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Response of Wheat to Irrigation Regime and a Gel-Conditioner

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Abstract. Two field experiments were conducted in Nov. 1985 and Dec. 1986 to investigate the effects of irrigation regime and a gel-conditioner commercially called Jalma (containing 24% humic acids, and 3.8% polysaccharides) on wheat response. The first experiment consisted to two irrigation regimes: wet (14 irrigations, 50 mm each) and dry (7 irrigations, 50 mm each) and four dry Jalma rates: 0.0, 0.05, 0.1 and 0.2% (2.4 tonne/ha), each replicated three times in a split plot design. The experiment was repeated in the second season without addition of Jalma. The wet regime gave highly significant ($P = 0.01$) taller plants and heavier kernels and thus resulted in significantly higher grain and biological yields than the dry regime. With the exception of plant height in the second season, Jalma had no significant effect on wheat growth or yield.

Introduction

Most of the cultivated soils of Saudi Arabia are sandy [1]. Their productivity is limited by their low water holding capacities and excessive deep percolation losses. Furthermore, the irrigation water resources are very limited and farmers are seeking ways to improve the productivity of soils and increase crop water use efficiency.

Synthetic gel-forming soil conditioners may increase soil water holding capacity, suppress evapotranspiration losses, and increase crop water use efficiency [2-4], Johnson [5] found that polyacrylamide reduced evaporation and increased available water of coarse sand. Wallace and Wallace [6] reported that the application of 450 kg/ha of anionic polyacrylamide increased the vegetative yield of wheat. Very limited research has been conducted on the interactive effect of irrigation and synthetic conditioners on crop response. The objective of this study was to investigate the effects of irrigation regime and a gel-forming conditioner (Jalma) on the response of wheat.

Materials and Methods

Two field experiments were conducted in two seasons, namely 19*th* November 1985 - 4*th* April 1986, and 8*th* December 1986 – 12*th* April 1987 at the Agricultural Experimental Station of King Saud University at Deirab. The soil of the site is a sandy loam, mixed (Calcareous), hyperthermic Typic Torrifluvents. Selected properties of the soil and irrigation water were determined by standard procedures [7] and reported in Table 1. Selected meteorological data collected during the two successive seasons are reported in Table 2. The synthetic conditioner (produced by S.A.I.D. Vaulx en Velin, France) used (Jalma) contains 24.5% humic acid and 3.8% polysaccharides. One kilogram of Jalma gel contains 0.0326 kg of dry Jalma; the remaining part is water.

Table 1. Selected physicochemical properties of soil and irrigation water

Properties	Soil[a]	Water
Clay (%)	19	–
Silt (%)	19	–
Sand (%)	62	–
pH	7.7	7.8
EC (mS/cm)	4.9	5.5
SAR	6.8	7.0

[a] Soil pH is for the saturated paste, EC and SAR are for the saturation extract.

The experiment consisted of two irrigation regimes: dry and wet, and four dry Jalma rates: 0.0, 0.05, 0.1 and 0.2% (= 2.4 tn/ha), each with three replicates in a split plot design. The irrigation regimes were accommodated in the main plots (3 × 16 m) and the Jalma treatments in the subplots (3 × 4 m). The main plots were 3 m apart to avoid lateral flow. A depth of 50 mm of water was applied to each subplot at a time using a hose with a water meter attached to it. For the wet irrigation regime, 700 mm of water were added in 14 irrigations (14 × 50 mm) in the first season and 750 mm in 15 irrigations (15 × 50 mm) in the second season. The dry regime consisted of 350 mm applied in 7 irrigations (7 × 50 mm) in both seasons. Depending on weather conditions, the plots were irrigated every 7-13 and 15-22 days for wet and dry regimes, respectively. In the first season, predetermined quantities of Jalma gel were uniformaly scattered, on the surface of each subplot, and then mixed with the 10 cm topsoil. In the second season the experiment was repeated without the addition of Jalma. Soil moisture distribution in duplicate plots were measured at sowing and at harvest in both seasons. Soil samples were taken at 10 cm increments down to 80 cm and gravimetric moisture contents were determined. In both seasons the seed appli-

Table 2. Monthly mean of selected meteorological data collected during the two successive seasons at Dirab Exp. Station.

