

# **Irrigation Scheduling on Small Grains using AZSCHED for Windows - Safford Agricultural Center, 2004**

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## ***Abstract***

*The AZSCHED irrigation scheduling software was developed in the early 1990's to be used in a DOS environment on computers (1) and has been used extensively for irrigation scheduling on the Safford Agricultural Center since its development. The new Windows version of AZSCHED (2) was first tested for barley and wheat in 2003. This is a follow-up verification to the first test using a wider range of irrigation depletion levels.*

## **Introduction**

AZSCHED software has been used for more than ten years at this location and has been of tremendous value to provide irrigation water to the many small plots in a timely fashion. The new Windows version was first tested in 2003 with a fairly narrow selection of soil water depletion levels. This trial is a follow-up experiment to verify the results of the previous trial but also modified to extend the soil water depletion level to 60%. Orita durum wheat and Nebula barley varieties were tested this year.

## **Materials and Methods**

Experimental plots were rowed-off and firmed with a roller prior to planting the variety trials so seed placement would be somewhat consistent from top of beds to bottom of furrows. Plots were planted with a 12-foot International grain drill with fertilizer attachment, over four 36" beds. The cultural practices applied are described below in the crop history.

### *Crop History (Wheat):*

Previous crop: Cotton

Soil type: Grabe clay loam

Planting date: 16 December 2003    Watered up: 17 December 2003    Seeding rate: 200 lbs/ac (Orita Durum)

Fertilizer: 400 lbs/ac of 16-20-0 at planting, 200 lbs/ac urea side dressed on 19 Feb and 23 Mar

Herbicide: 2,4-D applied 15 April

Insecticide: None

Irrigation: Furrow, watered up and watered according to AZSCHED schedule

Water holding capacity: 0-1' = 2.3 in/ft, 1-2' = 2.2 in/ft, 2-3' = 1.5, 3-4' = 1.0 in/ft

Rainfall during the growing season: 2.48 inches

Plot size: 4 rows (12 feet) wide by 200 feet long

Harvest date: 21 June 2004

Heat Units (40/81°F) from watering-up to maturity: 3248 HU

### *Crop History (Barley):*

Previous crop: Cotton

Soil type: Pima clay loam variant

Planting date: 12 December 2003    Watered up: 17 December 2003    Seeding rate: 160 lbs/ac (Nebula variety)

Fertilizer: 400 lbs/ac of 16-20-0 at planting, 200 lbs/ac urea side dressed on 19 Feb and 26 Mar

Herbicide: 2,4-D applied 15 April

Insecticide: None

Irrigation: Furrow, watered up and watered according to AZSCHED schedule

Water holding capacity: 0-1' = 2.3 in/ft, 1-2' = 2.2 in/ft, 2-3' = 1.5 in/ft, 3-4' = 1.6 in/ft

Rainfall during the growing season: 2.48 inches

Plot size: 4 rows (12 feet) wide by 200 feet long

Harvest date: 21 June 2004

Heat Units (40/81°F) from watering-up to maturity: 3180 HU

Fields in the AZSCHED program were set using our best estimates of water holding capacity throughout the rooting zone for wheat and barley (shown above in Crop History) and selecting wheat and barley, respectively, from the crop data file. The planting date was supplied to the program, AZMET data was updated approximately weekly and irrigation amounts and rainfall were input as they occurred. Weekly irrigation prediction reports were prepared and placed in the hands of the Farm Manager, Farm Supervisor and the irrigator. This group met and made final decisions on which fields were watered and when. Their decisions were made based on water availability, how many fields were needing water and the weather. The three treatments were to apply water at 40 percent, 50 percent and 60 percent soil water depletion.

At maturity plant height measurements and the plots were harvested using a Gleaner Model K combine. Grain from each plot was weighed in a weigh wagon where samples were taken to determine percent moisture, bushel weight and 1000 kernel weights. In the case of wheat, percent protein was also determined.

