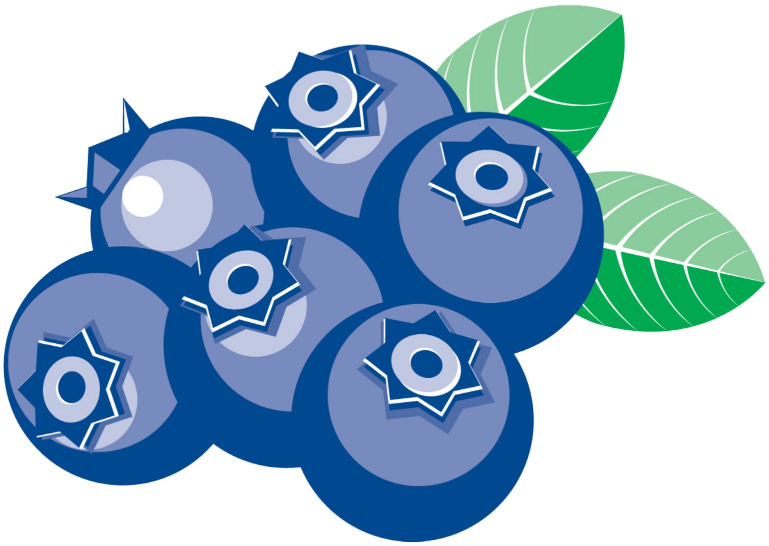

OSU Blueberry School

March 16-17, 2015 Corvallis, Oregon

Organized by:

Oregon State University OSU Extension Service

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OSU BLUEBERRY SCHOOL

March 16-17, 2015
held at
Oregon State University, Corvallis, Oregon

This two-day blueberry "school" was organized for new and experienced blueberry growers, farm managers, crew leaders, advisors, packers/shippers, and consultants. Experts from Oregon State University, USDA Agricultural Research Service, Washington State University, and the blueberry industry were asked to address key issues of where the blueberry market is going; how you might be more successful in tight labor or volume markets; which cultivars are easiest to grow and are in most demand; how to establish new acreage using cutting-edge methods; projected costs and the resources available to growers for selecting new planting sites; how to best manage existing acreage to maximize returns of high-quality fruit; provide basic information on blueberry plant physiology to help growers minimize environmental stresses and improve yield potential; nutrient management programs for optimal growth and quality; irrigation and fertigation practices for higher quality and better efficiency; use of organic amendments and mulches; planning for and improving machine harvest efficiency; pruning for hand or machine harvest (where can you cut corners….or not), maximizing pollination for good fruit and seed set; overviews of the most important blueberry viruses, diseases, insects, weeds, and vertebrate pests; and tools for good pest management. Information throughout the program addresses the needs of conventional, transitional, and organic growers. Simultaneous interpretation to Spanish has been provided. This proceedings book contains information provided on these topics by each speaker and co-authors. The thumb drive provided in the registration packet for each attendee includes a copy of each presentation. Thank you for attending. It is our sincere wish that this will be a very useful meeting and that you find the accompanying materials a valuable reference! –
Bernadine Strik, Professor and Extension Berry Crops Specialist, OSU and the members of the organizing committee

Organizing Committee

Bernadine Strik, Chair, Oregon State University (OSU)
Wei Yang, OSU. Co-chair (sponsorship coordinator), OSU
Donna Williams, Rachel Williams & team at OSU Conference Services
Dave Bryla, USDA-ARS HCRU
Chad Finn, USDA-ARS HCRU
Vaughn Walton - OSU
Steve Castagnoli - OSU
Steve Renquist - OSU
Bryan Ostlund – Oregon Blueberry Commission
Eric Pond - industry
Jon Umble – industry
Derek Peacock - industry
Steve Erickson - industry
Nancy Jensen - industry

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OSU Blueberry School

Irrigation scheduling: When, where, and how much?

David Bryla
USDA-ARS Horticultural Crops Research Unit

Irrigation scheduling, a key element of proper water management, is the accurate forecasting of water application (amount and timing) for optimal crop production (yield and fruit quality). The goal is to apply the correct amount of water at the right time to minimize irrigation costs and maximize crop production and economic return. Many techniques and technologies can forecast the date and amount of irrigation water to apply. The appropriate technique or technology is a function of the irrigation water supply, technical abilities of the irrigator, irrigation system, crop value, crop response to irrigation, cost of implementing technology, and personal preference. This paper illustrates the use of weather-based approach for accurately estimating daily water requirements of blueberry.

