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Effect of Three Sowing Dates on the Quality Characteristics of Bread Wheat (*Triticum aestivum* L.) Grown in Central Sudan

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Abstract: This research was conducted to study the effect of different sowing dates on the quality characteristics of bread wheat (*Triticum aestivum* L.) grains grown in central Sudan during 2005/2006 season. The field experiment was executed by split plot design with three replications. Three sowing dates (November 6th, November 21st and December 6th) were used to represent the early, mid and late sowing dates. Grain quality characteristics of four released cultivars; namely, Argine, Alneilain, Debeira and Condor were studied. Characters such as 1000 - kernel (grain) weight, test weight (Hectoliter weight) and flour yield declined progressively with delayed sowing date (6th Dec.). Maximum values were obtained in the early sowing date (6th Nov.) and minimum values in the late sowing date (6th Dec.).The results showed that proper sowing date resulted in the highest protein and gluten values in wheat grain and flour. With the late sowing date, these two parameters decreased in all cultivars tested. The cultivars Debeira and Condor were the most affected, while the cultivar Argine showed little effect. Argine had higher protein and gluten values than the other cultivars in the three sowing dates. The change of proportions of different protein components in wheat grain induced by the variation of sowing dates could be the main reason for the improvement in wheat grain quality in Sudan.

Key words: Sowing time; bread wheat; proximate composition; quality characteristics

INTRODUCTION

Wheat (*Triticum aestivum* L.), the most important cereal crop, feeds most of the world's population. It is contributing 28% of the world edible dry matter and up to 60% of the daily calorie intake in several developing countries (Singh *et al*. 2012). Wheat consumption is increasing worldwide as a result of higher income levels, urbanization, and substitution with other cereals. Therefore, the nutritional quality of the wheat whole meal has a significant impact on human health and well-being, especially in the developing world (Peleg *et al*. 2008).
Globally, wheat is the leading source of vegetable protein in human food, having higher protein content than the other major cereals.

Bread wheat provides a considerable amount of trade throughout the world and a lot of other products. Its suitability and superiority in bread making with viscoelastic dough properties has been well known and documented (Bushuk1985; Branlard *et al.* 2001). Tahir and Alahmadi (2007) reported that wet gluten is an important parameter for good baking quality, and the value of 30% is considered minimum requirement. Wheat growing temperature above normal has a direct influence on wheat grain quality. Short heat stresses affect wheat quality especially in the post-anthesis period (>35°C) which can significantly decrease wheat grain quality (Randall and Moss 1990; Savin *et al.* 1996).

Wheat yields, in all producing areas in the Sudan, have been characterized by high variability and generally low levels relative to research results. Yield variations of the wheat crop were recorded in Gezira and New Halfa over a 12-year period (Faki *et al.* 1995). The data showed that the average wheat grain yield was 1.5 and 1.44 tons per hectare in the Gezira and New Halfa, respectively.

In the Sudan, wheat is grown along a rising thermal gradient extending from the Northern State to the centre, where the winter season (wheat growing season) gets shorter and warmer southwards. The length of the growing season in the Sudan ranges from 90 to 100 days (Ibrahim 1995). The optimum range of sowing date was found to be from 5 November to 1 December at the Gezira (centre), 16 November to 16 December at New Halfa (east) and 1 November to 9 December at Hudeiba (north). Short winter season and heat fluctuations lead to reduced production and grain

quality of wheat in Sudan. This study was conducted to assess the quality of different bread wheat cultivars under varying sowing dates.

MATERIALS AND METHODS

Field experiment

Four agro-morphologically different bread wheat commercial cultivars; namely, Alneilain, Debeira, Argine and Condor, were studied in the growing season 2005/2006. The experiment was conducted at the Gezira Research Farm, Wad Medani, Sudan (Latitude 14º 24' N, longitude 33º 29' E, 407 msol). The soil is heavy cracking clay, classified as fine montmorillonitic, isohypermic with pH of 8.0 – 8.3 and rooting depth up to about 40/cm. This soil has total N of 0.9439/kl, available Olsen P of 3.5 mg/kg and exchangeable K of 0.285 mg/kg. The experiment was arranged in a split plot design. The sowing dates (November 6th, November 21st and December 6^{th,}; early, mid and late, respectively) were assigned to the main plots and the cultivars to the sub plots which consisted of 6 rows, 6 metres long and 0.2 metres apart (7.2 m^2 gross area). Recommended seed rate 50kg/ feddan. The seeds were treated with the insecticide Gausho (at the rate of 1 gm/kg) to avoid termites and aphids attack. The experiment received two doses of fertilizer nitrogen (36 kg N/feddan) in the form of urea and one dose of phosphorus (18 kg P_2O_5/fed.) in the form of super-phosphate. Both fertilizers were applied before planting. The experiment was irrigated every 10-14 days, depending on growth stage. Weeding was done manually, at least twice. Temperatures were recorded from Wad Medani Meteorological Station.

