DROUGHT ADVISORY

EM4822

Irrigation System Evaluation

Scientific irrigation scheduling is a tool that tells a grower when to irrigate and how much water to apply. This information is based on estimates of crop water use and routine monitoring of soil moisture condition in the field.

Another important factor is knowing the capacity of your irrigation system, or, how much water your irrigation system is capable of applying in a given time period. Generally, this requires an evaluation of the irrigation system to determine the gross application rate and any losses or nonuniformities which might be occurring during application. The entire irrigation system should be in the best shape possible to achieve maximum uniformity and efficiency.

A simple relationship can be used for any irrigation system to determine the gross amount of water being applied. This relationship states that the gross depth applied is equal to the flow rate of water in the irrigation system, multiplied by the total irrigation time, and divided by the area being irrigated.

$$\text{inches applied} = \frac{(\text{gpm}) \times (\text{hrs of irrigation})}{453 \times \text{acres irrigated}}$$

Or:

$$\text{inches applied} = \frac{(\text{gpm}) \times (\text{hrs of irrigation}) \times 96.3}{\text{square feet irrigated}}$$

Or:

$$\text{inches applied} = \frac{(\text{cfs}) \times (\text{hrs of irrigation})}{\text{acres irrigated}}$$

It is easy to measure the application time and the area irrigated. To measure the flow rate of water in the irrigation system requires some means of water measurement.

Most irrigatin district farm delivery gates are equipped with some type of water measurement device, such as a weir box. A common type of weir used is the Cipolleti Weir, which is trapezoidal-shaped, has a horizontal bladelike crest and outward sloping sides. A measurement of the water depth of flow over the weir, or the "number of points," can be translated easily into a rate of flow measurement and used in one of the above formulas.

A 3x5 pocket card, C0912, *Determining the Gross Amount of Water Applied—Surface Irrigation*, gives this conversion in table form for different size weir blades. Once a flow rate is determined in this way, an estimate of the gross depth applied to a given field area can be found, assuming all the water going over the weir blade is going to that field.

A water meter is suggested for water measurement in pressurized sprinkler and drip irrigation systems. Water meters are available which give reliable readings of the rate of flow in the pipeline, measure cumulative volume of flow, or both. These must be carefully installed in straight sections of pipe. There can be no fittings, valves, etc., within a minimum pipe length upstream and downstream of the water meter equivalent to a distance of 6 times the pipe diameter. Screen all debris out of the water to keep it from stopping the meter.

A simple 5-gallon bucket (or some other container of known volume) can be used to measure the flow rates of individual sprinklers. EB1305, *Sprinkler Irrigation Application Rates and Depths*, gives a procedure for making measurements on wheel-line, hand-line, and solid set sprinkler systems to evaluate gross water application rates and amounts. To obtain an accurate estimate of the overall average water application rate (or depth), measure several sprinklers throughout the system and determine an average.

Drip or trickle irrigation systems can be evaluated in a similar manner. Use a graduated cylinder or measuring cup and measure the time it takes to

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catch a certain volume of water from each of several emitters throughout a system. This average system emitter flow rate can be balanced with the individual plant water requirements and the number of emitters per plant to determine the irrigation schedule.

Irrigation systems do not apply water with 100% uniformity or at 100% efficiency. Losses which occur include deep percolation of water below the expected maximum rooting depth of the crop, surface runoff, evaporation, and wind drift. These losses must be evaluated for each irrigation system. Also, they can vary from one irrigation to the next. For instance, under cool, moist conditions (such as in the spring), sprinkle irrigation efficiencies will be near maximum. On the other hand, under hot, dry and windy (mid-summer) conditions, sprinkle irrigation efficiencies will be much lower. Average irrigation application efficiencies for different irrigation systems follow.

Multiply the gross irrigation depth by the decimal value of the efficiency to estimate the net irrigation depth. This net depth is the estimated amount of water which ends up in the plant root zone and is available for the plant to use.

Sprinkle systems:	
Center pivot	75% to 85%
Solid set	65% to 75%
Wheel-line	60% to 70%
Hand-line	60% to 70%
Big gun/traveller	55% to 65%
Micro-irrigation systems:	
Drip	85% to 90%
Micro-sprinklers	75% to 85%
Surface/gravity systems:	
Rill	45% to 60%
Rill with tailwater re-use on the same field	70% to 85%
Surge flow	60% to 70%
Surge flow with tailwater re-use on the same field	75% to 90%

Uniformity of irrigation is a measure of the evenness of the application. As higher uniformity of application is achieved, variation in the depths applied at different points in the field differ less from the average depth. This can be an important factor, particularly for high value crops, where small variations in irrigation uniformity can cause declines in crop quality or problems with pests.

Uniformity is generally measured using grids or lines of catch containers under sprinkle systems, by extensive monitoring of soil moisture from the head to the tail end of the run for rill irrigation, or by measuring emitter flow rates at several points in a drip system. An irrigation system with good uniformity of application saves water, because it allows you to avoid overirrigating parts of the field while concentrating on putting adequate water on dry or other problem areas.

An evaluation of your irrigation system will provide the necessary information for scientific irrigation scheduling. It will also tell you if you are experiencing excessive application losses (that is, runoff, deep percolation, wind drift) or if your irrigation system needs service or improvement to increase application uniformity. The goal of system evaluation is to determine how much water is being applied and where it is going. The end result is water savings. Stated in a slightly different context, evaluating and improving your system will help to stretch available water further. Operate irrigation systems near their design limits to achieve peak efficiencies and uniformities.

Information on soil moisture monitoring and crop evapotranspiration from Washington's Public Agricultural Weather Stations (PAWS) and Washington Irrigation Scheduling Expert (WISE) are available on the Scientific Irrigation Scheduling (SIS): web page http://sis.prosser.wsu.edu

Drought advisories and other Washington State University Cooperative Extension Bulletins are available online at http://pubs.wsu.edu
Type "drought" in the search box for downloadable files.

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