The Quality Characteristics of Different Wheat Varieties Grown Under Varying Sowing Dates in Two Locations in the Northern State in Sudan

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Abstract

This research was conducted to study the effect of different sowing dates on the quality characteristics of wheat (*Triticum aestivum* L.) grown in two soil types and to identify varieties that could perform relatively well under delayed sowing conditions. Six released Sudanese wheat varieties were chosen, namely, El Nilein, Wadi Elneel, Giza 168, Debeira, Sasaraibe and Condor which grown in Northern State at Selaim Basin (19º.11'N, 30º.31'E) and Dongola Research Station Farm (DRSF, 19º.08'N, 30º.27'E). The crops were sown in stratified sowing dates from 1st November up to 10th January with 14 days interval. The first location, Dongola Research Station Farm (DRSF), represented the high terrace soils, whereas the second, Selaim basin, represented the alluvial soils. Split-plot design was used, sowing dates in the main plots and varieties in the sub-plots. The six sowing dates (SD_1 to SD_6) were grouped to early (1th Nov (SD_1) –15th Nov (SD_2.), normal (29th Nov. (SD_3) -13rd Dec. (SD_4) and late (27th Dec. (SD_5)–10th Jan. (SD_6). At harvest, samples were taken from each plot and analyzed qualitatively. Characters such as hectoliter weight (test weight or grain density) and 1000 kernel weight showed maximum values in the fourth sowing date (13th Nov.) and minimum values in the late sowing dates (27th Dec. and10th Jan.) in the two locations. In Selaim, El Nilein and Debeira were found significantly higher in hectoliter and 1000 kernel weights (831.57g/Land 47.83); (827.9g/L and 40.00g, respectively), compared to the other varieties. Moisture contents for the whole meal and extracted flour, for all the varieties, in the two locations were found to be ranged from 5.90 to 6.60% and from 10.80 to 12.52%, respectively. All the results obtained for moisture were found to be within the Sudanese Standards Specifications (SDS 036/2013 and SDS 037/2014). Protein and gluten (wet and dry) contents improved by delayed sowing date. Debeira and El Nelein proved to be superior for protein and gluten contents in both Selaim and DRSF locations.

Key words: Wheat, Sowing dates, Quality characteristics, Falling number, Locations, Varieties.

1. Introduction

The nutritional value of wheat (*Triticum aestivum* L.) is extremely important as it takes an important place among the few crop species being extensively grown as staple food sources. The importance of wheat is mainly due to the fact that its seed can be ground into flour, semolina, etc., which form the basic ingredients of bread and other bakery products, as well as pasta, and thus it presents the main source of nutrients to the most of the world population. Wheat, the most important cereal crop feeds most of the world's population. It is contributing to 28% of the world edible dry matter and up to 60% of the daily calorie intake in several developing countries. Globally, wheat is the leading source of vegetable protein in human food having higher protein content than the other major cereals. Amount as well as composition of grain proteins determines the protein quality and hence the end-use of wheat. Wheat climatic variability in the marginal environments cause large annual fluctuations in yield as stated by Zare *et al.*, 2015 whereas 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).

In Sudan, wheat is cultivated along a rising thermal gradient extending from the Northern State to the Central, where winter season (wheat growing season) is gets shorter and warmer southwards. The length of the growing season in the Sudan is ranging from 90 to 100 days (Ibrahim, 1995). The optimum range of sowing date was determined from 5th November to 1st December at the Gezira (Center), 16th November to 16thDecember at New Halfa (east) and 1th November to 9th December at Hudeiba (north). Short winter season and heat fluctuations may lead to reduce production and grain quality of wheat in

Sudan as stated by Abdalla *et al*. (2014). `Although many of the released commercial wheat varieties in Sudan were tested for grain quality, however, little attention was given to the effect of some environmental conditions, such as soil type and thermal regimes prevailing during the growing season on grain quality. In the Northern State, wheat cropping expanded to new areas known as high terrace soils. Also, delaying wheat sowing time to December and January is noticeable among farmers of these areas. As the sowing of the wheat in Sudan is normally starts 1st Nov. Selaim Basin and Dongola Research Station Farm (DRSF) were two sites chosen for this experiment. The Selaim Basin soil is characterized by high fertility known as *Gureir* soil; which is the Nile deposit and DRSF soil is classified as high terrace soil, with limitations of salinity and/or solidity. This study was conducted to assess the quality characteristics of different wheat varieties grown under varying sowing dates in two locations in the northern state in Sudan.

2. Materials and Methods

2.1 Materials

Six improved wheat (*Triticum aestivum* L.) varieties namely, El Nilein, Wadi Elneel, Giza 168, Debeira, Sasaraibe and Condor were obtained from Dongla Research Station, Agricultural Research Corporation (ARC). The six varieties were sown at six different sowing dates started from 1st November up to 10th of January with 14 days interval. The sowing dates were as follows; the first (SD1, 1st Nov.), the second (SD2, 15[thl]] Nov.), the third (SD3, 29[th] Nov.), the fourth (SD4, 13[rd] Dec.), the fifth (SD5, 27[th] Dec.) and the six (SD6, 10[th] Jan.).