## **Results and Discussion**

Table 1 shows yield, grain quality and other agronomic data on durum wheat. Yields increased with decreasing depletion level, as would be expected. Increases in plant heights were seen with lower depletion levels and percent protein increased with higher depletion levels. Bushel weight, percent moisture in the grain, percent dark hard vitreous (DHV) kernels and kernel weight did not change significantly with soil water depletion treatment. All of the values were good and acceptable for export criteria. It is interesting that the values were slightly higher than for the Kofa variety of durum wheat which was used in the trial in 2003 (3).

The first column in Table 2 lists the number of inches of irrigation water applied with the various treatments. The number of irrigations applied are shown in the last column. The amount of irrigation water applied is proportional to the number of irrigations with the 40% depletion level receiving almost twice as much water at the 60% depletion level treatment. Calculated soil water depletion levels from AZSCHED generated tables were analyzed and displayed in the next two columns. The average depletion level from planting to maturity is low because it starts at zero at planting, slowly working its way up to the trigger level and then drops to low values after each irrigation or rainfall event. The average depletion level just before irrigation uses only values on the day before an irrigation. If irrigations were applied when the software called for an irrigation, one would expect to see values of 40, 50 and 60 in this column. The values are lower than these values for two reasons: depletion levels on the day before an irrigation vary from 1 to 7 percent lower than the day of the irrigation and irrigations are normally scheduled early rather than late, especially if a weekend is involved. The next column in Table 2 shows a value related to irrigation efficiency. The higher the value the more grain was produced per inch of water applied. This indicates that the 50% depletion level was the most water efficient treatment, which corroborates the results of last year's study. AZSCHED calculates a leaching loss. If more water is added to the soil profile than can be stored in the soil or used by the plant in 2 days, that water is considered as lost and added to the leaching amount. In this study, the least amount of water was leached in the treatment where the least amount of water was applied.

Tables 3 and 4 present data for barley. In Table 3 the yields varied inversely with depletion level, very similar to the

wheat yields. Percent moisture in the grain and plant height also increased as depletion level decreased. Table 4 shows the same data as described for wheat in Table 2. Worthy of note is that the 50% and 60% treatments received the same amount of water, only with slightly different timing. The timing made a big difference, yield wise, and with the yield per unit of applied water. The 50% depletion level was the superior treatment.

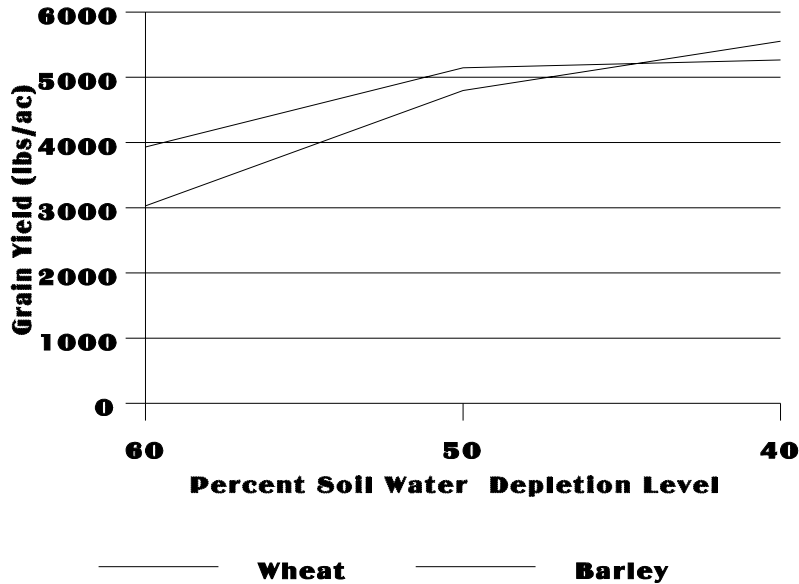


Figure 1 shows the relationship between grain yield and soil water depletion level for wheat and barley. A break point is seen at the 50% level for both grains, after this point grain yields continued to rise, but at a lower rate of increase. The economic breakeven point would depend on the value of the grain and the cost per unit of water.

