




Watering Systems for Home Gardens

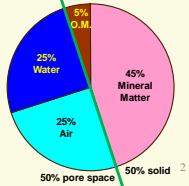
by
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for
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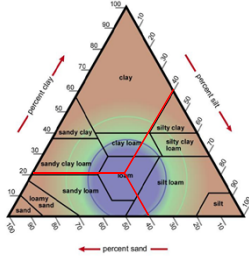
If you take care of your soil, the soil will take care of your plants.

- Plant available water depends on:
 - Soil structure & texture
 - Water infiltration rate
 - Soil organic matter
 - Soil type
 - Plant rooting depth



USDA Soil Texture Classes

- Particle size
 - Sand = 2.0-0.05 mm
 - Silt = 0.05-0.002 mm
 - Clay = <0.002 mm
- Characteristics
 - Sand adds porosity
 - Silt adds body to the soil
 - Clay adds chemical & physical properties



Determining Soil Texture

- By feel
 - Gritty, smooth, sticky
- Using the jar method
 - Fill a 1-quart jar ¼ full of soil
 - Fill the jar with water to ¾ full
 - Add 1 teaspoon of dishwashing detergent
 - Shake very well to suspend soil
 - Place on a flat surface and allow soil to settle for 2 days
 - Measure % thickness of each layer relative to all





Available Water Holding Capacity for Several Soil Types

Soil Texture	Available Water Holding Capacity	
	In Inches per Inch of Soil	In Inches per Foot of Soil
Loamy fine sand	0.08-0.12	0.96-1.44
Sandy loam	0.10-0.18	1.20-2.16
Loam	0.14-0.22	1.68-2.64
Silt loam	0.18-0.23	2.16-2.76
Clay loam	0.16-0.18	1.92-2.16

Reference: Midwest Vegetable Production Guide for Commercial Growers
<http://www.bny.purdue.edu/pubs/id/id-56/>

Checking Soil Drainage

- Perched water table
- Frigidon on upland soils
- Standing water after a rain



Benefits of Using Compost


- Improves drainage & aeration of heavy clay soils
- Increases moisture-holding ability of sandy soils
- Increases earthworm & soil microbial activity that benefit plant growth
- Improves soil structure & makes it easier to work
- Contains nutrients needed for plant growth



7

The Two Major Factors in Irrigation System Planning

1. How much water do you need?
2. How much time do you have?




8



Plants are 80-95% Water

- Water shortages early in crop development = delayed maturity & reduced yields
- Water shortages later in the growing season = quality often reduced, even if yields not hurt
- Short periods of 2-3 days of stress can hurt marketable yield
- Irrigation increases size & weight of individual fruit & helps prevent defects like toughness, strong flavor, poor tipfill & podfill, cracking, blossom-end rot and misshapen fruit

9

Basic Watering Facts

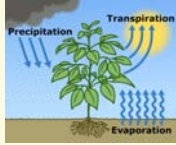
- Plants need 1"-1.5" of water per week
 - 624-935 gallons (83-125 cu.ft.) per 1,000 sq.ft.
- Can survive drought on half that rate
- Deep infrequent waterings are better than several light waterings
- Deeper roots require less supplemental irrigation
- Taller plants have deeper roots
 - Lowers tendency to wilt
 - Shades soil surface
 - Controls weeds by competition
 - Makes water "go farther"

10

Evapotranspiration (ET)

- Rate of water loss changes as plant grows and sets fruit
- Peak water use is during bloom, fruit set and ripening
- Factors that affect ET
 - Season
 - Temperature, wind, relative humidity
 - Type of crop or vegetation cover
 - Soil moisture content
 - Mulches and ground covers



11

Vegetable Crops & Growth Period Most Critical for Irrigation Requirements

Crop ¹	Most Critical Period
Broccoli, Cabbage, Cauliflower, Lettuce	Head development
Carrot, Radish, Beet, Turnip	Root enlargement
Sweet Corn	Silking, tasseling, and ear development
Cucumber, Eggplant, Pepper, Melon, Tomato	Flowering, fruit set, and maturation
Bean, Pea	Flowering, fruit set, and development
Onion	Bulb development
Potato	Tuber set and enlargement

¹ For transplants, transplanting & stand establishment represent a most critical period for adequate water.

