Water Conservation
FACTSHEET

BRITISH COLUMBIA
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DEVELOPING A SPRINKLER IRRIGATION SCHEDULE USING SITE PARAMETERS

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 develop an effective irrigation schedule that is appropriate for the irrigation system and crops being grown, the following **four** parameters should be calculated.

1 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 (RD) 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 (RD) 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 availability coefficients for various crops, that is, the maximum percentage of moisture that should be removed from the soil before irrigation is again required.

Example :

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

Table 1 Effective rooting depth (RD) = 4 ft

Table 2

AWSC = 2 ft sand @ 1.0 in/ft = 2.0 in
= 2 ft sandy loam @ 1.5 in/ft = 3.0 in
TOTAL AWSC = 5.0 in

Table 3 Availability coefficient = 50%

MSWD = 5.0 in x 0.50
= 2.5 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 (RD) of Mature Crops			
Shallow 1.5 ft	**Medium Shallow 2 ft**	**Medium Deep 3 ft**	**Deep 4 ft**
Cabbages	Beans	Brussels Sprouts	Alfalfa
Cauliflowers	Beets	Cereals	Asparagus
Clover (Ladino)	Blueberries	Clover (Red)	Blackberries
Cucumbers	Broccoli	Corn (sweet)	Corn (field))
Lettuce	Carrots	Eggplant	Grapes
Onions	Celery	Kiwifruit	Loganberries
Pasture	Peas	Peppers	Raspberries
Radishes	Potatoes	Squash	Sugar Beets
Turnips	Strawberries	Saskatoons	Tree Fruits (12' x 18')
	Tomatoes	Tree Fruits (6' x 13')	
	Tree Fruits (3' x 10')		

Table 2 Available Water Storage Capacities (AWSC) of Soils	
Textural Class	**AWSC [in/ft]**
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 Coefficients (AC) of Crops	
Crop	**Maximum Percent [%]**
Peas	35
Potatoes	35
Tree Fruits	40
Grapes	40
Tomatoes	40
Other crops until additional data becomes available	50

Table 4 Maximum Design Application Rates		
Textural Class	**Grass Sod [in/hr]**	**Cultivated [in/hr]**
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

2 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. In this example, the application rates are:

sand = 0.75 in/hr
sandy loam = **0.45 in/hr**

The maximum application rate will be the lower infiltration value of the soil types present, that is, 0.45 in/hr in this example.

The application rate can be calculated by using the following equation:

$$A.R. = \frac{US\ gpm \times 96.3}{S_1 \times S_2}$$

where the application rate is in inches/hour and the sprinkler spacings (S_1 and S_2) are in feet. For this example,

$$A.R. = \frac{7.5\ USgpm \times 96.3}{40\ ft \times 60\ ft} = 0.30\ inches/hr$$

The application rate can also be determined from the nozzle specification tables in the B.C. Sprinkler Irrigation Manual, Irrigation System Assessment Guide, or the B.C. Irrigation Management Guide by knowing the nozzle size, nozzle pressure, nozzle flow rate and sprinkler spacing.

3 Gross and Net Amount Applied

The set time is the time required to apply the designed depth of water in one location. Therefore, the gross amount applied will be:

$$Gross\ Amt\ Applied = Application\ Rate \times Set\ Time$$

for this example, it will be:

$$0.3\ inches/hr \times 11.5\ hr = 3.5\ inches$$

Sprinkler irrigation system efficiencies are usually considered to be 72 – 75% with good management while a trickle irrigation system may be 90%. The net amount to be applied will therefore be:

$$Net\ Amt\ Applied = Gross\ Amt\ Applied \times Application\ Efficiency$$

for this example, it will be:

$$3.5\ inches \times 72\% = 2.5\ inches$$

4 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:

$$Interval = \frac{MSWD}{Peak\ ET\ Rate}$$

The peak ET rate can be obtained from tables provided in the B.C. Sprinkler Irrigation Manual. The maximum irrigation interval for the example cited in this note at a peak ET rate of 0.20 in/day would be:

$$Maximum\ Interval = \frac{2.5\ in}{0.20\ in/day} = 12.5\ days$$

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.
- 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 operational parameters in making a decision on when to start a new irrigation interval. Additional information is available from other factsheets and the B.C. Sprinkler Irrigation Manual.

In the example on this factsheet, the maximum set time is chosen to be 11.5 hr. The application rate required to apply 3.5 inches of irrigation over 11.5 hour is 0.30 in/hr. The field needs to be irrigate every 12.5 days. A blank version of this information sheet is provided at the back as working copies.

Sample Sprinkler Irrigation System Schedule

Crop and Soil Report

	PIT A	
Crop	Alfalfa	
Root Depth [ft]	4	
Soil Depth [in]	**Texture**	**AWSC [in/ft]**
0 – 12	Sand	1.0
12 – 24	Sand	1.0
24 – 36	Sandy Loam	1.5
36 – 48	Sandy Loam	1.5
Total AWSC [in]		5.0
Max. Application Rate (AR) [in/hr]		0.45

Design Parameters

	FIELD/BLOCK 1	
Crop	Alfalfa	
Root Depth	4	ft
Soil Type	Sandy Loam	
Total Available Water Storage Capacity (AWSC)	5.0	in
Maximum Soil Water Deficit (MSWD = 50 % AWSC)	2.5	in
Maximum Application Rate (AR)	0.45	in/hr
Evapotranspiration Rate (ET)	0.20	in/day

Design Data

Nozzle Size	11/64 " x 3/32 "	
Pressure at the Nozzle	45	psi
Gallons per Minute per Nozzle	7.5	gpm
Spacing (S_1 x S_2)	40 ' x 60 '	
Application Rate (AR)	0.30	in/hr
Set Time	11.5	hr
Gross Amount Applied per Irrigation	3.5	in
Net Amount Applied per Irrigation @ 72 % Efficiency	2.5	in
Interval	12.5	days

SPRINKLER IRRIGATION SYSTEM SCHEDULE

Farm Name: _____
Farmer's Name: _____
Date: _____
Water Source Flow Rate: _____ gpm

Schedule Developed by:

_____ Name _____ Signature

☐ Registered Environmental Farm Plan Planning Advisor

☐ Certified Irrigation Designer

Crop and Soil Report

	PIT A		PIT B		PIT C	
Crop						
Root Depth [ft]						
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. Application Rate (AR) [in/hr]						

Design Parameters	FIELD/BLOCK 1	FIELD/BLOCK 2	FIELD/BLOCK 3	FIELD/BLOCK 4
Crop				
Root Depth	ft	ft	ft	ft
Soil Type				
Total Available Water Storage Capacity (AWSC)	in	in	in	in
Maximum Soil Water Deficit (MSWD = _____% AWSC)	in	in	in	in
Maximum Application Rate (AR)	in/hr	in/hr	in/hr	in/hr
Evapotranspiration Rate (ET)	in/day	in/day	in/day	in/day
Design Data				
Nozzle Size	" x "	" x "	" x "	" x "
Pressure at the Nozzle	psi	psi	psi	psi
Gallons per Minute per Nozzle	gpm	gpm	gpm	gpm
Spacing (S_1 x S_2)	' x '	' x '	' x '	' x '
Application Rate (AR)	in/hr	in/hr	in/hr	in/hr
Set Time	hr	hr	hr	hr
Gross Amount Applied per Irrigation	in	in	in	in
Net Amount Applied per Irrigation @ _____% Efficiency	in	in	in	in
Interval	days	days	days	days

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