Comparison of Three Irrigation Scheduling Methods And Evaluation of Irrigation Leaching Characteristics

T. Scherer, D. Slack, J. Watson, F. Fox

ABSTRACT

Three methods were used to schedule irrigations during 1989 on replicated plots at the Maricopa Ag Center using DPL 90 cotton. This is a continuation of the research initiated in 1988 using the same field. The three methods were; a soil water balance model based on historic consumptive use curves, a soil water balance model based on the Modified Penman Equation and daily weather (AZMET), and infrared thermometry using the C.W.S.I. A potassium-bromide conservative tracer was applied at selected sites in the plots to evaluate leaching characteristics. The irrigation scheduling test was again duplicated at the Safford Experiment Station and is presented in another report. Results from this years data indicate that there was no significant difference in yield among the three methods. However, as in 1988 there was a significant difference in water applied with historic consumptive use (ERIE) the lowest and the Penman equation method (CHECKBOOK) the highest.

INTRODUCTION

At the present time there are no easy-to-use irrigation scheduling methods in common use in Arizona. This is unfortunate because scheduling methods have been used in other parts of the country for many years with successful results. The historic consumptive use curves published by Erie, et al (1965 and 1982) have been available yet they have not been used by growers in an organized manner for irrigation scheduling purposes. A major reason for this has been grower reliance on wells for their source of water. In most cases, scheduling was not possible because the flow of water from the wells was not enough to keep up with the demand from the planted acreage. With the arrival of CAP water into central Arizona and the creation of the AZMET weather system, it is now possible to use irrigation scheduling in real time. The purpose of this multiyear research is to evaluate three irrigation scheduling methods in terms of applied water, yield, ease of use, hours of labor and leaching characteristics.

METHODS AND MATERIALS

A randomized, complete block statistical design was used with the three irrigation scheduling methods and three replications (9 plots). DPL 90 cotton was planted April 10th on 40-inch, furrowed rows, 395 feet long. Each plot had 8 rows with a neutron access tube for soil moisture measurement located near the middle of the plot. The tubes were installed to 10 feet and were read at 1-foot increments before and after every irrigation. Water was applied with gated-pipe and the total volume to each plot was measured with an in-line meter. Standard application methods for fertilizer and pesticides were used. However, no fertilizer was applied after lay-by. The last irrigation was August 28th, the cotton was defoliated on September 26th and picked October 18th and November 17th.

The three irrigation scheduling treatments were; ERIE (historic consumptive use), CHECKBOOK (use of daily AZMET weather data with the Penman equation), and CWSI (infrared thermometer). Irrigation was initiated using the ERIE and CHECKBOOK methods when the calculated soil moisture depletion was 50%. A value of

0.3 initiated an irrigation using the CWSI method. The neutron probe soil moisture data were used as a check on the scheduling methods and also to determine time and depth of water removal.

After harvest, as in 1988, soil sampling was begun to evaluate the depth of movement of the applied bromide. The samples are being analyzed for bromide, nitrate-nitrogen and chloride content. The depth of movement of the bromide will allow for estimation of the depth of movement of the irrigation water applied following the bromide addition. The concentration of the chloride in the soil water will be compared to the concentration of chloride in the irrigation water to provide an estimate of the leaching percentage. This, when multiplied by the amount of water applied, will allow a check of the estimate of the depth of irrigation water that moved below the root zone during the season as calculated from the bromide data. The samples from the 1988 season have been analyzed. Most of the bromide applied to the plots remained in the top 3 feet of the soil profile when the samples were taken along the side of the furrow.

RESULTS AND DISCUSSION

The irrigation and yield results are shown in Table 1. The results are similar to those obtained in 1988 (Scherer, et al. 1989). The amount of irrigation water applied to all plots is greater than the previous year mainly due to the field being deep ripped during preparatory tillage operations. The deep ripping increased the infiltration capacity to the point where during the second irrigation (when the cotton was 2 inches tall), approximately 7 inches of water had to be applied to sub the water across the furrows. This was 5 inches more than was needed. If this value is subtracted from the irrigation water, the results are very similar to those obtained in 1988.

Analysis of the soil moisture readings from this year and 1988 has indicated that we need to adjust the crop coefficient curve for the CHECKBOOK method. The peak crop coefficient we have been using is 1.37 and this will be adjusted down to 1.15. This should bring the applied irrigation water of this method down nearer the other two methods. Also from the soil moisture readings, we have developed a much better root growth model, which will be incorporated into the ERIE method. These adjustments will be tested during the 1990 growing season.

Here are some observations on ease of use and labor hours needed to apply each method. The CWSI method by far requires more labor hours than the other two methods. The ERIE and CHECKBOOK methods require about 30 minutes and 1 hour, respectively, per week to obtain useful decision-making information. Both methods can be performed in the comfort of an office. The CWSI method requires about 5 hours a week to obtain useful information. Walking the fields during the hottest part of the day with an infrared thermometer is time-consuming and hard on the body.

Table 1. Yield and Water Applied Data.

Plot No.	Treatment	Yield (ba/ac)	Irrigation (in)	Rain (in)	Total (in)
4	ERIE	2.81	44.5	2.0	46.5
8	ERIE	3.02	43.3	2.0	45.3
10	ERIE	3.22	42.5	2.0	44.5
2	CWSI	3.21	49.1	2.0	51.1
7	CWSI	3.24	45.0	2.0	47.0
9	CWSI	3.59	43.7	2.0	45.7
3	CHECKBOOK	3.15	51.3	2.0	53.3
6	CHECKBOOK	3.03	50.9	2.0	52.9
11	CHECKBOOK	2.94	48.6	2.0	50.6

Treatment	Yield Avg (bales/ac)	Irrigation (inches)
ERIE	3.01(a)	43.4(a)
CWSI	3.35(a)	45.9(a)
CHECKBOOK	3.05(a)	50.3(b)

* Column means followed by the same letter are not significantly different (P<=0.05).

REFERENCES

Erie, L.J., French, O.F., and Harris, K. 1965. Consumptive Use of Water by Crops in Arizona, Technical Bulletin 169, Agricultural Experiment Station, University of Arizona, Tucson, AZ.

Erie, L.J., French, O.F., Bucks, D.A. and Harris, K. 1982. Consumptive Use of Water by Major Crops in the Southwestern United States, USDA/ARS Conservation Research Report No.29.

Scherer, T.F., D.Slack, J. Watson, and F. Fox. 1989. Comparison of Three Irrigation Scheduling Methods and Evaluation of Leaching Characteristics, Cotton Report, University of Arizona, Tucson, AZ.