The Washington Irrigator Newsletter

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WASHINGTON PRODUCERS IMPLEMENT IRRIGATION SCHEDULING

In the July 1997 issue of the Washington Irrigator Newsletter, a survey of scientific irrigation scheduling practices was included. Of those receiving the newsletter, 199 surveys were returned by Washington irrigators. representing 105,000 acres of Washington's 2,120,000 irrigated acres.

1997 IRRIGATION SCHEDULING SURVEY OF WASHINGTON STATE PRODUCERS

- 199 Surveys Returned
- 105,000 Acres out of 2,120,000 Irrigated Acres in Washington

Scientific irrigation scheduling (SIS) is defined as the use of both soil moisture sensors and crop evapotranspiration (ET) data to determine when and how much to irrigate. According to this definition, SIS is being practiced on 77% of the reported acreage.

SELF-IMPLEMENTED SCIENTIFIC IRRIGATION SCHEDULING

	by acreage
Use ET and Soil Sensors	77%
Professional Scheduling Service	14%

This high percentage is probably not representative of the entire state because those who practice SIS are more likely to return a survey than those who are not as interested in SIS. However, professional consultants were only responsible for implementing SIS on 14% of the survey acreage. Therefore, the survey represents the perspectives and practices of irrigators who implement SIS on their own.

Most SIS is being implemented with center pivot irrigation (77%). Furrow, set-move sprinklers, solid-set sprinklers, and drip are each less than 10% of the SIS acreage. However, solid-set sprinklers and drip systems only account for 10% and 4% of the irrigated acres in Washington, respectively. Therefore, irrigation of solid-set and drip systems is being scheduled at a higher rate than furrow and set-move sprinklers systems that account for 24% and 38% of Washington's irrigated acres, respectively.

IRRIGATION SYSTEMS USED IN IRRIGATION SCHEDULING

	Furrow	Set Move	Solid Set	Pivot	Drip
Irrigation Systems being Scheduled in Survey	7%	10%	9%	71%	3%
Irrigation Systems in Washington	24%	38%	10%	24%	4%

The farm size of survey respondents varied from 2 to 24,000 acres. It was assumed that a producer with 24,000 acres would have a different perspective on irrigation scheduling than one with 2 acres. Therefore, the survey data was split into two groups: producers with more than 1,000 acres (large) and those with less than 1,000 acres (small).

FARM SIZE MAKES A DIFFERENCE

	# Surveved	Total Acreage	Average Acreage
SMALL under 1000 ac.	182	26,852	147
LARGE over 1000 ac.	17	77,973	4589

Both large and small operators reported high utilization of the feel/appearance method (above 79% by acreage) to determine the status of soil moisture. As for sensors, both groups were most likely to use a neutron probe and least likely to use Time Domain Reflectometry (TDR). However, the rate of sensor utilization was much greater in the large farm group. As an example, the neutron probe was being used on 80% of the acreage in the large farm group and on only 20% of the acreage on smaller farms. Private companies are presently marketing many new soil moisture sensors and the types of sensors used in Washington may change drastically.

SOIL MOISTURE MONITORING

by acreage	*small*	*large*
Hand/Feel	79.1%	94.4%
Neutron Probe	19.8%	80.5%
Tensiometers	13.5%	41.0%
Gravimetric	9.0%	33.0%
Moisture Blocks	3.1%	1.5%
TDR	0.0%	1.5%

Crop evapotranspiration (ET) is another important tool in Scientific Irrigation Scheduling. Again, large farms reported greater use of ET information than the smaller farms, 90% versus 35% by acreage, and the sources of ET were also quite different. The small farm group predominantly used nearby weather stations, daily newspapers, and on-site evaporation pans, while the large farms used ET from computer software, nearby weather stations, and on-site weather stations.

EVAPOTRANSPIRATION

by acreage	*35% small*	*89% large*
On-site Weather Station	2.2%	29.2%
Nearby Weather Station	20.2%	60.5%
Historical on Computer	2.6%	72.6%
On-site Evap. Pan	6.8%	0.0%
Daily Newspaper	12.1%	4.0%

Finally, computers help producers implement irrigation by providing access to crop ET, processing soil moisture readings, and forecasting operation times for irrigation systems. The survey revealed that 77% of the small operators owned computers but only 3% used them to schedule irrigation. On the large farms, 94% owned computers and 47% were used for SIS. In both groups over 50% had modem connections.

