The Washington Irrigator NewsLetter

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WSU SIS Project Wrapping Up

Bob Evans and Cindy Mead, Biological Systems Engineering, WSU-Prosser

The scientific irrigation scheduling (SIS) project funded by the Bonneville Power Administration is wrapping up and final reports are being sent to cooperators.

Twenty-four cooperators in seven south central Washington counties participated in the 1997 SIS demonstration project. There were 6 fields in Adams County, 6 in Benton County, 2 in Franklin County, 2 in Grant County, 6 in Kittitas County, 6 in Walla Walla County and 6 Yakima County. A total of about 1800 acres were covered by this project and included rill, wheel line, hand line, solid set, center pivot, and drip irrigation systems. Crops scheduled included alfalfa, sweet corn, hops, sugar beets, potatoes, asparagus, onions, cucumbers, dry beans, timothy hay, apples, sweet cherries, and wine grapes. Irrigations were scheduled on a weekly basis using WSU Washington Irrigator Forecaster software (WIF), daily PAWS weather data and weekly readings of soil water status using a neutron probe. Some sites were also equipped with other soil water monitoring tools to help educate irrigators on the available equipment and how they work.

The primary purpose of this project was to conserve electrical energy and water resources as well as reduce overall irrigation costs for growers. Consequently, project personnel also cooperated with the Benton County, Kittitas County and Othello Conservation Districts on some of their water management programs by providing irrigation scheduling services on selected fields. Data analysis are not complete, but specific results and benefits of the project will be presented in future issues of *The Washington Irrigator NewsLetter*. Included in this issue are some highlights from the survey you participated in last spring (see sidebar on page 2).

New AG Engineer at Prosser!

Washington State University is pleased to announce the appointment of Dr. Brian Leib as the new state extension irrigation specialist as of February 2, 1998. Brian will be located at the Irrigated Agriculture Research and Extension Center in Prosser and will be replacing Dr. Tom Ley who left last April after 14 years at WSU to pursue other interests.

Dr. Leib completed his Ph.D. at The Pennsylvania State University in Agricultural Engineering where he taught basic irrigation classes and conducted research in trickle irrigation and pesticide movement in soils. He received his BS in Agricultural Engineering at The Pennsylvania State University and his MS from Colorado State University in Agricultural Engineering. Prior to working on his Ph.D., Brian was an extension irrigation engineer for Colorado State University on a large salinity control project near Cortez, CO for four years. He developed an impressive educational and field demonstration program while at CSU. He has good practical irrigation experience in both arid and humid areas.

Brian's duties will include developing and coordinating statewide extension educational programs dealing with irrigation, drainage, water-resource management, and impacts of irrigated agriculture on natural resources and the environment (e.g., water quality, soil erosion). He will also provide training and technical assistance to county Extension faculty, commodity groups, irrigators, irrigation dealers, irrigation districts, consultants, state and federal agency personnel and conservation districts. Brian is a very energetic person and plans to be active in many irrigation and water resources organizations as well as conducting a wide variety of irrigation research and field destration projects throughout the state.

Irrigating on Your Farm A Survey of Central Washington

Remember the survey? Well here are a few highlights.

Do you use/practice irrigation scheduling?

Yes	No	Sometimes	Total
144	49	28	221
65.2%	22.2%	12.6%	100%

What methods do you use to schedule irrigation water applications?

Visual Status of Crop	108
Soil Moisture Monitoring	100
Seat of the pants	85
Personal Weather Observations	78
Calendar	60
Newspaper ET and Rainfall	25
Crop Temperature	20
Commercial Irrigation Scheduling Service	18
Irrigation Scheduling Software	16
Infrared Photography	10
Other	14

When water available
Irrigate until water puddles on soil surface
April to October
Depends on how nervous grower is

Of the 193 growers scheduling irrigation on a full time and part time basis, most utilize more than one method.

What method do you use to measure soil water content?

Feel/Appearance	153
Neutron Probe	25
Tensiometer/Irrometer	23
Moisture Block	15
Gravimetric Sampling	8
TDR	5
Other	16

Growers are experimenting with the higher tech methods but still tend to rely the feel and appearance of the soil to determine the soil water content.

Do you know/analyze irrigation systems to determine the application rate?

