The Washington Irrigator NewsLetter

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Scientific Irrigation Scheduling Project Going Strong

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The scientific irrigation scheduling (SIS) project funded by the Bonneville Power Administration is off and running strong. Twenty-four cooperators in seven south central Washington counties are participating in the 1997 SIS demonstration project. There are 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 in Yakima County.

There are about 1800 total acres covered by this project and include rill, wheel line, hand line, solid set, center pivot, and drip irrigation systems. Crops being scheduled include alfalfa, sweet corn, hops, sugar beets, potatoes, asparagus, onions, cucumbers, dry beans, timothy hay, apples, sweet cherries, and wine grapes.

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Irrigations are being scheduled weekly using the Washington Irrigation Forecaster software (WIF), PAWS data and readings of weekly soil water status. The field demonstrations involve weekly soil water monitoring using a neutron probe. Some sites were also equipped with additional soil water monitoring tools (e.g., buried Watermark® sensors) to educate cooperators on the available devices and how they work. Project personnel are refining the process and improving the timeliness of the irrigation scheduling reports to assist irrigators in planning future cultural activities including water applications.

The primary purpose of this project is to conserve electrical energy and water resources as well as reduce irrigation costs for growers. Consequently, project personnel are also cooperating with the Kittitas County and Adams County Conservation Districts on some of their water management programs by providing irrigation scheduling services on selected fields.

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There have been some changes in personnel for the Scientific Irrigation Scheduling Demonstration Project. Dr. Robert Evans, Agricultural Engineer, replaced Dr. Tom Ley who has left WSU, as project leader and the main technical support person for this project. Next, Ms. Cindy Mead was hired in May as the principal field technician responsible for the day-to-day operation of the SIS project. Dr. Mary Hattendorf at WSU Prosser has also assumed the management of the Washington Public Agriculture Weather System (PAWS) from Tom Ley.

And on the inside?

Irrigating with High Sodium Well Water

Robert Evans - Biological Systems Engineering
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Many of the deep wells in central Washington produce water that is high in bicarbonate and sodium with a pH 8 or greater. Application of high sodium water quickly creates problems with soil sealing and limited infiltration of water into the soil. Overcrop applications of these waters can result in significant deposits of lime (calcium carbonate -$CaC0_3$) on fruit when used for cooling. If allowed to accumulate, sodium may also cause serious leaf burn if applied over crop on sensitive crops such as apples or grapes for either irrigation or cooling. These two separate problems must be considered together but treated individually.

Sodium ions held on soil exchange sites become available for leaching from the soil profile when exchanged for calcium ions. However, the high bicarbonate levels cause the calcium to be unavailable and the sodium builds up on or near the soil surface. The concentration of sodium causes soil structure to break down (deflocculate) and the soil surface develops an infiltration seal resulting in large amounts of runoff and dry root zones. This problem is best addressed by: 1) treating the soil with several tons of gypsum (calcium sulfate - $CaS0_4$) incorporated prior to planting; and 2) continuously keeping the pH of the applied water between 6 and 6.5 with an acidifying agent such as sulfuric acid. Irrigation systems can be used after planting to apply very finely powdered gypsum which is injected as a calcium source but water pH should be 6.5 or less for best results.

Deposits on fruit and leaf burn must be reduced by: 1) reduction of water pH every time the water is applied; and 2) periodic washing of the canopy using low pH water at night. Calcium carbonate (lime) precipitates can be readily controlled by maintaining the pH of the applied water at about 6.5-6.6 (a swimming pool pH tester can be used to monitor) by the careful injection of an acidifying agent or a sulfur burner. The use of "spent acids" from smelting or other industrial applications is not recommended. Technical grade sulfuric acid is commonly used and is the least expensive, but this is a dangerous compound to handle. Another compound that some use is a combined mixture of urea and sulfuric acid (N-pHuric) that is easy to handle but this use may apply nitrogen in excess of plant needs over the season. High quality phosphoric acid may also be used to lower pH but the amount of acidity required to lower pH of water to acceptable levels from phosphoric acid alone usually exceeds the crop's requirement for P. Certain chelating agents are often used to reduce calcium deposits on fruit because of safety concerns, but they are considerably more expensive and less effective than acids. Chelates do not affect water pH and are not needed when acidifying agents are used to lower water pH to acceptable levels. Chelates do not improve soil conditions created by high pH or sodium.