COMPUTERS ON-FARM

by survey	*small*	*large*
Used to Schedule Irrig.	3%	47.1%
Own a Computer	77%	94.1%
Connected to Modem	50.8%	52.9%

There are three main conclusions: 1) a significant number of Washington producers are implementing SIS on their own, 2) large farming operations are making SIS a standard practice, and 3) a majority of producers have the infrastructure for computer based irrigation scheduling but most are not using their computers for this purpose.

Washington State University is supporting SIS for self-implementers through the Public Agriculture Weather System (PAWS) and the Washington Irrigation Scheduling Expert software (WISE to be released for the 1999 growing season).

Brian G. Leib, WSU - Extension Irrigation Specialist

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The Northwest Energy Efficiency Alliance is a non-profit group of electric utilities, state governments, public interest groups and industry representatives committed to bringing affordable, energy-efficient products and services to the marketplace.

NORTHWEST ENERGY EFFICIENCY ALLIANCE

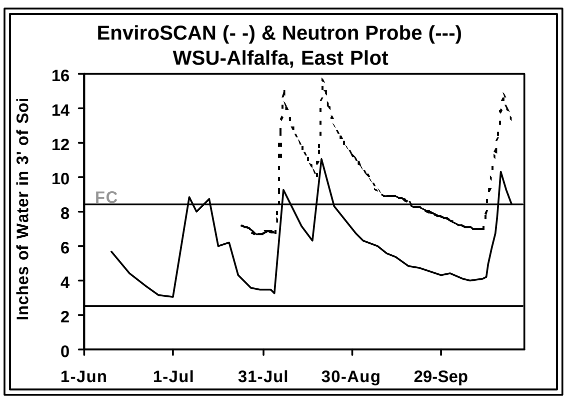
"*TIME*" TO COMPARE SOIL MOISTURE SENSORS

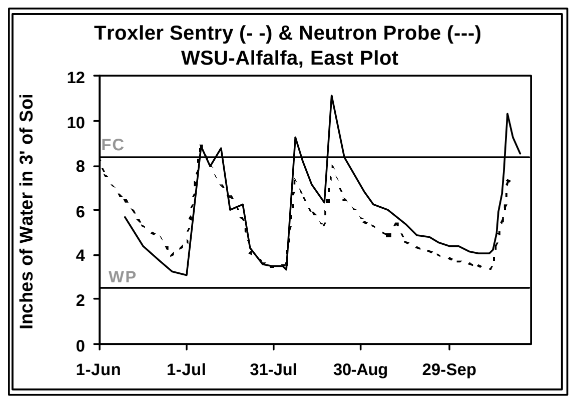
Speaking of time, I am reminded of a proverb that states, "*A man with two watches never knows what time it is.*" I felt much the same way as I compared eight different soil moisture sensors during the 1998 growing season. First of all, the sensors provide output in different units: centibars, inches per foot, and percent by volume. Even the sensors that use similar units rarely give the same reading. Most often, scientists strive for absolute accuracy, but I wanted to know whether relative accuracy was sufficient for irrigation scheduling. In other words, do the measured changes in soil moisture match the expected changes caused by crop water use and irrigation regardless of whether sensor readings are identical or not?

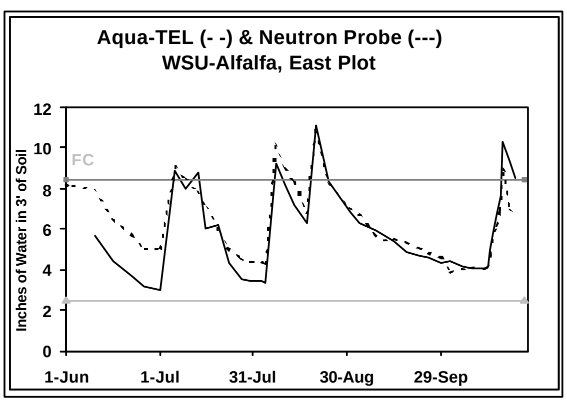
The sensors used in this trial are all being marketed and supported by companies working in Washington. The neutron probe, tensiometers and watermarks are fairly common to irrigation scheduling. However, there are many new instruments coming to the market that measure the capacitance/dielectric constant of the soil. These include EnviroScan, Troxler Sentry, AquaTel and AquaFlex.