Quality characteristics

At maturity, the crop was harvested and threshed. Two kilogrammes from each cultivar for each sowing date were subjected to the quality analysis, included physical testing according to the AACC (2000) standard methods. Data were collected on 1000- kernel (grain) weight, hectoliter weight (Test weight or grain density) and flour yield (Extraction rate). Proximate composition was carried out for whole meal (ground in a laboratory mill falling number, type KT120), using AOAC (1990) standard methods of analysis. Extracted flour was prepared using laboratory Quadramat junior mill after tempering the grains to 13.5% moisture level according to the standard method of the AACC (2000).

Gluten (wet and dry) and flour yield were determined according to the method of the AACC (2000). Falling number was measured according to Perten (1996) and bread specific volume according to Pyler (1973).

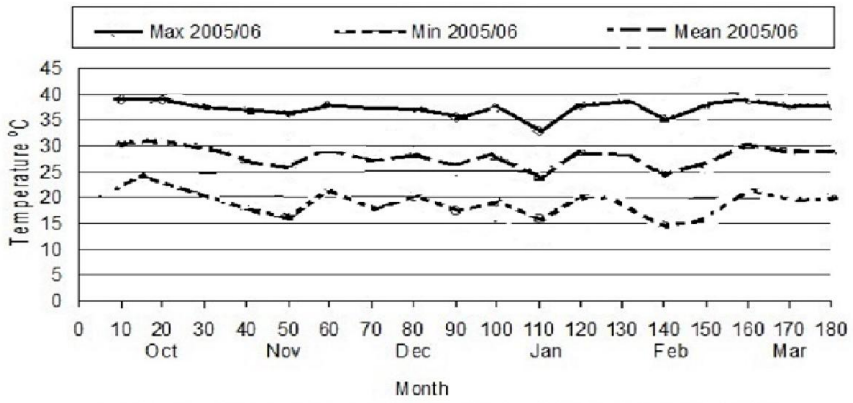
Statistical analysis

Data was subjected to the Statistical Package for Social Sciences (SPSS). Means were tested using One-Factor Analysis of Variance, and then separated using Duncan's Multiple Range Test (Mead and Gurnow 1983).

RESULTS AND DISCUSSION

Effect of temperature

Figure 1 shows the maximum, minimum and mean temperature (10 days intervals) at Wad Medani station during the growing season of 2005/2006. Maximum temperatures (C°) increased from the first of March to the end of the season (≥37°C). Throughout this period, all the cultivars were subjected to high temperatures during grain filling in the second and third sowing dates. Temperatures above normal alter plant functions and productivity. Short heat stresses (≥35°C) in the post-anthesis period can significantly decrease grain quality in wheat (Randall and Moss 1990; Stone and Nicolas 1994; Savin *et al*. 1996; Reynolds *et al.* 2001).



Maximum, minmum, and mean temperature °C (10 days interval) at Wad medani season 2005/06

1000-kernel weight

Thousand kernel (grain) weights (TKW) were affected by the sowing date and the cultivars (Table1). However, the cultivars differed significantly in this character. The first sowing date (Nov.6th) showed the maximum TKW for each cultivar. Debeira gave the highest value (34.89g) of TKW followed by Alneilain (34.80g), Condor (33.72g) and Argine (30.56g). There was a gradual decrease in TKW with delayed sowing date (Dec. 6th) and minimum values of grain weight were recorded for the last sowing date for the different cultivars (Table 1). Similar results were found by Singh and Pal, 2000; Qamar *et al.* 2004; Subhan *et al*. 2004; Abdullah *et al*. 2007. Decreasing trend of thousand grain weight was found with all cultivars from early to late sowing date except Alneilain. Lower grain sizes were obtained with delayed sowing. Similar results were reported by Patil e*t al.* (2000). The results of Alneilain cultivar indicated that it was less affected by varying temperatures. All the results of TKW were within the Sudanese Standard Specification (036 SDS) for wheat grain issued by SSMO (2012a).