Reference: irrigationtraining.tamu.edu/docs/irrigation-training/south/crop-guidelines/estimatedwaterrequirementsvegetablecrops.pdf

12

Soil Properties

- Soils store 1.5"-2.5" of water per foot of depth (check county NRCS Soil Survey)*
- Intake rate = 0.2" 2.0" per hour, rest is runoff
- Plant Available Water ** = % of soil water between field capacity & permanent wilting point = ranges by crop from 25% to 75%
- Summer E.T. rate can be 0.25"+ per day
 - E.T. affected by radiation, humidity, air temperature, wind speed
- A 2-ft. deep soil at best holds a 9-15 day supply of available moisture for plants

References: * websoilssurvey.nrcs.usda.gov/app/ ** www.ces.ncsu.edu/depts/hort/hil/hil-33-e.html

13

Is a Rain Barrel Enough?

- 1" of rain from a 1,600 sq. ft. house roof = 1,000 gallons
- Elevation dictates pressure
 - 2.3 feet of head = 1 psi pressure





14

Low-Budget Options?

- What is your time worth?
- What is your mechanical expertise?

\$129 for 15' dia. x 3' = 3,300 gallons




Photo credit: www.walmart.com

An Automatic Back Scratcher


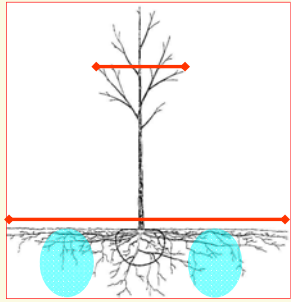


Photo credit: http://thackermot.com

15

Watering Mature Trees and Shrubs


- Most roots in top 12" of soil
- Root spread up to 4X tree crown spread
 - Varies by tree species
- Saturate 20% of root zone 12" deep



16

Bucket & Jug Irrigation


- Labor-intensive
- Efficient water use
- Point-source application
- 0-2 psi system operating pressure
- Rates:
 - 2 GPH = 5/64" hole (put in bottom of bucket)
 - 5 GPH = 1/8" hole



17

How Much Water for Trees?



- Gallons needed for 1" water per week = $\frac{\text{Diameter} \times \text{Diameter}}{2}$
- Example #1: $\frac{6 \text{ ft.} \times 6 \text{ ft.}}{2} = 18 \text{ gal./wk.}$
- Example #2: $\frac{20 \text{ ft.} \times 20 \text{ ft.}}{2} = 200 \text{ gal./wk.}$



Formula: (Dia.' x Dia.' x 0.7854 ÷ 43,560 sq.ft./ac.) x 27,154 gal./ac.-in.)

18

Watering Trees

Soaker hose around drip line of tree

"Gender bender" to improve uniformity of water flow

19

Plant Water Requirements

(Estimated design rates for southwest Missouri)

Vegetable Crop (mature)	Gallons per 100 Feet of Row per Week
Minimum for plant survival	100
Lettuce, spinach, onions, carrots, radishes, beets	200
Green beans, peas, kale	250
Tomatoes, cabbage, peppers, potatoes, asparagus, pole beans	300
Corn, squash, cucumbers, pumpkins, melons	400-600

20

Plant Water Requirements


(Design rates for southwest Missouri assuming no effective rainfall for >60 days.)

Fruit Crop	Plant x Row Spacing, Ft.	Sq.Ft./ Plant	Plants/ Acre	Gal./Plant/Day Gal./Acre/Day
Apples	6 x 14	84	518	8 4144
	18 x 26	468	93	42 3906
Peaches	15 x 20	300	145	28 4060
	18 x 20	360	121	34 4114
Grapes	8 x 10	80	540	10 5440
	8 x 16	128	340	16 5440
Blueberries	4 x 12	48	908	4 3632

21

Sprinkler Irrigation



- 1.5-8.5 GPM flow rate
- 5-7 GPM water supply/acre for irrigation
- 45-60 GPM/acre for frost control from 25°F-20°F.
- 25-45 psi system operating pressure
- Equipment & labor tradeoff
- Cost = \$800 - \$1,000/acre



22

Overhead Irrigation Use


- Apply water at rate to avoid puddling and runoff
- Water early morning (4 a.m. to 8 a.m.)
 - Less evaporation loss (no sun, calmer winds)
 - Knocks dew and guttation fluid off leaf blades
 - Lets plant leaves dry before evening to discourage fungal growth and infection

