# Irrigation

## Efficiency on small farms and gardens.

Dean Moberg
USDA – NRCS

# Welcome and introductions

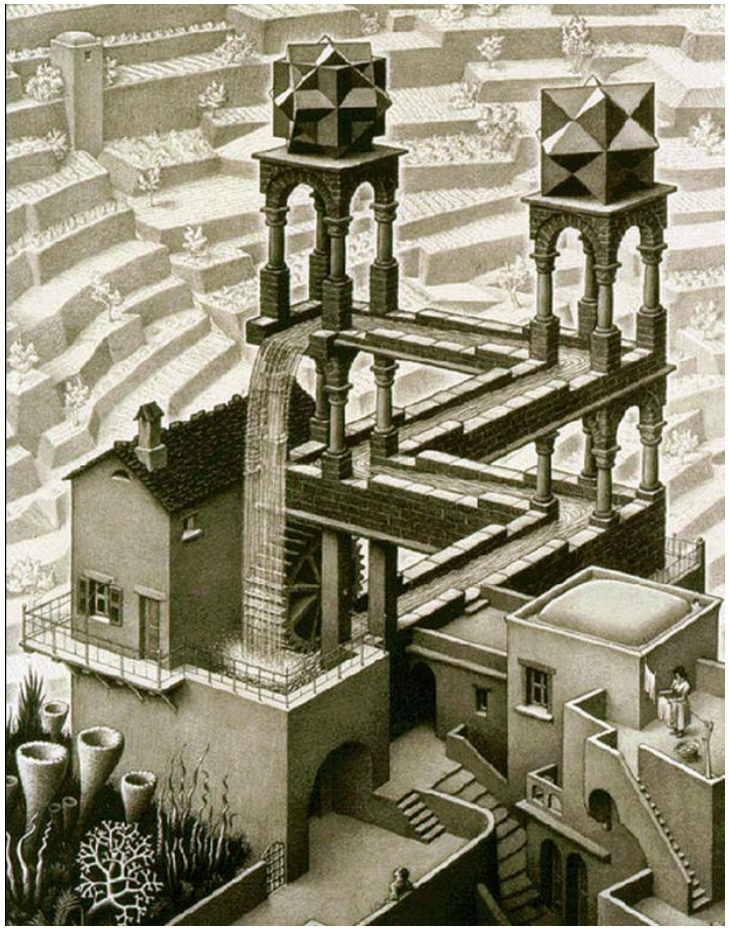
Monet, *Haystacks*

# Irrigation as a system

*Hardware.*

*Soil.*

*Plants.*



Escher, *Waterfall*

# Irrigation as a system

*Hardware.*

*Soil.*

*Plants.*

# Hardware

- *Flood*
- *Sprinkler*
- *Micro*

# Hardware

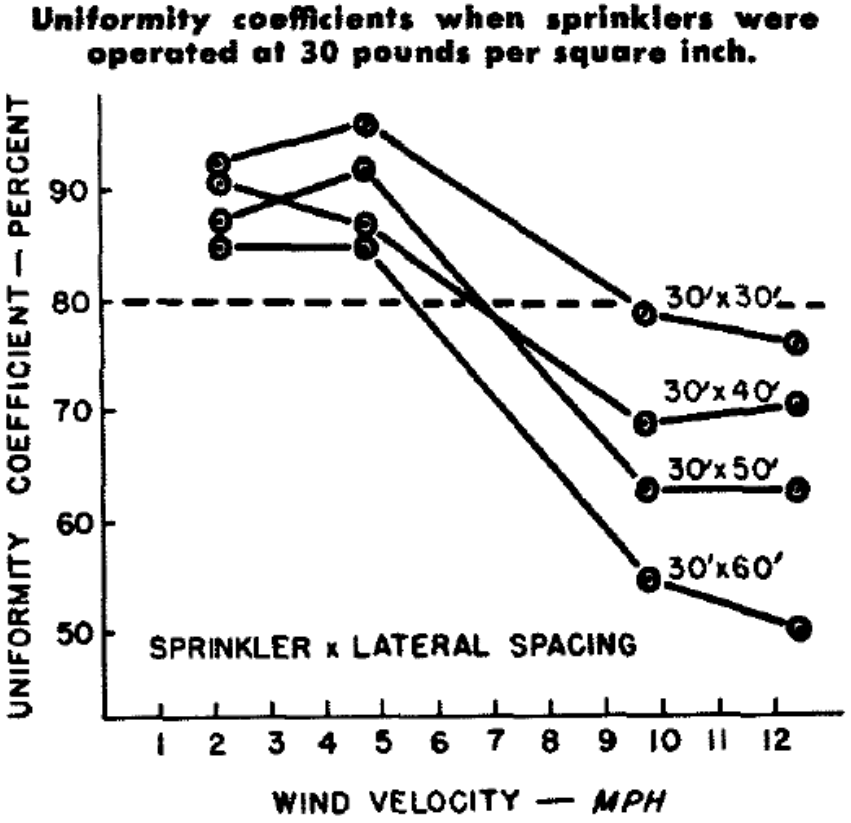
- ~~*Flood*~~
- *Sprinkler*
- *Micro*

# Sprinkler benefits

- *Can be portable*
- *Cooling*
- *Frost protection*

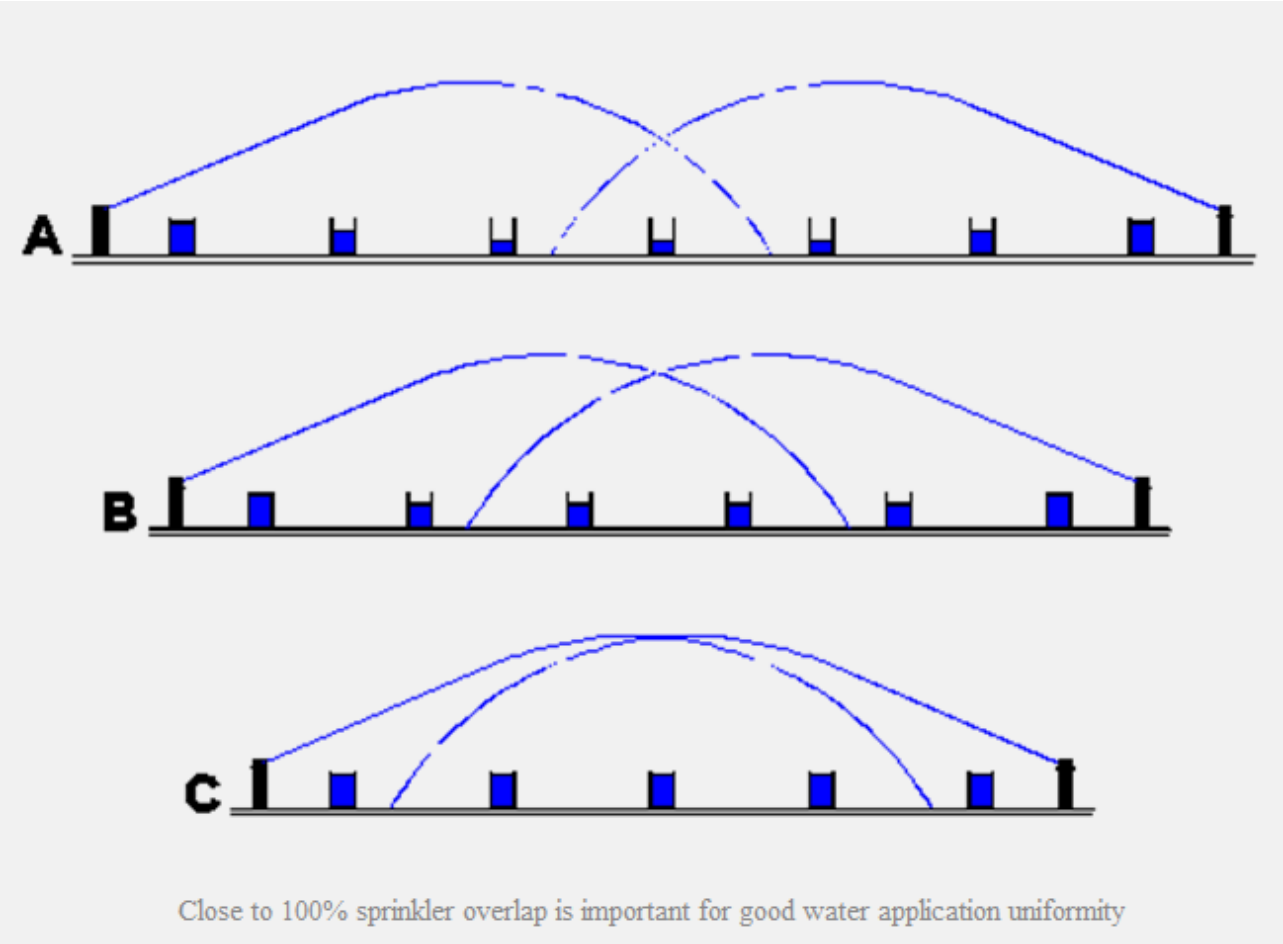
# Sprinkler drawbacks

- *Uniformity difficult*
- *Affected by wind*
- *Wet foliage*
- *High energy cost*
- *Smaller sets*