Injection equipment (pumps, tubing, etc.) must be able to withstand the specific chemicals being injected (e.g., PVC pipe cannot be used with concentrated sulfuric acid). The injection pump supplier should have the necessary information for you to purchase and install the correct materials. Positive displacement chemical injection pumps are recommended.

Use a simple, inexpensive portable pH meter to monitor the applied water throughout the season since the chemical characteristics of the water can vary over the year, and adjust injection rates accordingly. Remember that acidification only addresses the carbonate/bicarbonate problem, it may do nothing for problems due to other salts and precipitates.

Mineral deposition tends to be more significant at lower application rates (<30 gpm/ac) because less is washed from the fruit during overtree evaporative cooling. Even with acid treatment, growers may still need to operate low application rate systems for 4-6 hours using with low pH water 1-2

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continued from High Sodium ...

nights each week to try to wash off deposits . Water for overtree applications must be treated anytime and every time bicarbonate concentrations greater than about 50 ppm are present.

The treatment and use of chemicals requires an in-depth understanding of water and soil chemistry and an idea of what is desired. The first step in determining treatment needs is to have a chemical analyses made of the water supply (pH, electrical conductivity, Ca^{++}, Mg^{++}, Na^{+}, CO_3^{-2}, HCO_3^{-}). These analyses can be used to determine, among other needed information, the "lime deposition potential" (LDP). The LDP is estimated as the least concentration of either (CO_3^{-} milli-equivalents per liter [meq/L] + HCO_3^{-} meq/L) or Ca^{++} meq/L. Halverson and Dow (1975) suggested that a LDP below 2.0 should not be a problem for over crop irrigation. However, LDPs above 2 (100 ppm $CaCO_3$) should be cause for concern and probable treatment. An LDP above 4 (200 ppm $CaCO_3$) should be used for over crop irrigation with caution and only with pH reduction treatment. However, experience has shown that LDPs as low as 1.0 have caused serious mineral deposition problems with evaporative cooling applications.

All chemicals and/or chemical mixtures added to irrigation water should also be checked to avoid phytotoxic effects as well as for compatibility to prevent precipitations and maximize efficacy. Except for acids, chemicals should usually be injected upstream of any filters or screens. Injection locations should always provide for adequate mixing. With the exception of chlorine treatments for microirrigation and acidifying agents, the hydraulic systems must be flushed of the chemicals before turning off the water.

Special chemigation safety devices are required for all chemical injection systems under federal/state laws and regulations. There can be no reverse flows, system drainage or back siphoning.

Some Thoughts About "PAM"

Bob Stevens - Extension Soil Scientist
WSU - Prosser

More and more growers are using polyacrylamide (PAM) to reduce erosion and increase infiltration with furrow irrigation. Whether applied through the irrigation water or as a patch treatment in the furrow PAM has been very effective.

I recently received some interesting information from R.E. Sojka and R.D. Lents leading PAM researchers with USDA-ARS at Kimberly, Idaho. They noted two very important points about PAM use.

PAM use in the US for soil erosion control last year (based on an estimate of 400-500,000 acres treated at 3 lbs per acre) was about 1.5 million lbs of PAM applied. This is up from zero acres just a few years ago. Note this application is via irrigation water in one fashion or another, but the application is to the land. Data suggests that the worst case scenario for PAM-loss in tail water is under 5%. Using the NRCS standard the losses are much less than that. Furthermore, in less than 2000 ft of travel in return flow ditches the lost PAM has been shown to adsorb to entrained soil contained in the flow and/or ditch walls, reaching undetectable concentrations.