Experimental sites represented different environments: Dongola Research Station Farm (DRSF), 19º.08'N, 30º.27'E; and Selaim basin, 19º.11'N, 30º.31'E. The first site represents a high terrace soil with salinity and/or solidity limitations while the second site represents the alluvial soils of Nile deposits. Split-plot design with three replications was used; the main plots were assigned to sowing dates, and the sub-plots to the varieties. All the cultural practices were applied as recommended by the Agricultural Research Corporation (ARC). The six sowing dates were grouped as early (SD1 and SD2), normal (SD3 and SD4) and late (SD5 and SD6) to identify the performance of the varieties under the three sowing date occasions.

2.2 Methods

2.2.1 Physical testing methods

Wheat grains from the different varieties were subjected to physical tests according to the AACC methods (2000). Parameters tested included 1000 kernel weight and hectoliter weight or test weight (grain density).

2.2.2 Proximate Composition

Part of the wheat grains was cleaned from impurities (organic and inorganic) and milled into whole meal flour using KT type 120 Mill. Wheat grain flours were extracted using the Brabender Quadramat senior roller mill. Moisture and ash contents of whole meal and extracted flours were determined according to the AACC standard method (2000). Protein content was determined by the semi-micro Kjeldahl according to the standard methods of the AOAC (1990). Falling number apparatus (FN 1400, Nor Landsgation 16) was used to measure the activity of α- amylase in wheat flour according to the AACC method (2000). Wet and dry gluten were determined by using the Glutomatic system (Perten Instruments). Wet gluten was determined according to the standard method of the ICC (1968) using a gluten washing machine (Type G.E.B No 17).

2.3 Statistical Analysis

Data generated was subjected to the statistical analysis using Gen Stat Discovery Edition 2 package (2011).

3. Results and Discussion

Results of the physical and chemical parameters studied for the six wheat varieties grown in Selaim Basin and DRSF at six sowing dates (SD) in the Northern State are presented and discussed.

3.1 Physical characteristics

3.1.1 Thousand kernel weight (g):

Thousand kernel (grain) weights of the six wheat varieties are shown in Fig. 1. Highly significant differences ($P<0.05$) were observed in Selaim and DRSF locations for this parameter. However, El Nilein was found to be the highest value for the fourth sowing date (SD4, 13thDec.) having value of 47.83g followed by the value 44.61g for the fifth sowing date (SD5, 27thDec.). Giza-168 gave a maximum value of 43.52g in the first sowing date (SD1) and decreased gradually till it reached the minimum value of 29.84g for the fifth sowing date (SD5) for Selaim location. The other varieties showed gradual decrease with delayed sowing date. This trend was similar to that reported by Abdalla *et al*. (2014) for 1000 kernel weight of wheat grown in Central Sudan. On the other hand, the highest value of the 1000 kernel weight obtained in DRSF was 39.72g for Debeira in the fourth sowing (SD4); and the lowest value 26.32g was for Sasaraibe in the six sowing date (SD6).

The different sowing dates effect on the 1000 kernel weight were found to be highly significant and varieties showed different behavior in different sowing dates and in different locations. Similar results of a gradual decrease in 1000 kernel weight with delayed sowing date were reported earlier (Qamar *et al*., 2004; Singh and Pal, 2000; Subhan *et al*., 2004 and Abdullah *et al*., 2007). All the results of 1000 kernel weight obtained in this study were found within the Sudanese Standard Specification (036 SDS) for wheat grain issued by SSMO (2013).

3.1.2 Hectoliter weight (g/l)

Figure 2 shows the hectoliter weight or test weight of the six wheat varieties grown in Selaim basin and DRSF at six sowing dates in the Northern State. Significant differences ($P<0.05$) were observed between the different varieties and the highest values were obtained in the fourth sowing date (SD4) in Selaim Basin for all varieties. The highest values of hectoliter weight (831.57 and 827.9g/l) were obtained by El Nilein and Debeira, respectively; while Sasaraibe and Wadi Elneel showed the lowest values (803.7 and 803.4g/l), respectively. On the other hand, in the DRSF location, Debeira gave the highest value for the forth sowing date (SD4, 843.27g/l), followed by Wadi Elneel and El Nilein; (816.51 and 813.53 g/l), respectively.

Normally, high test weight indicates sound wheat grains and higher correlations is found between hectoliter weight and flour yield. Previous findings by Kumar and Sharma (2003); Singh and Dhaliwal (2000) and Abdallah *et al*. (2014) showed that maximum test weight was recorded in the first three sowing dates.