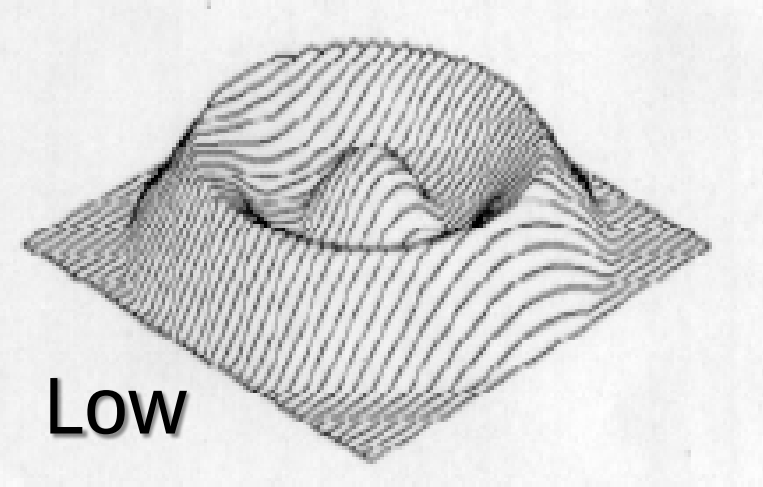

Scott and Cory, 1957

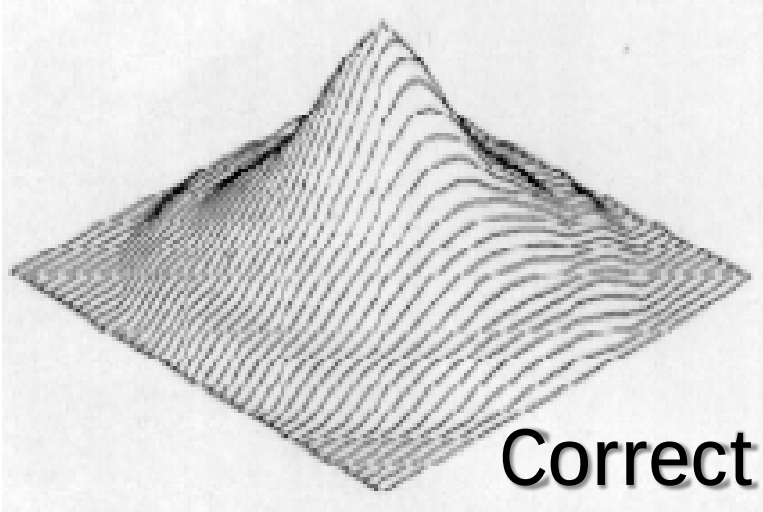
# Sprinkler tip 1: overlap




Close to 100% sprinkler overlap is important for good water application uniformity

# Sprinkler tip 2: pressure




Smesrud et al., 1997

# Sprinkler tip 3: maintenance


# Micro (drip) benefits

- *Less waste*
- *Uniform*
- *Low labor*
- *Dry foliage*
- *Less bacteria on fruit?*