Procedures for calculating the plant water requirements

Irrigation is required of course whenever precipitation is inadequate to meet the water demands of the crop, which, depending on the year and location, can occur anytime from late March through early October in the Pacific Northwest. In western Oregon, average seasonal water requirements for blueberry range from 0.5 to 2 inches per week. The highest irrigation requirements typically occur in July, although actual peak irrigation demands vary considerably throughout the summer, depending on weather and the stage of fruit development. Nearly all water taken up by a plant is lost by transpiration, a process that consists of the vaporization of liquid water contained in the plant to the atmosphere (only a tiny fraction is used within the plant). The water, together with some nutrients, is absorbed by the roots and transported through the plant. The water is vaporized within the leaves and transferred to the atmosphere through pores in the leaves called stomates. Water use by the plant itself is fairly complicated to estimate and will depend on numerous factors, including weather, plant age and cultivar, soil conditions, and cultural practices. Water is also lost from the soil surface by evaporation, particularly within the first few days after rain or irrigation. Because plant transpiration and soil evaporation occur simultaneously, there is no easy way of distinguishing between the two processes. Therefore, crop water requirements are typically estimated as the combination of the two processes, collectively termed crop evapotranspiration (ET).

Weekly estimates of crop ET are accessible on the internet from weather-based websites such as AgriMet (Pacific Northwest Cooperative Agricultural Weather Network; http://www.usbr.gov/pn/agrimet/) and AgWeatherNet (AWN; http://weather.wsu.edu/awn.php). These sites obtain data from a network of automated agricultural weather stations located throughout Oregon and Washington. Weather data are used to estimate ET of a reference surface such as grass (ET_o) or alfalfa (ET_r), which is then converted to crop ET using an appropriate crop coefficient (K_c) for blueberry. A crop coefficient represents the relative amount water used by a crop (e.g., blueberry) to that used by grass or alfalfa. Therefore, K_c will change over the season as the crop canopy develops. Crop coefficients will also differ depending on whether crop ET is calculated using ET_o or ET_r. An example of a set of crop coefficients used for calculating blueberry ET based on weather-based estimates of ET_r is shown in Fig. 1. The coefficients increase as the canopy develops from bud break to the beginning of fruit ripening and then

