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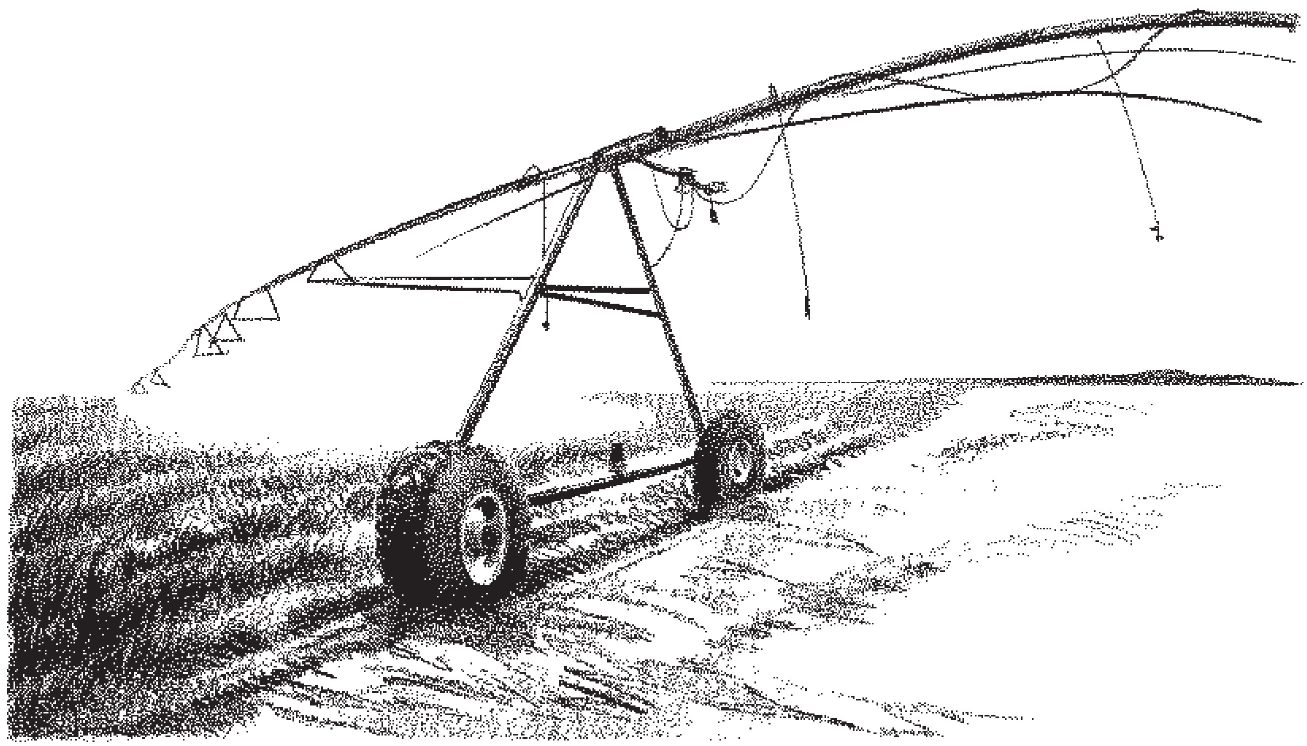
Western Oregon Irrigation Guides



OREGON STATE UNIVERSITY
EXTENSION SERVICE

Contents

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Foreword

The greatest single consumptive use of water in the Willamette Valley is irrigated agriculture. These activities generate generous returns in harvests and livelihood for Willamette Valley residents, but compete for resources with alternate uses of these waters. Optimum returns from irrigation systems can be realized only if systems are operated and maintained with care. Over-irrigation can lead to leaching losses of nutrients from farms, costing farmers precious funds, and potentially degrading the aquifers underlying the farms. There has been very little support from state agencies in improving the efficiency of irrigated agriculture in the past 20 years.

Through this project, we have developed a set of irrigation guides for farmers in the Willamette Valley, covering the primary field, row, and orchard crops. The first section provides an overview of the decisions and factors that go into irrigation system design, operation, and maintenance. The 16 crop-specific fact sheets cover all of the major crops grown in the valley. Each fact sheet covers the key water management issues for that crop and includes a simple worksheet for easily computing the entire seasonal irrigation requirements for crops.

These materials are supported by a slide show, set up in PowerPoint, which provides a comprehensive introduction to these materials suitable for irrigators, crop consultants, and Extension personnel. All of the essential calculations employed in the project are described in appendices and are available in full in spreadsheet files in a two-disk set. The slide show and disks are available from the OSU Department of Bioresource Engineering, 541-737-2041.

