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Microirrigation of Young Blueberries in Florida[1]

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Blueberry production shows great promise as a fruit crop in Florida. Although blueberries are grown in many other states, Florida's climate allows fruit to reach maturity earlier, avoiding competition with growers in other states. The unique market window brings very high prices to blueberry growers. This advantage has been increased by the recent introduction of earlier-yielding highbush varieties.

Currently, about 2,100 acres of blueberries are grown in Florida. This acreage is expected to expand with new early-yielding blueberry varieties, and existing growers expanding their acreage. Presently, the blueberry acreage is evenly divided between rabbiteye and highbush varieties. However, for the last 10 years, new plantations have been almost exclusively planted to highbush varieties.

Newly developed early ripening highbush varieties are of the greatest interest to Florida growers. These varieties are lower yielding and much more difficult to grow than rabbiteye varieties, but the early ripening fruit brings high prices since it is the only blueberry available at this time. Before May 20, the average price is approximately five dollars per pound. After June 1, the average price drops to around one dollar per pound. Highbush plants are more difficult to establish and have a shorter life expectancy than the rabbiteye varieties. They are also much more sensitive to water stress and require frequent irrigation to grow and produce even when well established.

Rabbiteye blueberries are native to Florida. They are relatively easy to grow and they are the highest yielding variety under Florida's climatic conditions. The plants are more vigorous, longer living, higher yielding, but later ripening than the highbush variety. However, the rabbiteyes experience some problems with fruit setting, thus yields do not always reach the expected levels. If the pollination problems can be solved, it is very likely that rabbiteyes will again account for a significant percentage of new plantings since they are much easier to grow, and once established, live longer and produce much better. During the establishment period the plants respond very well to irrigation, however, once well established, they are less sensitive to water stress than highbush varieties. In addition, rabbiteye blueberries can be mechanically harvested which significantly decreases production cost.

The recommendations presented in this publication were developed based on a three year

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experiment on water requirements for establishment of young blueberry plants which was conducted at the University of Florida. The project was partially funded by the St. John's River and the Southwest Florida Water Management Districts. Both native rabbiteye and newly developed early-yielding highbush varieties were studied. Two-year old, container-grown plants were transplanted to the field at the beginning of 1991. The experiment ended in December 1993. Total water use (evapotranspiration), irrigation requirements, crop yield, and vegetative plant growth were evaluated during the three years after transplanting.

IRRIGATION SCHEDULING OF YOUNG BLUEBERRIES

To avoid drought stress, irrigation and rain must be adequate to provide water for plant transpiration and evaporation from the soil and plant surfaces. The term which describes the amount of water used in this processes is called evapotranspiration (ET). For young plants, ET is a fraction of reference evapotranspiration (ETo) which is defined as the evapotranspiration rate from an extensive, short grass cover, completely shading the ground, and not subjected to water stress. ETo is a function of climatic conditions and can be calculated from an energy balance at the crop canopy level. The most accurate method of calculating ETo is the Penman method which is based on radiation, temperature, humidity, and wind velocity. Long-term average values of ETo for Florida are available from IFAS extension service (Extension Bulletin 205).

Evapotranspiration of young blueberries

The evapotranspiration of young blueberry plants during the first three years after transplanting was presented in the IFAS Extension Bulletin "Water Use in Establishment of Young Blueberry Plants". The amount of water used by the plants is a direct function of ETo and depends on plants' age, planting density, and the blueberry species (highbush or rabbiteye). In this publication, a density of 1000 plants/acre was assumed. Estimates of water use, in gallons per acre, in inches over the entire production area, and in gallons per plant during the first three years after transplanting, are presented in Table 1. These amounts of water must be supplied to the plant to provide moisture conditions for optimum plant growth. If density of planting is different from 1000 plants per acre, the gallons per plant can be multiplied by the number of plants to calculate the amount of water which must be applied per acre.

Effective Rainfall

In arid climates all water required for plant growth must be applied through an irrigation system. In humid climates rainfall will contribute to the water supply, decreasing the amount of water which must be provided by irrigation.

The root zone of a blueberry plant is very shallow, especially for the highbush species. The roots of a highbush plant can uptake water from only the upper 1 foot of the soil profile. The rabbiteye species has a deeper root system which allows the plants to utilize 2 feet of the soil profile.

