IRRIGATION SCHEDULING WITH AN "ON FARM" MICRO-COMPUTER

by
Dr. David Curwen
Department of Horticulture
University of Wisconsin - Madison, Wisconsin

Traditionally, Wisconsin potato growers have used irrigation to insure adequate soil moisture for potato production. The primary concern is to prevent moisture stress which can have direct, significant effects on potato yield and quality. In addition, moisture stress increases potato susceptibility to disease problems such as scab and early dying. These disease problems can also affect potato yield and quality.

In avoiding moisture stress, many growers over-irrigate. The consequences of over-irrigation are excessive use of water resources and energy and thus are costly. In addition, over-irrigation has significant impacts on groundwater quality. In Wisconsin, most irrigated potato production is in areas having light sandy soils and shallow depths to groundwater. In these areas, several ag chemicals used in potato production have been detected in groundwater. These include nitrate-N, Temik, Sencor/Lexone, Dual and Dinoseb. Groundwater contamination with ag chemicals is an obvious concern to both grower and non-grower alike. Groundwater is the source of drinking water for 70% of Wisconsin's population, particularly the rural population.

Additionally, over-irrigation also affects potato yield and quality. Over-irrigation results in high moisture conditions in the soil and plant canopy. Such high moisture conditions favor the development of early and late blights, aerial blackleg and sclerotinia white mold.

The role of irrigation management in water/energy use, groundwater impacts and disease management has pointed to the need for more efficient irrigation. This need has been met through the development of WISP * The Wisconsin Irrigation Scheduling Program. This research-based program is designed to increase irrigation efficiency (through better scheduling), thereby conserving water/energy resources and enhancing disease management. Effective use of the program can also eliminate irrigation as a source of leaching water. This reduces the potential for groundwater contamination problems. The bottom line is . . . . .

maintaining potato productivity (yield/quality) and
groundwater quality, while reducing irrigation costs.

This Presentation is part of the Proceedings of the 1988 Washington State Potato Conference & Trade Fair.

WISP Described

Like other irrigation scheduling programs, WISP uses a water budget approach. Crop water use (evapotranspiration - ET) estimates are used to determine soil moisture levels. Soil moisture status is then used to determine the frequency and amounts of irrigation.

WISP is unique because it is a grower interactive program. That is, WISP does not actually make the decision of when to irrigate and how much to apply. Rather, WISP provides data on current soil moisture conditions which the grower uses in the irrigation decision-making process. This approach ensures maximum flexibility in scheduling irrigations. Maximum flexibility is essential in a humid area, such as Wisconsin, where weather patterns, particularly rainfall, are variable and changeable.

A software package has been developed which allows WISP to be used with "on farm" micro-computers. This takes advantage of increasing grower use of computer technology in crop enterprise management. The WISP software has been designed to be used with IBM and IBM compatible micro-computers. This software package is "user friendly" and simple to operate. Many Wisconsin growers have successfully used the WISP software package and have achieved the benefits of more efficient irrigation scheduling.

Operating WISP

As with most computer programs, WISP requires the creating of a file for each field irrigated with this scheduling program. After the file has been created, the grower begins inputing data at the time the potato crop emerges. The input data required by WISP consists of following five potato growth parameters:

Allowable Depletion (AD): is a measure of soil water storage. It is that amount of soil water (at field capacity) which potatoes can easily extract without a crop stress occurring. The AD is a fixed value determined by the soil type and the maximum effective rooting depth of potatoes on that soil. The WISP software provides a table which contains AD value for the major potato soils in Wisconsin. For most potato/soil systems, the AD is equivalent to 50 - 60% of the traditional "available moisture holding capacity" values provided in the SCS soil survey reports.

Rainfall: even in small amounts can reduce the need for irrigation. In addition, rain can add water in excess of soil storage and thus contribute to leaching. Thus growers are asked to account for all rainfall greater than 0.1 inch.

Irrigation: is the other water addition that must be inputed into the WISP program. Rain gauges placed under the system can be used to measure irrigation applied. However, most growers use system operating time and pumping rates to determine irrigation applied.

% Canopy Cover: is used to adjust the ET Estimate (see following input). The grower must regularly estimate the % Cover until "full" cover is obtained. Crop cover is easily obtained by measuring canopy width in several areas of the field, and dividing by the between-row spacing. For example, if the canopy width averages 18 inches and the between-row spacing is 38 inches, the % Canopy Cover is 50%.

ET Estimate: is a measure of crop water use. The ET Estimate is a calculated value which represents the potential evapotranspiration (ET) from a well-watered potato crop at full cover. In WISP, full cover is defined as 80% or more of the soil surface being shaded at noon. In other words, "full" cover is the same as 80% cover. Thus the grower needs only input % Cover values until 80% cover is reached.

