Wheat and Barley Irrigation Scheduling using AZSCHED

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Abstract

Irrigations for Aldura wheat and two varieties of barley were scheduled using AZSCHED software. Planting of the crops was delayed by adverse weather so the cropping season was compressed from normal. No statistical differences were seen between the three irrigation treatments, but it was felt that AZSCHED tracked the crop water needs during the season.

Introduction

ASZCHED was released for general use in January of 1992 (1). These studies were a continuation of the previous experimental development studies. They contained the same treatments as the previous study (2), namely, scheduling irrigations at 40, 50 and 50% soil water depletion or management allowed deficiencies (MAD).

Methods and Materials

These two experiments were performed on adjacent fields with clay loam soils. In the 1991 trial, only wheat was studied, so this year the study was broadened to include barley, as well. The format of the experiment was the same as last year with AZSCHED scheduling the treatments, which were to be irrigated when the Management Allowed Deficiency (MAD) reached 40, 50 and 60%, respectively. A difference from the previous year's trial was the planting dates. The wet winter weather prevented planting at the optimal time and this delay shortened the growing season by more than 30 days. AZMET (3) data were downloaded weekly into the AZSCHED program, at which time the fields were updated with rainfall and irrigation data. With these inputs, a prediction report was generated with each plot listed as to when it should be irrigated and how much water was needed to bring the soil back to field capacity. The crop histories are given below:

Crop History (Wheat)

Cultivar: Aldura wheat
Elevation: 2950 feet above sea level
Soil type: Pima clay loam
Available Water: 2.3" in the top feet
2.2" in the second foot
1.5" in the third foot
1.6" in the fourth foot
Irrigation Efficiency: 70%
Management Allowed Deficiency (MAD): 40, 50, and 60%
Planting date: 11 February 1992, replanted 25 February
Planting rate: 200 pounds of seed per acre
Fertilizer: 200 lbs/ac 16-20-00 pre-plant
200 lbs/ac Urea applied over the top, 13 March
200 lbs/ac Urea applied over the top, 13 April
Herbicide: None
Insecticide: None
Rainfall: 4.6 inches
Harvest date: 13 July
Number of replicates: 4

Crop History (Barley)

Cultivar: Gustoe (2 reps), Beardless (2 reps)
Elevation: 2950 feet above sea level
Soil type: Guest clay loam
Available Water: 2.3" in the top feet
2.2" in the second foot
1.5" in the third foot
1.6" in the fourth foot
Irrigation Efficiency: 70%
Management Allowed Deficiency (MAD): 40, 50, and 60%
Planting date: 30 January 1992
Planting rate: 200 pounds of seed per acre
Fertilizer: 200 lbs/ac 16-20-00 pre-plant
200 lbs/ac Urea applied over the top, 13 March
200 lbs/ac Urea applied over the top, 13 April
Herbicide: None
Insecticide: None
Rainfall: 5.8 inches
Harvest date: 13 July
Number of replicates: 2+2

Results and Discussion

The wheat yields were a little more than a ton lower than the previous year, but that was understandable with the late planting date. Seed and fertilizer inputs were comparable between the two years but two thirds as much irrigation water was applied. The numerical results of the wheat irrigation study are found in Table 1. In comparing the yields between the three irrigation treatments, one sees that they are not significantly different, but that the treatment irrigated when the soil water depletion reached 60% tended to be slightly less than the others. The amount of water applied to all plots was approximately the same, but timing and average *percent soil water depletion* just prior to irrigation varied by treatment. This average percent depletion is shown in Table 1 and can also be seen in Figure 1. The percent depletion in the figure would ideally be sawtoothed with the points resting on the line defined in the Management Allowed Deficiency. For example, in the 40% depletion curve, the line should rise until it touched the "40" line, then an irrigation would drop the curve to zero and the line would rise again and go through the same routine again. In farming, it is difficult to achieve this model, as can seen in the figure. After the first peak, the line falls rapidly and becomes negative. This is because more water was applied than the soil could hold. This led to some leaching as shown by empty squares on the graphs. Just before the third irrigation, in the curves on Figure 1, it can be seen that the percent depletion curves all rise well above the specified MAD's. This was because water was not available to irrigate when the crop needed it. Inabilities to deliver the amount of water when it is needed causes losses in yield, which undoubtedly affected to yields in this study. Efficiencies shown in Table 1 are slightly higher than seen in previous years. In this case, it is due to the small amounts of irrigation water added. Part of this reduction was caused by the increase in rainfall from average and part by the increased relative humidity which decreased evapotranspiration from the plants. The biggest factor in the reduction of water use was from the shortness of the growing season. (The watering-up irrigation and the last irrigation were inadvertently omitted from the graphs, but are contained in the table.)