Western Oregon Irrigation Guides

The *Western Oregon Irrigation Guides* were developed to help growers manage and schedule irrigation for common field crops. Each guide contains key facts concerning crop-specific water management, along with an easy-to-use worksheet for scheduling irrigation. These guides lead you through the development of site-specific irrigation schedules, based on plant and soil demands as well as on labor and irrigation system limitations.

Guides presently available include blueberry, broccoli, bulb onion, caneberry, carrot, cauliflower, cucumber, green bean, leafy green, orchard, peppermint, potato, squash, strawberry, sweet corn, and table beet.

Why should I use these guides?

Western Oregon's dry summer climate makes irrigation essential for most crops. With increasing population pressure, the demand on water resources in this region continues to rise, paralleled by increasing costs of water and electricity. Furthermore, the occurrence of agricultural chemicals in groundwater causes significant public concern. In other regions of the state, the Department of Environmental Quality therefore has designated groundwater management units to address this issue.

Irrigation efficiency represents a great opportunity for western Oregon farmers. Improved irrigation practices can reduce operation costs as well as the risk of groundwater contamination and regulation, while assuring adequate food production.

Limitations of these guides

To simplify management, the schedules produced from these guides are fixed on monthly intervals and are based on historical weather data. Since plants and weather do not operate on monthly schedules, this approach is only a first step in optimizing irrigation management.

Daily monitoring of crop water use and soil moisture is the most accurate method for scheduling irrigation. You're strongly encouraged to use both daily monitoring and these guides. For example, you can use a set monthly schedule for long-range planning but validate short-term irrigation needs by monitoring soil moisture. For more information on soil water monitoring, see PNW 475, *Soil Water Monitoring and Measurement* and USDA SCS, *Estimating Soil Moisture by Feel and Appearance*.

Another point of caution is that schedules produced from these guides are based solely on projected crop water use and do not account for precipitation. There are two ways to deal with irrigation when rainfall occurs. One is to record rainfall on a daily basis and subtract the amount of rain that falls between irrigations from the next irrigation. The other, which may be easier if you are managing several fields, is to stop irrigating after a significant rain and delay the next irrigation until that rain is consumed by the crop. To determine how long to wait before irrigating again, divide the depth of rainfall by the evapotranspiration rate shown on each worksheet.

Finally, the crop-specific worksheets were designed for sprinkler irrigation systems, since this is the most common irrigation technique in western Oregon. Much of the information in these guides applies to other irrigation techniques as well. In particular, most of the information in this section and the comments on the front of each crop-specific guide apply to all western Oregon farmers, regardless of the irrigation method used. The projected crop water requirements also are valid for all irrigation methods.

Example worksheet

Peppermint

1. Determine irrigation interval.

Available water capacity (in/in)	a.	0.21
Maximum allowable depletion (percent)	b.	35
Effective rooting depth (in)	c.	24
Peak ET (in/day)	d.	0.21
Maximum irrigation interval (days) *e = (a∗b∗c)/(d∗100)*	e.	8.4
Your irrigation interval (days) *Note: f should be equal to or less than e.*	f.	8

Use values for your specific soil and depth range from Appendix A if available. Otherwise, use Table 1.

Table 1.—Available water capacity (AWC).

Soil texture	AWC (in/in)
Sandy	0.07–0.10
Sandy loam	0.09–0.15
Loam	0.14–0.19
Clay loam	0.17–0.22
Clay	0.20–0.25

2. Determine combined efficiency.

Uniformity coefficient	g.	82
Combined efficiency *h = (0.01583∗g) - 0.6327*	h.	0.665

Table 2.—Uniformity coefficient.

Irrigation system	Uniformity coefficient*	
Solid set	70	63
Hand move or side-roll	82	74
Pivot or linear move	90	81
Offset managed hand-moved	90	81

**Use Tables 3 and 4 below to find your sprinkler spacing and discharge rate. If your spacing/discharge combination falls in the shaded area of Table 4, use the uniformity coefficient from the right (shaded) column of Table 2. Otherwise, use the left (unshaded) column.*

3. Determine depth of irrigation.

		April	May	June	July	August
Monthly evapotranspiration rate (in/day)	i.	0.09	0.12	0.20	0.21	0.14
Depth of irrigation per set (in) *j = (i∗f)/h*	j.	1.08	1.44	2.40	2.52	1.68

4. Determine set time.

Application rate (in/hr) k. 0.36

Measure or use Tables 3 and 4 below to determine your application rate.