# Micro drawbacks

- *Hard to see clogs and leaks*
- *Animal damage*
- *Hard to "catch up"*

# Micro tip 1: good filtration

# Micro tip 2: regular flush

# Irrigation as a system

*Hardware.*

*Soil.*

*Plants.*

# Available water, simplified

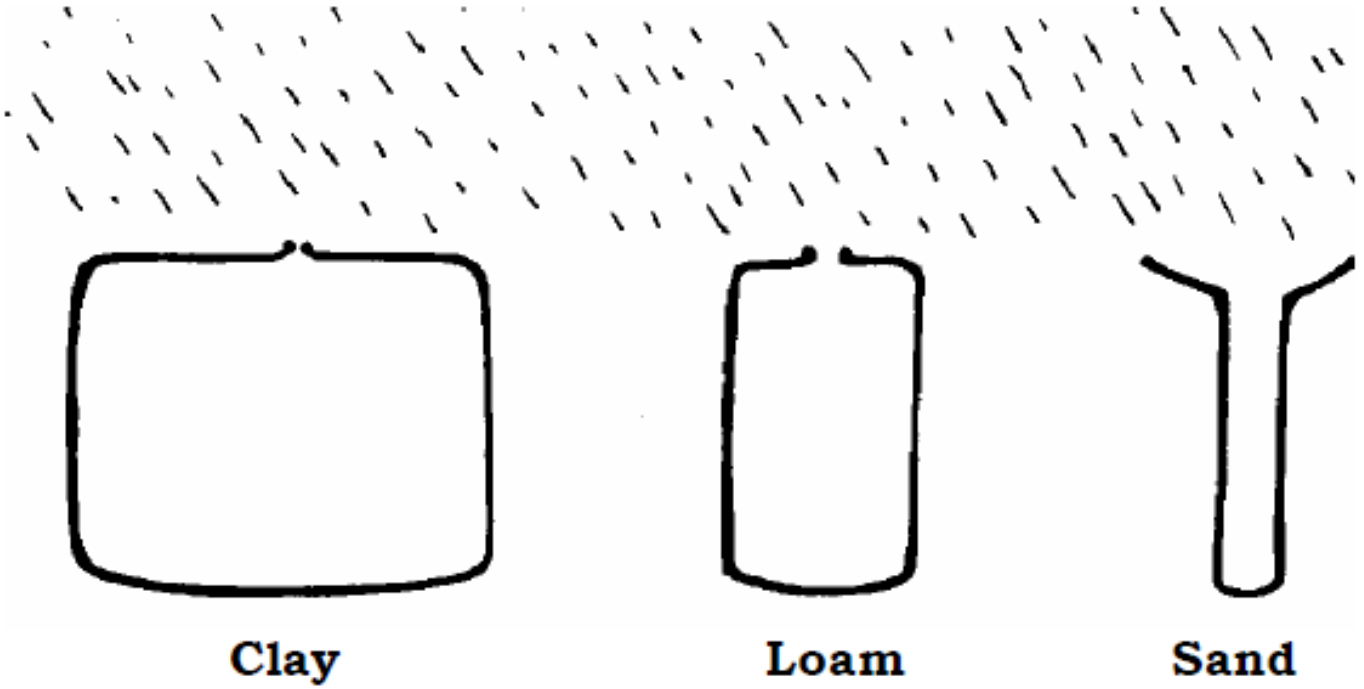


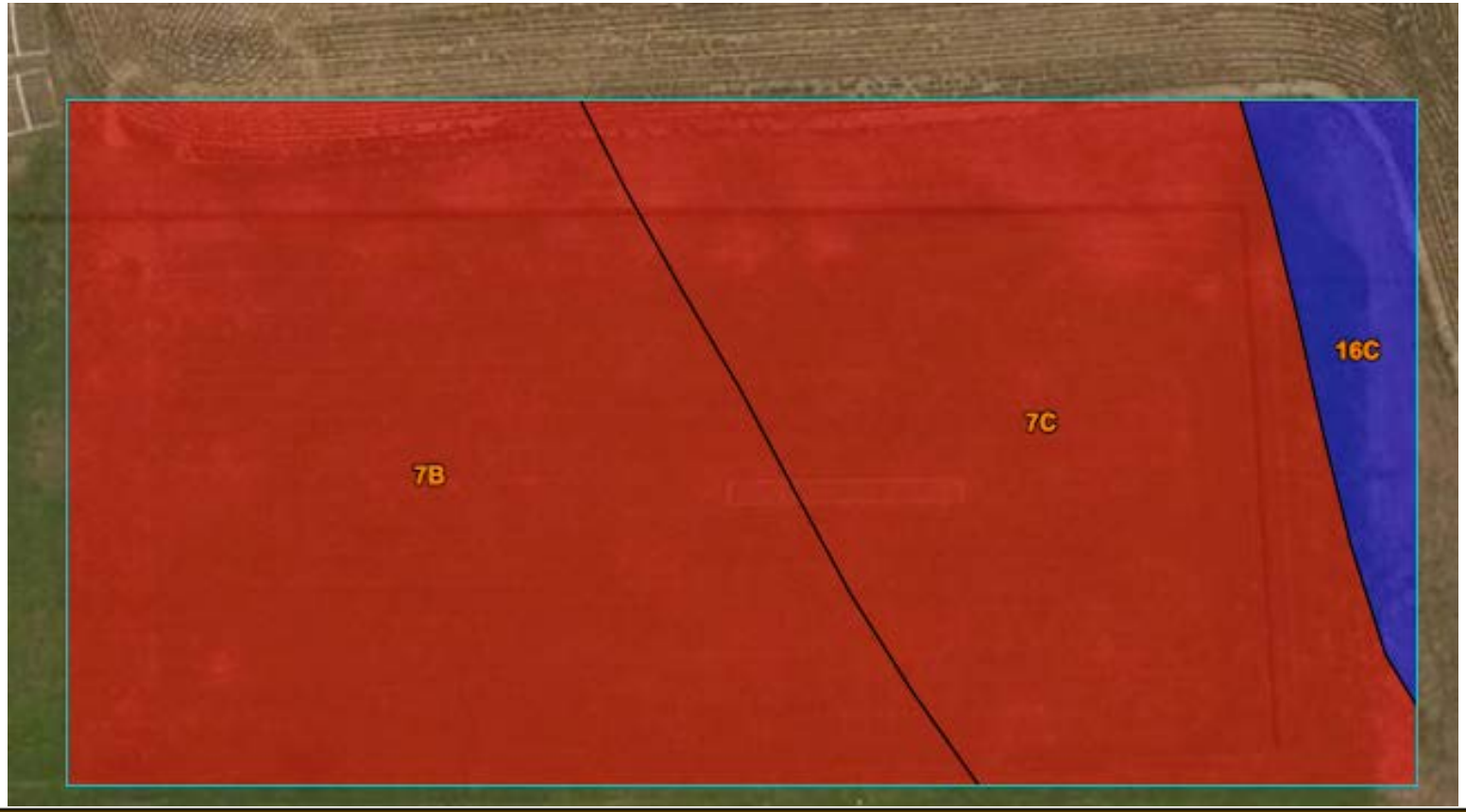

*Figure 1. Soil-Bottle Analogy.*

Smesrud et al., 1997

# Web Soil Survey

*Free, fun, easy*


http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm



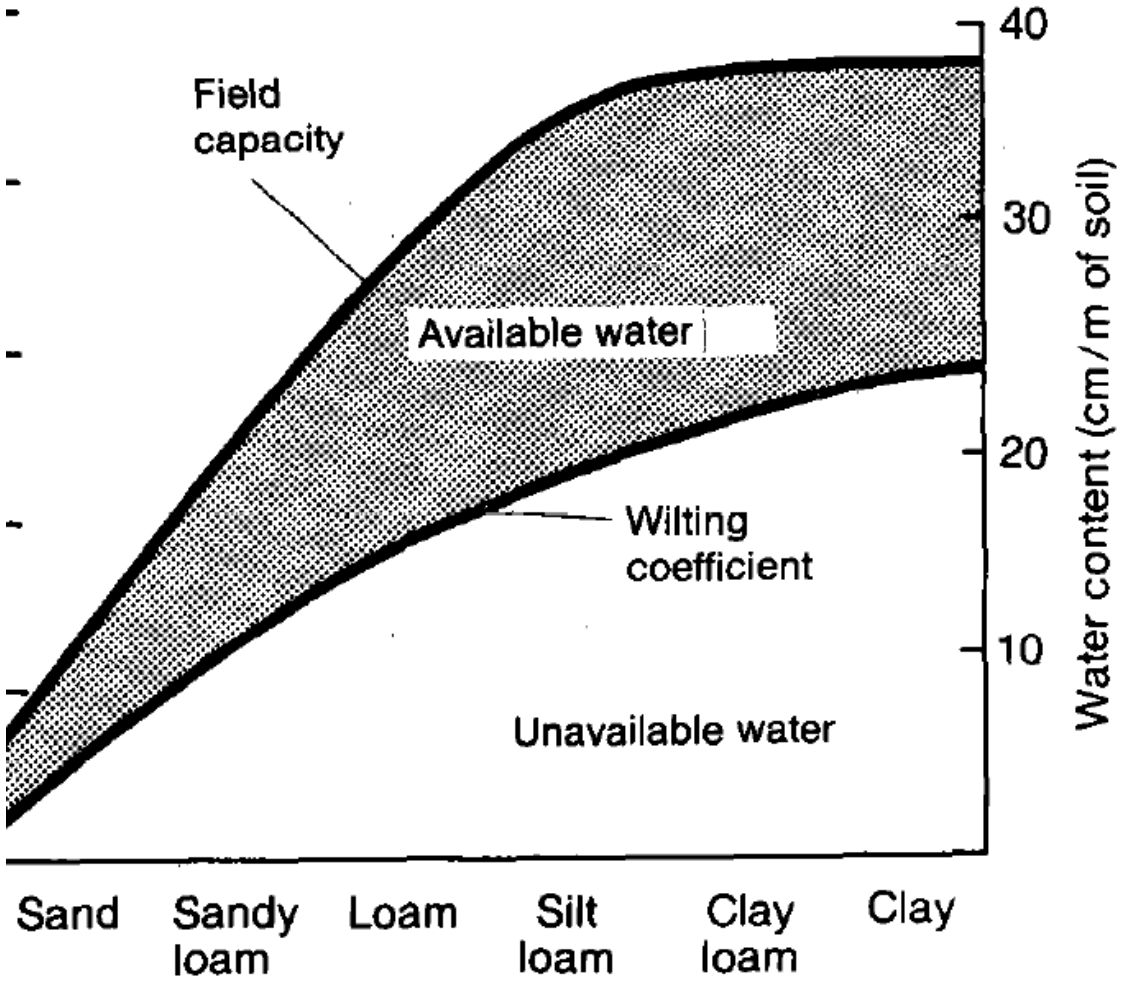

## Tables – Available Water Capacity – Summary By Map Unit

### Summary by Map Unit – Washington County, Oregon (OR067)

| Map unit symbol | Map unit name | Rating (centimeters per centimeter) |
|---|---|---|
| 7B | Cascade silt loam, 3 to 7 percent slopes | 0.19 |
| 7C | Cascade silt loam, 7 to 12 percent slopes | 0.19 |
| 16C | Delena silt loam, 3 to 12 percent slopes | 0.20 |

# Volunteer needed

# Available Water



# Irrigation as a system

*Hardware.*

*Soil.*

*Plants.*

# Western Oregon Irrigation Guides

Mario Hess, Jason Smesrud, and John Selker

The Western Oregon Irrigation Guides were developed to aid growers in this region with irrigation management and scheduling for common irrigated crops. of appropriate irrigation schedules. Guides presently available are listed below.

The detailed guides are provided in Adobe Acrobat format. This requires your browser to have an Acrobat Reader plug-in. If you don't already have this plug

- Blueberry
- Broccoli
- Bulb Onion
- Caneberry
- Carrot
- Cauliflower
- Cucumber
- Green Bean
- Leafy Green
- Orchard
- Peppermint
- Potato
- Squash
- Strawberry
- Sweet Corn
- Table Beet

Additionally, the Background & References Guide provides further information and tips concerning irrigation in Western Oregon.

http://bioe.oregonstate.edu/Faculty/selker/wo_irrigation_guide.htm

# Oregon State University
## Western Oregon
# Blueberry Irrigation Guide

Mario Hess, Bernadine Strik, Jason Smesrud, and John Selker
Department of Bioresource Engineering
116 Gilmore Hall, (541) 737-6304
Corvallis, OR 97331-3906

November 1997

| | |
|---|---|
| Total Seasonal Evapotranspiration [in] | 37.5 |
| Peak Evapotranspiration Rate [in/day] | 0.25 |
| Maximum Allowable Depletion [percent] | 50 |
| Critical Moisture Deficit Period | Fruit Expansion |

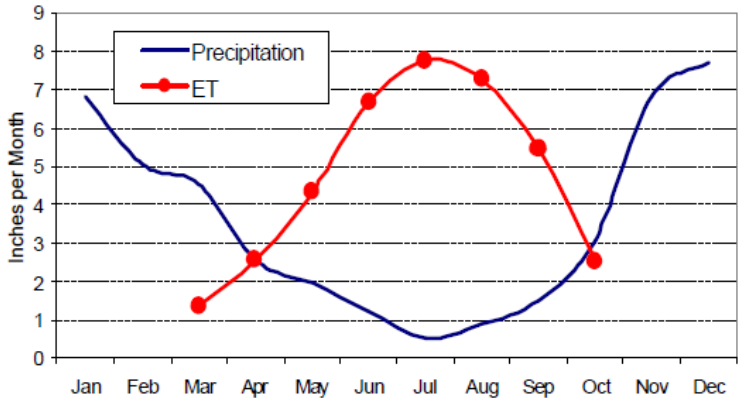



**Figure 1: Typical precipitation and blueberry evapotranspiration (ET) in the Willamette Valley. Tabulated values of ET are provided on the back of this sheet.**

Blueberries have most of their effective rooting system in the upper 18 inches of soil. Since 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 is also 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. However, with a continuous supply of moisture, the fruit skin remains elastic and cracking is less likely to occur. 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. Fruit may also shrivel under periods of water stress. Growers should be aware however that excessive, standing water in blueberry fields can reduce root growth and promote root diseases like 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 side of this page is a worksheet to aid in calculating irrigation schedules for blueberries. These calculations are most straightforward for those using side-roll, hand-move, or solid set sprinkler irrigation. For those with linear move or center pivot systems, all information applies except for the set time, which must be gauged to the tower travel speed. For basic schedule information, sprinkler nozzle diameters, operating pressures, and spacing and soil type must be known. To more accurately describe individual systems, the uniformity coefficient of the system and available water capacity of your soil is also needed. This worksheet was designed to be progressed through sequentially starting with item *a*). Equations listed under item headings use item letters for reference. Although the rooting depth is already supplied in the worksheet, if you have reason to believe your site is an exception (e.g. shallow restrictive layer), this may be altered. Evapotranspiration rate estimates for the growing season are listed in the worksheet.

