurrred on March 22 and 23, respectively. In 1987, damaging low temperatures ranged from -3.9 to 0.0°C between March 31 and April 6. In 1988, damaging low temperatures of -6.1 to -2.8°C occurred nightly on March 15 to 20. 'Climax' and 'Woodard' were near full bloom at this date, and all other cultivars ranged from 10 to 50 percent full bloom. Yields of some cultivars were reduced by frost injury more than others each season. Yields of 'Tifblue,' 'Premier,' and 'Powderblue' were affected the least (Table 1).

Yields of 'Climax,' 'Woodard,' and 'Delite,' three widely recommended and planted cultivars, were greatly reduced by the late frost each season. Frost injury was greater on 'Delite' and 'Climax' than on other cultivars in the test. The flower buds of 'Climax' were further advanced at the occurrence of the damaging low temperatures. Flower buds of 'Delite' appeared to be more cold tender at the same state of development than flower buds of other cultivars. This is reflected in the low cumulative yield of these cultivars (Table 1).

Table 1. Yield of rabbiteye blueberry as affected by cultivar.[1]

Cultivar	Yield (kg/ha), by year							7-year avg yield (kg/ha)
	1983	1984	1985	1986	1987	1988	1989	
Tifblue	1,339	7,596	12,402	6,661	12,056	15,371	24,837	11,466a[2]
Woodard	848	4,840	9,594	3,333	3,132	7,543	11,347	5,805b
Southland	756	2,862	6,261	2,504	5,590	8,618	12,219	5,544b
Climax	747	2,460	6,960	1,551	939	6,543	5,010	3,459c
Garden Blue	598	4,460	9,521	4,370	9,801	9.062	8,530	6,620b
Delite	564	3,351	5,229	1,445	2,196	10,918	5,100	4,115c
Homebelle	333	3,892	9,205	4,256	1,917	7,132	12,195	5,561b
Menditoo	557	2,227	5,467	4,980	2,582	11,549	10,940	5,472b
Premier	1,354	6,516	11,555	7,106	12,380	13,577	19,673	10,309a
Powderblue	792	4,576	10,657	7,758	9,364	16,918	20,422	10,069a

[1]Hectare yields calculated with 1494 plants per hectare on a 1.8 m spacing in rows 3.7 m apart.
[2]Mean separation within columns by Duncan's multiple range test, $P \leq 0.05$

Austin and Bondari (1) compared the yields of seven rabbiteye cultivars from ten different locations in the United States and Japan. They found that the average yield for all plant ages varied with location of harvests for 'Tifblue,' 'Woodard,' 'Homebelle,' and 'Delite,' but yields did not vary with location for cvs. 'Briteblue,' 'Southland' and 'Climax,' indicating that the latter cultivars may be less productive, but somewhat better adapted to various soil and climatic conditions. When all locations were pooled, 'Tifblue' had the highest average yield, and 'Delite' had the least uniform yield over all locations. Moore (11) reported the yields of seven cultivars in Arkansas. The most productive cultivars were 'Bluebelle,' 'Tifblue,' 'Woodard,' 'Briteblue,' and 'Climax,' followed by 'Southland' and 'Delite.' A comparison of rabbiteye cultivars in Georgia (2) showed 'Tifblue' and 'Delite' to be the most productive cultivars followed by 'Bluebelle' and 'Woodard.' Additional named cultivars in order of production included 'Climax,' 'Southland' and 'Briteblue.' By comparison the top yielding cultivars in trials in other rabbiteye-producing areas showed 'Tifblue,' 'Southland,' 'Briteblue,' 'Alice-

Table 2. Effect of cultivar of rabbiteye blueberry on first harvest date and number of weekly harvests required.