Test weight

All tested cultivars affected significantly on the Test weight (g/l) due to the different sowing dates (Table 1). Maximum test weight was recorded in the first three sowing dates for each cultivar. Debeira gave the highest value of test weight (865.6g/l) followed by Condor (852.5g/l), Alneilain (838.1g/l) and Argine (817.7g/l). Higher test weight indicates sound grain and can be used to predict the potential flour yield in wheat grain. Results of test weight are in accordance with the previous findings (Singh and Dhaliwal 2000; Kumar and Sharma 2003).

Flour yield

Significant differences were found between the different sowing dates and the different cultivars for flour yield (Table 2). Flour yields decreased from 76.9%, 59.5%, 66.4% and 70.3% for the first sowing date to 62.7%, 55.3%, 62.1% and 58.1% for the last sowing date for Argine, Alneilain, Debeira and Condor, respectively (Table 2). Debeira and Argine showed the highest values of flour yield (73.7% and 71.9%, respectively) in the second sowing date. Effects of different sowing dates on flour yield (milling yield) were reported to be significant (Flood *et al.* 1996).

Proximate composition

Moisture content

Grain and moisture contents of the bread wheat cultivars were in the range of 7.23% to 8.3%, and 12.82% to 13.18%, respectively. These values are in accordance with the Sudanese Standard Specifications (036 SDS) for wheat grain (SSMO 2012a) and 037 SDS for wheat flour (SSMO 2012b). No significant differences were obtained between the different sowing dates and the cultivars (Table 1).

Crude protein content

Sowing dates and varietal effects on protein content of whole meal and extracted flour were generally highly significant (Tables 1 and 2). Crude protein content decreased gradually with delayed sowing date for all cultivars. Maximum value of protein (14.69%) for whole meal was obtained by Debeira in the first sowing date (Nov.6th) followed by Argine (14.56%) and Condor (14.41%) and significant differences were found between the sowing dates and between the cultivars. Alneilain gave the highest value (14.47%) of protein in the second sowing date (Nov.21st)

compared to the first and late sowing dates. On the other hand, there were varietal effects on protein content of the extracted flour. Argine gave significantly the highest value (13.80%) while Alneilain gave the lowest value (11.45%) of protein in the first sowing date. Patil et *al*. (2000) and Yadava and Singh (2003), reported increment of protein content with delayed sowing dates, and similar results were obtained by Tayyar (2010).

Ash content

The results of the ash contents for the investigated grain and extracted flours over the three sowing dates are presented in Tables 1 and 2, respectively. Significant differences were found between the cultivars and the sowing dates. Debeira whole meal gave the highest value of ash (1.80% and 1.79%) in the first and late sowing dates, respectively, while Condor was the lowest in ash content (1.54%) in the late sowing date. On the other hand, ash content of the extracted flours ranged from 0.59% for Condor at late sowing date to 0.80% for Alneilain at the second sowing date, and significant differences were found between the cultivars. Higher ash content indicated higher bran in the extracted flour.

Gluten content

The gluten (wet and dry) values were affected by the sowing date and the cultivars (Table 2). Gradual decrease of gluten was recorded from the first to late sowing date. Argine had the highest values of wet and dry gluten (46.47%, 14.45%; 45.55%, 14.50% in the first and second sowing dates, respectively), compared with the other cultivars and no significant differences were found between them. The same trends were recorded for the other cultivars in gluten content, whereas the late sowing date gave the lowest values for all cultivars and significant differences were found between the late and the other sowing dates (Table 2). Lower values (26.2%-31.9%) of wet gluten for Sudanese cultivars were reported by Mohammed (2000) and Ahmed (2005). Lower wet gluten (22.7–28.9 g) for Sudanese wheat flours was found by Abubaker *et al*. (2013). Acceptable values of over 30% wet gluten were registered for all cultivars tested in three sowing dates and all values obtained were higher than the Sudanese Standards Specification for bread wheat flour (Minimum value of 27%).

Falling number

Table 2 shows the falling number (FN) values, i.e., alpha amylase activity for the cultivars and the different sowing dates. FN was extremely high (ranging from 449 to 779 sec.). Generally, the Sudanese wheat is characterized by high levels of falling number (low alpha-amylase). Alpha- amylase may be added to wheat flour to achieve any desired level of enzyme activity. The optimum level of falling number (250-300 sec.) or enzyme activity is ultimately governed by end use of the flour and the type of processing involved in the end use, as mentioned by Mailhot and Patton (1988).

Bread specific volume

Bread specific volume (BSV) was significantly high at the first sowing date for Argine, Alneilain and Debeira, and the values obtained were 3.99, 3.81 and 3.93 Ml/g, respectively. No significant differences were found between the first and the second sowing dates for Argine and Debeira. On the other hand, Condor had high BSV in the second sowing date (4.13 Ml/g). Condor grain filling coincided with the cool second sowing date (7 to 21 February). Condor had the same BSV value under the same hotter temperate conditions through grain filling on the first and third sowing dates. Condor is considered an early maturing cultivar (about 90 days; Modather 2007).