3.2 Proximate composition

3.2.1 Moisture and ash contents

Figures 3 and 4 show the moisture contents of the whole meal and the extracted wheat flours. Moisture content in the whole wheat flours ranged from 5.90 to 6.60% for all the varieties in the two locations and was found within the Sudanese Standard recommended levels. Higher values of moisture content were found in the extracted wheat flour due to the conditioning or tempering of the wheat grain and these were also within the limits of the Sudanese Standards Specifications (036 SDS) for wheat grain (SSMO 2013) and (037 SDS) for wheat flour (SSMO 2014).

The results of ash (minerals) content for the flour extracted (Fig. 4) was found to be higher in Selaim location than in DFRS. Significant differences were found between the different cultivars and the sowing dates. In Selaim, values of ash were increased with delayed sowing date and Debeira and El Nilein obtained the highest values of ash (2.033 and 2.017%), respectively. Abdalla *et al*. (2014) reported values of ash for Debeira whole meal 1.80 and 1.79% in the first and late sowing dates, respectively in the Central Sudan. Higher values of ash were found in Selaim than in DRSF (Fig. 4).

*3.2.2 **Protein and gluten contents (%)***

Sowing dates significantly (P<0.05) affected protein and gluten contents in the six wheat varieties grown in Selaim and DFRS locations. In Selaim location, the protein content increased with delayed sowing date and was found to be maximum for all varieties in the fifth sowing date (SD5) except in Giza 168 which was obtained the maximum content in the sixth sowing date (SD6; Fig. 5). Debeira gave the highest value for protein (17.85%) while Giza 168 gave slightly lower value than the other varieties (15.96%)) in SD5. On the other hand, in DRSF location, the sixth sowing date (SD6; the last sowing date) gave the highest values for protein. In the last sowing date (SD6), the highest value of protein was found to be 19.65% for Debeira followed by the value of 19.54% for Sasaraib and the lowest value 18.25% for El Nelain. Condor gave a minimum value of protein content (12.42% and 14.17%) for SD1 in the two locations. Crude protein content decreased gradually with delayed sowing date for all cultivars grown in Central Sudan as stated by Abdalla *et al*. (2014).

Regarding the gluten content (Wet and Dry), significant differences (P<0.05) were observed in the wet gluten (Fig. 6) and dry gluten (Fig. 7). The fifth sowing date (SD5) gave the highest values compared to other sowing dates in Selaim Basin for all varieties. Debeira was found to be the highest values for wet and dry gluten (51.25and 15.85%). On the other hand, in the DRSF location, Giza 168 and Debeira gave the highest values of wet and dry gluten for SD5 (61.45; 20.78 and 60.35; 20.58%, respectively. It was observed that protein and gluten (wet and dry) values were noticed to be higher in DRSF than in Selaim location.

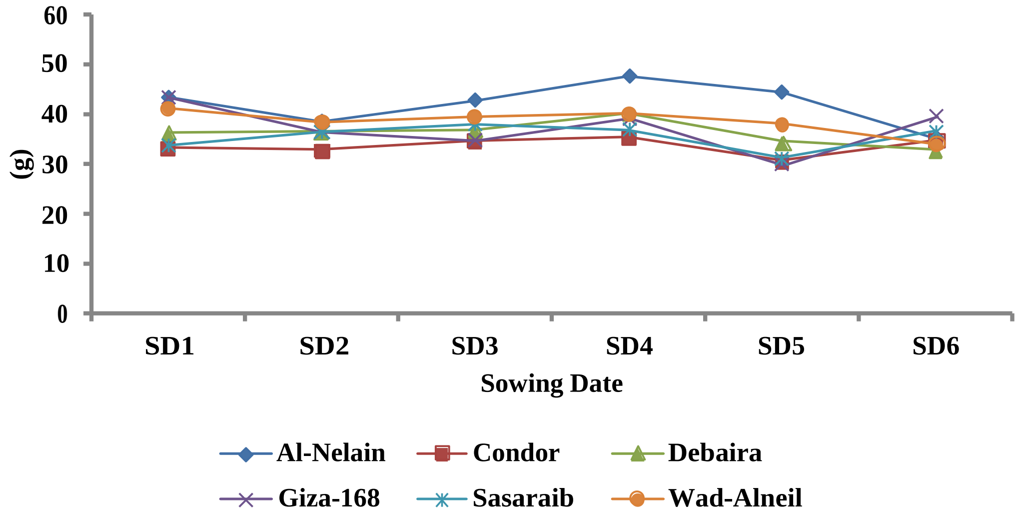
3.3 Falling number (alpha amylase activity)

The different Sudanese wheat flours are generally characterized with high falling number (FN) which indicates low alpha amylase activity (FN is higher than 350 sec.) as reported by Badi *et al*. (1978), and Hassan (2006; 2007). According to Perten (1999), the standard optimum level of falling number reported is between 250-300 sec. Alpha amylase is added to wheat flour to improve its enzymatic activity and hence improve bread quality. All values obtained for the FN in the two locations and in the different varieties were found to be higher than 470 sec.