**References**

1. Oregon State University Extension Publication PNW 215. 1993. Highbush Blueberry Production.

*Note: For additional background information and references, see "Western Oregon Irrigation Guides: Background and References."*

Hess et al., 1997

# From blueberry guide

- *Effective root depth = 18 inches*
- *Maximum allowable depletion = 50%*

# Available water, simplified

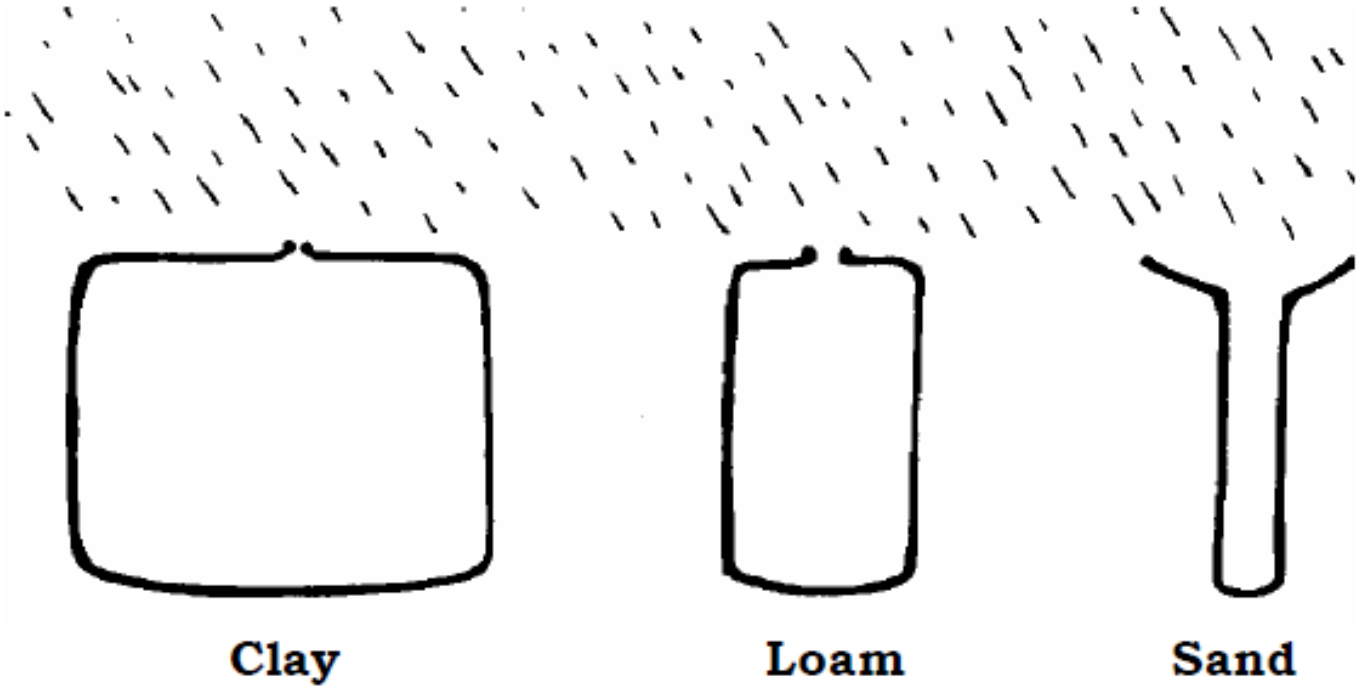



*Figure 1. Soil-Bottle Analogy.*

Smesrud et al., 1997

# Total available water

$$AW/inch \ x \ root\ depth \ x \ MAD$$

$$0.20 \frac{in}{in} \ x \ 18 \ in \ x \ 50\% = \ 1.8 \ in$$

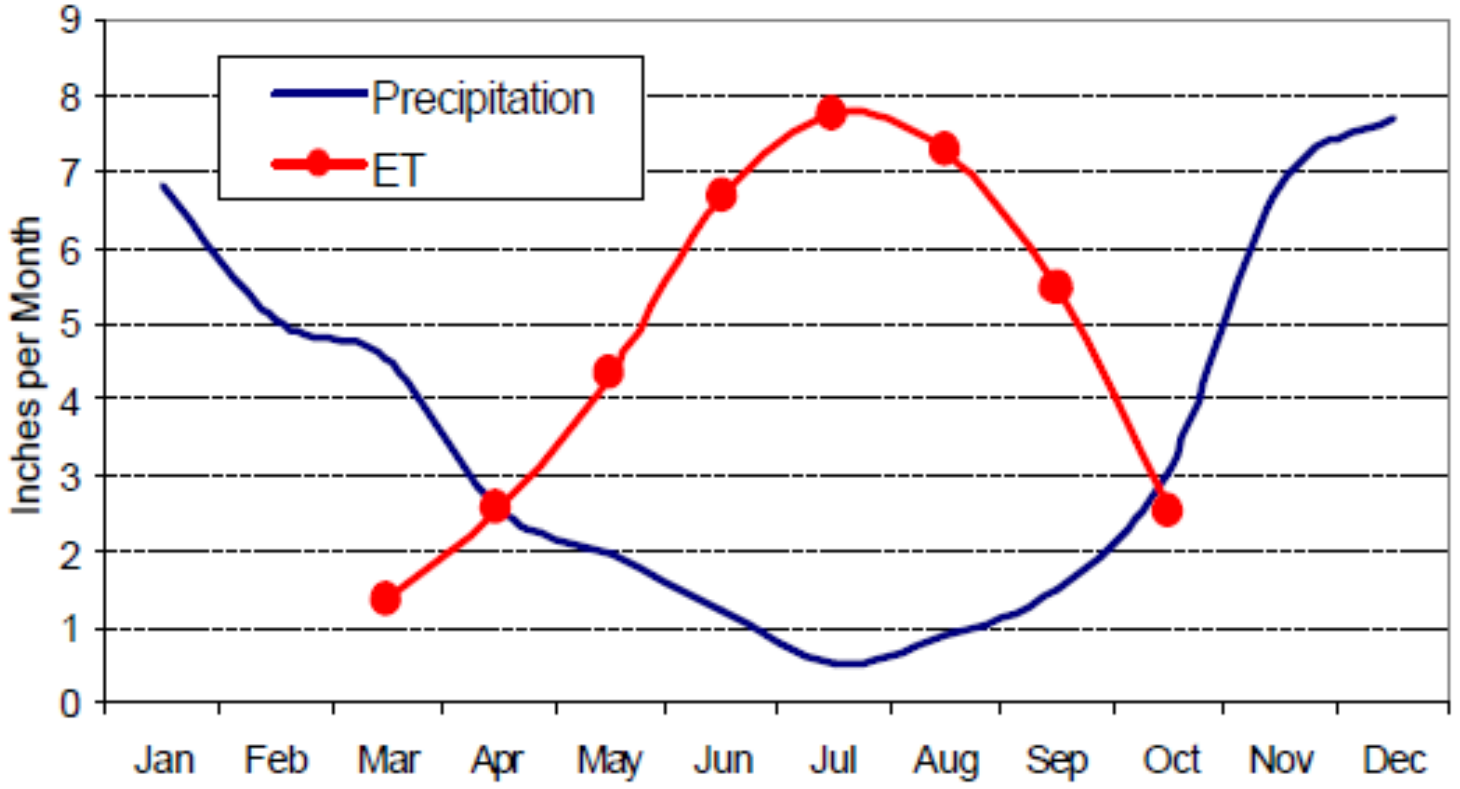
# Total available water

$$AW/inch \ x \ root\ depth \ x \ MAD$$

$$0.20 \frac{in}{in} \ x \ 18 \ in \ x \ 50\% = \ 1.8 \ in$$

*Your available water calculation will depend on your soil and crop.*

# Evapotranspiration (ET)




*Peak ET for blueberries = 0.25 in/day*

# Irrigation Schedule Worksheet: Blueberry

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

*Otherwise use Table 1 below.*

*Table 1*

| Soil Texture | AWC [in/in] |
|---|---|
| Sandy | 0.07 to 0.10 |
| Sandy Loam | 0.09 to 0.15 |
| Loam | 0.14 to 0.19 |
| Clay Loam | 0.17 to 0.22 |
| Clay | 0.20 to 0.25 |

## A. 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 shorter than e.*

*Table 2*

| Irrigation System | Uniformity Coefficient (*) | |
|---|---|---|
| Solid set | 70 | 63 |
| Hand move or Side-roll | 82 | 74 |
| Pivot or Linear Move | 90 | 81 |
| Offset Managed Handm | 90 | 81 |

## B. Determine Combined Efficiency

| | | |
|---|---|---|
| Uniformity Coefficient | *g.* | |
| Combined Efficiency | *h.* | |
| *h = (0.01583 * g) - 0.6327* | | |

## C. 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.* | | | | | | | |

## D. Determine Set Time

| | | |
|---|---|---|
| Application Rate [in/hr] | *k.* | |

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

| | | April | May | June | July | August | September |
|---|---|---|---|---|---|---|---|
| Irrigation Set Time [hrs] | *l.* | | | | | | |
| *l = j / k* | | | | | | | |

*Table 3*

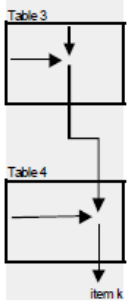
| Pressure [psi] | Discharge [gpm] Standard Tapered Nozzle Diameter [in] 3/32 | 1/8 | 9/64 | 5/32 | 11/64 | 3/16 | 13/64 | 7/32 |
|---|---|---|---|---|---|---|---|---|
| 35 | 1.5 | 2.7 | 3.40 | 4.16 | 5.02 | 5.97 | 7.08 | 8.26 |
| 40 | 1.6 | 2.9 | 3.63 | 4.45 | 5.37 | 6.41 | 7.60 | 8.87 |
| 45 | 1.7 | 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 |