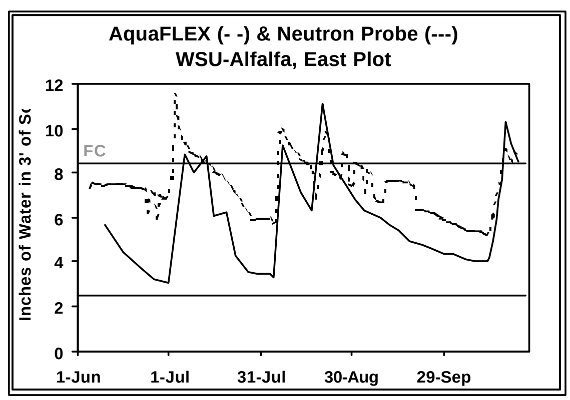
The sensors were installed in two alfalfa plots of Warden silt loam at the WSU-Prosser Research Station. In order for results to be similar to what an irrigator would encounter in the field, no special effort was made to calibrate the sensors to this location. The companies' calibration procedures were followed or the companies' calibration curves were utilized.

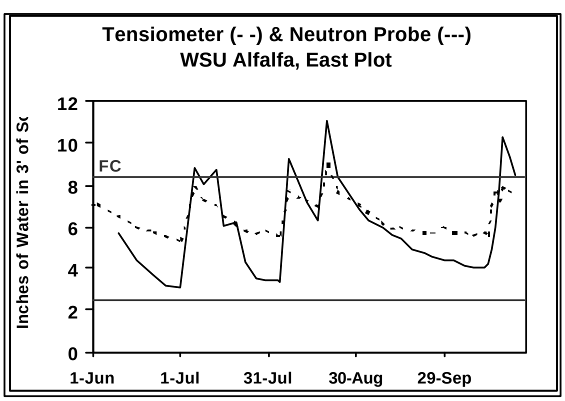
The sensor measurements are graphed below and similar trends between sensors are obvious. The alfalfa plots were irrigated four times and these peaks are very distinct. Three deep valleys are also very distinct indicating when the alfalfa was allowed to dry out over several weeks. The neutron probe data (calibrated to gravimetric samples) was graphed with individual sensors to facilitate comparison. Only the graphs of the east plot are included due to space limitations.

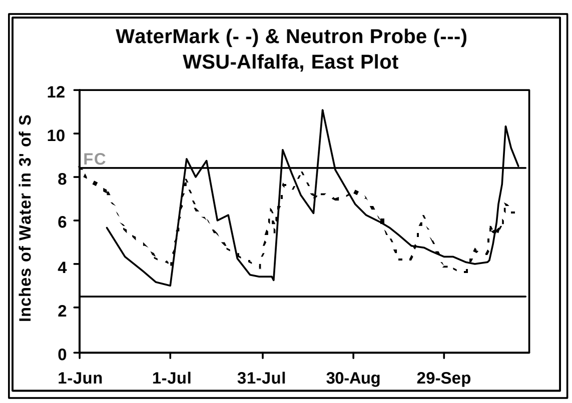












For each sensor, soil moisture measurements were recorded before and after irrigation and the change in soil moisture was divided by the amount of water caught in the rain gages to calculate an Irrigation Ratio shown in the first column of Table 1. In almost every case, the Irrigation Ratio was less than 1.0 which means that the measured increase in soil moisture was less than the amount of water applied. This discrepancy could be partly due to water evaporating off soil and plant surfaces before entering the soil.

In between irrigation events, alfalfa evapotranspiration (ET) was estimated from a nearby Public Agriculture Weather System (PAWS) station while declining soil moisture was being measured twice per week. This drop in soil moisture was divided by PAWS ET to calculate an ET Ratio. The average ET Ratio for each sensor is shown in the second column of Table 1. Most of the ET Ratios are less than 1.0 similar to the Irrigation Ratios. Perhaps PAWS is slightly over estimating alfalfa ET while some of the sensors are under estimating ET.

Finally, each sensor was correlated against the neutron probe. Correlation values (R square) are shown in column 3 of Table 1. As the correlation value gets closer to 1.0, a sensor has more potential to be recalibrated to match the neutron probe results.

