Response of Young Blueberry Plants to Irrigation in Florida

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Abstract. Two-year-old, container-grown rabbiteye (*Vaccinium ashei* Reade) and highbush (*Vaccinium corymbosum* L.) blueberry plants were used in a 3-year study of water requirement for blueberry production in Florida. The rabbiteye cultivars Powderblue and Premier and the highbush cultivar Sharpblue were grown under three irrigation regimes. Irrigation events were triggered when soil water tensions in the upper 15 cm of the containers reached either 10, 15, or 20 kPa. Neither yield nor vegetative growth of rabbiteye cultivars differed among treatments. During the third year, the growth increase in highbush blueberry was significantly greater in the 10-kPa than in the 15- and 20-kPa treatments. The highest water treatment (10 kPa) resulted in a significant yield increase for the highbush cultivar.

The Florida blueberry industry consists of ≈200 growers on 810 ha concentrated in the north-central part of the state. The production is evenly divided between rabbiteye and highbush blueberry species. Blueberry production in Florida can potentially be very profitable, as warm temperatures during February, March, and April allow for a very early crop, which can bring high prices.

Florida blueberries are generally planted at densities of 2470 plants/ha and take ≈5 years to reach full maturity. The typical annual yield of mature plants at this density is ≈6700 kg·ha⁻¹ for both species. Rabbiteye blueberries are native to Florida and are potentially the highest yielding species grown in this climate. They are also rather drought-tolerant after establishment, more vigorous, longer living, and easier to care for than highbush cultivars. However, their production is sometimes reduced by fruit-setting problems related to pollination (Lyrene and Crocker, 1991). Highbush blueberries are more drought-sensitive and more difficult to grow (Pritchard et al., 1993). However, the ability to produce early yields, with resultant higher prices, makes them popular among growers.

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production in Florida was documented by Haman et al. (1988).

Solid-set sprinkler irrigation systems are the most common means of applying irrigation water; overhead sprinkler systems also can be used for frost and freeze protection, which often is necessary in Florida. However, growers who use microirrigation report better fruit quality and fewer disease problems. The increased interest in microirrigation has also been propelled by water conservation concerns. The objective of this project was to evaluate the impact of irrigation scheduling on the vegetative growth and yield of young blueberry plants of two species.

Materials and Methods

A 3-year study of water use by two species of cultivated blueberry was conducted in a field lysimeter system at the Institute of Food and Agricultural Sciences Irrigation Research and Education Park in Gainesville, Fla. The system consisted of 24 drainage-type lysimeters (Fig. 1), which were cylindrical tanks, 1.6 m in diameter and 1.8 m deep. The distance between lysimeters within each block was 1 m, and the distance between the blocks was 4.8 m. Details of the lysimeter construction at this site were given by Smajstrla (1985). Modifications of the system were described by Haman et al. (1997).

The soil used was Arredodo fine sand (hyperthermic, coated, Typic Quartzipsamment). A 5-cm layer of organic peat was placed in the lysimeters and incorporated into the top 25 cm of the soil. In addition, the surface of the soil was covered with a 15-cm layer of pine bark mulch.

Two-year-old, container-grown blueberry plants were transplanted into the lysimeters. Two cultivars of rabbiteye ('Powderblue' and

Because of uneven distribution of rainfall and sandy soils in Florida, irrigation is required for maintaining optimum soil moisture for blueberry production. Blueberry plants respond very well to irrigation, especially during the time of establishment, fruit formation, and fruit sizing (Buchanan et al., 1978), and under Florida conditions, irrigation increases fruit production (Andersen et al., 1979). Deyton and Thompson (1992) reported that drip irrigation increased production of rabbiteye blueberries 40% and increased plant size, in Tennessee. The benefit of mulch in blueberry

Fig. 1. Design of the experiment.

'Premier') and one of highbush ('Sharpblue') were used. One plant of each rabbiteye cultivar was planted per lysimeter. This is a typical practice in Florida to improve pollination. For the highbush species, two 'Sharpblue' plants were planted per lysimeter. Another highbush cultivar, 'Misty', was used in border plantings for cross-pollination. The layout of the experiment is presented in Fig. 1. The lysimeters were used to maintain a total water budget that allowed evapotranspiration (ET) to be calculated.

The experimental design was a completely randomized design with four replications of six treatments (two species of blueberry $\times$ three irrigation treatments). Each species was analyzed separately, comparing the three water treatments. Each lysimeter tank was treated as a replication. Water was applied using 40 L·h⁻¹, 360° microspray emitters, using six microirrigation laterals (one per treatment). One emitter was placed per lysimeter, positioned centrally between the two plants. Irrigation events were controlled by three Irrrometer (Irrrometer Co., Riverside, Calif.) electromechanical controllers (model #210-2HM). Magnetic switching tensiometers (model RA6; Irrrometer) were placed at a depth of 15 cm and set to trigger irrigation at threshold soil matrix tensions of 10, 15, and 20 kPa. The application durations were preset and changed over time. In the first year after transplanting, 5-min irrigation events were used because of limited root development. During the second year the irrigation events were gradually increased to 30 min to better simulate a typical grower's irrigation practice. Up to three irrigations were allowed per day. The effective use of switching tensiometers for blueberry irrigation scheduling was previously documented by Smajstrla et al. (1988).

