Wheat Irrigation Scheduling at the Safford Agricultural Center, 1989

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ABSTRACT

Wheat irrigations were scheduled using two computer models and an infrared thermometer, using three critical threshold values. Yields from these plots were compared with plots scheduled by the farm manager. The highest yield was obtained by the computer model using evapotranspiration data taken from the local AZMET station; this corroborates results from the previous year. The crop coefficients and the irrigation model that have been developed over the past several years are very accurate for this area. The two lower threshold infrared treatments were second and third in yield and had lower water use efficiencies.

INTRODUCTION

Since water is one of the major concerns in Arizona agriculture, our research has continued to define several alternatives in irrigation scheduling on wheat. Previous research has provided computer models and crop coefficients that produced yields superior to the farmer-scheduled irrigations. Also, work with the infrared thermometer has defined the critical stress levels which must not be exceeded to achieve maximum yields. This present research is to corroborate the results of the previous year on the work (1) with computer models and to add an intermediate stress level on the infrared thermometer work.

METHODS AND MATERIALS

Six different methods were used to schedule irrigations in this study.

1. Availability of ditch water and the farm manager's knowledge of the crop's needs determined when to irrigate and how much water to apply.

2. A computer method described by Clark and Biggs (2) was used. This was a checkbook method that used historical evapotranspiration (ET) calculated for this area from Erie, French and Bucks' consumptive use curves. Soil moisture holding capacities were supplied to the computer program which simulated root growth with time and showed moisture status throughout the root zone and of water needed to bring the soil back to field capacity. Irrigation was initiated when this model showed a deficit greater than 3 inches.

3. The second method was repeated, except that ET data from the AZMET system replaced historical ET values.

4.,5.,6. The infrared thermometer determined the crop stress index (SI). These plots were irrigated when the SI were approximately 2, 3 and 4 and are referred to as the IR low (Method 4), medium (Method 5) and high (Method 6) threshold, respectively.

The Stress Indices computed by the Scheduler are approximately ten times the value of the Crop Water Stress Index values. The infrared thermometer methods did not indicate the amount of water to be added at each irrigation, so generally, the water was pushed through the furrows and as soon as the furrows were full, the flow was stopped.

Crop History: Aldura wheat

Soil type: Grabe clay loam
Water holding capacity: 2.42 inches in the 0 - 6" layer
3.54 inches in the 6 - 18" layer
2.67 inches in the 18 - 24" layer
Planting date: 21 December 1988
Planting rate: 150 pounds of seed per acre
Fertilizer: 300 lbs/ac 16-20-0 preplant
222 lbs/ac urea on 10 - 17 March
Herbicide: 2,4-D
Insecticide: Malathion
Irrigation:

Date/Trtmt	1	2	3	4	5	6
	Frm mgr	Comp(hist)	CompAZMET	IR low	IR med	IR hi
21 Dec	12.0	12.0	12.0	12.0	12.0	12.0
10 Feb	3.0	3.0	3.0	3.0	3.0	3.0
10 Mar		3.2	3.2	3.2	3.2	
17 Mar	3.1					3.1
24 Mar				3.0	3.0	
31 Mar	2.9	2.9	2.9	2.9		
6 Apr				2.6	2.6	2.6
22 Apr	5.4	5.4		5.4		
26 Apr			3.2		3.2	3.2
6 May			3.7	3.7	3.7	
9 May	3.4	3.4				3.4
19 May			4.1	4.1	4.1	
Totals	29.8	29.9	35.7	39.9	34.8	27.3

Rainfall: 1.39 inches
Harvest date: 12 June
Plot size: 12 feet by 220 feet
Harvested area: 6 feet by 200 feet
Number of replicates: 4

Plant heights were measured prior to harvest, plots were harvested with a Massey Harris Clipper small plot harvester. Bushel weights and percent moisture were determined in the field.

RESULTS AND DISCUSSION

Table 1. Yield, Bushel Weight, Plant Height and Amount of Irrigation Water Applied by Treatment on the Safford Agricultural Center, 1989.