Table 1: RELATIVE ACCURACY OF SOIL MOISTURE SENSORS

	IRRIG. RATIO	PAWS ET RATIO	Correlatation Value
NEUTRON PROBE – EAST	0.86	0.86	1
WEST	0.78	0.87	1
ENVIROSCAN - EAST	1.13	1.14	0.97
WEST	0.88	0.94	0.96
TROXLER SENTRY - EAST	0.58	0.67	0.82
WEST	0.57	0.63	0.82
AQUATEL - EAST	0.71	0.81	0.79
WEST	0.45	0.43	0.65
AQUAFLEX - EAST	0.77	0.45	0.71
WEST	0.38	0.23	0.65
TENSIOMETER - EAST	0.4	0.42	0.86
WEST	0.39	0.34	0.68
WATERMARK - EAST	0.28	0.59	0.52
WEST	0.1	0.6	0.12

Soil moisture sensors that have an Irrigation Ratio, PAWS ET Ratio, and Correlation near 1.0 have relative accuracy and could possibly have a high degree of absolute accuracy. These sensors could be used in a predictive type of irrigation scheduling to determine when and how much to irrigate via direct measurement.

However, all of the sensors (as calibrated during the trial) followed soil moisture trends in a fairly stable manner and they could be useful in a reactive type of irrigation scheduling where the sensor acts as a marker i.e. start irrigation when a sensor reaches a certain mark and stop irrigating at another mark. In this scenario, soil moisture does not have to be quantified and experience in reacting to the sensors is the key factor. Most of the sensors correlate with the neutron probe and site calibration would improve their accuracy.

In addition to sensor accuracy, the costs in capitol, labor, training, maintenance, data availability, and crop compatibility should be weighed against the benefits of conserving water, saving energy, increasing yield, improving yield quality, and reducing non-point pollution. Whichever sensor you chose, *time* must be invested to become proficient with a new tool. Soil moisture sensors will continue to be tested by Washington State University via financial support from the Northwest Energy Efficiency Alliance

Brian G. Leib, WSU - Extension Irrigation Specialist

SIS PROGRAM 1998

The 1998 growing season had five scientific irrigation scheduling (SIS) cooperators representing 706 acres. The variety of crops grown were grain corn, sweet corn, apples (assorted), hops, matuwa grass and alfalfa. The irrigation systems used were center pivot, solid set, and drip.

The intent and purpose of the program is to familiarize the irrigator with SIS methods and procedures so that they may become self sufficient with SIS practices.

The program involves soil moisture reports (involving PAWS or WISE) that indicate present soil moisture levels and forecast recommended future irrigation.

The reports also indicate change in soil moisture and depletion from one sampling to the next. This allows a chronological view of soil moisture over the season and reflects irrigation practices.

This familiarization gives the irrigator some insight into the direction and choices one has toward implementing SIS, either themselves or contracting the service through one of many providers.

Gary R. Matthews, WSU - SIS Technician

CHEMIGATION AND FERTIGATION: REGULATION AND PRACTICE

The greatest challenge with any business is to drop old business practices and apply new and creative approaches. As Will Rogers once said, "Even if you're on the right track, you'll get run over if you just sit there."

Agricultural producers are well recognized for their application of Will Roger's common sense philosophy to their farm operations. To more effectively utilize resources already in place and to realize greater efficiency from production inputs, producers are giving greater consideration to the time proven practice of applying agricultural chemicals by injection into irrigation water. The placement of a pesticide or fertilizer into an irrigation delivery system is known, respectively, as chemigation and fertigation. As a management practice, chemigation and fertigation are not new, neither are the federal and state rules that govern their use.

Witnessing the increased use of irrigation systems to apply pesticide products, the concern expressed by regulatory agencies for the potential of groundwater and surface water contamination was a logical, predictable outcome. Thus, on June 5, 1980, the U.S. Congress authorized the United States Environmental Protection Agency (USEPA) to initiate what is now known as the Label Improvement Program (LIP). With congressional authorization, the USEPA required registrants of pesticide products to "upgrade, improve or revise" labels to comply with current labeling standards by no later than April 30, 1988. In effect, pesticide registrants were compelled to include information in their labeling on the safe and effective use of their product as a requisite for a chemigation use provision.

USEPA regulations governing the application of pesticides through irrigation systems were subsequently set forth in PR Notice 87-1, which became effective in March of 1987. Washington state's Chemigation Law and Fertigation Law are based upon this notice. The additional use requirements of the Notice apply to ANY pesticide product applied through ANY type of irrigation system. The provisions of PR Notice 87-1 extend beyond agricultural use to include nurseries, turf farms, golf courses, and greenhouses.