Plant growth was measured each month. The approximate cylindrical volume occupied by the plant was calculated based on the height and the average of two perpendicular widths, north-south and east-west.

Plants were grown following typical commercial practices (Lyrene and Crocker, 1991). Fertilizer applications of "Blueberry Special" (12-4-8-2, magnesium sulfate) were manually applied over the entire lysimeter surface once a month, from February through September for rabbiteye and through October for highbush plants. The fertilizer application rate was increased from 30 g per plant per month in the first year of the experiment to 60 g per plant in the last year, increasing 15 g per year. Fungicides and insecticides were used as needed to control insects and foliar and soil-borne diseases.

Yield data were collected only for the last two years of the experiment. In the first year, flowers were removed to enhance vegetative growth of the plants. Netting during the berry ripening season prevented losses to birds. Only fully ripened berries were harvested manually each week. Number and total mass of berries were recorded for each plant. Average berry diameter was calculated assuming a spherical shape and density of 1.0 g·cm⁻³.

Results and Discussion

For rabbiteye blueberry, the 10-kPa treatment required ≈ 1.6 times as much irrigation water as the 15 kPa and almost twice that of the 20-kPa treatment over the 3 years of the experiment (Fig. 2). For highbush blueberry, the 10-kPa treatment required almost 2.5 times more water than the 15 kPa and about four times more than the 20-kPa treatment. The increased amounts of irrigation applied to the 10-kPa treatment in the last year, especially for the highbush species, are clearly shown by the steep incline of the curve. The nonstressed, 10-kPa plants increased rapidly in size during the last year (Table 1). This indicates that under lowest water-stress conditions, the highbush cultivar required more time to establish an efficient root system than did the rabbiteye cultivars.

Irrigation levels did not affect canopy vol-

ume in rabbiteye blueberry (Table 1). In the first year, canopy volume in rabbiteye increased rapidly. However, for both species, the most rapid growth occurred in the last year of the experiment; in this year, the growth of the highbush cultivars in 10-kPa treatment was significantly greater than in the 15- and 20-kPa treatments.

'Powderblue' consistently produced the highest yield and the largest number of berries per plant (Table 2). Production from 'Premier' increased in the second year but still did not exceed the yield of 'Powderblue'. Both rabbiteye cultivars produced ripe fruit in early June.

Much lower yields were recorded for the highbush cultivar. However, this is normal and early harvest of these blueberries brings much higher prices that usually compensate for the low yield. The harvest of highbush berries started both years at the beginning of May, 1 month before rabbiteye.

Fig. 2. Cumulative irrigation for all blueberry species and treatments over the 3 years of the experiment.

Table 1. Effect of irrigation level on volume (m³) of rabbiteye (RE) and highbush (HB) blueberry plants.

Max. soil water tension (kPa)	Year					
	1		2		3	
	RE	HB	RE	HB	RE	HB
10	1.86 a ²	0.36 a	2.25 a	0.61 a	3.60 a	1.95 a
15	1.44 a	0.20 b	1.91 a	0.44 b	3.09 a	0.76 b
20	1.65 a	0.42 a	1.91 a	0.56 ab	2.88 a	0.56 b

²Mean separation within years and species by Duncan's multiple range test, $P \leq 0.05$.

Table 2. Effect of irrigation level on yield, mass per plant, number of berries per plant, and average berry diameter for the last 2 years of the experiment of three cultivars.

Cultivar	Max. soil water tension (kPa)	Mass of fruit (g/plant)		No. berries/plant		Diam/berry (mm)	
				Year			
		2	3	2	3	2	3
Premier	10	1669 a	2127 a	897 a	1086 a	1.53 a	1.52 a
	15	1565 a	2010 a	939 a	1065 a	1.47 a	1.50 a
	20	1525 a	1685 a	904 a	968 a	1.48 a	1.49 a
Powderblue	10	3519 a	2527 a	2707 a	2146 a	1.35 a	1.31 a
	15	2837 b	2388 a	2295 b	1889 a	1.33 a	1.33 a
	20	3767 a	2672 a	2864 a	2238 a	1.36 a	1.31 a
Sharpblue	10	1396 a	1000 a	1561 a	1213 a	1.24 a	1.12 a
	15	480 b	926 a	585 b	1076 a	1.16 a	1.17 a
	20	235 b	373 b	337 b	654 b	1.10 a	1.02 b

²Mean separation within cultivars and years by Duncan's multiple range test, $P \leq 0.05$.

By the end of the experiment (year 3) there was no significant difference among irrigation treatments within rabbiteye cultivars. The plants were well established, and the various irrigation levels did not have a significant impact on yield or vegetative growth. For the highbush cultivar, the effect of water stress became more pronounced by the end of three years. The 20-kPa treatment plants, which experienced the greatest stress, yielded significantly less and had smaller fruit.

Comparing the two species, we conclude that rabbiteye plants were quicker to establish, more drought-tolerant, and higher yielding, but produced fruit much later in the season when prices are lower.

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