		April	May	June	July	August
Irrigation set time (hr) *l = j/k*	l.	3.01	4.01	6.68	7.01	4.68

Table 3.—Discharge (gpm).

Pressure (psi)	Standard tapered nozzle diameter (in) 3/32	1/8	9/64	5/32	11/64	3/16	13/64	7/32
35	1.5	2.7	3.40	4.16	5.02	5.97	7.08	8.26
40	1.6	2.9	3.63	4.45	5.37	6.41	7.60	8.87
45	1.7	3.2	3.84	4.72	5.70	6.81	8.07	9.41
50	1.8	3.1	4.04	4.98	6.01	7.18	8.49	9.88
55	1.9	3.3	4.22	5.22	6.30	7.51	8.87	10.30

Table 4.—Application rate (in/hr).

Sprinkler spacing (ft)	by (ft)	Discharge per nozzle (gpm) from Table 3: 2	3	4	5	6	8	10
20	20	0.48	0.72	0.96	1.20	1.44	1.93	2.41
20	40	0.24	0.36	0.48	0.60	0.72	0.96	1.20
30	30	0.21	0.32	0.43	0.54	0.64	0.86	1.07
30	40	0.16	0.24	0.32	0.40	0.48	0.64	0.80
30	50	0.13	0.19	0.26	0.32	0.39	0.51	0.64
40	40	0.12	0.18	0.24	0.30	0.36	0.48	0.60
40	50	0.10	0.14	0.19	0.24	0.29	0.39	0.48
40	60	0.08	0.12	0.16	0.20	0.24	0.32	0.40

Blueberry

M. Hess, B. Strik, J. Smesrud, and J. Selker

Total seasonal evapotranspiration	37.5 inches
Peak evapotranspiration rate	0.25 inch/day
Maximum allowable depletion	50 percent
Critical moisture deficit period	Fruit expansion

Blueberries have most of their effective rooting system in the upper 18 inches of soil. Because they are relatively shallow rooted, blueberries are subject to drought injury. A uniform and adequate supply of moisture is essential for optimum growth.

In most areas of western Oregon, irrigation is required to maintain adequate soil moisture from mid-June to mid-September. The demand for moisture is greatest from the time of fruit expansion until harvest. July and August are the lowest rainfall months, and this is the period when the developing fruit produces the greatest plant water demand.

This also is the period when floral initiation for next year's crop begins. If soil moisture is lacking at this time, a reduced set of buds will occur.

Some cultivars are sensitive to fruit cracking. Cracking often occurs after a period of drought. Fruit growth is slowed, and the skin becomes less elastic. Then, if precipitation or a period of high humidity occurs, the fruit flesh swells faster than the skin can accommodate, and the skin splits. However, with a continuous supply of moisture, the fruit skin remains elastic, and cracking is less likely to occur. Fruit also may shrivel during periods of water stress. Be aware, however, that excessive standing water in blueberry fields can reduce root growth and promote root diseases such as phytophthora.

The peak water use for blueberry is approximately 0.25 and 0.23 inches per day for July and August, respectively.

On the back of this page is a worksheet for calculating irrigation schedules for blueberries. These calculations are most straightforward for side-roll, hand-move, or solid-set sprinkler irrigation. If you have a linear move or center pivot system, all information applies except for the set time, which must be gauged to the tower travel speed.

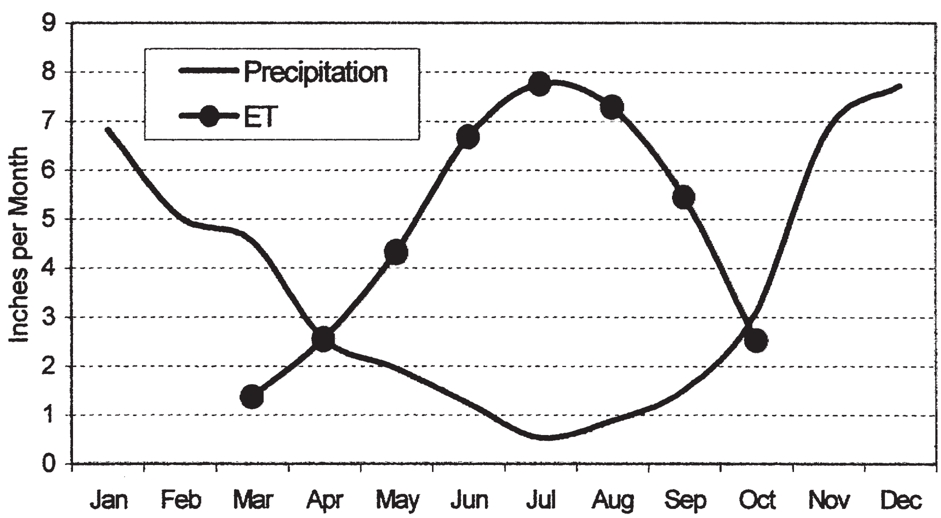
For basic scheduling, you need to know sprinkler nozzle diameters, operating pressure, spacing, and soil type. To describe individual systems more accurately, you also need to know the uniformity coefficient of the system and available water capacity of your soil.