Cultivar	Date of first harvest (A) and number of harvests (B), by year														Avg. date of first harvest	Avg. No. yearly harvests
	1983		1984		1985		1986		1987		1988		1989			
	A	B	A	B	A	B	A	B	A	B	A	B	A	B		
Tifblue	6-16	(6)	6-8	(5)	6-10	(5)	6-16	(4)	6-15	(5)	6-13	(5)	6-12	(5)	6-13	5.0
Woodard	6-10	(6)	6-8	(5)	6-3	(10)	6-9	(5)	6-15	(4)	6-7	(5)	6-12	(4)	6-9	5.6
Southland	6-16	(5)	6-8	(5)	6-10	(8)	6-16	(4)	6-15	(6)	6-13	(5)	6-12	(4)	6-13	5.3
Climax	6-10	(5)	6-8	(5)	6-3	(6)	6-9	(3)	6-15	(2)	6-7	(4)	6-5	(4)	6-8	4.1
Garden Blue	6-24	(4)	6-8	(5)	6-10	(6)	6-16	(4)	6-15	(5)	6-13	(4)	6-12	(4)	6-14	4.7
Delite	6-16	(5)	6-8	(5)	6-10	(6)	6-16	(3)	6-15	(5)	6-13	(5)	6-12	(4)	6-13	4.7
Homebelle	6-24	(4)	6-8	(6)	6-10	(8)	6-16	(4)	6-15	(5)	6-7	(5)	6-12	(4)	6-13	5.1
Menditoo	6-24	(5)	6-18	(5)	6-17	(8)	6-16	(5)	6-15	(6)	6-20	(5)	6-12	(6)	6-17	5.7
Premier	6-24	(4)	6-8	(6)	6-8	(7)	6-16	(4)	6-15	(5)	6-13	(5)	6-5	(5)	6-13	4.4
Powderblue	6-24	(4)	6-8	(6)	6-8	(8)	6-16	(4)	6-15	(5)	6-13	(5)	6-5	(5)	6-14	5.3

Table 3. Effect of cultivar on average weight per berry and number of berries per kg.

Cultivar	Weight per berry (g)							7-yr. avg. wt./berry (g)	Berries per kg.
	1983	1984	1985	1986	1987	1988	1989		
Tifblue	1.27	1.36	1.23	1.14	1.34	1.26	1.66	1.32c[z]	758ef
Woodard.....	1.09	1.18	1.20	1.17	1.31	1.21	2.05	1.32c	758de
Southland	1.45	1.27	1.08	1.03	1.24	1.09	1.83	1.29c	775cd
Climax.....	1.08	1.20	1.35	1.32	1.42	1.54	2.11	1.43b	699fg
Garden Blue...	0.91	0.95	0.97	0.75	0.88	0.91	1.37	0.97e	1031a
Delite.....	1.63	1.38	1.37	1.25	1.35	1.76	2.49	1.61a	621h
Homebelle	0.91	1.13	1.03	1.07	1.07	1.15	1.56	1.13d	885b
Menditoo	1.09	1.23	1.09	1.06	1.20	1.05	1.58	1.19d	840c
Premier	1.09	1.25	1.21	1.08	1.28	1.29	1.70	1.27c	787de
Powderblue ...	1.45	1.54	1.25	1.20	1.42	1.39	1.76	1.43b	699g

[z]Mean Separation within columns by Duncan's multiple range test, $P \leq 0.05$.

blue' and 'Centurion' to be the most productive in southern Mississippi (17), while 'Bluebelle,' 'Tifblue,' and 'Southland' were the top performers in northern Mississippi (10). Eck (6) reviewed the yields of seven rabbiteye cultivars in three different locations and also found 'Tifblue' to be the top performer, as was the case in Alabama. In Texas 'Tifblue,' 'Climax,' 'Brightwell,' 'Delite,' 'Baldwin' and 'Premier' have performed well, with 'Tifblue,' 'Delite,' 'Climax,' 'Brightwell,' and 'Briteblue' being currently recommended for planting (3). 'Beckyblue,' 'Bluegem,' 'Briteblue,' 'Climax,' 'Delite,' 'Powderblue,' 'Premier' and 'Tifblue' are currently recommended for planting in Louisiana (11). Sixteen rabbiteye cultivars are suggested for planting in Georgia with 'Climax,' 'Premier,' 'Brightwell,' and 'Powderblue' being best suited for mechanical harvesting for the fresh market. (5).

The date of the first picking and number of weekly pickings required to harvest all fruit show that the ripening sequence for the cultivars varied between seasons (Table 2). It should be noted that crop load, which is often a function of the severity of frost damage and the availability of soil moisture, greatly affects time of fruit ripening. The smaller the crop load and the more adequate the supply of soil moisture from either rainfall or irrigation, the earlier the berries ripen. However, the time of ripening can be altered if all the early fruit buds are killed leaving only those fruit buds which produce the latter ripening portion of the crop. Differences in ripening sequence in a given season were not as clear cut in this study as in previous reports, nor did the cultivars ripen in reported (6, 7, 12) order of ripening each season. 'Woodard' and 'Climax' were the earliest ripening cultivars for five of the seven harvest seasons. The average ripening dates of 'Woodard' and 'Climax' were nine days earlier than 'Menditoo," the latest ripening cultivar, and 4 to 5 days earlier than the other cultivars. In 1984 and 1987, all cultivars matured at the same time, except in 1984 'Menditoo' ripened ten days later than the other cultivars.