Conclusion

Concerning the results of this study, delaying sowing date adversely affects the physical characteristics such as 1000 kernel weight and hectoliter weight. However, protein and gluten contents improved by delayed sowing date compared to the early sowing date. Higher thousand kernel weight, hectoliter weight, protein quality and quantity are considered good indicators for wheat grain soundness.

SELAIM



FARM

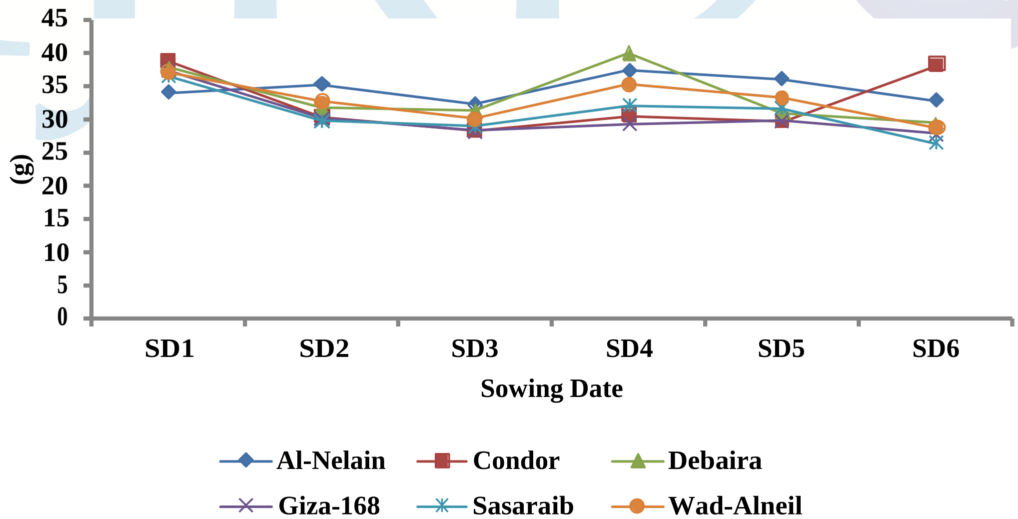
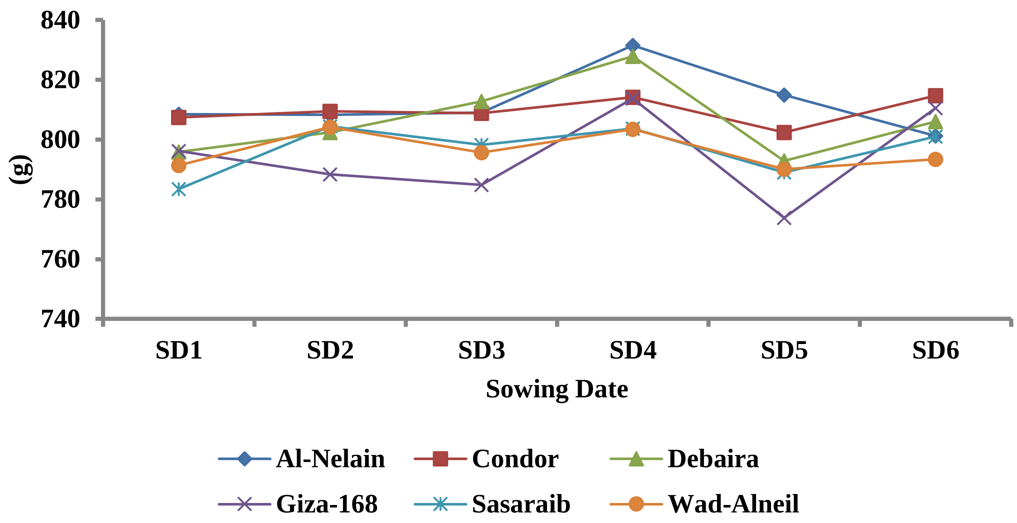


Fig.1: 1000 kernel weight (g) of six wheat cultivars grown in two locations at different six sowing dates in Northern State

SELAIM



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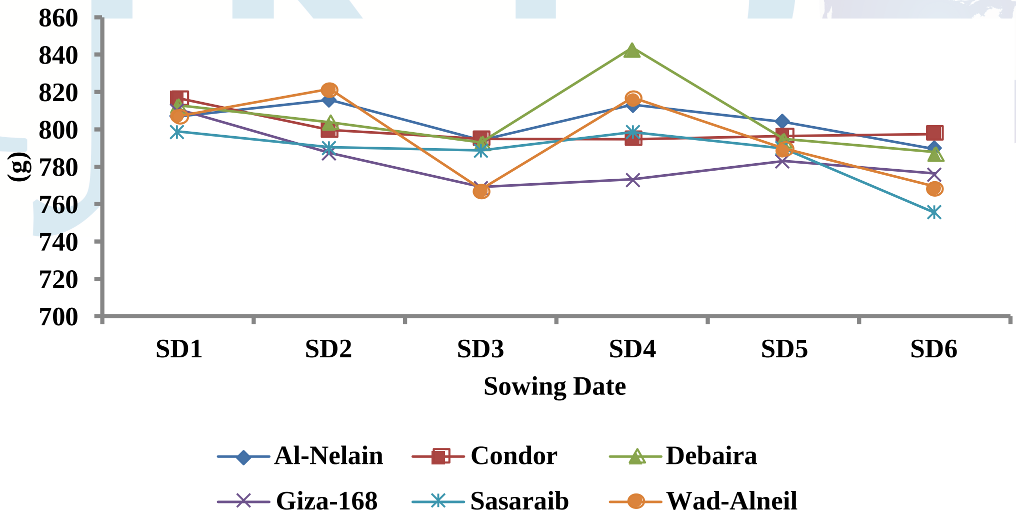