TREATMENT	YIELD* (lbs/ac)	BU WT (lbs)	PL HT (in)	IRRIG (in)	EFFIC (lbs/ac in)
Comp (AZMET)	4081 a**	55.0 a	25.6 a	35.7	114.3
IR (Low)	3795 a	55.6 a	25.0 a	39.9	95.1
IR (Med)	3664 ab	57.3 a	24.3 a	34.8	105.3
Check (Farm mgr)	3503 ab	57.3 a	24.5 a	29.8	117.6
Comp (Hist)	3018 b	57.0 a	22.3 a	29.9	100.9
IR (High)	2929 b	56.0 a	22.1 a	27.3	107.3
LSD (05)	629	ns	ns		

* Yields are corrected to 10% moisture.
** Values followed by the same letter, in a given column, are not statistically different at the 5% level using the Student-Newman-Keuls method.

The highest yield was for the treatment scheduled by the computer using real time weather data from the AZMET system. This indicates that the evapotranspiration model and the crop coefficients used must have been accurate. The significantly higher yield of the computer model driven by the AZMET real-time weather data over the computer model driven by the historical weather data is testimony to the fact that 1989 had a warmer, drier spring than normal. Heat units (86/55 deg F) from January 1st to May 20th in 1989 were 1169, whereas the normal is 829 (3) and the rainfall from January through May in 1989 was 1.34 inches and the average is 2.32 inches (4). The crop coefficients used are tabulated in Table 2.

Table 2. Crop coefficients with dates and growth stages of Aldura wheat in Safford, Arizona.

Dates	Crop coefficients	Stage of Growth
February 12th to March 5th	.75	1 to 4 leaves
March 5th to 11th	.85	
March 12th to 18th	.95	Ground covered, little soil showing
March 19th to 25th	1.05	First node visible
March 26th to April 1st	1.15	
April 2nd to end	1.20	Boot stage to hard dough

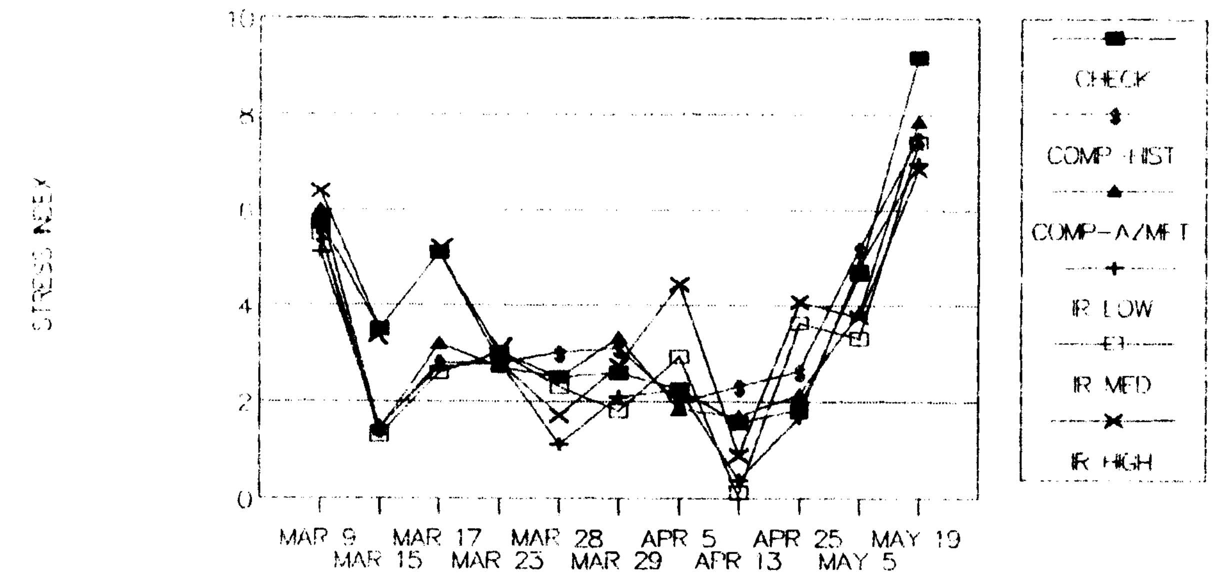

Figure 1. Stress levels on Aldura wheat as measured by an infrared thermometer throughout the season at Safford, Arizona.