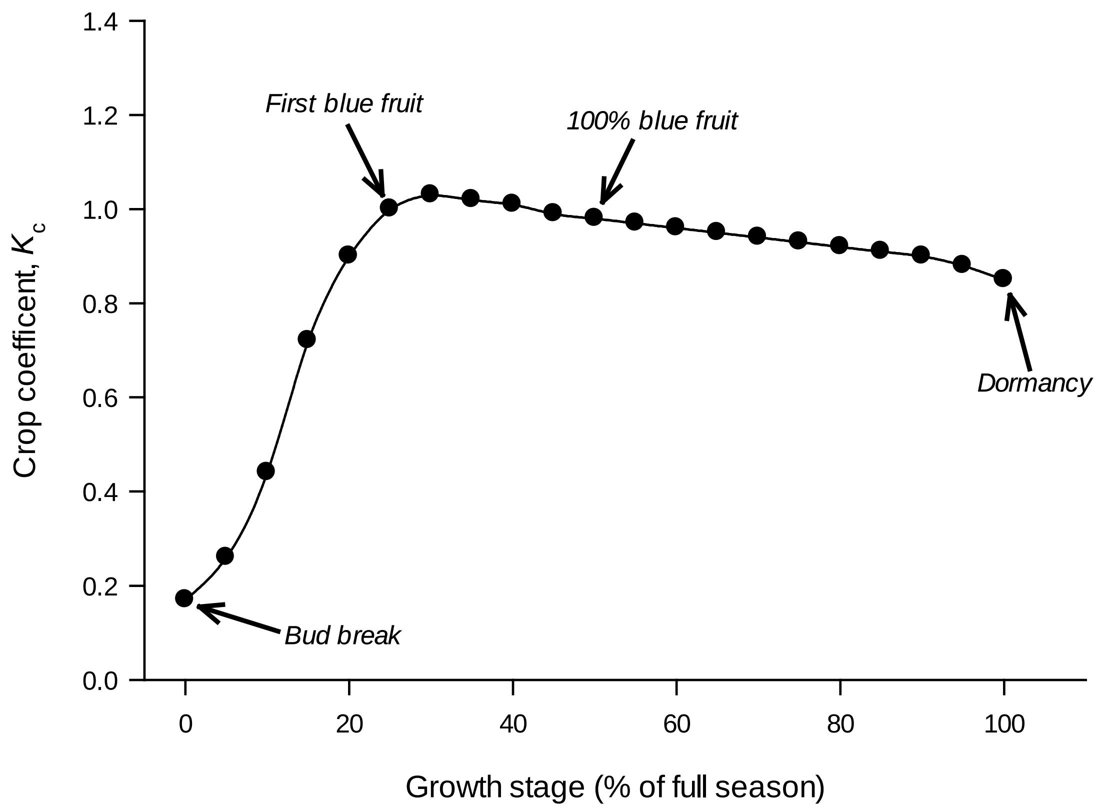

Fig. 1. Crop coefficient curve for highbush blueberry (obtained from AgriMet). Blueberry ET is calculated at various stages of crop development by multiplying K_c by reference evapotranspiration (ET_r) available online from the AgriMet (Pacific Northwest Cooperative Agricultural Weather Network) website.

gradually declines until leaf senescence and dormancy. Blueberry reaches full effective canopy cover when the first blue fruit appear in the early-season cultivars, and it is at this stage that water use by blueberry is equal to alfalfa and $K_c = 1$.

Normally, irrigation should be scheduled to replace any water lost by crop ET. Keep in mind that these are ET estimates for mature, healthy, well-irrigated blueberry plants. Adjustments to these values are needed when plants are young or stressed (e.g., nutrient deficient). Approximately, half as much water is needed during the first year after planting, and about two-thirds is needed during the second year. However, an additional 20% above these reduced amounts is recommended for new plantings mulched with landscape fabric (black weed mat). The fabric increases leaf and soil temperatures and results in greater crop water use.

Under stressed circumstances, irrigators should reduce the amount of irrigation water applied but pay close attention to soil moisture conditions to avoid under- or over-irrigation. There are numerous devices available for monitoring soil moisture, although some are more accurate and reliable than others. Many of these monitoring devices need to be calibrated to a particular site so that the gathered data can be related to actual soil moisture conditions. Soil moisture monitors should be installed within the root zone (usually 0.15-0.30 m deep) of a representative plant and should not be located directly beneath an irrigation emitter. A much simpler alternative is to sample the soil using a soil probe. Insert the probe to a depth of at least 12-18 inches, and examine the soil to ensure it remains wet (but not too wet) between irrigations and is watered completely (reaches the bottom of the soil sample).

Adjusting water applications for irrigation system efficiency

It is important to understand that a crop's irrigation requirements differ considerably from its actual water requirements. Crop water requirements indicate the total amount of water directly used by a crop but do not account for any extra water needed to compensate for non-beneficial water use or loss, e.g., run-off, deep percolation, evaporation, wind drift, ground cover, weeds, etc. Additionally, irrigation systems do not apply water with 100% uniformity. For accurate irrigation scheduling, these losses must be evaluated for each system. The most common systems used to irrigate blueberries are sprinklers and drip.

Average irrigation application efficiencies for well-maintained solid set sprinkler systems generally range from 65-75%, which largely depends on the quality of sprinkler overlap. Close spacing and newer sprinkler heads help to improve sprinkler water application efficiency. Brand new drip systems, on the other hand, are generally designed with 85-93% efficiency, except in cases with major changes in elevation. Beware that neglected drip systems may have an actual efficiency closer to 60-80% or less. Primary causes for low efficiencies include flow variation due to poor system design, emitter plugging, and pressure differences within the field.

In Corvallis, Oregon, average irrigation requirements throughout the growing season are estimated to range from 0.15 to 0.64 inches of water per day with sprinklers and 0.04 to 0.17 inches of water per day by drip (Table 1). The highest irrigation requirements typically occur in July, although actual peak irrigation demands will vary throughout the summer, depending on weather and stage of fruit development. A well-maintained drip system generally requires only about 25% of the water needed with sprinklers, due to the higher efficiency associated with drip irrigation. It should be noted, however, that the actual crop water use by sprinkler and drip-irrigated blueberries (i.e., the values calculated using crop coefficients) is theoretically identical. Irrigation requirements will also vary with location but are easily adjusted for it when local weather data are used to calculate crop ET.

