Establishment and Early Growth and Yield of 'Gulfcoast' Southern Highbush Blueberry

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Abstract. In a field study, 'Gulfcoast' southern highbush blueberry plants were subjected to irrigation [7.5 L (low) or 30 L per week (high)], mulching (none or 15 cm depth), row height (level or raised 15 cm), and soil-incorporated peatmoss (none or 15 L in each planting hole) treatments, in a factorial arrangement, at establishment. Plants were grown on a well-drained fine sandy loam soil that contained < 1.0% organic matter. Plant volume and fruit yield were greater with mulching, high irrigation, incorporated peatmoss, and level beds. Plants grown with the combination of mulching, level beds, incorporated peatmoss, and high irrigation levels yielded 2.4 kg per plant or approximately eight times as much as plants grown without mulch, with raised beds, without peatmoss, and with the low rate of irrigation. Of the four establishment practices evaluated, mulching had the greatest influence on plant growth and fruiting.

Southern highbush blueberries were developed from hybridization of the northern highbush blueberry (*Vaccinium corymbosum* L.) with one or more species (mainly *V. darrowi* Camp and *V. ashei* Reade) commonly found in southern regions of the United States (Lyrene, 1990). They have a low-chilling requirement and produce an early-ripening blueberry and are therefore adapted to the environmental conditions and upland soils of the South (Galletta, 1975).

Various cultural practices, such as supplemental irrigation, mulching, and incorporating peat into the planting holes, have improved the growth of highbush, rabbiteye (*V. ashei* Reade), and southern highbush blueberries (Eck, 1988; Gough, 1994; Moore, 1976, 1979; Patten et al., 1988; Spiers, 1983, 1996b). Moore and Pavlis (1979) found that continuously mulched commercial highbush blueberries outyielded plants mulched for three years or less. Clark and Moore (1991) reported that mulched southern highbush plants were much larger and yielded more than those not mulched in Arkansas, and had mulching requirements similar to those of northern highbush plants on upland soils. In Florida, Lyrene (1990) found southern highbush cultivars did not grow well in soils with <2% organic matter unless mulched with pine bark.

Davies and Johnson (1982) observed that moderately and severely water-stressed 1-year-old rabbiteye blueberries had one-half the leaf area of nonstressed plants. Drip irrigation doubled the dry mass of 'Tifblue' (rabbiteye) plants and increased plant survival in the first 2 years of growth (Spiers, 1983).

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Doehlert (1937) reported that highbush blueberries planted in poorly drained soils grew better when the rows were mounded. In commercial highbush blueberry fields, poor soil aeration can restrict growth, and growers often plant on beds or ridges to increase surface drainage from the root system (Eck, 1988). Korcak (1983) stated that highbush plants may be more sensitive to flooding than rabbiteye plants, but suggested that this might reflect greater susceptibility to *Phytophthora* root rot.

In the southeastern United States, rabbiteye blueberries are currently being grown on upland soils containing little organic matter, often without mulch, irrigation, or added organic matter. Rabbiteye cultivars are much more vigorous than the southern highbush cultivars currently available, and, while rabbiteye plants can often tolerate the absence of supplemental cultural practices, southern highbush plants apparently cannot (Makus et al., 1995).

This study, a combination of treatments not previously reported, was conducted to

study the relative importance of four cultural practices—bed height, irrigation, mulching, and incorporated peat—on the growth of southern highbush blueberries grown on typical southeastern U.S. upland soil. 'Gulfcoast' was selected for this study because it is one of the most vigorous and adaptable of the current southern highbush cultivars (A.D. Draper, personal communication).

Materials and Methods

In Jan. 1989, 2-year-old potted 'Gulfcoast' southern highbush blueberries were planted in a Ruston fine sandy loam soil (Typic Paleudult, fine-loamy, siliceous, thermic) utilizing a randomized complete block design. Treatments consisted of two levels each of four factors: drip irrigation (7.5 or 30 L per plant per week), bed height (level or raised 15 cm), noncompacted pine bark mulching (none or 15 cm), and soil-incorporated peatmoss (none or 15 L per planting hole). Individual plants (experimental units) were bordered by southern highbush plants of cultivars other than 'Gulfcoast' to ensure cross-pollination. All plants were pruned uniformly the first year and selectively pruned each succeeding year according to plant vigor. The plant material removed by pruning was dried and weighed. Floral ratings (Spiers, 1978) were recorded in Spring 1992. Plant volume (ellipsoid or approximately height × width × breadth divided by 2) and fruit yield (weekly harvest) were taken annually, from 1990 through 1992. Plants received uniform, recommended fertilization and pest control (Braswell et al., 1990).

The experiment was analyzed by SAS as a split-split-split-plot with the main block (irrigation) replicated five times, row height as the subplot, mulching as the sub-subplot and incorporated peat as the sub-sub-subplot.