Yes	No	Sometimes	Total
93	61	46	200
46.5%	30.5%	23.0%	100%

Do you know/analyze irrigation systems to determine the efficiency and/or uniformity of application?

Yes	No	Sometimes	Total
82	63	55	200
41.0%	31.5%	27.5%	100%

Do you adjust your irrigation schedule based on the environmental variables that affect application rates/efficiency/uniformity at the time of irrigation?

Yes	No	Sometimes	Total
126	28	49	203
62.1%	13.8%	24.1%	100%

Irrigation Scheduling Assistance Program To Be Launched in 1998

Bob Evans, Biological Systems Engineering Department, WSU-Prosser

As part of a consortium of agencies in Washington, Idaho, Montana and Oregon, Washington State University Cooperative Extension has received funding from the Northwest Energy Efficiency Alliance to increase the capability of irrigators in the Pacific Northwest to improve irrigation water management and thereby reduce electrical energy usage. The program will emphasize scientific irrigation scheduling (SIS) to time irrigations so that they just meet water needs of the crop at the right times, thereby eliminating unnecessary irrigations, minimizing overirrigation and conserving energy.

From an energy and water management standpoint, scientific irrigation scheduling (SIS) is a ready and proven vehicle for reducing irrigation energy consumption to help offset these higher demands and even reduce total irrigation energy use from current levels. Studies in Washington and several other states have shown that irrigation scheduling can, in most cases, reduce the gross amount of water normally pumped (with corresponding energy savings) ranging from 15% to 44% although on-farm water and energy savings of about 20% seems to be a generally achievable level. This reduction in on-farm water usage also greatly reduces energy requirements for water delivery to the farm since many water delivery agencies and districts in this state also use large amounts of electrical power to pump water from rivers as well as from one canal or reservoir to another. Based on analyses of a recent Grant County PUD SIS program, the total annual on-farm and water distribution system savings in Washington due to the adoption of SIS is about 680 kWh/ac.

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Continued next page .... See Next Year

Next Year................... agrichemical usage by improved irrigation methods and management. Recent droughts, water rights issues, reported ground water contamination and endangered species programs, are causing irrigators to invest in new and improved irrigation technologies that often include irrigation scheduoing. As a result, many irrigators are shifting from low-energy surface irrigation methods to more efficient, higher-energy pressurized sprinkler and microirrigation techniques with scheduling capbilities.

As part of this new project, WSU will continue development of the technical assistance tools, educational and demonstration activities in support of site specific irrigation scheduling through workshops and on-farm demonstrations. Field work would be directed towards assisting growers to use PAWS and WIF, conducting walk through analysis of field irrigation systems, and on-farm demonstrations of various soil water monitoring devices. Additional information on this new project will be announced in upcoming issues of the Washington Irrigator newsletters.

News from the Roza-Sunnyside Board of Joint Control (BOJC)

Cyndi King, BOJC

For the past several months, the Roza-Sunnyside Board of Joint Control (BOJC) has been busy discussing how to improve water quality in the lower Yakima River. The BOJC looked at water quality problems associated with irrigation, and with input from state and federal agencies, determined corrective measures to help improve water quality.

The BOJC recently adopted “Policies and Programs to Improve Water Quality and the Use of Water.” Several points that the policies addresses are discharges into project waterways, irrigation runoff, establishing buffer zones on project waterways, water quality monitoring and construction of sedimentation ponds and wetland areas.

To help enhance its efforts, the BOJC has applied for several funding opportunities through the Bonneville Power Administration and State Referendum 38. These requests include funding to improve Yakima River water quality, return flow water quality, and water quality monitoring program; establishing a landowner communication program; constructing sediment settling basins and wetlands; and evaluating return flow recovery.

The BOJC is taking a proactive approach to improving water quality in the lower Yakima River. By working with landowners, the BOJC feel confident that water quality can be improved in the Yakima River.

Benton Conservation District Update

Pat Daly and Scott Manley, Benton Conservation District

The Benton Conservation District has increased its programs in the irrigated agriculture community over the past years. A few of these projects are described in the here.