Go through the worksheet sequentially starting with item *a*. Equations use item letters for reference.

Although the rooting depth is supplied on the worksheet, if you believe your site is an exception (e.g., it has a shallow restrictive layer), you can change the rooting depth accordingly on the worksheet. Evapotranspiration rate estimates for the growing season are listed on the worksheet.

Reference

Strik, B. et al. *Highbush Blueberry Production*, PNW 215 (Oregon State University, Corvallis, 1993).



Typical precipitation and blueberry evapotranspiration (ET) in the Willamette Valley. Tabulated values of ET are provided on the back of this sheet.

Blueberry

Irrigation schedule worksheet

1. Determine irrigation interval.

Available water capacity (in/in)	a.	______
Maximum allowable depletion (percent)	b.	50
Effective rooting depth (in)	c.	18
Peak ET (in/day)	d.	0.25
Maximum irrigation interval (days)	e.	______
e = (a∗b∗c)/(d∗100)		
Your irrigation interval (days)	f.	[ ]
Note: f should be equal to or less than e.		

Use values for your specific soil and depth range from the Appendix, if available. Otherwise, use Table 1.

Table 1.—Available water capacity (AWC).

Soil texture	AWC (in/in)
Sandy	0.07–0.10
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Loam	0.14–0.19
Clay loam	0.17–0.22
Clay	0.20–0.25

2. Determine combined efficiency.

Uniformity coefficient	g.	______
Combined efficiency	h.	[ ]
h = (0.01583∗g) - 0.6327		

Table 2.—Uniformity coefficient.

Irrigation system	Uniformity coefficient*	
Solid set	70	63
Hand move or side-roll	82	74
Pivot or linear move	90	81
Offset managed hand-moved	90	81

**Use Tables 3 and 4 below to find your sprinkler spacing and discharge rate. If your spacing/discharge combination falls in the shaded area of Table 4, use the uniformity coefficient from the right (shaded) column of Table 2. Otherwise, use the left (unshaded) column.*

3. Determine depth of irrigation.

		April	May	June	July	August	September
Monthly evapotranspiration rate (in/day)	i.	0.09	0.14	0.22	0.25	0.23	0.18
Depth of irrigation per set (in)	j.						
j = (i∗f)/h							

4. Determine set time.

Application rate (in/hr) k. ______

Measure or use Tables 3 and 4 below to determine your application rate.

		April	May	June	July	August	September
Irrigation set time (hr)	l.						
l = j/k							

Table 3.—Calculating discharge (gpm).

Pressure (psi)	Standard tapered nozzle diameter (in) 3/32	1/8	9/64	5/32	11/64	3/16	13/64	7/32
35	1.5	2.7	3.40	4.16	5.02	5.97	7.08	8.26
40	1.6	2.9	3.63	4.45	5.37	6.41	7.60	8.87
45	1.7	3.2	3.84	4.72	5.70	6.81	8.07	9.41
50	1.8	3.1	4.04	4.98	6.01	7.18	8.49	9.88
55	1.9	3.3	4.22	5.22	6.30	7.51	8.87	10.30

Table 4.—Calculating application rate (in/hr).

Sprinkler spacing (ft)	by (ft)	Discharge per nozzle (gpm) from Table 3: 2	3	4	5	6	8	10
20	20	0.48	0.72	0.96	1.20	1.44	1.93	2.41
20	40	0.24	0.36	0.48	0.60	0.72	0.96	1.20
30	30	0.21	0.32	0.43	0.54	0.64	0.86	1.07
30	40	0.16	0.24	0.32	0.40	0.48	0.64	0.80
30	50	0.13	0.19	0.26	0.32	0.39	0.51	0.64
40	40	0.12	0.18	0.24	0.30	0.36	0.48	0.60
40	50	0.10	0.14	0.19	0.24	0.29	0.39	0.48
40	60	0.08	0.12	0.16	0.20	0.24	0.32	0.40

How to use these tables