23

Drip Irrigation 1

- 0.5-2.0 GPH flow rate per emitter
- 2-5 GPM/acre for water supply
- Point use gives less runoff, less evaporation, easier weed control, saves 30%-50% water
- Low pressure of 6-20 psi means smaller pumps & pipes
- Can fertilize through system
- Do field work while irrigating

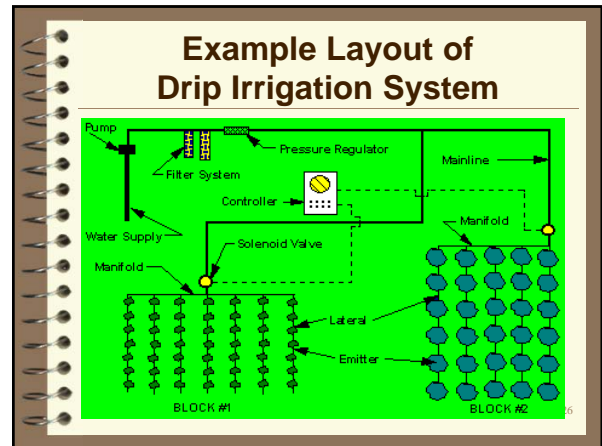


24

Drip Irrigation 2

- > Can automatically control
- > Susceptible to clogging
- > Must design system to carefully match equipment to elevation
 - 2.3 feet of head = 1 psi pressure
- > Requires diligent management
- > Cost = \$1,200 - \$1,500 for 1st acre; \$900 - \$1,100/acre for rest

25



Drip Irrigation Components

This slide displays several key components of a drip irrigation system:

- Vacuum Breaker**: Prevents backflow of water.
- Backflow Preventer**: Prevents contaminated water from entering the system.
- Filter**: Removes debris and sediment from the water.
- Pressure Regulator**: Maintains consistent pressure throughout the system.
- Manifold to Drip Tape Connectors**: Connect the mainline manifold to individual drip tapes.
- Manifold Pipe**: The main distribution line for the system.
- Drip Tape**: The final line that delivers water directly to the plant roots.

27

Line Source Drip Tape

- > Wall thickness = 6, 8, 10, 15-mil; 1-2 year life
- > Surface or sub-surface installation
- > Emitters manufactured within the tape wall
 - Common spacing = 4", 8", 12", 16" 18" 24"
 - Max. operating pressure
 - = 6-mil @ 10 psi
 - = 8-mil @ 12 psi
 - = 10-mil @ 14 psi
 - = 15-mil @ 25 psi
- > More animal damage outdoors

26

Hours Required to Apply 1" of Water to Mulched Raised Bed

Drip Tube Flow Rate		Width of Mulched Bed		
Gallons per Hour per 100 feet run of drip tape	Gallons per Minute per 100 feet run of drip tape	2 feet	2.5 feet	3 feet
16	0.27	8.0	10.0	11.5
18	0.30	7.0	8.5	10.5
20	0.33	6.0	8.0	9.5
24	0.40	5.0	6.5	8.0
30	0.50	4.0	5.0	6.0
36	0.60	3.5	4.5	5.0
40	0.67	3.0	4.0	4.5
42	0.70	3.0	4.0	4.5
48	0.80	2.5	3.0	4.0

28

Water Source Quality

↑ **Good**
↓ **Poor**



- > Well = check pH & hardness
- > Municipal = may be expensive
- > Spring = may not be dependable
- > River or stream = depends on runoff
- > Lake or pond water = sand filters
- > Pump to tank on hill = limited use

30

Water Quality Analysis

- > Inorganic solids = sand, silt
- > Organic solids = algae, bacteria, slime
- > Dissolved solids (<500 ppm)
 - Iron & Manganese
 - Sulfates & Chlorides
 - Carbonates (calcium)
- > pH (5.8-6.8 preferred)
- > Hardness (<150 ppm)
- > E. coli bacteria

Resources:
soil@landlab.missouri.edu/soil/water.aspx
https://utextension.tennessee.edu/publications/Documents/SP740-B.pdf