As part of the state-wide on-going Centennial Clean Water project, the District continues to do water quality monitoring on Spring and Snipes Creeks. Data collected includes suspended sediment, flow rate, temperature and pH., which are tracked to note changes in these conditions over both time and location along the creeks. This information is valuable to identify where, when and to what extent, ag activities impact these creeks.

The District is mapping the concentration of crops and irrigation practices using GPS/GIS technology (Global Positioning System and Geographical Information System). This information, combined with the water quality, has allowed the District to determine what ag practices, their locations and the times of year they occur, are more or less impacting the quality of these creeks. This is, in turn, useful in seeking funds to support cost-share programs for irrigation system conversions and improvements and to provide irrigation scheduling and soil moisture monitoring.

Cost-share assistance has been used for everything from rill to drip and sprinkler conversion and installing cross-field pipelines for shortening an irrigation water run length, to using PAM and monitoring soil moisture for proper irrigation system operation. These conversions and changes to irrigation management, work not only to reduce the amount of soil loss from fields and sediment entering the creeks, but serve as an example to the ag community of what can be done to control erosion and water quality and how it can be accomplished.

The District has also sponsored Irrigation Water Management Seminars in the past and, due to many requests, shall do so again this spring. For more information about the District’s various cost-share programs, soil moisture monitoring, trees for windbreaks and stream restoration, or the upcoming Irrigation Water Management Seminars, please call Pat at 786-9230 or Scott at 786-9216.

Columbia Basin Onion Drip Irrigation Study

Bob Mittelstadt, Othello Conservation District, Othello, and
Gary Pelter, WSU Cooperative Extension, Ephrata

An irrigation study was conducted on drip irrigated onions during the 1997 growing season. The onion cultivar, 'Vaquero', was planted in a very fine sandy loam on 44 inch wide beds in two double rows per bed. The double rows were about twelve inches apart with the drip tape positioned in-between about 1 inch below the soil surface.

Two irrigation treatments, replicated three times were monitored for soil moisture levels during the growing season and bulb yield and grade at harvest. The irrigation treatments consisted of two different drip tape flow rates: 170 and 250[1]. Irrigation set times were of the same duration for each irrigation treatment. The soil-water stress was measured using Watermark® sensors buried at three separate depths in each treatment plot: 6 inches (under the center of one double row of onions), 12 inches (at the bed shoulder) and 36 inches (directly under the tape in bed-center).

The soil moisture level, as indicated by soil-water tension measurements, was greater under the 250 tape than under the 170 tape as shown in Table 1. A total of 38 and 27 inches of irrigation and precipitation were applied under the two irrigation treatments respectively. Crop yields and grades under both irrigation treatments are shown in Table 2. This study indicates that the yield and grade was not significantly improved by the increase in tape flow rate from 170 to 250.

Table 1. Average soil-water tension values for each month under two drip irrigation treatments as measured in centibars by Watermark® sensors at three depths.

Tape flow rate	**170**			**250**		
Month	**6 in.**	**12 in.**	**36 in.**	**6 in.**	**12 in.**	**36 in.**
June	18	19	20	16	18	21
July	35	26	19	18	18	18
August	37	35	15	15	20	14

Table 2. Average yield and bulb size under two drip irrigation treatments. Sept., 1997.

	Yield	**Bulb size (%)**			
Tape size	**tons/ac**	**>4 in.**	**3-4 in.**	**2¼-3 in.**	**<2¼ in.**
170	50.3	24	70	4	2
250	54.3	17	77	5	1

[1] 170 and 250 drip tape flow rates correspond to a nominal 0.17 and 0.25 gpm/100 ft or 0.045 and 0.066 in/h respectively. The 170 drip tape was the standard used by the grower in the remainder of the field.

New WIF Software to be included in PAWS

The popular WSU Washington Irrigation Forecaster software for scientific irrigation scheduling (SIS) is being totally rewritten and expanded as a menu driven, interactive, state-of-the-art program that directly pulls climatic data from the PAWS weather system and reads soil moisture data files. The program will use site-specific, secure data entered by the users assisted by large "default" soils and irrigation system information files for quick, easy and accurate scheduling. It is being written in JAVA 1.11, a special programming language for internet applications with great graphics and an easy on-screen point-and-click (mouse) menu system.