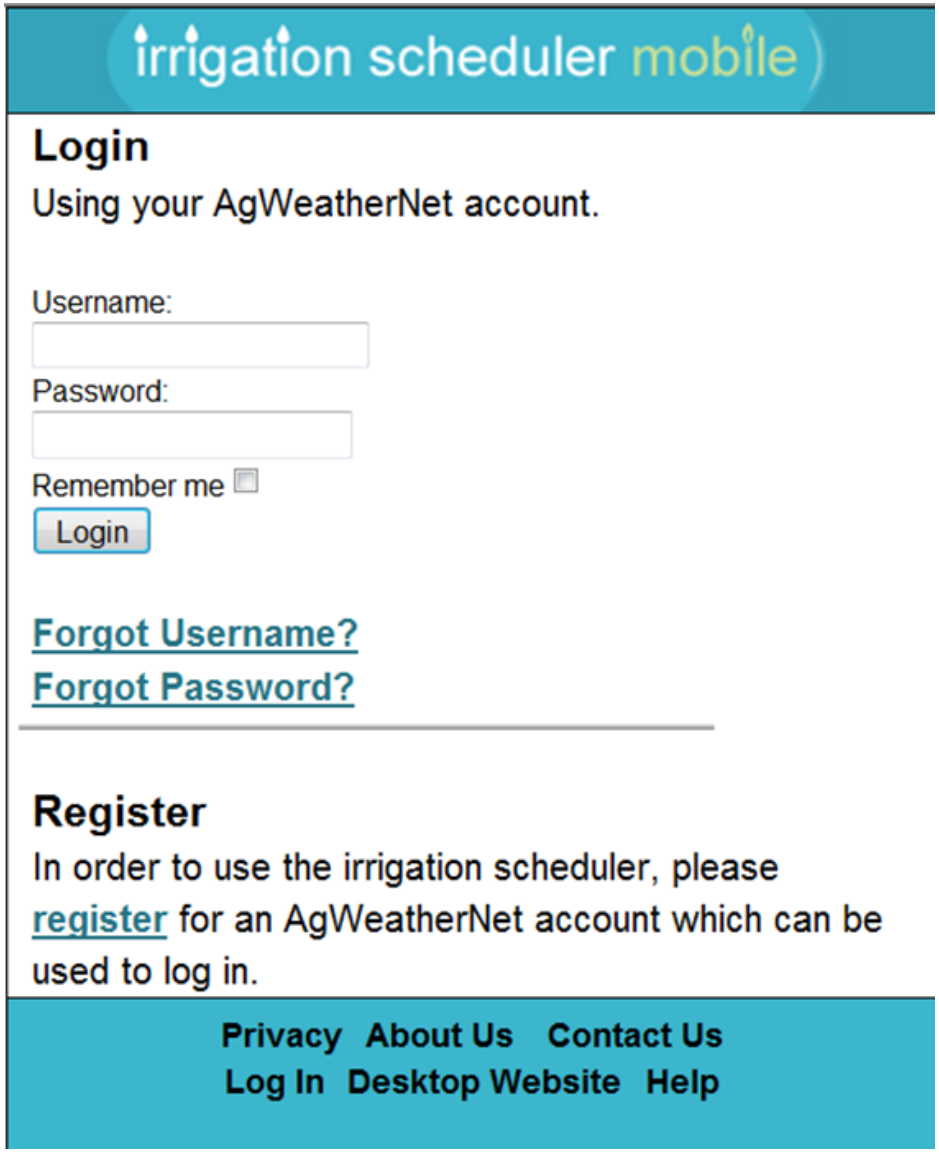
*Table 4*

| Sprinkler Spacing [ft] -by- [ft] | Application Rate [in/hr] Discharge per Nozzle [gpm] 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 |

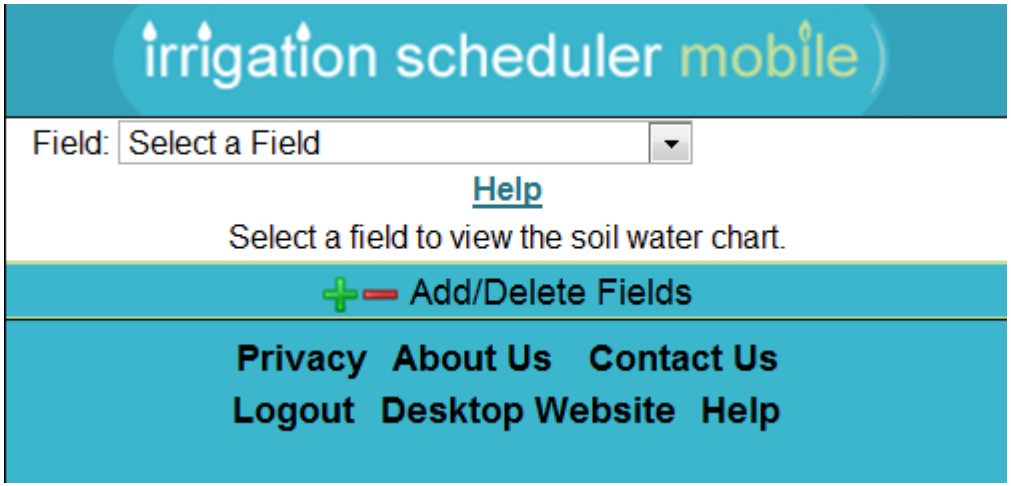
(*) If your sprinkler spacing/discharge combination falls into gray-shaded area, use uniformity coefficient from the right, also gray-shaded column. Otherwise use values from the left column.

How to use these tables:






http://weather.wsu.edu/ism/index.php?m=1


irrigation scheduler mobile
Field: Select a Field
Help
Select a field to view the soil water chart.
Add/Delete Fields
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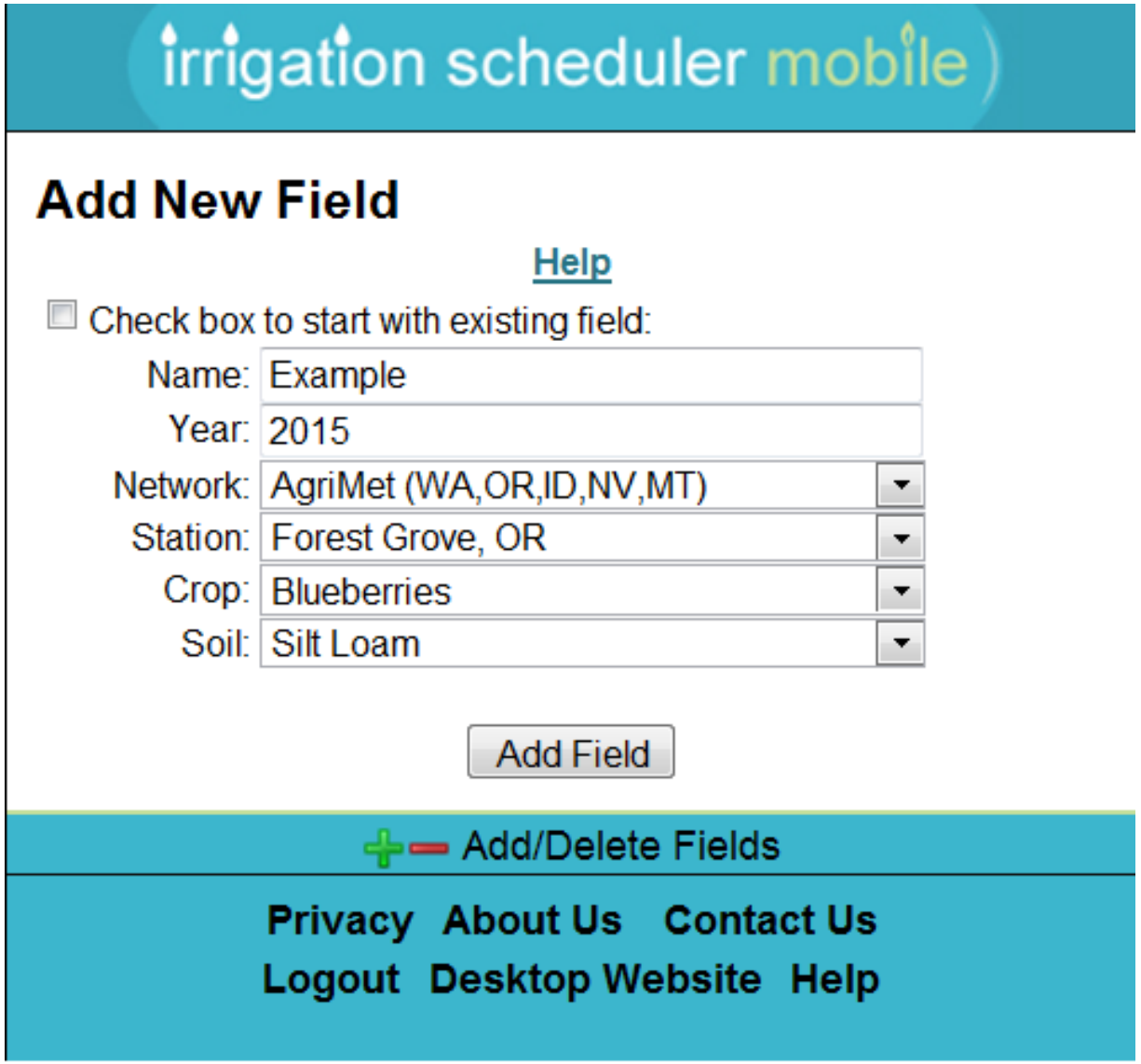
irrigation scheduler mobile
Add New Field
Help
Check box to start with existing field:
Name: Example
Year: 2015
Network: AgriMet (WA,OR,ID,NV,MT)
Station: Forest Grove, OR
Crop: Blueberries
Soil: Silt Loam
Add Field
Add/Delete Fields
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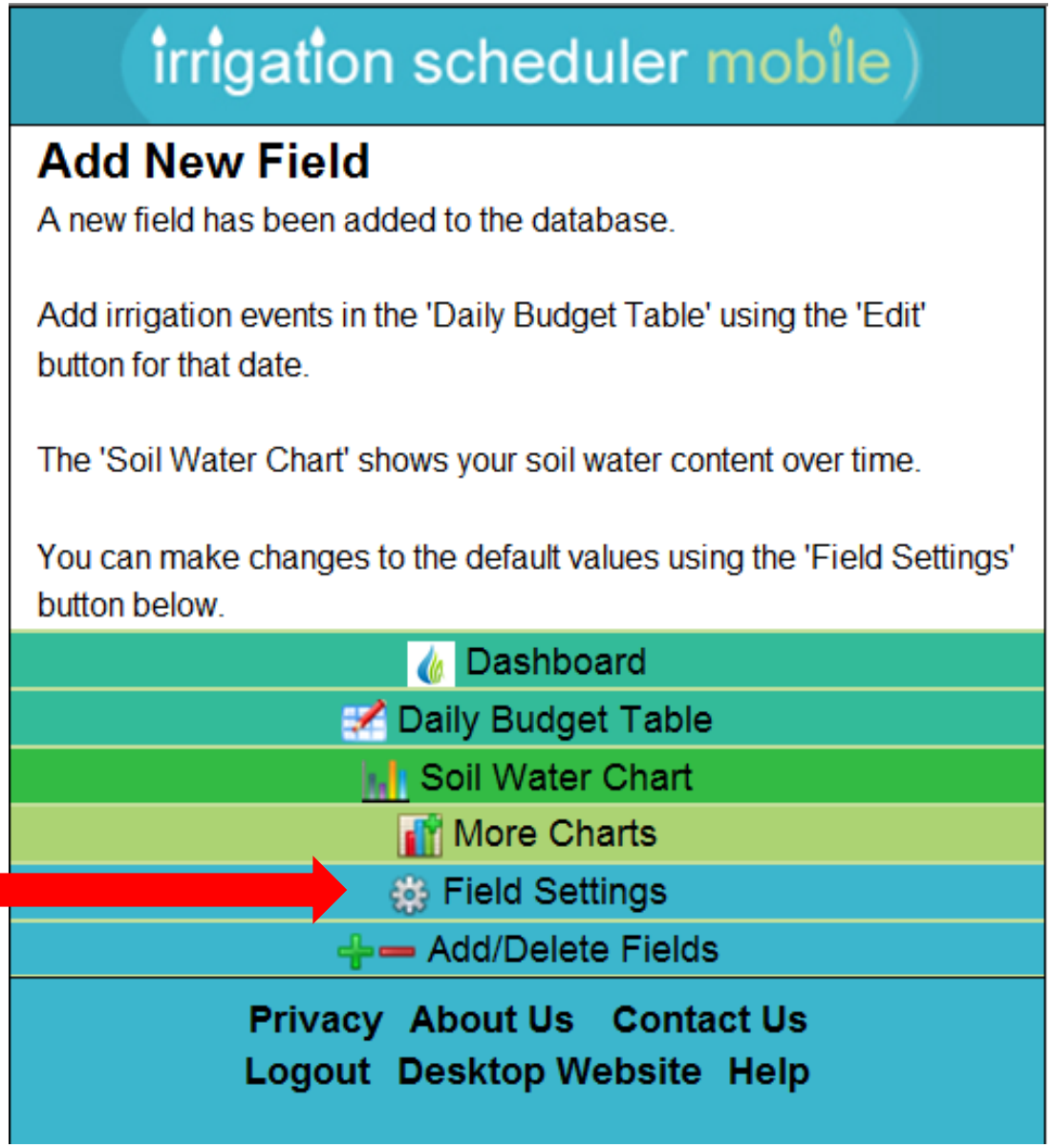
irrigation scheduler mobile
Add New Field
A new field has been added to the database.
Add irrigation events in the 'Daily Budget Table' using the 'Edit' button for that date.
The 'Soil Water Chart' shows your soil water content over time.
You can make changes to the default values using the 'Field Settings' button below.
Dashboard
Daily Budget Table
Soil Water Chart
More Charts
Field Settings
Add/Delete Fields
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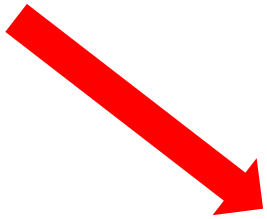
| | | |
|---|---|---|
| Root Depth on Start Date: | 36 | in |
| Maximum Managed Root Zone Depth: | 48 | in |