The industrial/government use of PAM is nearly 200X the use in agriculture, and most of that use is via direct additions to waters in close loop proximity to riparian resources. The annual growth in use of PAM for water treatment alone is over five times the entire use for erosion control in agriculture last year.

Sojka and Lentz also remind us that PAM reduces on-field erosion by ½ ton of soil per ounce of PAM used and that substantial reduction in N, P, BOD, COD and pesticides in return flows have been documented as a result.

To be effective the use of BMPs (Best Management Practices) such as PAM requires management. Irrigation application rates need to be modified (i.e., increased by as much as 2 times the normal rate) to obtain the full benefits of PAM, erosion reduction and infilitration increases, and to reduce the potential for increased leaching due to increased infiltration.

For additional information on the use of PAM contact Bob Stevens, WSU-Prosser, (509) 786-9231 or via email at stevensr@wsu.edu.

Keeping Microirrigation Systems Clean is Critical!!!

Robert Evans - Biological Systems Engineering
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Plugging of microirrigation systems is a major problem and it may occur from single or multiple factors. Physical factors such as suspended materials passing through filters or broken pipes, root intrusion and aspiration of soil particles into the emitter orifices are common causes of plugging. Chemical factors such as precipitation of carbonates and iron oxides, and precipitates from chemical injections are significant causes of emitter plugging. Likewise, biological factors such as insects and spiders, algae, fungi and bacteria can be serious plugging sources.

Plugging is minimized with proper design and management. Adequate air relief, vacuum breakers and pressure relief valves must be appropriately sited to ensure proper operation. Management must include regular flushing of lateral lines and faithful injection of chlorine or its equivalent to prevent clogging by algae and other biological growths (colonial protozoa, sulfur bacteria, and other mucous organisms) and even to minimize root intrusion. Iron and manganese precipitating bacteria can be controlled by chlorine treatments of a well, aeration, or polyphosphates.

Most programs chemically treat the water during every irrigation event, generally at the end of the irrigation cycle, although periodic (e.g., weekly) shock treatments using very high dose rates can also be effective. Generally, biocides are injected only when fertilizers or other chemicals are not being introduced into the system. Flushing velocities must be high enough (at least 2 ft/sec) to transport and discharge heavy particulate matter from the pipelines. Lateral lines should never be flushed uphill.

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Chlorine activity increases exponentially with decreasing pH. Thus, chlorine should be injected when the water pH is less than 6.5 which often requires injection of acids. Inject chlorine downstream from acids after the water pH has been lowered. A pH between 5.5 and 6.0 is preferred for optimal chlorine activity. Chemical compatibility is a concern if chlorine is injected simultaneously with other chemicals, even at low rates. Chlorine should always be injected separate from fertilizers and other chemicals as deadly chlorine gas may be produced by direct mixing in some cases.

All chemical injections should be filtered. Injection usually occurs after the pump and before the media and/or screen filters to trap any undissolved material. Chemicals should be injected into the center of the water flow to ensure quick dilution to safe levels, thus avoiding possible deterioration of the filter tanks, piping, valving or other components. Test kits for swimming pools are available to measure “total” chlorine or “free” chlorine. The use of free residual chlorine (D.P.D.) test kits is required.

Microirrigation also offers many other benefits when using chemical injection and application. For example, water soluble nutrients can be injected to more closely match crop requirements, increase nutrient use efficiencies, and reduce costs. Systemic pesticides and some soil fumigants may be injected with high efficacy. Consistent soil water contents and wetted soil volumes may also increase the efficacy of many chemical applications, but high application uniformities (e.g., DU 90%) are required since the chemical application uniformity will not exceed the water application uniformity.

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Irrigation Scheduling for Microirrigation Systems

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Microirrigation systems normally irrigate only a fraction of the cropped land area. Consequently, the volume of water stored in the soil and available for crop use can be considerably less than the amount of total available soil water volume under surface or sprinkler irrigation systems that wet the entire surface area. Thus, microirrigation is typically characterized by frequent, small water (and often nutrient) applications that are placed directly into or near the crop root zone with minimal losses. This practice can maintain higher, less variable soil water contents than other irrigation methods, reducing the occurrence of plant water stresses which often results in increased yields.