Two of the treatments scheduled by the infrared thermometer did not yield significantly different from the highest yielding treatment. Within the IR scheduled treatments, the lower the threshold value, the higher the yield, the more water consumed and the lower the water use efficiency. Due to lower yields, the water use efficiencies were much lower this year than last. The yields were lower due to reduced stands, probably caused by the cold, dry winter. Head counts were not significantly different from treatment to treatment, but they varied from 20.8 to 24.5 heads per square foot. Figure 1 shows the stress levels measured from all treatments through the season.

The high threshold IR treatment was irrigated March 17th, April 6th, April 26th and May 9th, each time near a stress level of 4. Each of the other treatments can be traced to observe their stress levels throughout the season. High stress levels on March 9th were due to the IR gun "seeing" soil through the wheat leaves. The soil temperature on March 10th was 112 to 114 degrees F with air temperatures of 88 to 90 degrees. The high stress levels seen after May 5th were due to the drying of the wheat crop with very little transpiration taking place.

Figure 2 shows the cumulative amounts of irrigation applied to the various treatments throughout the season. The first two irrigations were applied to all treatments alike. The first was the initial post-plant irrigation to sprout the seed; the second irrigation was applied when experience indicated to do so. At that time, the computer models did not indicate an irrigation, and there was insufficient foliage to get IR readings. This is an area for future investigations.

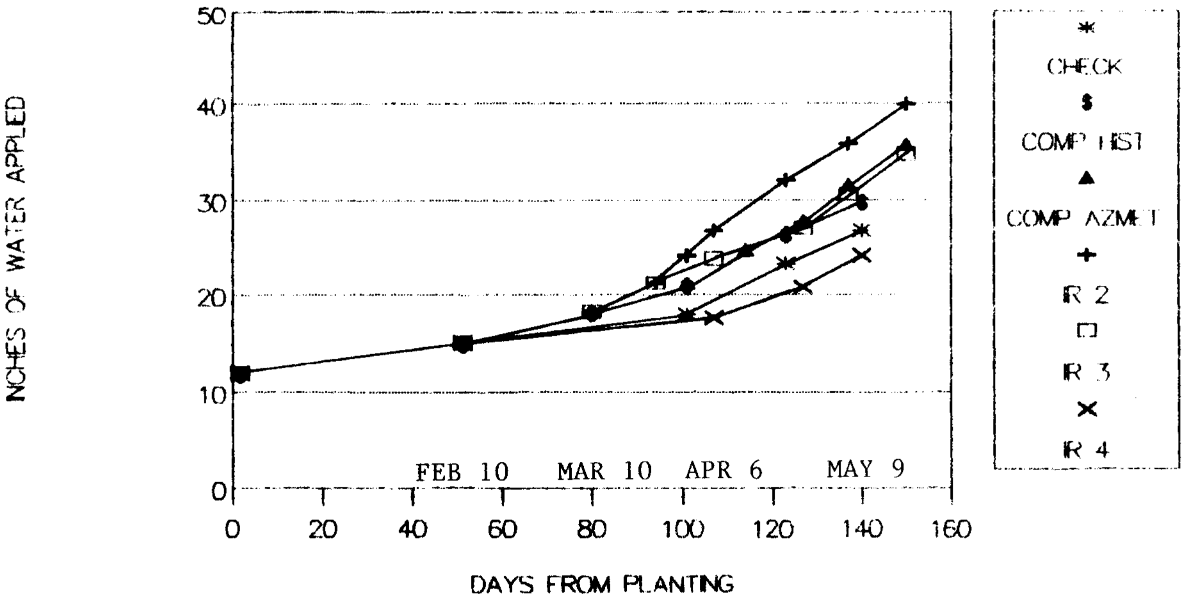

Figure 2. Cumulative irrigation amounts in acre inches applied by each treatment throughout the season.

ACKNOWLEDGEMENTS

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REFERENCES

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3. Personal communication with Paul Brown, Extension Biometeorology Specialist, University of Arizona, Tucson, AZ.

4. Personal communication with Jane Schlittenhardt, meteorologist at the Safford Agricultural Center and US Weather Bureau Station.