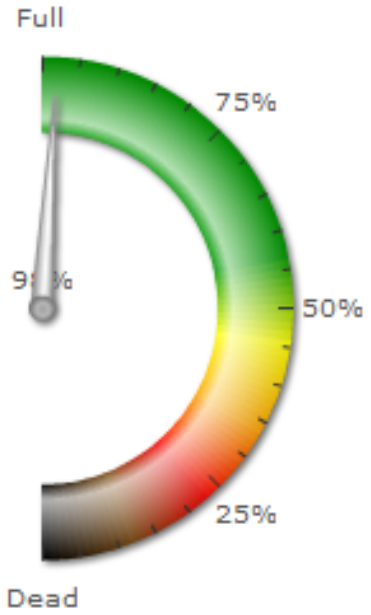


| | | |
|---|---|---|
| Root Depth on Start Date: | 18 | in |
| Maximum Managed Root Zone Depth: | 18 | in |

irrigation scheduler mobile

# Soil Water Dashboard

Field: Example, 2015; Blueberries




| This Morning's Soil Water | |
|---|---|
| Deficit: | 0 in. |
| Days Until Water Stress: | 31 |
| Today's Irrigation: | 0.00 in. |
| I Irrigated Today: | in. |

Save

Green is good. Crops increasingly stressed below green.

Dashboard

irrigation scheduler mobile

# 7-Day Daily Budget Table

Field: Example, 2015; Blueberries

Help

| Date | Water Use (in) | Rain & Irrig (in) | Avail. Water (%) | Water Deficit (in) | Edit Data |
|---|---|---|---|---|---|
| 03/27 | 0.03 | 0.00 | 99.3 | 0 | Edit |
| 03/28 | 0.03 | 0.01 | 98.8 | 0 | Edit |
| 03/29 | 0.03 | 0.00 | 98 | 0.1 | Edit |
| 03/30 | 0.03 | 0.00 | 97.2 | 0.1 | Edit |
| 03/31 | 0.02 | 0.16 | 100 | 0 | Edit |
| 04/01 | 0.02 | 0.09 | 100 | 0 | Edit |
| 04/02 | 0.03 | 0.00 | 99 | 0 | Edit |