In Florida's humid climate, part of the water used by the plant is supplied by rainfall. The annual rainfall in Florida is about 50-60 inches, however, most of this water is not available to the plant due to uneven distribution of rainfall throughout the year and very low water storage (water holding capacity) of Florida sandy soils. On average, only .75 in of water is available to the plant from each foot of the soil profile. Usually, an irrigation is scheduled when approximately one third of this water has been used. This means that at the time of irrigation there is room for only about 0.25 inch of water per foot of root depth.

Timing of rain is critical to its effectiveness. If rain occurs just before an irrigation would normally be scheduled, the maximum amount of rain which would be effective (stored in the root zone and available for plant use) is 0.25 in/foot. Any additional amount of rain will be lost to deep percolation and will not be available to the plant. If the rainfall occurs directly after irrigation and the root zone is already filled with water, most or all of the rainfall will be lost to deep percolation. As a result, for efficient water use, blueberries require frequent, small applications of water through an irrigation system and only a fraction of rainfall can be effective.

Irrigation scheduling

Irrigation scheduling must take under consideration the total water requirements of the plants, the amount of water which can be stored in the root zone for plant use, and the constraints of the irrigation system. The size of an irrigation system and its layout will have an impact on the minimum time the system can be operated. For example, for many larger systems, it is not practical to schedule irrigation events shorter than 1/2 hour.

A microirrigation system applies water to a portion of the field leaving a significant amount of land dry. However, it is important to realize that the amount which the plant needs per month is the amount listed in Table 1 regardless of the percentage of wetted area. The total amount which can be applied during a single irrigation event without significant losses to deep percolation depends on the wetted area of the emitter and the allowable depletion in the root zone. Therefore, more frequent irrigations will be required if the wetted area is reduced, while less frequent irrigations will be permitted if the wetted area is larger.

The wetted surface area of the emitter and the depth of the root zone determines the wetted volume of soil for each plant. For the highbush varieties, it was assumed that the root depth did not change significantly during the first three years of establishment and that it was equal to 1 foot. Since the rabbiteye varieties have a deeper root system, a gradual increase in root depth over three years was considered in the calculations. It was assumed that the root depth changed from 1 foot to 1.5 and 2 feet in the first, second, and third year, respectively. Based on the depletion level between irrigations, the amount of water necessary to bring the soil volume to field capacity (maximum water content) at each irrigation was calculated.

Table 1 was developed for a production system with a plant density of 1000 plants/acre. The irrigation system is microsprinklers with a flow rate of 10 gal/hr. A deflector should be used to limit the wetted diameter to 4, 5, or 6 ft for 1, 2, or 3-year-old plants, respectively. These diameter changes can be made by adjusting the height of the stake which supports the emitter.

In development of Table 2 it was assumed that the flow rate from each emitter is 10 gal/hr and there is 1 emitter for every two plants. To minimize the losses to deep percolation the duration of irrigation events must be carefully monitored. It is assumed that the duration of the irrigation events will change with the development of the root system and the change of wetted diameter of the emitter.

The root system for both varieties was assumed to be approximately 1 foot deep at the time of transplanting. Since the root depth for the highbush varieties remains quite shallow, only lateral growth in consecutive years is taken under consideration in calculating root volume of the plant. For all three years the depth of root zone was assumed to be 1 foot.

For the rabbiteye varieties the increase in root depth during the first three years of plant growth was large enough that this increase is reflected in scheduling the irrigation events. The depth of the root zone was assumed 1 foot, 1.5 feet and 2 ft for years 1, 2, and 3, respectively. Recommended maximum durations of irrigation events for the system described above are presented in Table 3. if the irrigation system does not permit 15 min water applications, the system should be run for as short a period of time as possible.

If the conditions of a specific production system are different, these numbers must be adjusted.

Irrigation adjustment after rainfall

Rainfall between irrigation events will contribute to the water supply in the root zone and delay the next irrigation event. The length of delay depends on the effectiveness of the rain which in turn depends on the amount and timing of the rain. A .25 inch rainfall per foot of root zone depth just before the scheduled irrigation is all available to the plant. The same amount of rain just after an irrigation event is lost to deep percolation since there is no room for additional water in the root zone.

The following tables give guidelines on adjusting the irrigation schedule depending on when rain occurred, and the amount of rainfall. Assuming Florida's sandy soils, the allowable depletion between irrigations was assumed to be .25 in/ft.