Results and Discussion

Mulching, levels of irrigation, incorporated peatmoss, and row height all individually increased plant volume and fruit yields (Table 1). After one growing season, only mulching and incorporated peatmoss had sig-

Table 1. Influence of bed heights, irrigation, mulching, and incorporated peatmoss on plant volume and yield of 'Gulfcoast' southern highbush blueberry.

Treatments	Plant vol (m ³)			Fruit yield (g/plant)		
	1990	1991	1992	1990	1991	1992
Bed height						
Raised	0.06	0.13	0.42	336	463	1030
Flat	0.05	0.18	0.55	293	610	1469
Significance	NS	***	**	NS	*	***
Mulch						
Yes	0.06	0.23	0.74	392	849	1739
No	0.04	0.08	0.24	237	225	763
Significance	**	***	***	**	***	***
Peatmoss						
Yes	0.07	0.19	0.55	413	627	1400
No	0.04	0.12	0.43	216	446	1099
Significance	***	***	**	***	**	**
Irrigation						
High	0.06	0.18	0.56	289	517	1386
Low irrigation	0.05	0.13	0.42	340	557	1113
Significance	NS	***	**	NS	NS	*

NS, *, **, *** Nonsignificant or significant at $P < 0.01$, 0.05, or 0.001, respectively.

nificantly increased growth and fruit yield. In the second and third year, plant volume and fruit yields were significantly increased by all treatments, but mulching had the greatest influence. After three growing seasons, mulched plants were about three times as large as control plants and yielded over two times as much fruit. Level beds, the higher irrigation rate, and incorporation of peatmoss individually resulted in about equal (1.3 $\times$) increases in plant volume and fruit yields compared with their respective controls. The same relationship existed in the mass of prunings collected at the end of the second and third growing seasons (data not shown). Mulching stimulated growth and more water was removed from mulched plants.

In the fine sandy loam soil used in this study, 'Gulfcoast' plants grew better in flat beds. This relationship was independent of the other cultural factors tested. Single treatment comparisons using plants with low irrigation, no incorporated peatmoss, and no mulch showed that plants grown on flat beds yielded 2.6 times as much fruit and were 2.7 times as large as plants on raised beds. Water retention in the flat beds was probably higher and appeared to be more beneficial than the increased aeration probably associated with raised beds.

Blueberry growers generally decide on the need for raised beds by determining soil type, aeration, and drainage conditions. However, regardless of bed level in this study, without mulch neither fruit yields nor plant volumes were significantly increased by increasing the amount of water applied or incorporating peatmoss alone (Fig. 1). Combining the high irri-

gation rate, incorporating peatmoss, and mulching produced the highest plant volume and fruit yields, regardless of bed height. Data averaged over bed treatments (plants grown with low irrigation and no incorporated peatmoss) indicated that mulching alone increased fruit yields 3.3-fold and plant volume 2.7-fold.

No interactions were significant for all three years (Table 2). However, in 1991 and 1992, there was a greater increase in plant volume due to irrigation in mulched than in nonmulched plants. Without mulch, plant volume in 1992 with low irrigation was 0.45 m³ and increased to 0.51 m³ with additional irrigation. With mulching, volume was 1.25 m³ with low irrigation and 1.68 m³ with the high irrigation level. The only other interaction that followed a pattern throughout the study was the effect of irrigation level $\times$ peatmoss on plant volume (1990, $P > 0.05$; 1991, $P > 0.01$; 1992, $P > 0.10$). This interaction indicated little difference in plant volume among the treatments low irrigation and no peatmoss, low irrigation and incorporated peatmoss, or high irrigation and no peatmoss, but a much higher plant volume with high irrigation plus incorporated peatmoss. Fruit was harvested weekly over a 5-week period. Percentage yields per harvest date were not influenced by bed level, irrigation rate, or the incorporation of peatmoss (data not shown). On the first harvest date in 1991, mulching reduced the percentage of ripe fruit (43% vs. 60%, respectively). This was not observed in 1992 or when yield data for both years were averaged.

Plant volume, pruning mass, and fruit yield were all highly correlated ($P > 0.001$) (Table 3). A previous study with 'Tifblue' rabbiteye blueberries reported positive correlations ($P < 0.001$) between plant volume, plant height, and fruit yields (Spiers, 1996a). Makus et al. (1995) also found significant correlations between plant volume and yield in both rabbiteye and southern highbush cultivars grown for 6 years in three southern states. These studies indicate that a less labor-intensive measurement of plant volume would be satisfactory in estimating fruit yields of 'Gulfcoast' blueberry and probably other rabbiteye and southern highbush cultivars.