ig.2: Hectoliter weight (g) of six wheat cultivars grown in two locations at different six sowing dates in Northern State

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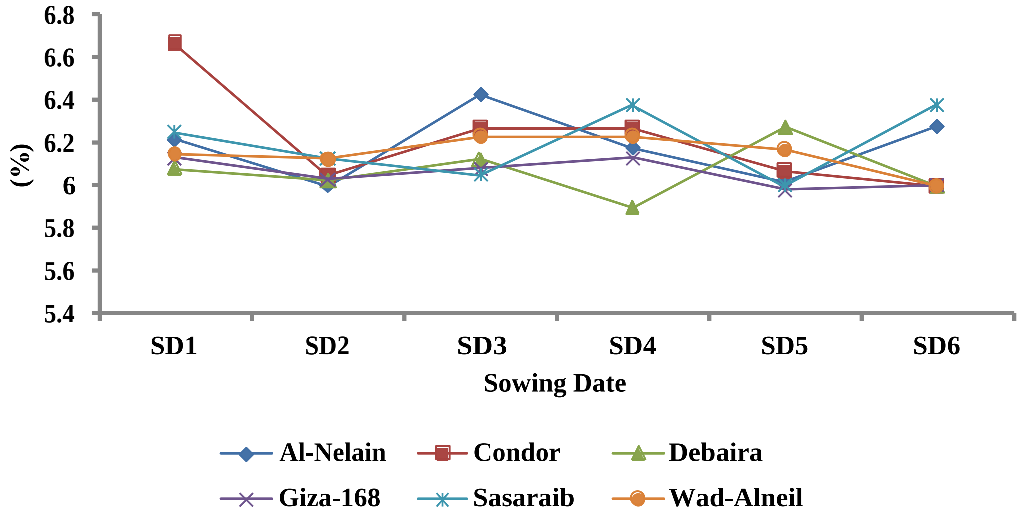

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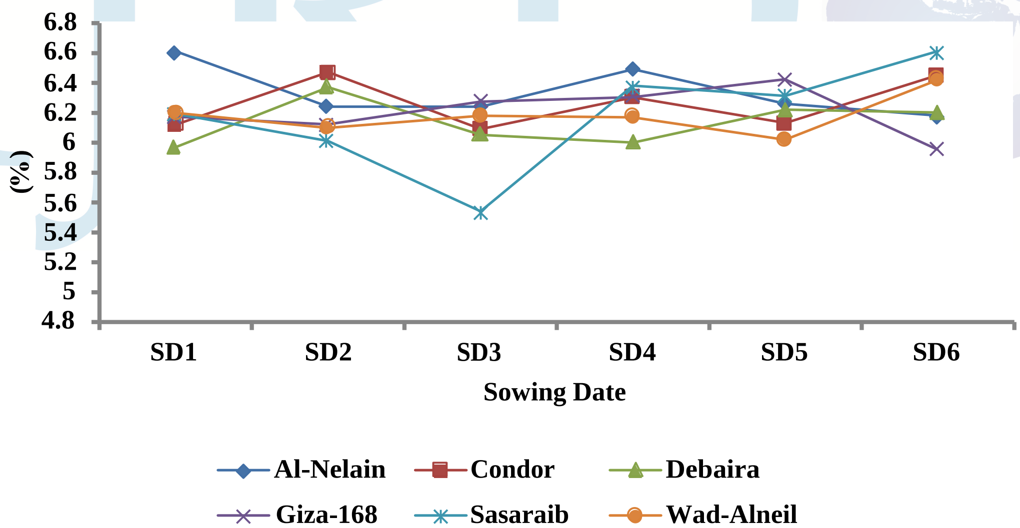
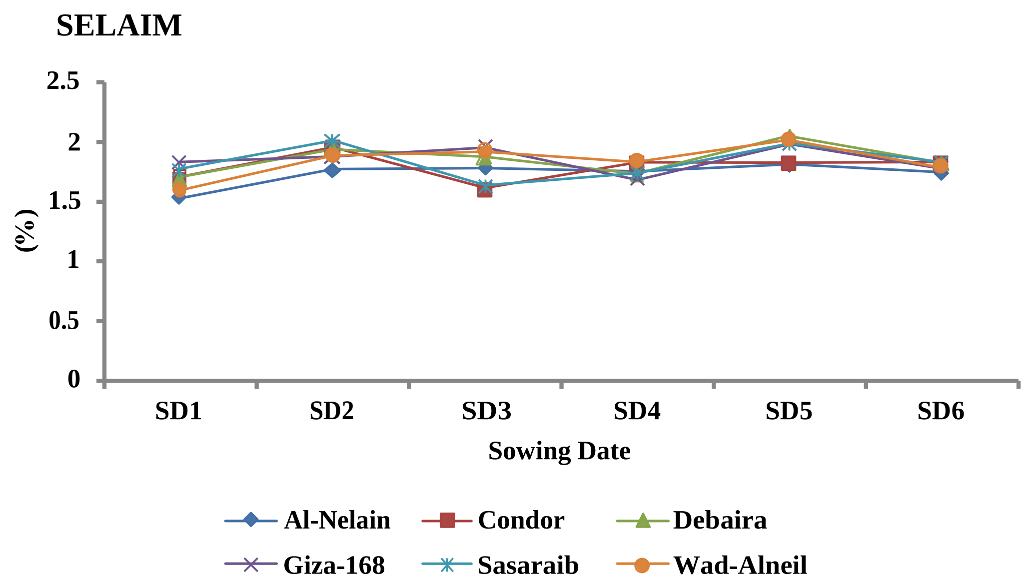