The basic philosophy of microirrigation is to be able to replace water in the root zone in small increments as it is used by a plant at intervals ranging from several times a day to every two to three days rather than refilling a much larger soil water reservoir after several days or weeks. Consequently, the old ideas about field capacity, wilting point and total water holding capacity do not really apply to microirrigation since there is essentially no soil water reservoir. Thus, to avoid plant water stress, microirrigations are scheduled based on replacing the immediate past water use or current plant water status and not on soil parameters such as the maximum allowable depletion (MAD). Sometimes microirrigated crops in Washington are deliberately stressed, such as wine grapes, at certain times during the season to control canopy, improve fruitfulness or improve quality, however, they still receive frequent irrigations during the stress periods but at greatly reduced levels.

There are two major concerns when scheduling microirrigation systems. The first is determining when to irrigate. The second consideration is how much to apply during an irrigation. When to irrigate depends on crop, climate, soil, irrigation system and management factors. It will vary through the season. The maximum interval between irrigations is primarily controlled by soil hydraulic characteristics, soil profile layering, and tubing placement. Irrigations can be scheduled whenever an allowable water use depletion level has occurred, or to replace estimated or measured crop water use, commonly called evapotranspiration (ET), each day. Alternatively, a preset amount of water can be automatically applied whenever the soil water potential (tension) in the wetted volume drops to a predetermined critical level as measured by sensors.

The estimated crop water use or plant water status, combined with the percent of the area irrigated, will determine the total amount of irrigation to be distributed by the microirrigation system. The irrigated area, in general, is taken as the total area, even row crops and high density tree plantings, considering that eventually most of the area is shaded when the crop matures. However, for low density or very young plantings, applications and schedules should be based on the actual canopy size or only the affected irrigated area.

The available soil water may be very limited by drip irrigated row crops such as vegetables with high ET rates with small root zones or on sandy soils, thus requiring irrigation two to ten times daily. Conversely, the irrigated root zone available water capacity might be much larger for tree crops on heavier soils allowing for less frequent irrigations. Daily microsprinkler applications may be required to increase the wetted volume and avoid leaching on light, highly permeable soils. Conversely, on heavier soils with high water holding capacities or poor drainage, optimal microsprinkler irrigations might be only every second or third day.

For more information contact Bob Evans at WSU-Prosser (509) 786-9281 or through the internet at revans@tricity.wsu.edu

There have been some changes at Washington State University's Public Agricultural Weather Systems, (PAWS) .

Mary Hattendorf - PAWS WSU - Prosser

The Public Agriculture Weather System (PAWS) is Washington State University's agricultural weather service. Weather data are collected electronically at the 58 stations throughout the state and transmitted by radio signal to the base station in Prosser. PAWS is one of the few near real time agricultural weather networks in the country, enabling it to provide up-to-the-hour information to growers.

PAWS has traditionally supplied weather data and models for growing degree days, evapotranspiration and irrigation scheduling, air stability, and pest and disease development. Major system changes have been instituted in the past few months, including high speed modem access on the 4 toll-free bulletin board phone lines, and a site on the World Wide Web(http://frost.prosser.wsu.edu).

PAWS data and models have been free of charge to users in the past; however, with tightening university budgets, PAWS has been required to support itself through paid subscriptions. PAWS new subscription structure is two tiered, with corporate rates at $1,065 per year, and individual rates of $130 per year. A corporate user is one who uses PAWS information to make recommendations to growers or clients. The individual rate is intended for in-house use by a grower, for instance.

PAWS future depends on your support. The PAWS system is actively seeking input from users on the new interface, services currently provided, and services not provided that may be valuable to users. We appreciate the interest in PAWS and plan to improve the system to meet client needs.

For more information, please contact Dr. M. J. Hattendorf at (509) 786-9219, or Todd Elliott, (509) 786-9367.

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