A discussion of the barley data is more complex because two varieties with very different growth characteristics were grown in the same test. Gustoe is a fairly short variety that has been developed for grain production, whereas the beardless barley grows tall and provides a large forage yield. The numerical data from this test are shown in Table 2. Yields across treatments were not significantly different, but the yields between varieties were greatly different. The Gustoe yields were below the acceptable range due to the late planting date, but

the objective of the study was to determine if AZSCHED would track the water use and accurately predict when irrigations were needed. Figure 2 shows a curve of the calculated percent water depletion throughout the growing season. The curves are quite similar to those seen for the wheat in Figure 1 and they reacted predictably to rainfall and irrigations. The average percent depletion at irrigation values in Table 2 show that even though the irrigation between 80 and 100 days was late, irrigations were applied close to the prediction dates. The average yield of Gustoe in this trial was around 3300 pounds per acre, this compares to a average yield of 3800 pounds per acre for a crop grown at the Safford Agricultural Center with similar seeding rate and planting date in 1987 (4). From these points of consistency, it is felt that AZSCHED did perform adequately for scheduling irrigations on barley in this test.

References

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Table 1. Yield and other agronomic variables on wheat irrigated using AZSCHED software, Safford Agricultural Center, 1992.

Treatment	Yield[1] (lbs/ac)	Percent Moistur	Bushel Weight	Irrigation (inches)	Efficiency[2] (lbs/ac/in)	Leaching[3] (inches)	Average[4] % Depl
MAD 40%	3466 a[5]	8.3 a	56.8 a	20.7	167.4	3.5	46.0
MAD 50%	3647 a	8.4 a	57.0 a	21.1	172.8	4.0	53.3
MAD 60%	3173 a	8.8 a	56.8 a	21.7	146.2	4.7	54.3
Average	3429	8.5	56.9	21.2	161.7	4.1	51.2
LSD(05)	509.5	1.6	6.1	--	--	-	--

1. Yield in pounds per acre corrected to 10% moisture.
2. Yield-to-water-use efficiency in pounds per acre per acre-inch of irrigation water applied.
3. Leaching value is calculated by AZSCHED as the difference between the water applied and the water that can be used to restore the soil to field capacity and to satisfy plant needs for two days after the water was applied.
4. Average % Depl is the average of the % soil water depletion levels immediately prior to an irrigation.
5. Numbers within a column followed by the same letter are not significantly different at the 5% level of confidence using Duncan's Multiple range test.

Table 2. Yield and other agronomic variables on barley irrigated using AZSCHED software, Safford Agricultural Center, 1992.

Treatment	Yield[1] (lbs/ac)	Percent Moisture	Bushel Weight	Irrigation (inches)	Efficiency[2] (lbs/ac/in)	Leaching[3] (inches)	Average[4] % Depl
Gustoe							
MAD 40%	3237 a[5]	8.3 a	41.5 a	36.8	88.0	13.8	45.5
MAD 50%	3131 a	8.6 a	44.5 a	30.4	103.0	8.7	54.2
MAD 60%	3445 a	7.6 a	45.5 a	26.0	132.5	7.4	62.0
Average	3271	8.2	43.8	31.1	105.2	10.0	53.9
Beardless							
MAD 40%	1215 a	7.2 a	35.0 a	36.8	33.0	13.8	45.5
MAD 50%	1499 a	7.1 a	36.5 a	30.4	49.3	8.7	54.2
MAD 60%	2143 a	7.5 a	37.0 a	26.0	82.4	7.4	62.0
Average	1619	7.3	36.2	31.1	52.1	10.0	53.9

1. Yield in pounds per acre corrected to 10% moisture.
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4. Average % Depl is the average of the soil water depletion levels immediately prior to an irrigation.
5. Numbers within a column followed by the same letter are not significantly different at the 5% level of confidence using Duncan's Multiple range test.