Fig.3: Moisture contents (%) of six wheat cultivars grown in two locations at different six sowing dates in Northern State



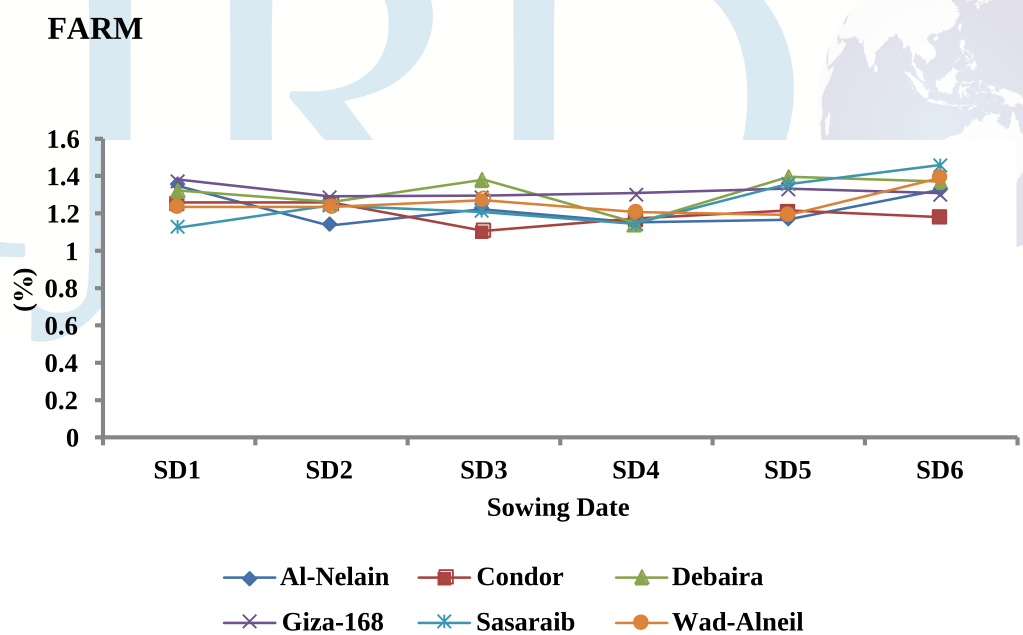


Fig.4: Ash contents (%) of six wheat cultivars grown in two locations at different six sowing dates in Northern State

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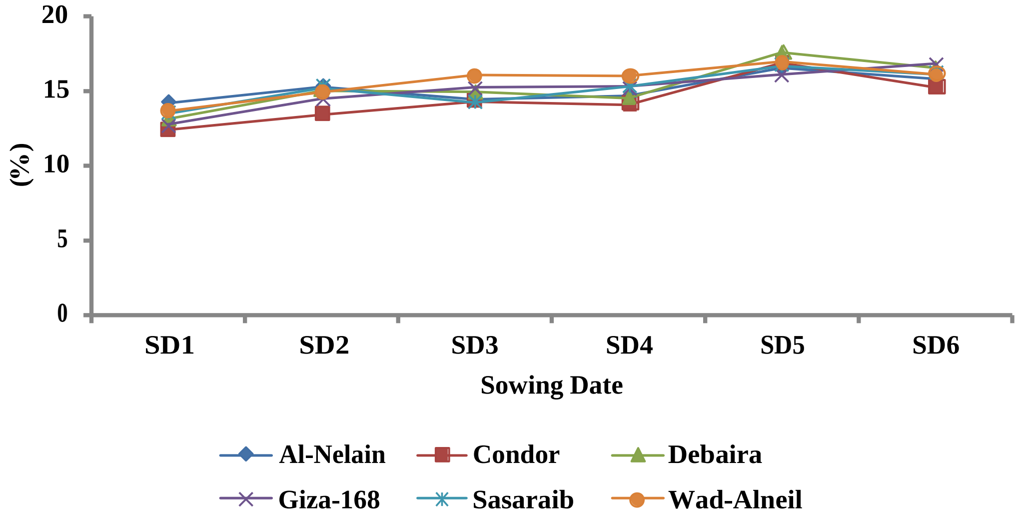

