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Differences in wheat grain yield under varying seed rates to within and inter seasonal temperature Variation

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ABSTRACT

Four wheat cultivars were studied at the Gezira Research Station Farm, Wad Medani, Sudan, for two seasons (2004/05-2005/06) in split-split plot design, where sowing dates occupied the main plots, seed rates in sub-plots and the cultivars in the sub-sub plots with four replicates. The First objective of this study was compared field performance of the cultivars under varying temperatures. Second one was assessed within season and between seasons variations in grain yield. The results show that three cultivars Elneilain, Debeira and Argine were obtained high grain yield in the early heat stress (early season) while, the cultivar Condor was best in the late heat stress. Moreover, the variations in grain yield were more within season than between seasons under varying temperatures. Population densities (seed rates), under varying temperatures, had significant effect on grain yield but the interaction between seed rates and cultivars had no significant effect

Keywords: Bread wheat; sowing date; seed rate; Gezira.

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INTRODUCTION

Heat stress is one of the major constrains of wheat (*Triticum aestivum* L.) production in many areas around the world. At late growth stages it is a problem in 40% of wheat areas in the temperate environments (Reynolds . 2001). Moreover, wheat encounters heat stress during the early growth stages in the tropical and subtropical regions (Elahmadi 1995). In the Sudan, wheat is cultivated along a rising thermal gradient extending from the Northern State to the Central, where is winter season (wheat growing season) gets shorter and warmer southwards. A number of environmental stresses affect wheat productivity, but heat stress remains the main constrain and affects the crop at all stages of its development (Ageeb 1994; Elahmadi 1995). Late heat stress is quite common because of the delay in sowing often practiced by farmers due to many reasons (Ibrahim 1995). However, early heat stress is also important because of the great annual weather fluctuations (Elahmadi 1995). Under such hot marginal environment for wheat growth, increasing grain productivity is a challenge to wheat breeding. Detailed studies of diverse and adapted commercial wheat cultivars may generate useful information to improve the breeding process. The main objective of this study is to compare field performance of the cultivars under varying temperatures and to assess within seasons and between seasons variations in grain yield by using four cultivars with three sowing dates and three seed rates.

MATERIALS AND METHODS

The experiment was conducted at the Gezira Research Farm, Wad Medani, Sudan (Latitude 14° 24' N, longitude 33° 29'E 407 msol). The soil is heavy craking clay cis classified as fine montmorillonitic, isohypermic with pH (8.0 – 8.3) and rooting depth of up to about 40 cm. Four agro-morphologically different bread wheat commercial cultivars; Elneilain, Debeira, Argine and Condor were studied for two seasons (2004/5 – 2005/06) in three sowing dates (November 6th, November 21th and

December 6th) and three seed rates (25, 50 and 75 kg/feddan). The seed rates were adjusted according to the thousand seed weight in order to get the same plant populations (densities) for all cultivars. The populations were 155, 310 and 415 grains per square meter. The treatments arranged in a split-split plot design. The sowing dates were assigned to the main plots, the seed rates to the sub-plots and the cultivars to the sub-sub plots. The sub-sub plot consisted of 6 rows, 6 meters long and 0.2 meters apart (7.2 m² gross area). The experimental seeds were treated with the insecticide Gaucho (at the rate of 1 gm/kg) to avoid termites and aphids attack. Seed planting in the first season was done by hand and in the second season was made by seed drill. The experiment received two doses of fertilizer nitrogen (36 kg N/feddan) in the form of urea and one dose of phosphorus (18 kg P₂O₅/feddan) in the form of super-phosphate. Both fertilizers applied before planting. The experiment was irrigated every 10-14 days, depending on growth stages. Weeding was done at least twice by hand. Harvesting (4 X 5X 0.2= 4 m² net area) and threshing was done by hand. The data were statistically analyzed using Gen Stat software. The means were separated by DMRT. Temperatures were recorded from Wad Medani Meteorological station for the two seasons.

RESULTS AND DISCUSSION

The mean temperatures for season 2004/05 and 2005/06 are shown in figure (1). Second season was warmer especially in December and January and it was cooler after February, 10 compared to the first season. Generally second season was considered warmer than the first season.