Timing of water applications

The timing or frequency of water applications will depend on soil texture (e.g., sand versus clay), the irrigation system used (e.g., drip versus sprinkler), the rate at which the plant is using water, and the overall development of the plant's root system. Blueberry is a shallow-rooted plant compared to many perennial fruit crops. The roots of highbush blueberry are usually located in the top 18 inches of soil and are often most concentrated near the soil surface. Consequently, when water demands are high, blueberry plants quickly deplete the water from their root zone and require frequent applications of water in order to avoid water stress (drought).

Frequent water applications are especially important when using drip, which tends to restrict soil wetting and thus produces a smaller root system. When done properly, frequent irrigations are beneficial and often increase growth and yield in many horticultural crops, including blueberry. It may also be important to apply water to both sides of the plant in order to develop a good root system. Irrigators should be careful to avoid the temptation to over-irrigate, which is especially easy to do with drip. Over-irrigation depletes the root zone of much-needed oxygen, thus reducing both root growth and nutrient uptake and leading to a host of potential root disease problems.

High-frequency irrigation may be especially beneficial and perhaps even required when organic matter is incorporated into the planting bed. Organic matter often reduces water holding capacity of the soil and can lead to problems with hydrophobicity. Soil hydrophobicity is the lack of affinity of soil to water and is thought to be caused primarily by a coating of long-chained hydrophobic organic molecules, such as those released from decaying organic matter, on individual soil particles. Hydrophobic soils often become very difficult to rewet once they dry out. Sawdust incorporated into a raised planting beds can make it difficult to retain adequate moisture near the soil surface where many of the blueberry roots are located. To compensate, more frequent irrigation is needed in beds with incorporated sawdust.

Additional resource

Crop Evapotranspiration and Irrigation Scheduling in Blueberry, pp. 167-186. In Gerosa G. (ed.) Evapotranspiration – From Measurements to Agricultural and Environmental Applications. 2011. (Open-access)

Western Oregon Irrigation Guides. Smesrud, Hess, Selker, Strik, Mansour, Stebbins, Mosley. 1998. Ore. St. Univ. Ext. Serv. Publ. EM8713.

Table 1. Average daily water requirements for healthy, mature plants of early- and late-season northern highbush blueberry.[*]

	Avg. daily water requirements							
		In-row spacing[¶]				In-row spacing[¶]		
Month	Early-season cultivars (in./day)	2.5 ft.	3 ft. (gal./plant/day)	4 ft.	Late-season cultivars (in./day)	2.5 ft.	3 ft. (gal./plant/day)	4 ft.
	Sprinkler irrigation[§]							
May	0.25	3.9	4.7	6.2	0.15	2.3	2.8	3.7
June	0.46	7.2	8.6	11.5	0.38	5.9	7.1	9.5
July	0.63	9.8	11.8	15.7	0.64	10.0	12.0	16.0
August	0.45	7.0	8.4	11.2	0.47	7.3	8.8	11.7
September	0.35	5.5	6.5	8.7	0.36	5.6	6.7	9.0
Max. demand[†]	0.88	13.7	16.5	21.9	0.88	13.7	16.5	21.9
	Drip irrigation[§]							
May	0.06	0.9	1.1	1.5	0.04	0.6	0.7	1.0
June	0.12	1.9	2.2	3.0	0.10	1.6	1.9	2.5
July	0.16	2.5	3.0	4.0	0.17	2.6	3.2	4.2
August	0.12	1.9	2.2	3.0	0.12	1.9	2.2	3.0
September	0.09	1.4	1.7	2.2	0.09	1.4	1.7	2.2
Max. demand[†]	0.23	3.6	4.3	5.7	0.23	3.6	4.3	5.7
	According to AgriMet[#]							
May	0.12	1.8	2.2	2.9	0.07	1.1	1.3	1.8
June	0.21	3.3	4.0	5.4	0.18	2.8	3.3	4.5
July	0.29	4.6	5.5	7.3	0.30	4.6	5.6	7.4
August	0.21	3.3	3.9	5.2	0.22	3.4	4.1	5.5
September	0.16	2.6	3.1	4.1	0.17	2.6	3.2	4.2
Max. demand[†]	0.41	6.4	7.7	10.3	0.41	6.4	7.7	10.3

[*]These are water requirements for Corvallis, OR. The values will differ at other locations.
[¶]Calculations are based on a 10-ft. between-row spacing.
[§]Values must be adjusted for precipitation before scheduling irrigation.
[#]Obtained from AgriMet website (http://www.usbr.gov/pn/agrimet/). Values must be adjusted for water application efficiency of the irrigation system.
[†]Occurs when conditions are very hot (>95ºF), dry, and windy in mid-July to early-August.