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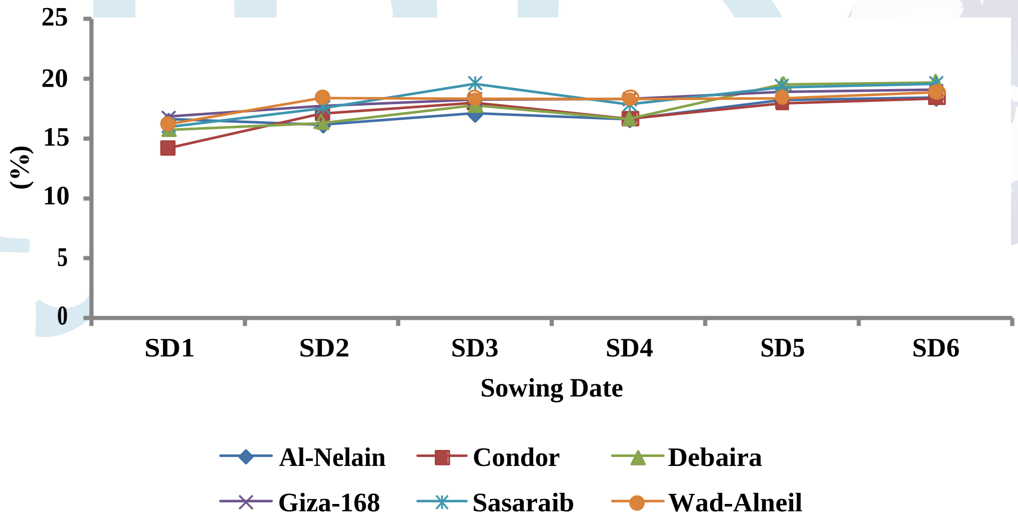

Fig.5: Protein contents (%) of six wheat cultivars grown in two locations at different six sowing dates in Northern State

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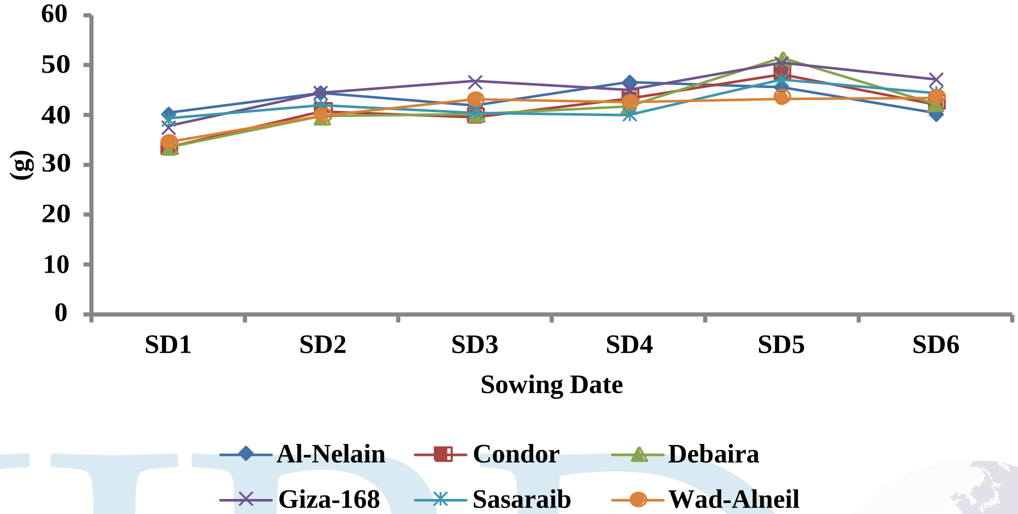