The expanded WIF program will be included in PAWS (http://frost.prosser.wsu.edu) subscriptions that currently supplies current weather data and crop, insect, and disease information to growers, industry, utilities, schools and universities via the Internet and telephone modems. We also plan to make it available by special order on CD to run as a stand alone application on home computers. It runs under any operating system that supports JAVA such as Windows 95, OS/2, OS-8, UNIX, Windows NT and some other operating systems. The new irrigation scheduling program is slated to be available for the 1998 growing season. Contact Dr. Mary Hattendorf (509-786-9219) for additional PAWS information.

Effects of Polyacrylamide Calculated in Kittitas County

Anna Olsen, Kittitas County Conservation District

During the last few years, the Kittitas County Conservation District (KCCD) has monitored the quality of the water in the Wipple Wasteway/Badger Creek. In 1995, polyacrylamide (PAM) was introduced in this area as an erosion control tool for row crops. In the past 3 years a considerable change in the sediment concentration has been observed as the use of PAM has increased.

Using the mapping capabilities of the newly acquired Geographical Information Systems (GIS), KCCD created the Wipple Wasteway watershed area. GIS allowed KCCD to map and quantify the cropping pattern in this area. Using this information and the water quality testing from previous years, KCCD was able to calculate the change in sediment load in the Wipple Wasteway since the inception of PAM use.

In 1997, approximately 20% of the irrigated lands in this watershed were row crops (e.g. corn, potatoes) or crops requiring cultivation of soil (e.g. small grains or a new seeding of timothy). Of this 20%, approximately one third applied PAM. Water quality testing revealed the sediment load in the Wipple Wasteway dropped 25% in 1997 from the average of 62.8 mg/L in 1993 (before PAM). Using these figures the sediment load is predicted to fall another 35% if PAM is used on all row crops in this watershed.

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KCCD is working toward the goal of 100% PAM application on row crop fields. PAM has proven itself as an erosion control tool in Kittitas County. Expanding the use of PAM promises improved water quality. For further information please contact KCCD at (509) 925-8590 or stop by our offices at 607 Mountian View, Ellensburg, WA 98926.

DOE's 1998 Program to Focus on Education and Technical Assistance

By Jane Tonkin, Washington Department of Ecology

Starting this spring, the Washington State Department of Ecology has started a new project to provide water quality education and technical assistance to irrigators and farmers in the Yakima River Basin. Ecology water quality specialists will be visiting agricultural areas throughout the Basin during the growing season to help identify and solve potential pollution problems.

The Agricultural Water Quality Education Program is non-regulatory. This means that the purpose behind all visits with farmers and other irrigators will be to discuss water quality and management issues and provide information rather than enforce laws.

The goals of the project are:

- To help farmers understand Washington’s water quality laws and let them know whether or not they are in compliance,
- To suggest remedies for specific water quality and irrigation management problems, and, ultimately,
- To reduce the load of suspended sediment in the river to levels that adequately support fish life, recreation and other uses.

You can arrange for an educational visit by Ecology’s technical assistance staff by calling our Yakima office. You can get general advice on regulatory compliance and best management practices over the phone, too. Ecology staff can also refer you to other agencies that will provide education, technical assistance (system design and management strategies) and potential cost share sources for water quality and irrigation management improvements. And Ecology will sponsor or participate in training workshops, seminars, small group discussions and individual training about agricultural BMPs and water quality in the Yakima River Basin.

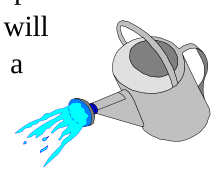
To learn more about Ecology’s agricultural water quality education program or to request educational materials, contact Jane Tonkin at (509) 454-7894.