Federal pesticide laws do not regulate the use of fertilizers or other nutrient containing compounds unless these materials are registered as a pesticide for the control or mitigation of pests. However, Washington state by means of the Fertigation Law does regulate the use of fertilizer material applied to land or plants through irrigation water. Backflow prevention requirements closely reference those specified for chemigation.

The pesticide label must address chemigation of the product by either (a) prohibiting chemigation or (b) permitting chemigation. **The label cannot remain silent in reference to chemigation.** If approved for chemigation, the label must contain use directions in addition to the customary safe and effective use provisions, posting requirements, and worker protection conditions. These additional use provisions may include:

- when to apply the product during irrigation,
- the quantity of water to be applied,
- the type of irrigation system the product can be applied through,
- the backflow prevention equipment that must be installed (and properly operating), and
- supplemental posting requirements. (Posting required for chemigation does not replace other posting and reentry interval requirements for farm worker safety. See example placard.)

The primary concern among federal and state regulators with regard to chemigation and fertigation is the direct connection to the irrigation water source and the potential ramification of a contamination event to groundwater or surface water quality. Another concern is the possibility of worker exposure during chemigation.

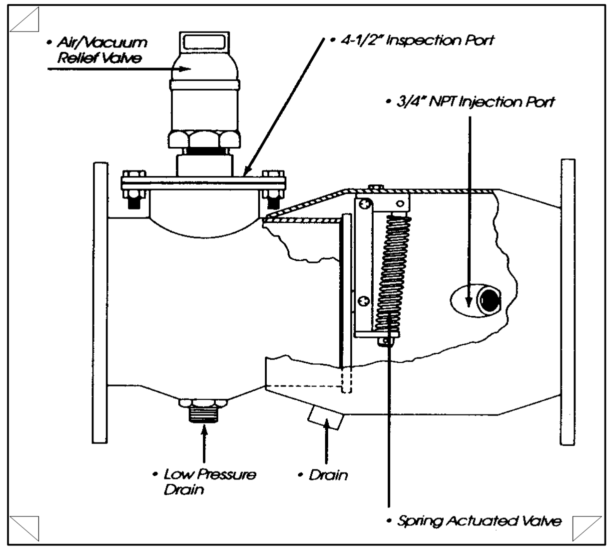
Indeed, all chemigation systems present the potential for contamination of the irrigation water supply if safety measures are not undertaken. Federal and state laws require the appropriate installation, proper operation, and suitable maintenance of chemigation safety devices. Proper and legal use of chemigation and fertigation requires that certain safety precautions and safety devices be installed on irrigation systems to prevent backflow or direct injection of agricultural chemicals into the irrigation water source or to avert other environmental contamination. At a minimum, the following safety devices are required with pressurized irrigation systems.

- Irrigation mainline check valve
- Vacuum relief valve
- Low pressure drain
- Automatic, quick-closing pesticide injection check valve
- Interlocking controls to automatically shutoff the pesticide injection pump when the irrigation pump stops or if the water pressure decreases to the point where uniform agricultural chemical distribution is being adversely affected
- Normally closed solenoid-operated valve located on the intake side of the injection pump (a USEPA exemption applies)
- A metering pump constructed of materials compatible with the agricultural material(s) being injected through system components and capable of being fitted with a system interlock.

While not required by existing federal or state law, an inspection port is suggested by the Agricultural Society of Agricultural Engineers and is currently required by several states. The mainline check valve, vacuum relief valve, low pressure drain, and inspection port (along with a threaded insert point for an injection line check valve) are often incorporated into a single device called an irrigation mainline chemigation valve. One type of chemigation valve is illustrated on this page.

Although specific safety equipment was identified in PR Notice 87-1, the USEPA later issued a list of alternative devices. In some cases, these alternative devices may be less expensive, more reliable, or more available than some of the originally required devices. Unless otherwise stated, alternative devices may replace those mentioned on the label. One such common exception is the normally closed solenoid-operated valve. The USEPA alternative device list permits the use of a functional spring-loaded check valve with a minimum of 10 psi cracking pressure or a functional normally closed hydraulically operated check valve, which is used in place of the automatic quick-closing pesticide injection check valve and the normally closed solenoid valve.

Backflow prevention devices are also required for pesticides placed into open irrigation systems. Both a float valve assembly (float box) and a sliding metering device are necessary to compensate for flow variations due to changing fluid levels and different fluid viscosity.



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