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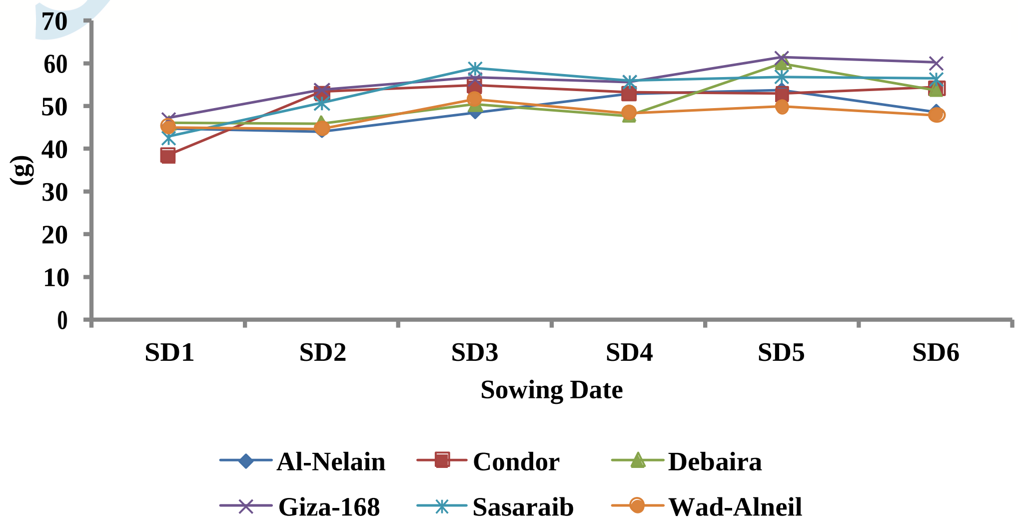

Fig.6: Wet gluten contents (%) of six wheat cultivars grown in two locations at different six sowing dates in Northern State

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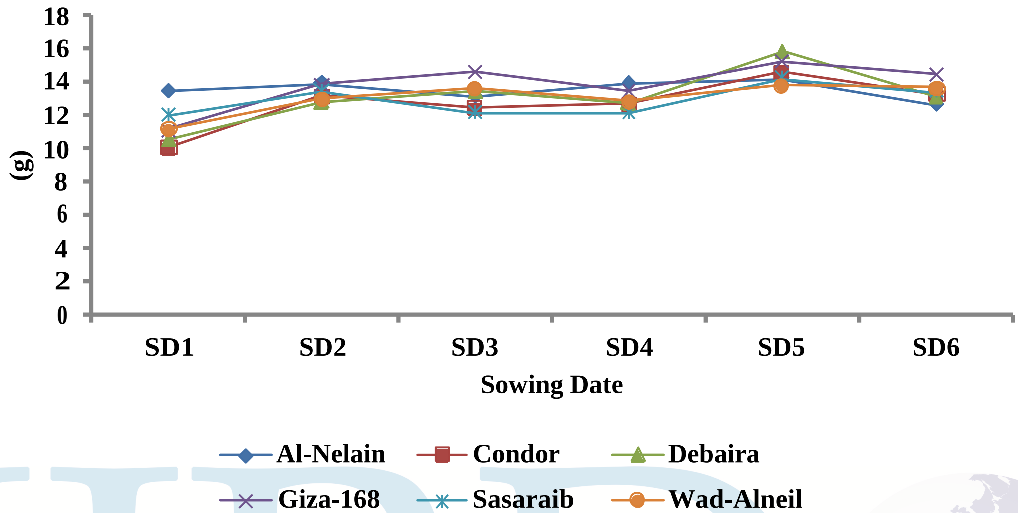

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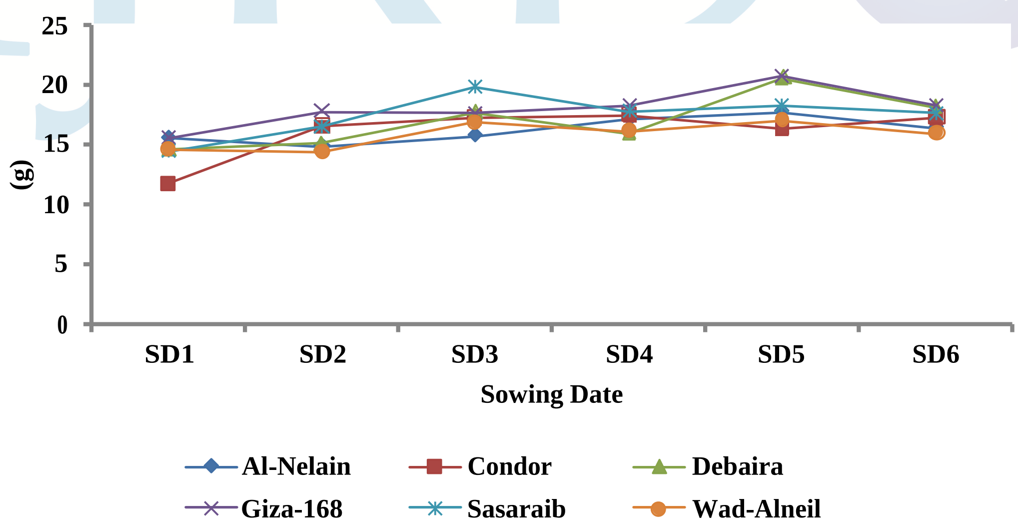

Fig.7: Dry gluten contents (%) of six wheat cultivars grown in two locations at different six sowing dates in Northern State

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