Season	Air temperature		Radiation	Relative humidity		Wind speed	US class A pan evaporation
	Max.	Min		Max.	Min.		
	°C		Cal/cm²/day	%		km/day	mm/day
1985/86							
November	28.9	10.8	332	75	19	69.8	5.4
December	20.3	4.9	291	85	22	71.2	3.3
January	20.5	6.2	322	85	23	72.4	3.9
February	24.5	8.1	382	74	21	108.7	5.4
March	28.6	16.2	416	72	19	115.2	7.7
April	32.0	16.0	435	75	20	100.6	6.9
1986/87							
December	20.1	5.0	281	82	22	77.5	3.2
January	22.7	4.8	336	88	19	69.1	4.1
February	27.6	7.1	408	82	21	81.1	5.8
March	26.5	12.3	392	72	19	105.0	5.9
April	35.2	17.0	504	70	14	106.0	9.9

cation rate was 150 kg/ha and each subplot received 75 kg/ha P_2O_5, 54 kg/ha K_2O and 150 kg/ha N. One cultivar (Yecora Rojo) was planted in 19 Nov. 1985 and in 8 Dec. 1986 for the first and second season, respectively. Wheat was harvested on 4 April 1986 and 12 April 1987 in the two seasons, respectively.

In each season, plant height at heading, weight of 1000 kernels, grain and biological yields were determined and analysis of variance of these parameters were carried out.

Results and Discussion

In general, the irrigation regime (quantity and frequency) had a very highly significant effect ($P = 0.01$) on mean plant height at heading, weight of 1000 kernels, grain and biological yields of wheat in the two seasons (Table 3). The results indicate that the wet regime (14 irrigations, 50 mm each) gave significantly taller plants, heavier kernels and higher grain and biological yields than the dry regime (receiving 7 irrigations, 50 mm each). It seems that the dry regime subjected the crop to intermittent higher water and osmotic stresses, particularly at grain development stages when the consumptive water use was at its peak (Table 2). These stresses may be responsible for the resultant depression in growth and yield.

Table 3. Effect of irrigation regime on mean (of 12 subplots) plant height at heading, weight of 1000 kernels, grain and biological yield of wheat.

Irrigation regime	Plant height	Weight of 1000 kernels	Grain yield	Biological yield
	cm	gm		tn/ha
		1985/86 Season		
Dry	60.7 ± 2.2	36.1 ± 3.0	5.1 ± 0.7	16.4 ± 2.7
Wet	76.7 ± 0.3	43.8 ± 3.5	7.8 ± 0.7	25.9 ± 3.2
$LSD_{.01}$	–	6.9	–	–
$LSD_{.001}$	4.3	–	1.2	6.7
		1986/87 Season		
Dry	76.0 ± 0.9	28.9 ± 1.8	3.9 ± 0.6	13.7 ± 1.2
Wet	90.6 ± 0.7	38.7 ± 0.8	6.8 ± 0.5	17.2 ± 0.7
$LSD_{.001}$	1.6	5.2	1.4	3.0

In 1986/87 season, the addition of 0.05% Jalma significantly ($P = 0.01$) increased plant height at heading from 89.3 to 91.0 cm for the wet regime and from 74.7 to 75.7 cm for the dry regime (Table 4). There was no significant additional increase with further increase of Jalma. The slight increase in plant height caused by Jalma addition was obviously too weak to reflect upon biological yield. Lack of significant conditioner effect may be attributed to the fact that the rate applied was too low to reduce evaporation or deep percolation losses. Our laboratory studies indicated that 0.4% Jalma was essential for significantly reducing evaporation and deep percolation losses [8,9]. While Shaviv *et al.* [10] reported that applying conditioners in the field similar to the laboratory studies led to much poorer results than expected. Accordingly, Jalma rates higher than 0.4% would be required for obtaining positive results. In this case cost-benefit analysis would be desirable.