Table 4 was developed for both highbush and rabbiteye varieties during the first year after transplanting. A 1 ft root depth and a .25 inch allowable water depletion in the root zone were assumed. Since the root depth for highbush varieties was assumed to be constant, Table 4 should be used during all three years for these varieties of blueberry. Table 5 was developed for the second year of establishment of rabbiteye varieties with a 1.5 ft root depth and a 0.38 inch allowable water depletion. And finally, Table 6 was developed for the last year of establishment of rabbiteye blueberries with a 2 ft root depth and 0.50 inch allowable water depletion.

These tables should not be used without adjustment if soil and plant conditions are different from the above assumptions.

Example

How many days should irrigation be delayed for rabbiteye blueberries during April of the second year of establishment if there is a .30 inch rainfall 2 days after irrigation?

From Table 2, rabbiteye blueberries in the second year of establishment require an irrigation every 3 days in April under no-rain conditions. From Table 5, a rain event of .30 inch 2 days after irrigation allows for an additional two days before scheduling the next irrigation. This means that the next irrigation event will be scheduled 3 days after the rain, for a total irrigation interval of 5 days.

SUMMARY

The recommendations presented in this publication were based on three-year experiment on water requirements for establishment of young blueberry plants which was conducted at the University of Florida. The project was partially funded by the St. John's River and the Southwest Florida Water Management Districts. Based on the results from this project and long term average weather data, a general schedule of irrigation events was developed for the first three years of blueberry establishment. A series of tables adjusting the timing of irrigation events due to rainfall was also developed and presented.

Table 1.

Table 1. Water requirements of young blueberries during the first three years of establishment based on long term average weather data.

		Rabbiteye			Highbush		
Year	Month	gal/acre	in/acre	gal/plant	gal/acre	in/acre	gal/plant
1	Apr	5550	.26	6	6940	.26	7
	May	22120	.81	22	7900	.29	8
	Jun	30850	1.14	31	16240	.60	16
	Jul	37660	1.39	38	19650	.72	20
	Aug	32440	1.19	32	16220	.60	16
	Sep	27120	1.00	27	13560	.50	14
	Oct	23760	.88	24	11400	.42	11
	Nov	16090	.59	16	10300	.38	10
	Dec	6210	.23	6	6210	.23	6

Table 1.

2	Jan	6610	.24	7	7720	.28	8
	Feb	8810	.32	9	9610	.35	10
	Mar	12900	.48	13	9680	.36	10
	Apr	27750	1.02	28	12490	.46	12
	May	36350	1.34	36	15800	.58	16
	Jun	38971	1.44	39	19490	.72	19
	Jul	40930	1.51	41	24560	.90	25
	Aug	35380	1.30	35	26540	.98	27
	Sep	28350	1.04	28	23420	.86	23
	Oct	19960	.74	20	19000	.70	19
	Nov	12230	.45	12	11580	.43	12
	Dec	7170	.26	7	6210	.23	6

Table 1.

3	Jan	7720	.28	8	3300	.20	3
	Feb	6400	.24	6	4800	.24	5
	Mar	7530	.28	7	7530	.28	8
	Apr	277750	1.02	28	23590	.87	24
	May	56890	2.10	57	39510	1.46	40
	Jun	61700	2.27	62	43840	1.61	44
	Jul	68770	2.53	69	49120	1.81	49
	Aug	60450	2.23	60	42760	1.57	43
	Sep	57940	2.13	58	43140	1.59	43
	Oct	29460	1.09	29	29460	1.09	29
	Nov	14160	.52	14	22520	.83	23
	Dec	13860	.51	14	21980	.81	22

Table 2.

Table 2. Approximate numbers of days between irrigations during the first three years after transplanting under no-rain conditions.**

Table 2.

	Year one		Year two		Year three	
	rabbiteye	highbush	rabbiteye	highbush	rabbiteye	highbush
	4 ft WD*		5 ft WD		6 ft WD	
Jan	10	10	10	7	14	12
Feb	10	10	7	4	14	9
Mar	10	10	6	4	14	9
Apr	5	4	3	3	4	2
May	2	3	2	3	2	1
Jun	1	2	2	2	2	1
Jul	1	1	2	2	2	1
Aug	1	2	2	1	2	1
Sep	1	2	3	2	2	1
Oct	1	2	4	2	4	2
Nov	2	3	6	4	9	2
Dec	5	4	10	7	9	3

* WD-wetted diameter of the microsprinkler.

