

Irrigation FACTSHEET



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IRRIGATION PARAMETERS FOR EFFICIENT SYSTEM OPERATION

Efficient irrigation can be described as applying the crop's water needs, as required, to sustain optimum growth and production at the lowest capital and operating cost possible. Efficient irrigation is obtained by correctly designing and operating the irrigation system to match water, crop and soil management limitations. To ensure proper design and operation of an irrigation system, the following three parameters should be calculated.

Maximum Soil Water Deficit

Maximum soil water deficit (MSWD) is the maximum moisture that can be removed from the soil before irrigation is again required. The soil type and depth and crop rooting depths must be determined to calculate MSWD. Often a soil observation hole must be dug to adequately determine the changing soil textures.

Table 1 indicates the maximum effective rooting depth that can be developed by various crops. These rooting depths should be obtained providing good soil and moisture conditions are present and impermeable boundary layers do not exist.

Table 2 provides values on the available water storage capacities (AWSC) of various soils. The AWSC is the amount of water that can be stored in the soil against the force of gravity. As the soil texture becomes finer, more water can be stored.

Plants are capable of extracting only a portion of the water from the soil before being stressed. To obtain optimum production, the soil regime should be replenished before undue stress occurs. Table 3 indicates the maximum percentage that should be removed before irrigation is again required.

Example 1:

What is the maximum soil water deficit of a mature tree fruit crop growing in 2 ft. of sand underlain by 3 ft of sandy loam?

Table 1 Effective rooting depth = 4 ft

Table 2

A.W.S.C. = 2 ft sand @ 1.0 in/ft	= 2.0 in
2 ft sandy loam	
@ 1.5 in/ft	= <u>3.0 in</u>
TOTAL	<u>5.0 in</u>

Table 3 Availability coefficient = 40%

M.S.W.D. = 5.0 in x 0.40 = 2.0 in

Note that the AWSC is calculated to the rooting depth of the crop. If a boundary layer or soil conditions reduce the rooting depth, the AWSC must be calculated accordingly.

Table 1**Effective Rooting Depth of Mature Crops**

<u>Shallow</u> 1.5 ft	<u>Medium Shallow</u> 2 ft	<u>Medium Deep</u> 3 ft	<u>Deep</u> 4 ft
Cabbages	Beans	Brussels Sprouts	Alfalfa
Cauliflowers	Beets	Cereals	Asparagus
Clover (Ladino)	Blueberries	Clover (Red)	Blackberries
Cucumbers	Broccoli	Corn (sweet)	Corn
Lettuce	Carrots	Eggplant	Grapes
Onions	Celery	Kiwifruit	Loganberries
Pasture	Potatoes	Peppers	Raspberries
Grasses	Peas	Squash	Sugar Beets
Radishes	Strawberries		Tree Fruits
Turnips	Tomatoes		

Table 2**Guide to Available Water Storage Capacities of Soils**

<u>Textural Class</u>	<u>Available Water Storage Capacity in Inches of Water per Foot of Soil</u>
Sand	1.0
Loamy Sand	1.2
Sandy Loam	1.5
Fine Sandy Loam	1.7
Loam	2.1
Silt Loam	2.5
Clay Loam	2.4
Clay	2.4
Organic Soils (muck)	3.0

Table 3**Availability Coefficient to Determine Plant Water Use Capabilities**

<u>Crop</u>	<u>Maximum Percent (%)</u>
Peas	35
Potatoes	35
Tree Fruits	40
Grapes	40
Tomatoes	40
Other crops until additional data becomes available	50

Application Rate

To ensure that the irrigation system applies water to the soil in an efficient manner, the maximum application rate must be determined. Table 4 provides data on the maximum design application rates for irrigation systems on various soils and ground cover. Exceeding these values may cause puddling, soil compaction and runoff. Irrigation system efficiency will then decrease. Sprinkler irrigation system efficiencies are usually considered to be 72 – 75% with good management while a trickle irrigation system may be 90%.