Little difference occurred among cultivars in number of weeks required to harvest the fruit. The average number of weeks required to harvest the crop was least for 'Climax.' However, this resulted from the light crops following frost injury in 1986, 1987, and 1988. Similar variations in ripening season have been reported in other states (6, 8, 13, 16). In Mississippi (16), 'Climax' and 'Woodard' were the earliest ripening cultivars, however, 'Tif-

blue' was reported to ripen before 'Woodard' at three locations in Arkansas over a 7-year period (13). The possibility exists that the cultivars named in the Arkansas study were mixed, resulting in the reversed ripening order of 'Woodard' and 'Tifblue.'

Fruit weight, size, shape, and percent soluble solids data are presented in Tables 3 and 4 for the 7-year period. 'Delite' berries were the largest of the cultivars tested and fewer fruit were required to make a kg. This was probably due to a lower fruit set per plant. The average weight of 'Climax' fruit was increased due to low yields in 1986, 1987, and 1988. However, 'Climax' fruit size was not as large as fruit of many other cultivars in 1983 and 1984. Fruit size of 'Powderblue' was the largest of the higher yielding cultivars. The fruit of 'Garden Blue' were the smallest, requiring more fruit to make a kg, and 'Delite' produced the largest fruit, Tables 3 and 4. Austin *et al.* (2) pointed out that with practically every cultivar they studied, larger fruit size was associated with lower yields. A similar trend was also noted in the present study.

Table 4. Effect of cultivar of rabbiteye blueberry on fruit length, width, and percent soluble solids.

	4-year average (1986-1989)		
Cultivar	Width (cm)	Length (cm)	Sol. solids (%)
Tifblue	1.34ef	1.29bcd	13.1cd[z]
Woodard	1.41bcd	1.30bcd	12.9cd
Southland	1.38bcde	1.28cd	12.9cd
Climax	1.44ab	1.32bc	14.6b
Garden Blue	1.23g	1.15e	15.5a
Delite	1.49a	1.39a	12.2e
Homebelle	1.32f	1.26d	14.6b
Menditoo	1.36def	1.29bcd	14.1b
Premier	1.37cdef	1.28cd	13.2c
Powderblue	1.40bcd	1.34ab	13.0cd

[z]Mean separation within columns by Duncan's multiple range test, $P \leq 0.05$.

Percent soluble solids varied each season for all cultivars (Table 4). The soluble solids were highest in 1988 and lowest in 1985. However, there was little difference in percent soluble solids between the higher yielding cultivars within the same year. The 4-year average soluble solids content was highest in fruit of 'Garden Blue' and lowest in fruit of 'Delite.' The percent soluble solids decreased with increasing fruit size.

The potential gross income on a per ha basis is presented in Table 5. This yearly potential income figure was derived from the yield data in Table 1 and the actual weekly wholesale price received by Alabama growers in the Escambia County Blueberry Growers Association presented in Table 6. The wholesale prices received by the growers were highest at the beginning of the harvest season and declined as the harvest season progressed (Table 6). In 1988, the price did not change during the season and remained higher throughout the season than in other years. Due to higher early season prices, there was a potential for greater income from early ripening cultivars, such as 'Climax' and 'Woodard.' Higher yields of the slightly later maturing cultivars resulted in greater gross income per ha than the early ripening cultivars even though they sold for lower prices in most years (Table 5). The average annual gross income for the seven fruiting years was $24,229, $21,612, and $21,060 per ha for 'Tifblue,' 'Premier,' and 'Powderblue,' respectively, compared to $7,685, $12,375, and $8,567, respectively, for 'Climax,' 'Woodward,' and 'Delite.'

At least two cultivars must be included in a planting to ensure adequate pollination. From yields and fruit quality data derived from this study, it appears that 'Tifblue,' 'Premier,' and 'Powderblue' would offer the greatest potential for sustained yields and income. The commonly planted cultivars 'Woodard,' 'Climax,' and 'Delite' pro-

Table 5. Effect of cultivar and year on potential, gross income per ha.