The higher grain yields of the first season may be mainly attributed to a favorable growing period (earlier sowing and harvesting dates and longer season) (Table 2). Table 3 and 5 show that crop yield, significantly, increased with increase of total water use, and that on the average 800 mm of water may be essential for obtaining good yield. Since water use efficiency in the field may be about 75% of that of the experimental plots, a total irrigation water of 1067 mm may be required to give a desirable yield. The water use efficiency for the wet treatments of the two successive seasons were 98.5 and 80 kg/ha-cm, respectively.

Table 4. Effect of Jalma rate on plant height at headings, weight of 1000 kernels, grain and biological yield of wheat

Parameter	Irrigation regime	Jalma rate 0.0	0.05	0.1	0.2	$LSD_{.05}$	0.0	0.05	0.1	0.2	$LSD_{.05}$
		1985/86					1986/87				
Plant height (cm)	Dry	59.1	59.3	60	64.4	N.S.	74.7	75.7	76.3	76.3	0.8
	Wet	76.2	77.5	77	75.9	N.S.	89.3	91.0	91.0	91.0	0.8
weight of 1000	Dry	38.8	35.5	34.2	35.5	N.S.	20.6	28.8	27.7	38.5	N.S
kernels	Wet	44.0	41.5	46.7	42.9	N.S.	38.4	38.7	38.0	39.8	N.S
Grain yield	Dry	4.2	4.9	5.7	6.0	N.S.	3.8	4.1	4.0	4.0	N.S
(tn/ha)	Wet	8.1	8.6	7.2	7.2	N.S.	7.0	7.4	6.6	6.0	N.S
Biological yield	Dry	14.80	15.7	18.0	17.1	N.S.	14.7	13.3	12.7	14.0	N.S
(tn/ha)	Wet	25.6	28.8	24.4	24.9	N.S.	18.0	17.0	17.3	16.3	N.S

Table 5. Seasonal water use of wheat in the two seasons as affected by the irrigation regime [a]

Irrigation regime	Growing period	Amount of rainfall	Amount of irrigation	Amount of water stored in soil	Water use	U.S. class A pan evaporation
	days	mm	mm	mm	mm	mm
			1985/86 Season			
Dry	146	96	350	46.2	492.2	755.3
Wet	146	96	700	-4.2	791.8	755.3
			1986/87 Season			
Dry	125	54	350	67.9	471.9	664.8
Wet	125	54	750	46.5	850.5	664.8

[a]Water use includes the leaching requirement
Amount of water stored = Moisture content at sowing-(0-80 cm) – Moisture content at harvest (0-80 cm)

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استجابة محصول القمح للري وأحد المحسنات الصناعية

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ملخص البحث. أجريت دراسة حقلية لمدة سنتين (نوفمبر ١٩٨٥م وديسمبر ١٩٨٦م) حول تأثير مستوى الري وسوبر جل عضوى، جلما (يحتوي على ٢٤٫٥٪ حامض هيومى و ٣٫٨٪ سكر عدادى) على استجابة محصول القمح، شملت التجربة الأولى على مستويين من الري: عالي (١٤ رية، ٥٠ ملم لكل رية) ومنخفض (٧ ريات، ٥٠ ملم لكل رية) وأربع معدلات جلما: صفر، ٠٫٥، ١ر، ٢ر٪ (٢٫٤ طن/هكتار) بثلاث مكررات لكل معاملة في تصميم قطعة منشقة. أعيدت التجربة في الموسم الثاني، ولكن بدون إضافة جلما.

أعطى مستوى الري العالي زيادة معنوية في طول النبات ووزن ١٠٠٠ بذرة وإنتاجية المحصول. لم يكن هناك تأثير لجلما على نمو وإنتاجية المحصول باستثناء تأثيرها على طول النبات في الموسم الثاني.