The results of the first season 2004/05 showed that the four wheat cultivars demonstrated highly significantly different mean grain yields and in a decreasing trend with sowing date (Table 1). The first three cultivars, Argine, Elneilain and Debeira exhibited more differences between the first and the third sowing date due to the low yields in the third sowing date resulting from terminal heat stress. However the crop was exposed to water stress in the third sowing date and hence most likely affected by it. The yield variations in Condor were less than expected because the mean yield at the three sowing dates were comparable, it benefited from the cooler temperatures in December and January and being early maturing, it was less stressed by the terminal high temperature.

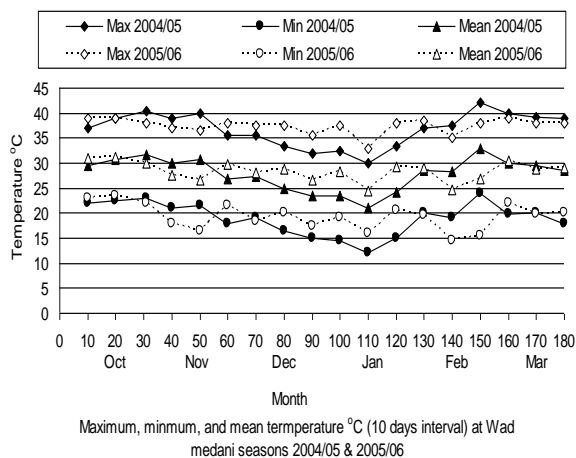


Figure 1

On the first season the yield reduction in the third sowing date could be the results of a number of factors; including moisture stress and high temperatures. Cultivars subjected to late heat stress that accelerated their development and thus reduced their potential for grain yield. Same results were found by Harrison, , 1987 and Reynolds , 1998.

On the second season, the mean grain yields of the three wheat cultivars, Argine, Elneilain and Debeira were not significantly different (Table 2). The fourth cultivar, Condor, produced significantly different mean grain yields with an increasing trend from early to late sowing date. The second season was generally warmer in December and January and cooler in February (Fig 1). Therefore, the cultivars Argine, Elneilain and Debeira being tolerant to early heat stress demonstrated less variation in mean grain yield in the first two sowing dates, while the yield in the third sowing date was more than expected due to the cooler temperatures in February. Condor is more sensitive to early and less sensitive to late heat stress, exhibited large yield variations due to the low yields in the first and the second sowing dates and relatively higher yield in the third sowing date.

Generally, wheat productivity was higher in the first season than in the second season. This was obviously due to cooler temperatures in the first season especially in December and January (fig 1). The late rise of temperatures in February in the first

season exerted terminal heat stress and it is resulted in lower yield in the third sowing date. Early and mid-season high temperatures in the second season reduced and sealed the mean yields in all four wheat cultivars in the first and second sowing dates. The cultivar Condor, being early maturing and heat sensitive, was generally adversely affected by early planting that resulted in relatively lower yields (second season).

Variations in grain yield between the two seasons:

The two seasons were contrasting in temperatures (fig.1). The first season compared to the second was warmer in November, cooler in December and January and warmer in February. Since the first season was generally cooler than the second season, wheat productivity was higher in the first season. Yield variations of the cultivars in the two seasons are given in (Table 3). In the second season grain yield was reduced by; 28 %, 10 % in Argine, 33 %, 16% in Elneilain, 31 %, 18 % in Debeira and 48 %, 42 % in Condor in the first and second sowing date respectively. Grain yield in the third sowing date was increased in the second season due to the cooler conditions by 35 %, 17 %, 21% and 32 % in Argine, Elneilain, Debeira and Condor, respectively. The cultivar Argine produced comparable mean yields in the early sowing dates in both season, and Condor did the same in the third sowing date. This was probably due to the better heat tolerance in Argine to early season high temperatures and Condor tolerance (or escape) to late season high temperatures. Condor due to its sensitivity to early heat stress showed higher yield variations between the two seasons in the first two sowing dates. Elneilain and Debeira showed comparable high yield variation between the two seasons. However, the cultivar Argine demonstrated least variation between the two contrasting seasons.

Sowing date x cultivar interaction showed highly significant differences on grain yield with the forth cultivar (Condor). In contrast to the first season, the second season showed no significant sowing date x cultivar interaction with respect to the grain yield in the other three cultivars Argine, Elneilain and Debeira due to high temperatures in the first and second sowing time.