** root zone depths assumed- 1, 1.5, and 2 ft in for years 1, 2, and 3, respectively for rabbiteye and a constant depth of 1 ft highbush varieties during all three years.

Table 3.

Table 3. Recommended maximum duration of irrigation events in minutes for highbush and rabbiteye blueberries during the first three years of establishment.*

	Year 1	Year 2	Year 3
	4 ft WD**	5 ft WD**	6 ft WD**
Highbush	15	20	30
Rabbiteye	15	20	60

* microsprinkler flow rate 10 gla.hr.

** WD-wetted diameter of the microsprinkler

Table 4.

Table 4. Number of days an irrigation should be delayed for highbush varieties during all three years and for rabbiteye varieties in the first year.

Normal Irrigation Interval (Days)	Rain Depth (Inches)	1	2	3	4	5	6	7
7	.10	1	2	2	2	2		2
	.20	1	2	3	4	5	2	5
	.25 or more	1	2	3	4	5	5	7
6	.10	1	2	2	2	2	6	
	.20	1	2	3	4	4	2	
	.25 or more	1	2	3	4	5	4	
5	.10	1	2	2	2	2	6	
	.20	1	2	3	4	4		
	.25 or more	1	2	3	4	5		
4	.10	1	1	1	1			
	.20	1	2	3	3			
	.25 or more	1	2	3	4			
3	.10	1	1	1				
	.20	1	2	2				
	.25 or more	1	2	3				

Table 4.

2	.10	0	0					
	.20	1	1					
	.25 or more	1	2					
1	.10	0						
	.20	0						
	.25 or more	1						

Table 5.

Table 5. Number of days an irrigation should be delayed during the second year for rabbiteye varieties.

Normal Irrigation Interval (Days)	Rain Depth (Inches)	1	2	3	4	5	6	7
7	.10	1	1	1	1	1	1	1
	.20	1	2	3	3	3	3	3
	.30	1	2	3	4	5	5	5
	.38 or more	1	2	3	4	5	6	7

Table 5.

6	.10	1	1	1	1	1	1	
	.20	1	2	3	3	3	3	
	.30	1	2	3	4	4	4	
	.38 or more	1	2	3	4	5	6	
5	.10	1	1	1	1	1		
	.20	1	2	2	2	2		
	.30	1	2	3	4	4		
	.38 or more	1	2	3	4	5		
4	.10	1	1	1	1			
	.20	1	2	2	2			
	.30	1	2	3	3			
	.38 or more	1	2	3	4			
3	.10	0	0	0				
	.20	1	1	1				
	.30	1	2	2				
	.38 or more	1	2	3				

Table 5.

2	.10	0	0					
	.20	0	1					
	.30	0	1					
	.38 or more	1	2					
1	.10							
	.20							
	.30							
	.38 or more							

Table 6.

Table 6. Number of days an irrigation should be delayed during the third year for rabbiteye varieties.

Normal Irrigation Interval (Days)	Rain Depth (Inches)	1	2	3	4	5	6	7
7	.10	1	1	1	1	1	1	1
	.20	1	2	2	2	2	2	2
	.30	1	2	3	4	4	4	4
	.40	1	2	3	4	5	5	5
	.50 or more	1	2	3	4	5	6	7

Table 6.

6	.10	1	1	1	1	1	1	
	.20	1	2	2	2	2	2	
	.30	1	2	3	3	3	3	
	.40	1	2	3	4	4	4	
	.50 or more	1	2	3	4	5	6	
5	.10	1	1	1	1	1		
	.20	1	2	2	2	2		
	.40	1	2	3	3	3		
	.30	1	2	3	4	4		
	.50 or more	1	2	3	4	5		
4	.10	0	0	0	0			
	.20	1	1	1	1			
	.30	1	2	2	2			
	.40	1	2	3	3			
	.50 or more	1	2	3	4			

Table 6.

3	.10	1	0	0				
	.20	1	1	1				
	.30	1	1	1				
	.40	1	2	2				
	.50 or more	1	2	3				
2	.10	0	0					
	.20	0	0					
	.30	1	1					
	.40	1	1					
	.50 or more	1	2					
1	.10	0						
	.20	0						
	.30	0						
	.40	0						
	.50 or more	1						