### References

1. Fox, F.A. Jr., T.F. Scherer, D.C. Slack and L.J. Clark. 1992. Arizona Irrigation Scheduling (AZSCHED Version 1.01): Users Manual. Cooperative Extension, Agricultural and Biosystems Engineering. The University of Arizona, Tucson, AZ. Publication number, 191049.
2. Martin, E.C., D.C. Slack, H. Detwiler and J. Jones. 2003. Arizona Irrigation Scheduling System (AZSCHED Version 1.14): Users Handbook. Cooperative Extension, Agricultural and Biosystems Engineering. The University of Arizona, Tucson, AZ. <http://ag.arizona.edu/crops/irrigation/azsched/azsched.html>.
3. Clark, Lee J., K.F. Ellsworth. 2003. Irrigation Scheduling on Small Grains using AZSCHED for Windows - Safford Agricultural Center, 2003. Forage and Grain, A College of Agriculture and Life Sciences Report, The University of Arizona, Tucson, AZ. Series P-135, pp. 49-54.

**Table 1. Yield and other agronomic data from the durum wheat irrigation scheduling trial, Safford Agricultural Center, 2004.**

Treatment	Yield per acre @10% M	Bushel Weight	Percent Moisture	Plant Height (in)	Percent Protein	% DHV Kernels	100 Kernel Weight(g)
40% Depletion	5553 a <sup>1</sup>	61.4 a	10.1 a	32.4 a	14.53	100.0 a	5.35 a
50% Depletion	4794 a	61.3 a	9.7 a	30.3 ab	14.80	99.5 a	5.43 a
60% Depletion	3027 b	61.6 a	9.7 a	28.1 b	15.31	99.8 a	5.35 a
Average	4458.0	61.4	9.8	30.3	14.9	99.8	5.4
LSD (05)	1686.2	0.9	1.6	2.6	--	0.64	0.31
CV (%)	21.9	0.8	9.4	5.0	--	0.4	3.4

1. Values followed by the same letter, within a column, are not significantly different at the 95% level of confidence using Duncan's Multiple Range test.

**Table 2. Measured and calculated water data from the durum wheat irrigation scheduling trial, Safford Agricultural Center, 2004.**

Treatment	Irrigation Water Applied (in)	Average Depletion Level (Planting to Maturity)	Average Depletion Level (Just Before Irrigation)	Yield Divided by Applied Water	Water Leached From Root Zone (in)	Number of irrigations
40% Depletion	37.3	18.4	46.4	148.9	0.43	7
50% Depletion	31.3	20.3	44.8	153.2	0.28	6
60% Depletion	20.1	33.3	69.0	150.6	0.04	4
Average	29.6	24.0	53.4	150.9	0.25	5.7

**Table 3. Yield and other agronomic data from the barley irrigation scheduling trial, Safford Agricultural Center, 2004.**

Treatment	Yield per acre @10% M	Bushel Weight	Percent Moisture	Plant Height (in)	100 Kernel Weight(g)
40% Depletion	5265 a <sup>1</sup>	53.7 a	11.4 a	26.0 a	4.67 a
50% Depletion	5143 a	53.3 a	11.3 a	24.3 a	4.47 a
60% Depletion	3930 a	52.7 a	10.8 b	21.2 a	4.37 a
Average	4779.3	53.2	11.2	23.8	4.5
LSD (05)	1501.8	2.0	0.18	6.9	0.45
CV (%)	13.9	1.7	0.7	12.8	4.4

1. Values followed by the same letter, within a column, are not significantly different at the 95% level of confidence using Duncan's Multiple Range test.

**Table 4. Measured and calculated water data from the barley irrigation scheduling trial, Safford Agricultural Center, 2004.**

Treatment	Irrigation Water Applied (in)	Average Depletion Level (Planting to Maturity)	Average Depletion Level (Just Before Irrigation)	Yield Divided by Applied Water	Water Leached From Root Zone (in)	Number of irrigations
40% Depletion	31.3	17.6	37.8	168.2	0.47	6
50% Depletion	20.1	25.6	58.8	255.9	0.12	4
60% Depletion	20.1	24.4	59.3	195.5	0.20	4
Average	22.53	52.0	206.5	0.26	4.67	