Correlations also indicated the relative importance of mulch ($r = 0.78$, $P > 0.001$), bed height ($r = -0.20$, $P > 0.05$), incorporated peatmoss ($r = 0.20$, $P > 0.05$), and irrigation level ($r = 0.20$, $P > 0.05$) on plant volume and plant yields. Mulching significantly advanced the rate of floral bud development ($P > 0.01$) but floral bud ratings were not influenced by the other cultural factors tested. Mulching tends to reduce soil temperature in the summer, increase it in the winter, and reduce daily soil temperature fluctuations (Gough, 1994; Magee and Spiers, 1995). Flower initiation may have been accelerated in the early fall because of increased plant vigor and/or cooler soil temperatures with mulching. Flower buds that are initiated early usually bloom earlier than those that form later (Patten et al., 1988). Also, radiation from mulch may have increased air temperatures resulting in earlier bud break. In May and June, reduced soil temperature due to mulching may have delayed ripening.

Soil moisture and temperature appeared to be major limiting factors in the sandy, well-aerated mineral soil used in this study. Plants grew best in flat beds with high irrigation, incorporated peatmoss, and mulch—all cultural practices that tend to increase soil moisture. Of the four cultural practices tested, mulching was the most beneficial, perhaps because of its added advantage of reducing soil temperature. Southern highbush blueberries have much greater root and shoot growth when grown in cool soils (Spiers, 1995). In the Gulf States region of the United States, mulching should be considered the most essential cultural practice in the establishment and early growth of southern highbush blueberries.

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Fig. 1. Influence of irrigation, mulching, and incorporated peatmoss on (A) fruit yield and (B) plant volume of 'Gulfcoast' blueberry plants, averaged over bed height. 1992.

Table 2. F values and probability of significant differences for all parameters measured.

	Fruit yield						Plant vol					
	1990		1991		1992		1990		1991		1992	
	F	P	F	P	F	P	F	P	F	P	F	P
Irrigation	1.71	0.227	0.67	0.437	9.17	0.008	4.27	0.073	14.81	0.005	14.68	0.005
Bed height	1.29	0.289	9.35	0.016	23.98	0.0002	1.88	0.208	17.15	0.003	15.50	0.004
Irrigation × bed height	7.76	0.024	0.27	0.614	0.60	0.448	0.27	0.620	0.68	0.433	0.00	0.977
Mulch	16.27	0.001	168.29	0.0001	120.34	0.0001	20.74	0.002	135.21	0.0001	233.08	0.0001
Irrigation × mulch	0.43	0.530	4.16	0.076	1.43	0.249	0.13	0.729	9.21	0.016	8.30	0.021
Bed height × mulch	6.84	0.031	6.02	0.040	0.02	0.885	3.49	0.100	1.23	0.300	0.18	0.684
Irrigation × bed height × mulch	0.17	0.695	0.43	0.430	0.00	0.976	1.02	0.342	0.33	0.584	0.17	0.690
Peatmoss	26.18	0.001	14.17	0.006	12.61	0.027	59.75	0.0001	31.09	0.001	14.98	0.005
Irrigation × peatmoss	0.32	0.585	4.43	0.683	3.80	0.691	6.41	0.035	10.56	0.012	3.96	0.082
Bed height × peatmoss	2.59	0.146	1.39	0.272	0.02	0.893	0.58	0.469	0.16	0.702	0.06	0.807
Irrigation × bed height × peatmoss	1.25	0.296	0.94	0.361	0.04	0.847	0.17	0.691	0.07	0.795	0.01	0.924
Mulch × peatmoss	13.13	0.007	0.46	0.517	1.07	0.317	1.74	0.224	0.00	0.992	0.08	0.786
Irrigation × mulch × peatmoss	0.02	0.906	2.96	0.127	0.06	0.847	0.12	0.741	3.15	0.114	1.71	0.227
Bed height × mulch × peatmoss	1.21	0.303	0.45	0.523	0.78	0.317	0.59	0.466	1.25	0.296	0.04	0.838
Irrigation × bed height × mulch × peatmoss	1.41	0.270	2.82	0.132	0.99	0.809	0.35	0.569	0.19	0.673	0.13	0.730

Table 3. Correlations between treatments, growth parameters, and floral bud ratings in 'Gulfcoast' southern highbush blueberry, 1992.

	Bed	Peat	Mulch	Irrigation	Plant vol	Pruning mass	Fruit yield
Plant volume	-0.20*	0.20*	0.78***	0.20*			
Pruning mass	-0.19*	0.19*	0.65***	0.31***	0.83***		
Fruit yield	-0.31***	0.21*	0.69***	0.19*	0.88***	0.74***	
Floral bud rating	0.01 ^{NS}	-0.01 ^{NS}	0.70***	0.06 ^{NS}	0.70***	0.53***	0.55***

^{NS}, *, **, ***Nonsignificant or significant at $P \leq 0.01$, 0.05, or 0.001, respectively.

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