The Wisconsin Cooperative Extension Service calculates and provides daily ET Estimates for the state's major irrigated areas. These ET Estimates are calculated from temperature and solar radiation data collected from remote, computer-accessed weather stations located in the major irrigated areas. Calculation and dissemination of the daily ET Estimates usually begins about May 15. These ET Estimates are available over the toll-free IPM PEST PHONE and on WISPLAN, extension's computer service.

WISP uses the above input data to derive the AD BAL which is the main output of the program. This is illustrated in Figure 1.

Figure 1. Computer Printout of Summary Table for File: South.Irr.

File: SOUTH.IRR
File Description: POTATO/SAND
Allowable Depletion: 0.70

First date of data: JUN 1
Last day of data: JUN 15
Initial AD Balance: 0.70

Date	Rain	Irrig	ET	Cover	Adjusted ET	AD BAL	AD Left
JUN 9	0.00	0.00	0.22	73%	0.21	0.10	14%
JUN 10	0.10	0.80	0.16	77%	0.16	0.70	120%
JUN 11	0.00	0.00	0.19	80%	0.19	0.51	73%
JUN 12	0.00	0.00	0.22	80%	0.22	0.29	41%
JUN 13	0.00	0.00	0.21	80%	0.21	0.08	11%
JUN 14	0.00	0.00	0.23	80%	0.23	0.00	-21%
JUN 15	0.00	0.70	0.19	80%	0.19	0.51	73%

Projected AD*

Date	AD Bal
JUN 16	0.30
JUN 17	0.09

* Based on mean ET for the last 4 non-rain days.

The AD BAL and AD Left columns are the output data that the grower uses in making the irrigation decision. AD BAL and AD Left are different expressions of the current soil moisture status. The AD BAL indicates the amount of soil water, in inches, still available to the potato crop. The AD Left expresses this amount on a percentage basis. For example, on June 9 in the Summary Table (Figure 1.) the AD BAL was 0.10 inch. The AD Left column shows that this 0.10 inch was equal to 14% of the total allowable depletion (AD) of 0.70 inch.

The AD BAL (and AD Left) is a running total and changes with water withdrawals due to crop use and water additions due to rain and irrigation. Such changes are readily apparent in Figure 1. The decision to irrigate (both frequency and amount) is based on the need to maintain soil moisture levels (the AD BAL) within the AD range (0.70 inch in the Figure 1. example). Maintaining soil moisture within the Ad range will provide adequate moisture for potato production.

As both the AD BAL and AD Left approach zero (0), the grower should make an irrigation decision. Allowing soil moisture to be depleted to zero (0) will cause the crop to come under stress. This was the case on June 14 (see Figure 1.) where the AD BAL was 0.00 and the AD Left was -21%. A zero (0) AD BAL and a negative (-) AD Left indicate crop moisture stress. An AD Left percentage greater than 100 indicates over-irrigation and/or excessive rain.

Additional data is provided the grower to assist in the irrigation decision. This is in the form of Projected AD values located at the bottom left of the Summary Table (see Figure 1.). Projected AD values are given for the next two days (June 16/17 in the Figure 1. example). Such data can assist the user in timing irrigations. A negative (-) Projected AD value indicates that the crop will come under stress on that date if no water is added.

The grower decides how much irrigation to apply based on irrigation system capability, AD BAL (AD Left), Projected AD and rain forecasts. However, the applied irrigation should never exceed the AD value for the potato/soil system. To do so would result in over-irrigation and increased leaching. This occurred on June 10 (see Figure 1.) when 0.8 inch irrigation was applied in addition to a 0.10 inch rain. The total water applied was more than the amount needed to bring soil moisture back to the AD of 0.70 inch, which is field capacity in the Figure 1. example. This resulted in over-irrigation by some 20% as indicated by an AD Left of 120%.

A final feature of the WISP program is that the complete file can be printed out at the end of the season. This provides a "hard copy", historical record of the irrigation program for that field. Review of this record can be useful in explaining yield/quality responses obtained and in "fine-tuning" future irrigation scheduling practices.

Research and grower experience have verified the overall concept upon which WISP is based. Additionally, grower experience with the WISP software package has led to refinements and improved ease of operation of the package. Grower experience has, in fact, shown that the computerized WISP scheduling program can maintain potato yields and quality while applying fewer irrigations. Thus over-irrigation can be reduced and along with it, costs and leaching. WISP is, indeed, a management tool which can enhance profitability and environmental protection.