Irrigation Scheduling on Barley at the Safford Ag Center, 1997

L.J. Clark and E.W. Carpenter

Abstract

An irrigation study on barley was made to determine the economical consequences of irrigating the crop when an irrigation scheduling program called for an irrigation compared to waiting 3 to 6 days for a water turn from the ditch. The plots irrigated when the soil moisture depletion level reached 40% produced the highest yield. Yields were decreased 700 and 1000 pounds respectively for waiting 3-4 days and 6-7 days, respectively. The economics of using the pump are discussed and a chart is given to help determine a break-even point.

Introduction

Applying irrigation water to small grain crops in a timely manner is one of the most important keys to having an economically successful crop. The amount of soil water that will be allowed to be depleted from the root zone between irrigations will affect the yield potential of the crop as well as the irrigation costs to produce the crop. AZSCHED irrigation scheduling software was used in this study to aid the researchers in applying water at prescribed soil moisture depletion levels. The intention of this study was to use a given soil moisture depletion level to call for irrigations and then deviate from the dates that irrigations were called for by a given number of days to simulate waiting for a water turn. The results would then be used to help grain growers develop irrigation strategies.

Materials and Methods

Our last reported research on irrigation scheduling (1) was inconclusive for the optimal soil moisture depletion level, however, subsequent unreported data indicate that barley will yield better if the soil moisture levels do not exceed 40%.

Crop History:

Location: Safford Agricultural Center, Graham County
Elevation: 2950 feet above sea level
Soil type: Pima clay loam
Planting date: 9 December 1996 Rate: 150 lbs/acre of Gustoe barley
Herbicide: None
Fertilizer: 200 lbs/ac 16-20-0 at planting, 150 lbs/ac of Urea on 10 Feb 97, 130 lbs/ac of Urea on 13 March (Total of 160 lbs/acre of nitrogen)
Insecticide: None
Irrigation: Furrow, varied according to treatment
Rainfall during the growing season: 2.3 inches
Plot size: 12 feet by 210 feet
Replicates: Four

Plots were combined with a Gleaner Combine with a 13 foot header. Grain was caught in buckets as it exited the

clean grain auger, where it was weighed and samples collected for bushel weight and moisture determination. Grain weights were all corrected to 12% moisture to determine yields.

Results and Discussion

Table 1 shows the information related to the irrigations applied per treatment from farm records and from AZSCHED irrigation scheduling software. On average the 40% and 50 % depletion plots were watered a little bit earlier than the computer called for since the average depletion level at irrigation was 34.8% and 47.4%, respectively. It is interesting to note the tremendous increases in percent soil moisture depletion with just a few days delay in irrigation. The average depletion levels of 60% and 73% for the 3 and 6 day treatments were higher than expected. Those treatments were applied a little bit late with the 3 day and 6 day treatments being applied 4.0 and 6.6 days after the plots reached the 40% depletion level, respectively. The last column shows the leaching losses as calculated by AZSCHED. In salty soil a certain amount of leaching in required to keep salt from building up. Maas (2) indicates that the threshold electroconductivity (ECe) for barley is 6 dS/m and the Western Fertilizer Handbook (3) indicates that a soil with an ECe of 9 dS/m has a leaching requirement of 9%. Soils at the Safford Agricultural Center are around 6 dS/m, so with a leaching loss <9% would be adequate to prevent yield loss due to salts. The leaching losses from the 40% depletion treatment were in the order of 20%, which is considered to be more than is needed. Leaching losses from the other plots varied from 7 to 12% and are in the right order of magnitude.

Table 2 shows the barley yields and other agronomic information from the treated plots. The plots that were maintained below 40% soil moisture depletion level yielded significantly higher that the rest of the plots. Plants in these plots were taller and the grain more moist at harvest time. The other three treatments did not vary significantly in yield, even though the 6 day treatment yielded 300 pounds per acre less than the other two treatments. Figure 1 shows the soil moisture depletion levels throughout the season for each of the four treatments. These graphs also show the irrigations applied and the leaching losses as negative numbers.