Cultivar	Yearly per ha income[z]							Cumulative income, 1983-89	7-year average income
	1983	1984	1985	1986	1987	1988	1989		
Tifblue	2,782	13,489	26,007	12,783	23,304	33,833	57,404	169,602	24,229a[y]
Woodard.....	1,880	8,975	20,543	6,212	6,037	16,642	26,343	86,632	12,375b
Southland	1,646	5,268	12,829	4,853	10,779	19,007	24,268	78,650	11,236b
Climax.....	1,722	4,725	16,259	3,116	1,779	14,436	11,755	53,792	7,685c
Garden Blue...	1,226	7,818	20,116	8,248	19,143	19,990	19,859	96,400	13,771b
Delite.....	1,181	5,750	10,156	2,782	4,267	24,038	11,792	59,966	8,567c
Homebelle	724	6,785	18,241	8,312	3,694	20,465	28,162	86,383	12,340b
Menditoo	1,095	3,497	9,462	9,229	4,999	25,390	23,974	77,646	11,092b
Premier	2,807	11,401	23,966	13,687	23,979	29,879	45,563	151,282	21,612a
Powderblue ...	1,631	7,895	20,957	14,754	18,713	37,253	46,220	147,423	21,060a

[z]Derived from actual yield times actual price per week each season.
[y]Mean separation within columns by Duncan's multiple range test, $P \leq 0.05$

duced some of the lowest yields and income on a per ha basis. The low yields and returns of these cultivars resulted in part from greater frost injury than was suffered by other cultivars during the bloom period in 1986, 1987, and 1988. At present, 'Woodard' and 'Delite' are not currently recommended in Alabama for large commercial plantings that involve packing and shipping of berries. 'Climax' remains the leading companion cultivar for

Table 6. Weekly blueberry prices received by growers at the Escambia County Alabama blueberry growers association, 1983-88.

Price per kg by week and year							
Week	1983	Week	1984	Week	1986	Week	1988
6/20	$2.38	6/12	$1.98	6/17	$2.02	6/09	$2.20
6/21	2.29	6/20	1.83	6/23	1.83	6/15	2.16
6/28	2.29	6/28	1.65	6/30	1.83	6/20	2.20
6/29	2.11	7/02	1.43	7/07	1.74	6/23	2.20
7/05	2.24	7/10	1.56			6/27	2.20
7/06	1.89	7/17	1.47	Week	1987	6/30	2.20
7/07	1.65	7/18	1.39	6/18	1.89	7/05	2.20
7/11	1.65			6/25	2.02	7/08	2.20
7/12	1.65	Week	1985	7/02	2.02	7/12	2.16
7/13	1.61	6/12	2.49	7/08	1.67	7/14	2.16
7/14	1.65	6/19	1.83			7/20	2.16
7/18	1.98	6/27	1.78				
7/19	1.83	7/03	1.74			Week	1989
7/20	1.83	7/10	1.67			6/05	2.38
7/25	0.90	7/16	1.47			6/12	2.29
7/26	1.83					6/19	2.38
						6/26	2.29
						7/03	2.02
						7/10	2.02
						7/17	1.83

'Tifblue' in commercial plantings. However, it has been clearly established in Alabama that late spring freezes greatly reduce yields of 'Climax.' Therefore, if this cultivar is used in plantings to meet the need for an early cultivar, growers must be willing to provide freeze protection during years of unfavorable weather or they will suffer considerable economic loss. Planting of a third cultivar such as 'Brightwell' is also another possible alternative to insure adequate production in years when frost damage occurs. Based on information obtained from this study, 'Premier' appears to be a better choice than 'Climax' for an early season cultivar.

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Spur Pruning— Spur-bound 'Delicious'

In a Virginia study spur bound 'Delicious' trees were spur pruned for 2 years and/or treated with Promalin. All treatment combinations generally failed to improve yield or fruit weight. Promalin reduced yield and fruit weight and increased the number of pygmy fruit one year, but had little effect on fruiting or vegetative growth for 3 years after treatment. Although spur pruning improved spur length, spur bud diameter, leaf area per spur, and leaf dry weight per spur, fruit weight was not improved. (From Marini and Sowers. 1991. J. Amer. Soc. Hort. Sci. 116:454-459)