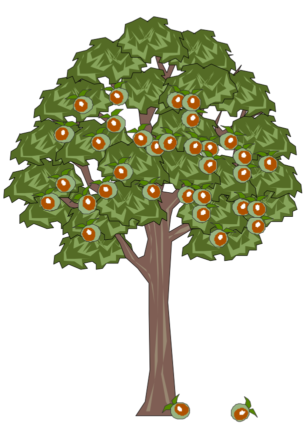
Using Irrigation Systems for Frost Protection in Orchards and Vineyards

By Robert Evans, Washington State University-Prosser, IAREC

The objective of any orchard and vineyard frost protection system or, more correctly, cold temperature modification, is to keep plant tissues above their critical temperatures. The critical temperature is defined as the temperature at which buds and/or other plant tissues (cells) will be killed. It varies with the stage of bud development and ranges from well below 0^{o}F in midwinter to near 32^{o}F in the spring. Knowledge of the current critical bud temperatures and the weather forecast for air and dew point temperatures are important because they tell the grower if cold temperature protection measures are necessary at any stage of development and how much of an air temperature increase should be required to protect the crop. There are very few years when frost protection is not needed, but these systems must always be ready, just in case.

In addition to good site selection, a substantial portion of available frost control options for producers has included water applications by sprinkler irrigation systems using a wide range of techniques and procedures. Undertree sprinkler (UT) and overtree sprinkler (OT) are probably the most common water application systems for frost protection. Heat is lost that rises above the canopy and by the natural "air drift" or wind carrying it out of the orchard. Any practice that reduces these major losses will increase the effectiveness of a protection measure.





Overtree Sprinkling for Frost Protection. Overhead or overtree sprinkling is the field system which provides the highest level of frost protection and it does it at a very reasonable cost. However, there are several disadvantages and the risk of damage can be quite high if the system should fail in the middle of the frost event. It is the only frost protection method that does not rely on the inversion strength for the amount of its protection and may even provide protection in windy (advective) frost conditions with proper design.

Water requirements are quite high which severly limits their adoption plus large pipelines and big pumps greatly increase initial costs. Water supplies capable of sustaining 60 to 80 hours of frost protection per week are required because these systems typically start earlier and run longer than undertree frost protection systems. They start earlier because of initial air temperature "dips" caused by droplet evaporation and turn off later because of the need to sprinkle until most of the ice is off the tree after sunrise. Do not turn off the system too early!

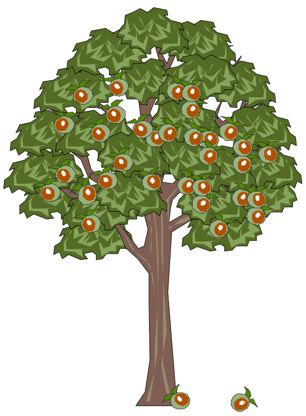
Generally, adequate levels of OT protection require that 70 to 80 gpm/ac (0.15 - 0.18 in/hr) of water (total protected area basis) be available for the duration of the heating period which will protect down to about 24^{o}F without wind. Lower application rates will have corresponding less protection capability. "Targeting" OT applications to apply water only to the area covered by the tree canopy (eg. one microsprinkler per tree) can reduce overall water requirements down to about 50-55 gpm/ac, but the water applied directly to the tree must still be 0.15 in/hr. Protection under advective conditions may require application rates greater than 100 gpm/ac depending on wind speeds and temperatures. The entire block or orchard must be sprinkled at the same time. Most stone fruit trees will not be able to support the ice loads. OT systems are never used with wind machines for frost protection. Because of the very low application rates (eg., 15 gpm/ac), overtree misting for frost protection is a very high risk option and is not a recommended practice.

Overtree Sprinkling for Bloom Delay. Bloom delay is overtree evaporative cooling in the spring. It is intended to delay bloom which ostensibly keeps the buds "hardy" until after the danger of frost has passed. It has been found to delay bloom of apples, peaches, pears and other crops, however, it has not been successful as a frost control measure on deciduous trees because of water imbibition by the buds causing them to lose their ability to supercool. This

Continued on next page ....See Frost

Frost.... results in critical bud temperatures that are almost the same as those in non-delayed trees. In other words, although bloom is delayed, there is no delay in critical bud temperatures and, thus, no frost benefit.

Undertree Sprinkling for Frost Protection.



Undertree sprinkle systems can be a good method of protecting orchards from frost if the grower only needs a couple of degrees of protection provided by a system that can also be used as an irrigation system. It is more economical and pollution-free than an oil heating system, and does not entail the dangers of limb breakage, disease, and sprinkler system failure of an overtree sprinkle system. There are lower risk and have less disease problems (eg., fireblight) than OT systems since little water comes in contact with buds. UT systems do not work well in windy frost conditions.