An economic analysis is shown in Table 3. The value of the crop is calculated using a value of $5.67 per hundredweight. This value as well as the costs of irrigation came from the 1996-97 Arizona Field Crop Budget (4). Irrigation costs were calculated as follows: each irrigation cost $2.82 per acre in labor costs and water was charged at $1.17 per acre inch. These values may vary greatly from farm to farm throughout the area. Net values were figured subtracting only the irrigation costs from the total value. The question to be answered from this study was: if the crop needs water today but the water boss indicates that water will not be available for 3 to 6 days, does it pay to start the pump to irrigate the crop. The answer is not simple and with only one year's data is not definitive. The extra $17 to $27 per acre gained over the growing season was gained over 7 to 11 different irrigation events. One must evaluate the actual cost difference between river water and pump water and the percent of the time that the pump replaced the ditch stream to determine if more timely irrigations using a pump are economically feasible. The chart below will help figure out the break-even point. The difference in water cost between ditch water and the pump are on the left hand side of the chart, the percent of the time that the pump replaced ditch water is across the top. When the numbers in the chart exceed $17 or $27 the use of the pump is uneconomical.

		Break-even costs for 10 irrigations				
		Percent of the time using the pump				
		0%	25%	50%	75%	100%
Differential water cost (pump - ditch water)	$2.00	$0.00	$5.00	$10.00	$15.00	$20.00
	$2.25	$0.00	$5.60	$11.30	$16.88	$22.50
	$2.50	$0.00	$6.25	$12.50	$18.75	$25.00
	$2.75	$0.00	$6.88	$13.75	$20.63	$27.50
	$3.00	$0.00	$7.50	$15.00	$22.50	$3.00

References

1. Clark, L.J. and E.W. Carpenter. 1992. Wheat and barley irrigation scheduling using AZSCHED. Forage and Grain, A College of Agriculture Report, The University of Arizona, Tucson, AZ. Series P-92, pp.28-33.

2. Maas, E.V. 1986. Salt tolerance of plants. Applied Agricultural Research Vol. 1, No. 1, pp. 12-26. Table 1.

3. Western Fertilizer Handbook. 1980. Sixth Edition. The Interstate Printers and Publishers, Inc. Danville, Illinois.

4. Daugherty, Lew and Ron Cluff. 1996. 1996-97 Arizona Field Crop Budgets - Graham County. The University of Arizona College of Agriculture Extension Bulletin #196013.

Table 1. Irrigations applied, affect on soil water depletion and leaching losses.

Treatment	Irrigation water applied	Number of applications	Average % Depletion at applic.	Average number of days delayed	Leaching losses
40% Depletion	45.0	11	34.8	–	8.27
40% Depletion + 3 days	34.1	8	60.0	4.0	4.29
40% Depletion + 6 days	28.7	7	73.0	6.6	2.13
50% Depletion	36.9	9	47.4	–	3.31

Table 2. Barley yields and other agronomic data by irrigation scheduling treatment, Safford Agricultural Center, 1997.

Treatment	Yield @ 12% Moisture	Plant Height	% Moisture	Bushel Weight	Plant Population
40% Depletion	6700 a	32.0 a	14.0 a	51.5 ab	424710 a
40% Depletion + 3 days	6035 b	28.8 ab	11.5 c	51.8 ab	348480 ab
40% Depletion + 6 days	5703 b	26.0 b	12.0 bc	52.0 a	283140 b
50% Depletion	6098 b	26.8 b	13.7 ab	51.0 b	315810 b
Average	6134.1	28.4	12.8	51.6	343035
LSD(05)	412.7	4.2	1.7	0.85	86124
CV(%)	4.2	9.3	8.2	1.0	15.7

Table 3. Economics of various irrigations scheduling strategies on the Safford Agricultural Center, 1997.