The gross amount to be applied will therefore be:

$$\frac{\text{MSWD}}{\text{application Efficiency}}$$

for this example, it will be:

$$\frac{2.0 \text{ in}}{0.72} = 2.8 \text{ inches}$$

<u>Textural Class</u>	<u>Grass Sod (in/hr)</u>	<u>Cultivated (in/hr)</u>
Sand	0.75	0.40
Loamy Sand	0.65	0.35
Sandy Loam	0.45	0.25
Fine Sandy Loam	0.40	0.25
Loam	0.35	0.20
Silt Loam	0.35	0.20
Clay Loam	0.30	0.15
Clay	0.25	0.10
Organic Soils (muck)	0.50	0.50

Maximum Irrigation Interval

The maximum irrigation interval is the maximum number of days, during peak conditions, that the crop can maintain optimum growth between

irrigations if the soil regime has been filled to capacity. The maximum irrigation interval can be calculated by:

$$\text{Interval} = \frac{\text{MSWD}}{\text{Peak E.T. rate}}$$

The peak E.T. rate can be obtained from tables provided in the agriculture irrigation design manual. The maximum irrigation interval for the example cited in this note at a peak E.T. rate of 0.20 in/day would be:

$$\text{Maximum interval} = \frac{2.0 \text{ in}}{0.20 \text{ in/day}} = 10 \text{ days}$$

Calculating MSWD, maximum application rate and maximum irrigation interval will allow an irrigation system manager to:

- Check to ensure that the correct amount of water is applied. Sprinkler nozzles, spacing, pressures and set times should be checked to ensure that the soil can store the amount of water applied.
- Ensure that the application rate does not exceed the soil capability.

Application rate can be calculated by:

$$\text{A.R.} = \frac{\text{gpm (U.S.)} \times 96.3}{S_1 \times S_2}$$

Where the application rate is in inches/hr and the sprinkler spacings (S_1 and S_2) are in feet.

- Provide a guide to the maximum irrigation interval during peak conditions.

The irrigation system manager can use the above values in making scheduling decisions. The use of soil moisture monitoring devices should be used in conjunction with the above irrigation design and operation parameters in making a decision when to start on a new irrigation interval. Additional information is available from other factsheets and the agriculture irrigation system design manual.

The sprinkler irrigation design information sheet on the back can be used to calculate the design and operation parameters.

SPRINKLER IRRIGATION DESIGN INFORMATION

Soils Report

	PIT A		PIT B		PIT C	
Crop	_____		_____		_____	
Root Depth (in)	_____		_____		_____	
Soil Depth (in)	Texture	AWSC (in/ft)	Texture	AWSC (in/ft)	Texture	AWSC (in/ft)
0 – 12	_____	_____	_____	_____	_____	_____
12 – 24	_____	_____	_____	_____	_____	_____
24 – 36	_____	_____	_____	_____	_____	_____
36 – 48	_____	_____	_____	_____	_____	_____
Total AWSC (in)	_____		_____		_____	
Max Applic. Rate (A.R.) (in/hr)	_____		_____		_____	

Design Parameters

Crop _____
 Root Depth..... _____ ft
 Soil type..... _____
 Total available water storage capacity (AWSC) _____ in
 Usable amount of water (_____ % AWSC) _____ in
 Maximum application rate (AR) _____ in/hr
 Evapotranspiration rate (ET)..... _____ in/day
 Water source (gpm available)..... _____ gpm

Design Data

Interval _____ days
 Set Time..... _____ hours
 Gross applied per irrigation _____ in
 Net applied @ _____ % efficiency..... _____ in
 Application rate _____ in/hr
 Spacing _____ 'x _____'
 Nozzle..... _____ x _____
 Pressure at the nozzle _____ psi
 Gallons per minute per nozzle _____ gpm

FOR FURTHER INFORMATION, CONTACT:

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