Table 1. Physico-chemical characteristic of the grain of four bread wheat cultivars grown at Gezira Research Farm, season 2005/2006

Samples	1000-Kernel weight (g)	Hectoliter weight (g/l)	Extraction Rate (%)	Moisture (%)	Ash (D.B)* (%)	Protein (D.B) * (%)
S1V1	30.56efg	817.7a	67.9e	7.73ab	1.65h	14.56b
S2V1	30.4fg	816.6a	71.9b	7.36ab	1.56m	14.43c
S3V1	29.10g	810.9a	62.7g	7.30abc	1.64j	13.43f
S1V2	34.80a	838.1a	59.5h	7.87ab	1.66g	14.15d
S2V2	31.13def	817.5a	59.4h	7.83ab	1.76c	14.47c
S3V2	34.23a	836.2a	55.3k	7.78ab	1.61i	13.11g
S1V3	34.89a	865.6a	66.4de	7.63ab	1.80a	14.69a
S2V3	31.92de	833.4a	73.7a	7.23abc	1.66g	13.47f
S3V3	30.76ef	829.8a	62.1gh	7.52ab	1.79f	11.15k

Table 1. Cont.

Samples	1000 Kernel weight (g)	Hectoliter weight (g/l)	Extraction Rate (%)	Moisture (%)	Ash (D.B) (%)	Protein (D.B) (%)
S1V4	33.72abc	852.5a	70.3c	8.3a	1.70e	14.41c
S2V4	32.22cde	831.5a	63.1f	7.33abc	1.62k	13.94e
S3V4	32.56bcd	824.0a	58.1i	7.42abc	1.54n	11.56i
Mean	32.30	816.2	64.2	7.44	1.68	13.61

Means having different superscript letter (s) in each column differ significantly ($P \leq 0.05$). S1: early sowing date, S2: medium sowing date, S3: late sowing date, V1: Argine, V2: Elneilain, V3: Debeira, V4: Condor, D.B: On dry basis

Table 2. Quality characteristics of extracted flour and bread specific volume of four wheat cultivars grown in Gezira Research Farm, season 2005/2006

Samples	Moisture (%)	Ash (D.B) (%)	Protein D.B. (%)	FN (Sec)	Gluten (%)		BSV Ml/g
					Wet	Dry	
S1V1	13.03e	0.65i	13.80a	761a	46.47a	14.45a	3.99ab
S2V1	13.17cd	0.60i	13.20b	707bc	45.55a	14.50a	3.97ab
S3V1	13.17cd	0.63k	13.59a	651d	40.10b	12.60cd	3.95b
S1V2	13.10de	0.73e	11.45e	744ab	39.35b	12.85bcd	3.81bc
S2V2	13.03e	0.80c	12.11c	747ab	41.00b	13.00bc	3.59de
S3V2	13.08e	0.71g	11.71d	728ab	34.45cd	11.75e	3.61de
S1V3	12.82f	0.74d	12.14c	778a	41.80b	13.65b	3.93b
S2V3	13.03e	0.72f	12.11c	779a	38.95b	13.45b	3.93b

Table 2. Cont.

Samples	Moisture (%)	Ash D.B. (%)	Protein D.B. (%)	FN (Sec)	Gluten %		BSV (Ml/g)
					Wet	Dry	
S3V3	13.10de	0.70h	11.75f	658cd	33.20d	10.30f	3.49e
S1V4	13.02e	0.65i	11.72d	664cd	41.80b	13.60b	3.71cd
S2V4	13.18c	0.64j	13.17b	657cd	40.70b	12.90bcd	4.13a
S3V4	13.02e	0.59m	11.25e	449e	36.30c	12.15de	3.74cd
Mean	13.06	0.68	12.48	693	39.97	12.93	3.82

Means having different superscript letter (s) in each column differ significantly ($P \leq 0.05$) using DMRT, S1: early sowing date, S2: Mid sowing date, S3: Late sowing date, V1: Argine, V2: Elneilain, V3: Debeira, V4: Condor, D.B: On dry bases, BSV, Basis specific volume, FN: Falling number

CONCLUSIONS

Delaying sowing time adversely affects wheat quality. However, protein content, gluten value and bread specific volume are improved with optimum sowing time from early to mid-November, especially in central Sudan.

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