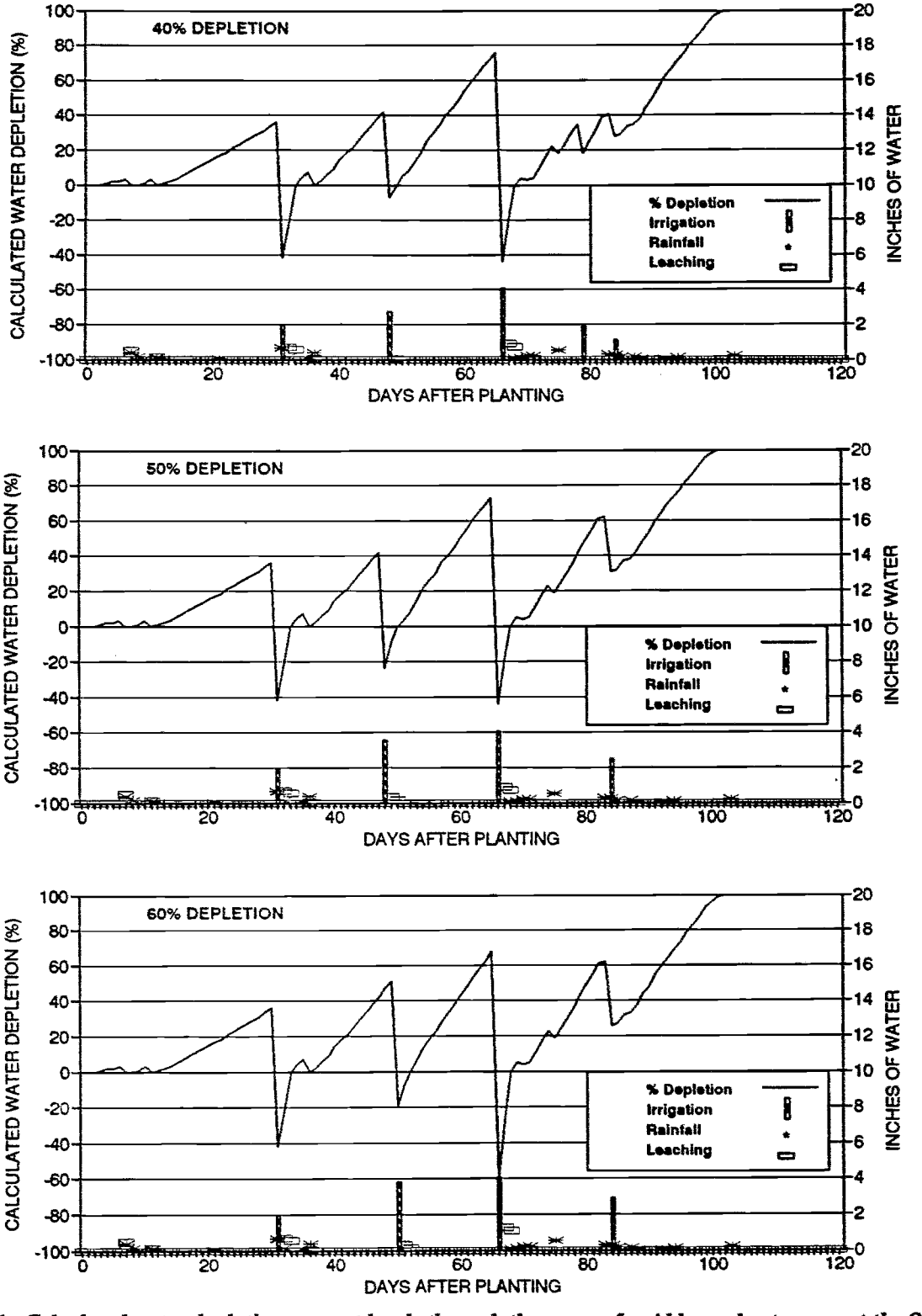

Figure 1. Calculated water depletion percent levels through the season for Aldura wheat grown at the Safford Agricultural Center under three irrigation strategies, using AZSCHED software.