Research and experience has shown that the success of UT systems (including microsprinklers) is influenced by five main factors. These are (in approximate order of importance):

•the height and strength of the temperature inversion;

• the level of protection is directly proportional to the amount (mass) of water applied and the temperature of the applied water (generally 40-45 gpm/ac are required with 40°F water);

• the volume of air flow moving into the orchard (advection) which accounts for at least 50% of loss of heated air; and,

• release of latent heat from the freezing of the applied water (minimal benefit).

•Other important, but less significant, parameters are the height and type of cover crop (soil heat flux) and soil moisture.

It has been found that producing large amounts of very fine water droplets is not a significant factor in undertree frost protection.

The use of undertree sprinkling in conjunction with wind machines works well since heat from the thermal inversion is supplied plus the heat and humidity from the sprinkling is recirculated back through the orchard. Sprinkler heads should not be turned off around the fan since the amount of protection is dependent on the sprinkled surface area and the low temperatures causes the heat to rise slowly where it can be recycled by the wind machine. Finally, the water is often turned on first and the wind machines later since the use of water is usually less expensive.

Hot Water. Using warm water (eg. 80-150°F) is a definite advantage for undertree frost protection systems and water application amounts can be greatly reduced. In fact, because of the great inefficiencies in keeping and getting all heat from freezing water into the orchard air, it is been experimentally determined that almost all the heat measured in an undertree sprinkled orchard under freeze conditions can be accounted for by just the heat released by the sprinkled water as move through the air and cools to 32 °F. Using oil or LP gas to heat the water before it is applied is a much more efficient use of fuel than to use it in heaters. Other sources of warm water may include well water and shallow ponds that act as solar collectors and heat cold water as high a 70-80°F on clear spring days.

Conclusions. Economically it is not possible to protect against all frost situations which may occur, so you must decide what level of protection you need and can afford. These decisions must be based on local fruit prices plus the cost of the equipment and increased labor for frost protection activities. They must be balanced against the costs of lost production and possible long-term tree damage. The added capital cost for the equipment must be borne by the total added income generated by increased fruit yields and quality. There is no perfect frost control system.

For more information contact Dr. Robert Evans at Washington State University - Prosser, (509) 786-9281 or through the internet at revans@tricity.wsu.edu.

Heavy Metals in the Environment

Dr. Al Ludwick and Dr. Terry Roberts,
Potash & Phospate Institute (PPI)

All soils contain small amounts of heavy metals. A portion of the total is available for absorption by plants and could be, therefore, ultimately consumed by animals and humans. Generally, the concentration of heavy metals is lowest in the southeastern U.S. and highest in the Midwest, West and Northern Great Plains. Concentration is related to the weathering of naturally occurring rocks and minerals; weathering is fastest in warm, humid regions.

Table 1 shows the concentration of heavy metals, in parts per million (ppm), in soils from various regions of the U.S.

Zinc (Zn) and copper (Cu) are essential nutrients for plants and must be present in the soil in an available form for plants to grow and reproduce. They are applied as fertilizers when soils are deficient. Nickel (Ni) is an essential nutrient for some plants, but has not been found to be deficient in production situations. Lead (Pb) and cadmium (Cd) are not required by plants, but are easily absorbed by some plants if available.

The total content of metals in soil is not nearly as important as the concentration of metals available for absorption by plants. The availability of metals in soils generally decreases with increasing ph, with increasing clay content, and with decreasing organic matter levels. Although western soils may have higher total metal content than other regions, availability is reduced by their typically higher pH and lower organic matter content.

Table1. Typical average concentrations and rangeof heavy metals in surface soils from selected regions in the U.S. (in ppm)

	Pacific Northwest	Northern Great Plains	Central Great Plains	Southeast
Cadmium (Cd)	**0.08-0.64**	**0.16-0.64**	**0.04-0.32**	**0.02-0.16**
Zinc (Zn)	**20-143**	**40-183**	**10-143**	**1-40**
Copper (Cu)	**10-80**	**10-40**	**5-20**	**1-40**
Nickel (Ni)	**20-80**	**10-80**	**10-40**	**2-40**
Lead (Pb)	**3-20**	**3-20**	**10-30**	**3-20**

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And on the inside?