PVC Casing Steel Casing

Home Garden Drip Irrigation



Laterals & Emitters



Split water flow for low-use plants

Roll up & store laterals at end of season

33

Home Garden Drip Irrigation

Supply, pressure regulator & filter



Home Garden Drip Irrigation

Layout & Connect



Home Garden Drip Irrigation

Push barbed valve into hole





Design Considerations 1

- Water supply capacity
- Source of power
- Hours of operation per day
- Field size, shape & elevation
 - 2.31 feet elevation change = 1 psi pressure change
 - Design for +/- 10% or less flow variation
- Plant spacing
- Row spacing

Friction Loss Design

- Size piping for 1 psi or less pressure loss per 100 feet
 - Pipe diameter x 2 = 4X flow rate
- Pipe friction may replace pressure regulators on downhill runs
- Vary flowrate no more than 20% (+/- 10%) within each block of plants
- Manifolds attached to mainline...
 - at center if < 3% slope
 - at high point if 3+% slope

Plastic Pipe Friction Loss

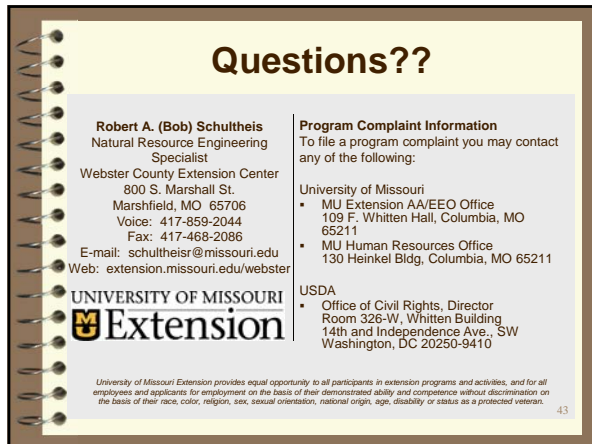
GPM	Pipe Diameter, inches			
	0.75"	1"	1.5"	2"
5	2.8	0.8	0.1	--
10	11.3	3.0	0.4	0.1
15	21.6	6.4	0.8	0.2
20	37.8	10.9	1.3	0.4
25	--	16.7	1.9	0.6
30	--	--	2.7	0.8

Calculating Irrigation Water Needs


- 1" of water = 27,154 gallons per acre
- 1 acre = 43,560 sq. ft.
- 0.25"/day pan evaporation rate = 1.75"/week
- Formula for 1.5" of water per week:
 - Gallons/100 ft. of row/day = (66 x 80% of Pan Evaporation Rate x Row width in feet)
- Example: 10 rows 100 ft. long x 2 ft. wide
 - GPD/100 ft. = (66 x 0.25 x .80 x 2) = 26.4 gallons
 - Gallons per day = 26.4 x 10 plant rows = **264 gallons per day = 1,848 gallons per week**
 - 264 GPD ÷ (30 GPH/100 ft. drip tape) x 10 rows = **0.88 hours/day = 53 minutes/day**

Irrigation Resources on the Web

- Irrigation System Planning & Management Links
extension.missouri.edu/webster/irrigation.aspx
- USDA NRCS Web Soil Survey
websoilsurvey.sc.egov.usda.gov/App/



Questions??

<p>Robert A. (Bob) Schultheis Natural Resource Engineering Specialist Webster County Extension Center 800 S. Marshall St. Marshfield, MO 65706 Voice: 417-859-2044 Fax: 417-468-2086 E-mail: schultheisr@missouri.edu Web: extension.missouri.edu/webster</p> <p>UNIVERSITY OF MISSOURI  Extension</p> <p><small>University of Missouri Extension provides equal opportunity to all participants in extension programs and activities, and for all employees and applicants for employment on the basis of their demonstrated ability and competence without discrimination on the basis of their race, color, religion, sex, sexual orientation, national origin, age, disability or status as a protected veteran.</small></p>	<p>Program Complaint Information To file a program complaint you may contact any of the following:</p> <p>University of Missouri</p> <ul style="list-style-type: none">▪ MU Extension AA/EEO Office 109 F. Whitten Hall, Columbia, MO 65211▪ MU Human Resources Office 130 Heinkel Bldg, Columbia, MO 65211 <p>USDA</p> <ul style="list-style-type: none">▪ Office of Civil Rights, Director Room 326-W, Whitten Building 14th and Independence Ave., SW Washington, DC 20250-9410
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43