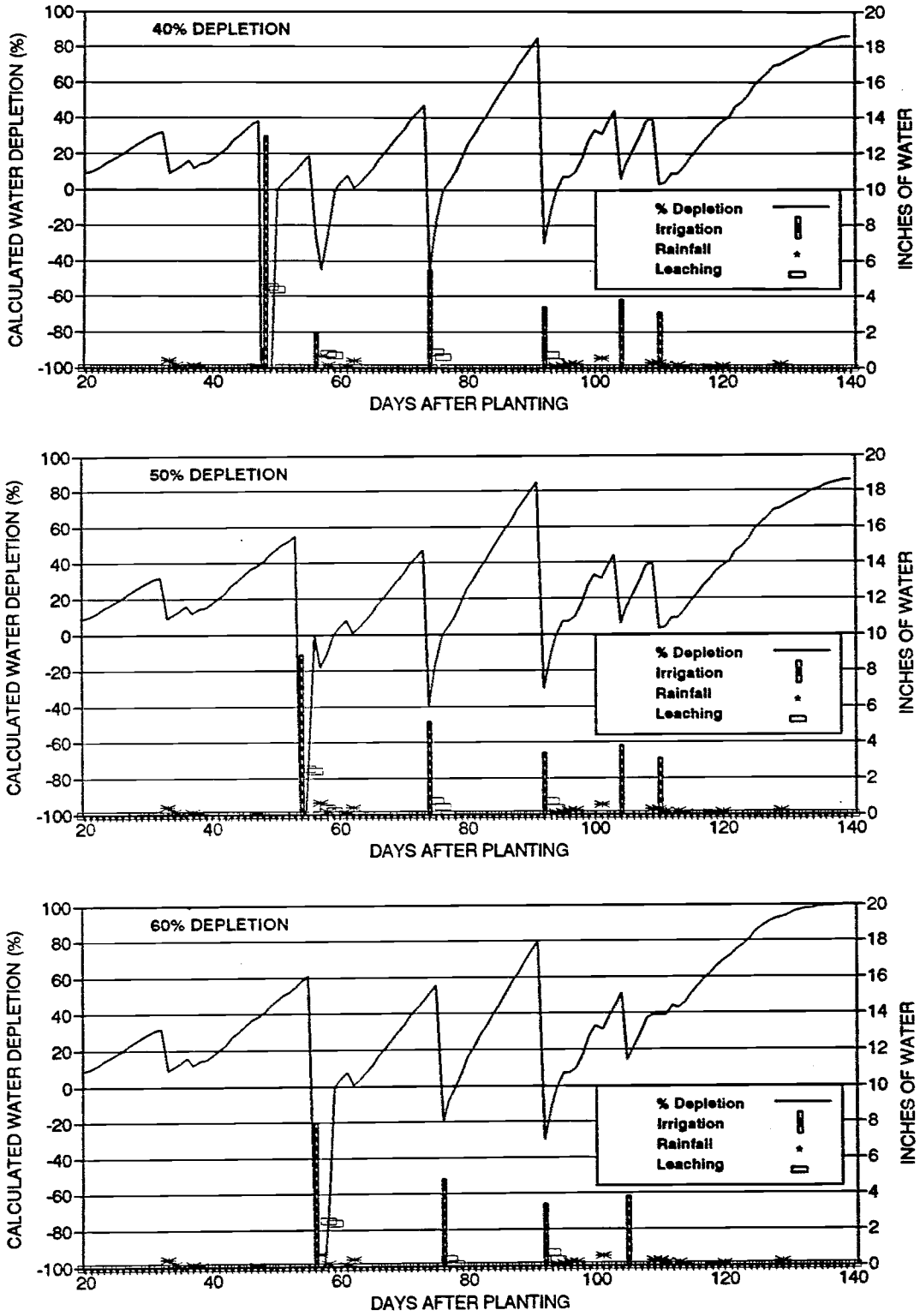

Figure 2 Calculated water depletion percent levels through the season for barley grown at the Safford Agricultural Center under three irrigation strategies, using AZSCHED software.