Effect of seed rate on grain yield:

The effect of seed rate on grain yield was highly significant in both seasons (Table 2 and 3). Similar result was found by Akasha, 1976 and Ageeb, 1977. The lowest seed rate (155 seeds / m²) produced significantly lower yield than the other two while in the second season the higher seed rate (415 seeds / m²) produced significantly higher yield than the other two lower seed rates. In the first season, grain yield was reduced by delayed planting but, magnitude of yield loss was reduced by using an early maturing cultivar (Condor) and higher seeding rate. On The other hand, the seed rate x cultivar interaction on grain yield was not significant in both seasons.

Table 1. The response in grain yield (t/ha) in the four cultivars to the variation in sowing dates and seed rates season 2004 / 05

Season 2004/05								
	Sowing date			Means	Seed rate			Means
	6/11	21/11	6/12		155 seeds/m ²	310 seeds/m ²	415 seeds/m ²	
Argine	3.6	2.9	2.0	2.8	2.7	2.9	2.9	2.8 b
Elneilain	3.8	3.1	2.4	3.3	2.9	3.7	3.2	3.3 a
Debeira	3.5	2.8	1.7	2.7	2.4	2.8	3.0	2.7 b
Condor	3.3	3.3	2.6	3.1	2.8	3.2	3.2	3.1 a
Means	3.6 a	3.0 b	2.2 c		2.7 b	3.2 a	3.1 a	
C.V% 9.2								
SE ± SD = 0.18** SR = 0.15** CU = 0.13** SD X CU = 0.27***								
SR X CU = 0.27 ^{ns} SD X SR = 0.13***								
Sowing date = SD Seed rate = SR Cultivar = CU								

Table 2. The response in grain yield (t/ha) in the four cultivars to the variation in sowing dates and seed rates season 2005/ 06

Season 2005/06								
	Sowing date			Means	Seed rate			Means
	6/11	21/11	6/12		155 seeds/m ²	310 seeds/m ²	415 seeds/m ²	
Argine	2.6	2.6	2.7	2.6	2.5	2.6	2.9	2.7 a
Elneilain	2.6	2.6	2.7	2.6	2.6	2.5	2.9	2.7 a
Debeira	2.4	2.3	2.3	2.3	2.1	2.4	2.6	2.4 b
Condor	1.7	1.9	2.7	2.1	2.1	1.9	2.4	2.1 c
Means	2.3 b	2.4 b	2.6 a		2.3 b	2.3 b	2.7 a	
C.V% 9.2								
SE ± SD = 0.15** SR = 0.14** CU = 0.09** SD X CU = 0.27***								
SR X CU = 0.27 ^{ns} SD X SR = 0.11***								
Means followed by the same letter(s) within the same column and row are not significant different.								
** Significant the 0.01 level.								
* Significant the 0.05level								

Table 3. Difference in mean grain yield between the two seasons (2004/05-2005/06)

cultivars	season	sowing dates			Mean t/ha
		6/11 t/ha	21/11 t/ha	6/12 t/ha	
Argine	2004/05	3.6	2.9	2.0	2.7
	2005/06	2.6	2.6	2.7	2.6
	difference	28 %	10 %	35%	0.04 %
		(-)	(-)	(+)	(-)
Elneilain	2004/05	3.8	3.1	2.4	3.1
	2005/06	2.6	2.6	2.8	2.7
	difference	33 %	16 %	17	13 %
		(-)	(-)	(+)	(-)
Debeira	2004/05	3.5	2.8	1.9	2.7
	2005/06	2.4	2.3	2.3	2.3
	difference	31 %	18 %	21	15 %
		(-)	(-)	(+)	(-)
Condor	2004/05	3.3	3.3	2.6	3.1
	2005/06	1.7	1.9	2.7	2.1
	difference	48 %	42 %	.04	32 %
		(-)	(-)	(+)	(-)

CONCLUSION

This study was conducted to identify the fluctuations on wheat grain yield due to different sowing dates and seed rates to within and inter seasonal temperature variations. The findings can be summarized as following:

- (1) The coincident variation in the temperature within the two seasons provided good opportunity genotypic responds of the tested cultivars to heat stress witch is reflect on the grain yield.
- (2) Through variation between the two seasons the tested cultivars responded differently on the grain yield at different sowing dates.
- (3) None of the wheat cultivars studied was suitable for both early and late plantings but the medium maturing cultivars (Argine, Elneilain and Debeira) should be planted early in the season, while the early maturing cultivar Condor can be planted relatively late.
- (4) Generally population densities (seed rates by cultivar interaction), under varying temperatures, have no significant effects on grain yield, but the study suggested its better to use higher seed rates (310-415 seeds / m²).

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