Treatment	Value of Crop ($5.67/cwt)	Cost of Irrigation	Net Value of Crop	Water Use Efficiency ($/ac in)
40% Depletion	$380	$84	$296	$6.58
40% Depletion + 3 days	$342	$63	$279	$8.18
40% Depletion + 6 days	$323	$54	$269	$9.37
50% Depletion	$346	$68	$278	$7.53

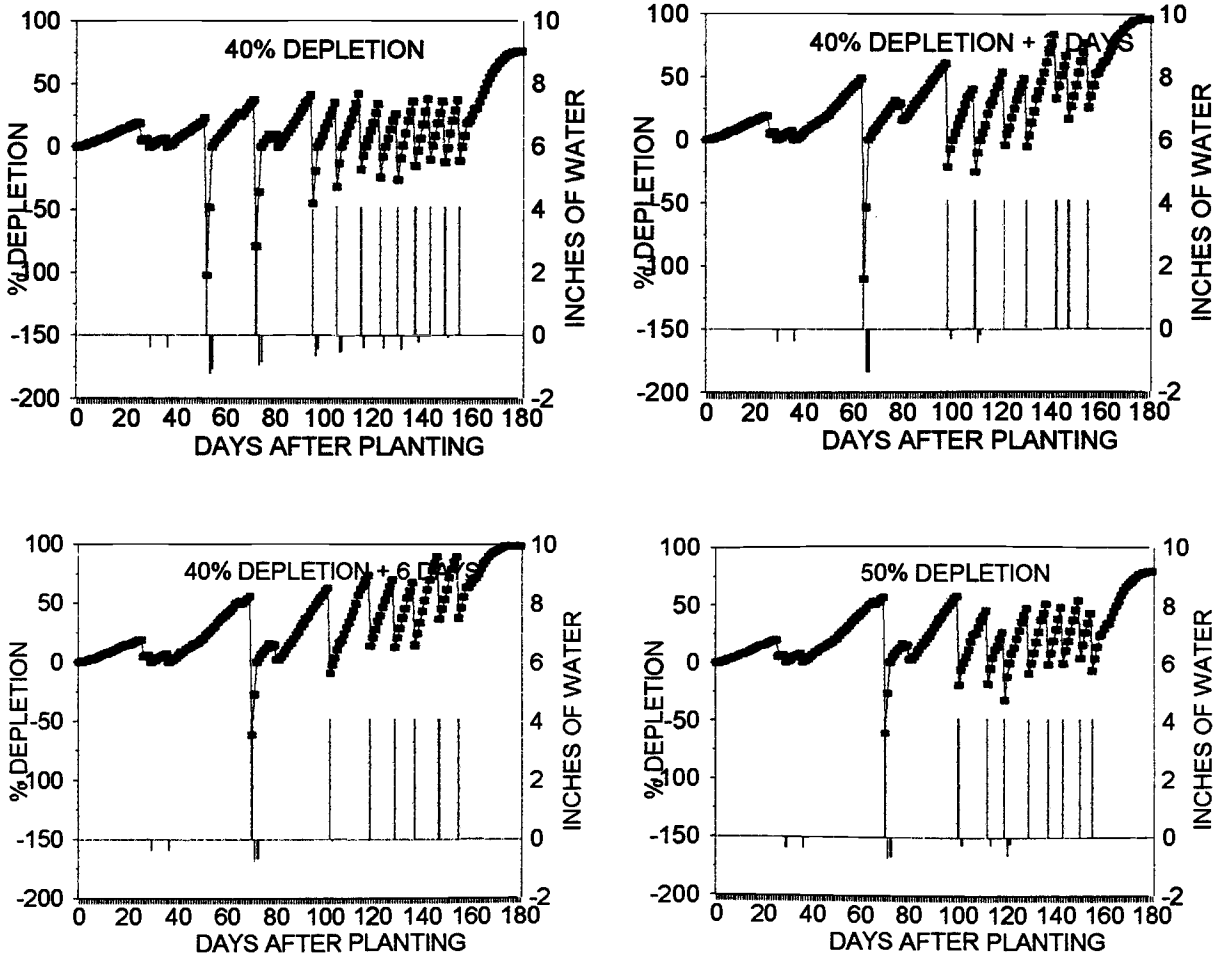

Figure 1. Graphs of soil moisture depletion, irrigation events and leaching events by irrigation treatments, Safford Agricultural Center, 1997.