|<< <<< Mar 27, 2015 Forecast

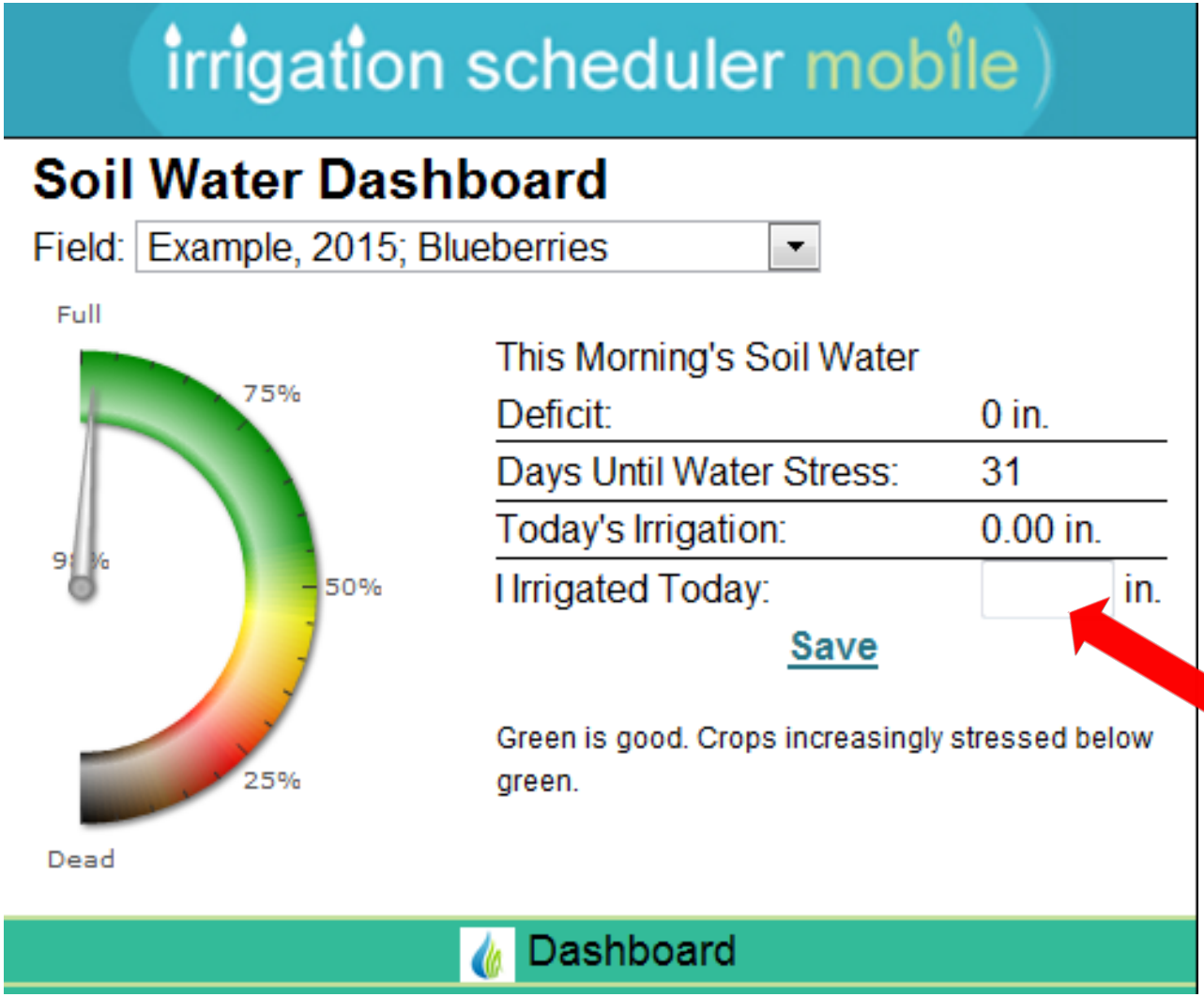
irrigation scheduler mobile

## 7-Day Daily Budget Table

Field: Example, 2015; Blueberries

Help

| Date | Water Use (in) | Rain & Irrig (in) | Avail. Water (%) | Water Deficit (in) | Edit Data |
|---|---|---|---|---|---|
| 04/03 | 0.04 | 0.00 | 97.8 | 0.1 | Edit |
| 04/04 | 0.04 | 0.00 | 96.7 | 0.1 | Edit |
| 04/05 | 0.05 | 0.00 | 95.4 | 0.2 | Edit |
| 04/06 | 0.06 | 0.00 | 93.8 | 0.2 | Edit |
| 04/07 | 0.07 | 0.00 | 91.8 | 0.3 | Edit |
| 04/08 | 0.07 | 0.00 | 89.7 | 0.4 | Edit |
| 04/09 | 0.07 | 0.00 | 89.7 | 0.4 | Edit |


irrigation scheduler mobile
Soil Water Dashboard
Field: Example, 2015; Blueberries
Full
75%
50%
25%
Dead
This Morning's Soil Water Deficit: 0 in.
Days Until Water Stress: 31
Today's Irrigation: 0.00 in.
I Irrigated Today: in.
Save
Green is good. Crops increasingly stressed below green.
Dashboard


http://irrigation.wsu.edu/index.php

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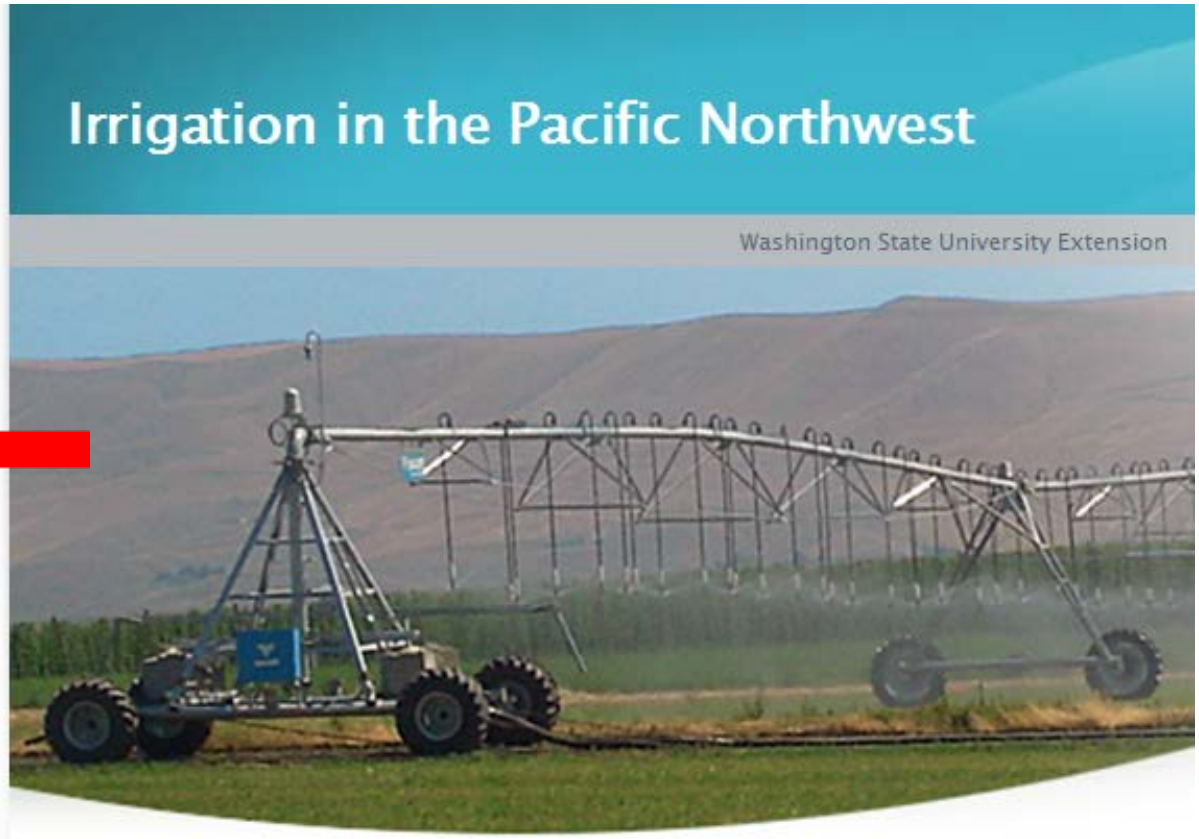


# Drip Line Rate

Use this form to calculate the water application rate of drip irrigation lines (tape, tubing) given the flow rate from individual emitters, the spacing of the emitters along the drip line, and the spacing between the drip lines.

Learn more about the units used on this page.

Emitter flow:

.53 gph

Emitter spacing along the line:

12 in

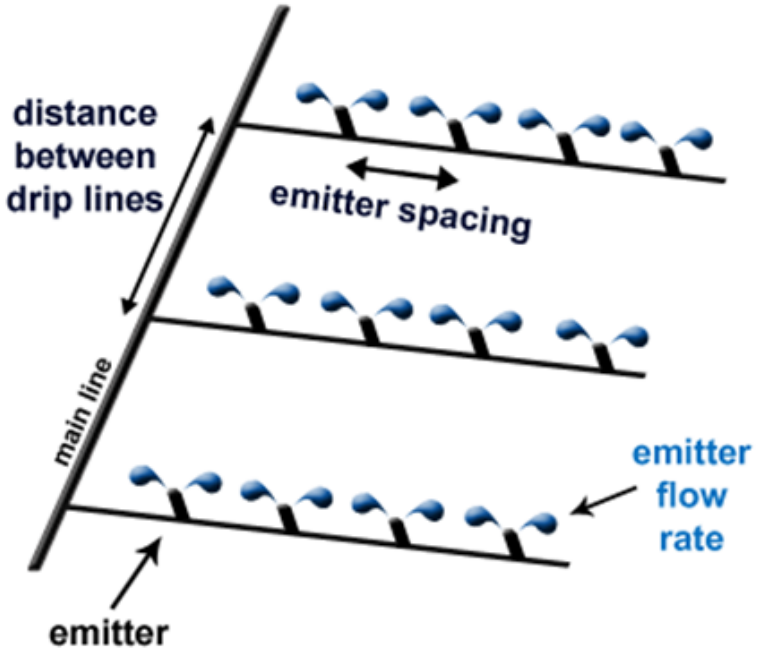
Distance between drip lines:

24 in

Calculate

Application Rate:

0.425 in/hr



# Nozzle Flow Rate and Effective Application Rate

Nozzle Diameter:

3 16ths in

Pressure:

50 psi

Head Spacing:

20 ft

Line Spacing:

40 ft

Sprinkler Efficiency:

70 %

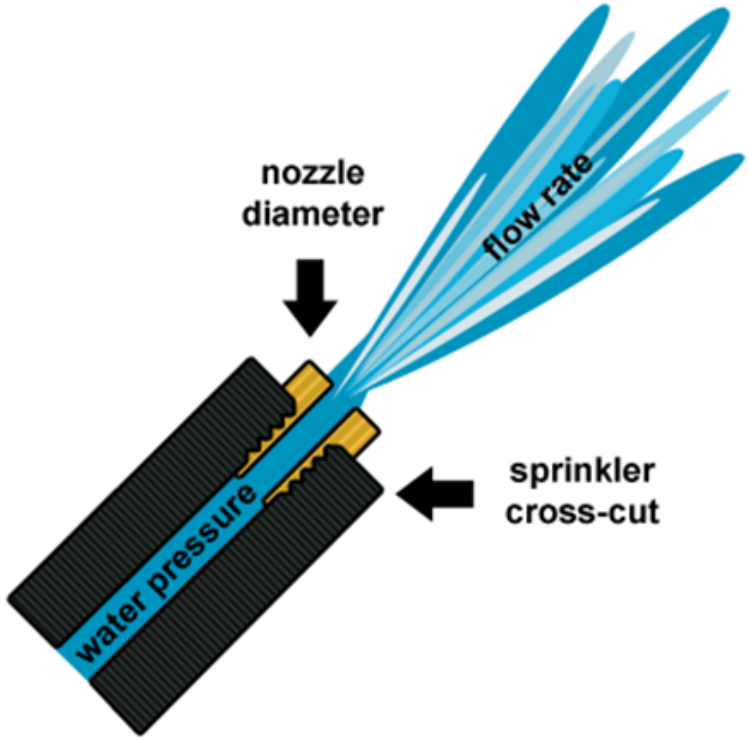
Calculate

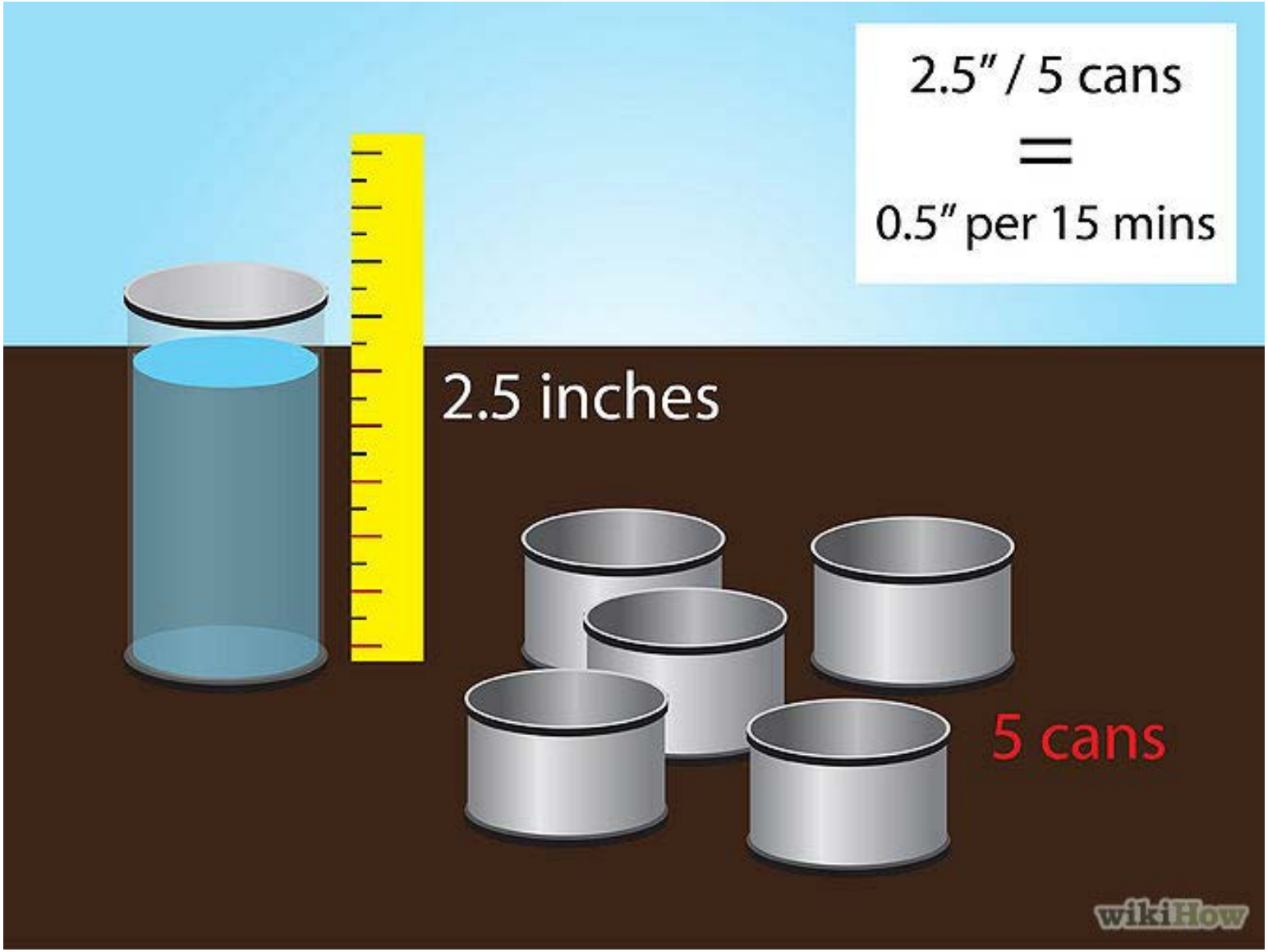
Nozzle Flow Rate:

7.19 gpm

Effective Application Rate:

0.606 in/hr




2.5" / 5 cans
=
0.5" per 15 mins
2.5 inches
5 cans
wikiHow

# Gadgets - atmometers

- *“Reverse rain gauge”*
- *Estimates ET*

# Gadgets - tensiometer

- *Measures true soil water tension*
- *Requires care, generally better for lighter soils that are kept fairly moist*

# Gadgets – granular matrix sensor

- *Simple*
- *Measures electrical conductivity and converts to tension estimate*

# Gadgets – volumetric

- *Volumetric data converts directly to inches water needed*
- *Higher cost*

# Gadgets – human hand

*25-50% AWC*

*50-75% AWC*

*75-100% AWC*

*Typical silt loam shown*

# Gadgets – variable frequency drives

- *Matches pump output (flow, pressure) to need.*
- *Saves energy.*
- *Only cost-effective in certain situations.*

# Staying legal

- *Water rights specify how you may irrigate:*
  - *Rate (gallons per minute)*
  - *Total amount (inches per year)*
  - *Dates*
- *See watermaster for help:*
  - *1400 SW Walnut St, Suite 240*
    *Hillsboro, Oregon 97123*

Vonnoh, *Coquelicots*

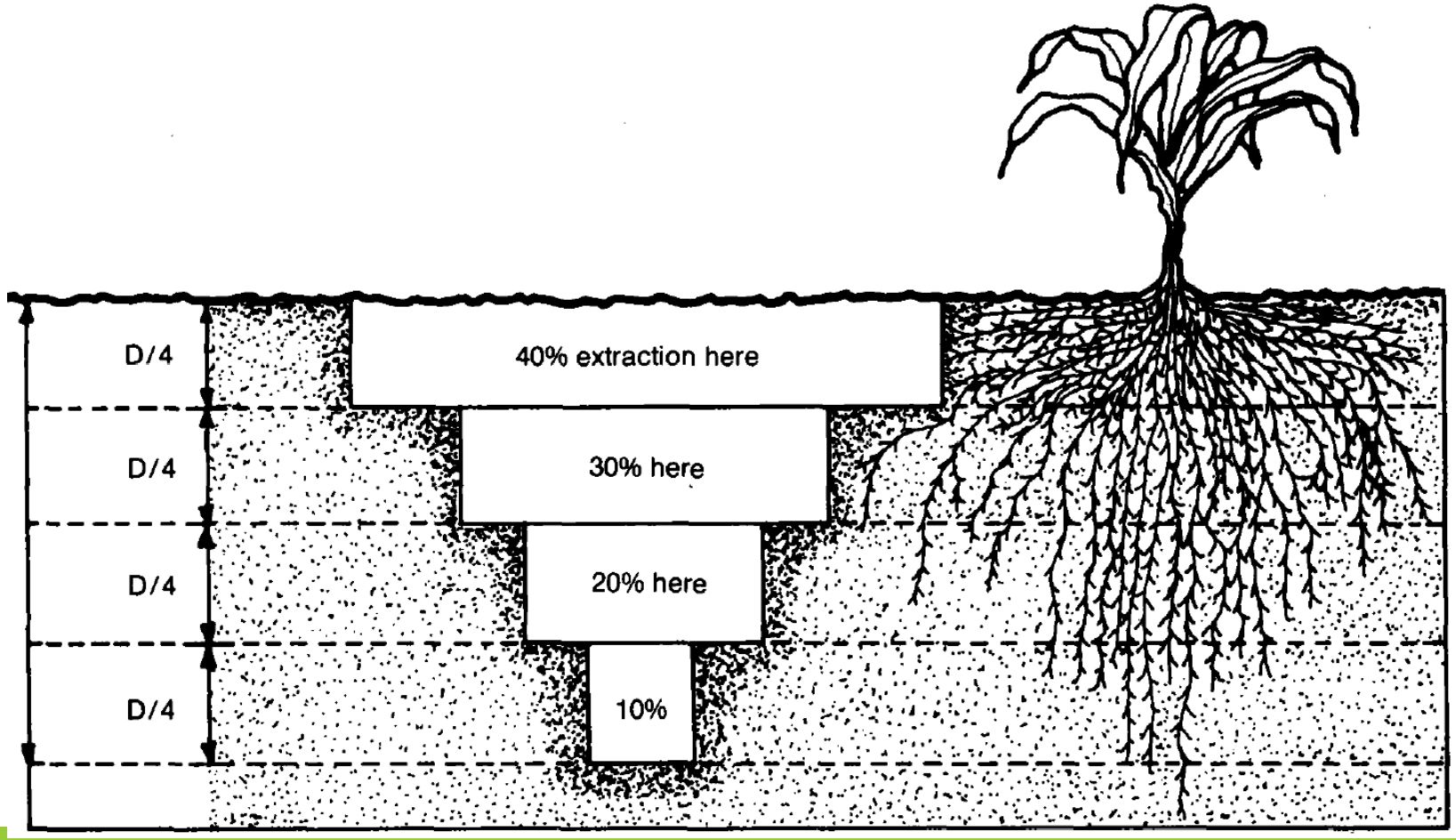
# And justice for all

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees and applicants for employment on the bases of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, or all or part of an individual's income is derived from any public assistance program, or protected genetic information in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

# Questions?


WAP WAP WAP
CALVIN! WHAT ARE YOU DOING TO THE COFFEE TABLE?!?
IS THIS SOME SORT OF TRICK QUESTION, OR WHAT?
WATTERSON

# Rooting depth




SCS, 1991