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Response of Yield and Grain Quality of some Bread Wheat (*Triticum aestivum* L.) Genotypes to Different Sowing Dates

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ABSTRACT

In order to study effect of sowing dates of some bread wheat genotypes on agronomic, growth, germination, seedling growth and quality characteristics. A field and laboratory experiments were carried out during 2010/2011 and 2011/2012 seasons. Three sowing dates starting from 20th November to 30th December with 20 days intervals and eight wheat genotypes. It could be noticed that delaying sowing date to 30th December resulted in the lowest number of days to maturity, grain yield, germination percentage, germination index, seedling length, seedling vigor index and seedling dry weight as well as protein percentage and gluten quality in both seasons. Misr 1 variety had a significant and highest grain yield compared with the other genotypes in both seasons. Also, it had a significant increment of germination and seedling traits followed by Gemmeiza 11, Line 2 and Line 1 genotypes. Line 2 recorded highest values of crude protein content, wet and dry gluten percentages followed by Misr 1 and Shandweel 1 varieties in both seasons. Tested genotypes could be discendingly arranged according to their grain yield/ha as follows: Misr 1, Line 2, Line 1, Gemmeiza 11 and Shandweel 1. The highest grain yield/ha resulted from planting Misr 1 variety under all sowing dates. The maximum quality measurements were obtained by Line 1 when planting on 20th November in both seasons. It may be recommended that planting Misr 1 to maximize the productivity per unit area while in case of delay in sowing date recommended planting Line 1 or 2 to maximize the unit area yield quantity and quality.

Keywords: *Triticum aestivum* L., planting dates, genotypes, growth, yield, germination, quality

INTRODUCTION

Bread wheat (*Triticum aestivum* L.) is one of the most important crops in Egypt, where its planted area ranged about 1.42 million hectares (3.40 million feddans). The local production is about 9.5 million tons (FAO, 2013), however it covers less than half of the local consumption. Increasing wheat productivity is a national target in Egypt to reduce the gap between wheat consumption and production.

The production of wheat can be increased either by increasing the planted area or by increasing crop yield productivity per unit area. Currently, it is difficult to increase the planted area of wheat crop due to competition with other winter crops and because each of restricted reclaimed lands and water shortage, etc. Therefore, it is very important to the choice of the suitable sowing date and there are enough possibilities to increase wheat yield through developing new high yielding varieties and by adopting proper sowing date. Therefore, the sowing date and genotype are the most important factor that affects grain quality. Wheat planting at dates late usually faces high temperature during its grain filling period which ultimately results into lower crop yield. The higher yield and improvement in various yield components were recorded at normal sowing as compared to late sowing (Sial *et al*., 2010**)**. Sohail *et al*. (2014) reported that late sowing of wheat reduced grain yield up to 29%. Wheat yield is quite sensitive to late plantings. Genotypes also showed significant variation regarding grain yield production under both normal and late sowing dates. Under more stressful growing conditions (late planting), minimum grain yield reduction was noticed in line NR-397 (19%) followed by NARC-09 (20%), NR-400 (30%) and NR-379 (35%). Late planting significantly reduced days to maturity, spikes/m^2 and 1000-grain weight in all genotypes as compared to normal sowing however, the reduction in these parameters were significantly less in wheat lines NR-397 and NARC-09 as compared to other two genotypes. Optimum planting time of different cultivars varies with regions depending on growing conditions of a specific tract that could be assessed by planting them at different times (Zia – ul – Hassan *et al.,* 2014). Late in wheat sowing drastically decreased the growth attributes (germination count/m^2, No of tillers/m^2 and plant height) and yield attributes (number of grains spike^{-1}, 1000-grains weight and grain yield). Wheat sown at 11th Nov. followed by 1st Nov. and 21st Nov. recorded the maximum growth and yield attributes. Maximum reduction in growth and yield of wheat were observed by sowing on 21st Dec. and 11th Dec. The differences among genotypes in days to maturity, plant height, number of spikes/m^2 number of kernels/ spike, 1000-kernels weight, grain yield/ha, protein content percentage, germination% and seedling length were significant under normal irrigation conditions (Abd El-Kareem and El-Saidy, 2011). Variations among genotypes were also observed. Genotype Aas-11 and Punjab-11 performed better in all the sowing dates while genotype Sehar-06 showed poor growth and yield attributes (Mumtaz *et al*., 2015).

Temperature is a modifying factor in germination since it can influence the rate of water absorption and other substrates supply are necessary for growth and development (Essemine *et al*., 2002). The rapid and uniform field emergence is essential to achieve better growth and high yield (Parera and Cantliffe, 1994). The optimum sowing date of wheat cultivars lead to increase grain protein content and wet and dry gluten content (Jie *et al*., 2005). The optimal temperature favors a good aptitude to germinate, whereas low and high temperature extends delay in germination. All the wheat varieties germinated well (80-97%) sown at 10-30^{o}C, whereas, shoot length was maximum in Moomal-2000 and Mehran-89 sown at 20 and 30^{o}C, respectively. Root length, fresh shoot and root weight, root dry weight including seed vigor index were maximum with increasing temperature particularly in case of variety Mehran-89. The maximum seed germination, vigor index occurred at 20-30C^o and these temperature

regimes were identified as optimum for wheat seed germination (Mahmooda Buriro *et al*., 2011). Early sowing (15th November) produced grains with higher protein contents followed by 30th November and 15th December sowing, respectively (Shahzad *et al.*,2007).They stated that protein contents of wheat greatly affected by the genotype and prevailing condition during growth period. Sowing on 1st October produced the highest significant grain crude protein, wet and dry gluten and statistically decreased by delaying sowing date (Fergany *et al*., 2014).

Therefore, the aim of this study was to evaluate the agronomic, growth, germination, seedling growth and quality characteristics of eight bread wheat genotypes under three sowing dates.

MATERIALS AND METHODS

Two field experiments were conducted at Experimental Farm of Sakha Agric. Res. Station, Kafer El-Sheikh, Agricultural Research Center (ARC), Egypt during 2010/2011 and 2011/2012 growing seasons. Also, two laboratory experiments were carried out under the laboratory conditions of Seed Technology, Research Department, Field Crops Research Institute, ARC, Giza.

Six bread wheat cultivars and two promising lines selected from Sakha wheat program were used in this experiment (Table1). The genotypes were evaluated under three sowing dates i.e. 20th November (optimum planting), 10th December and 30th December, respectively. Each year the experiments were arranged in a split plot design with three replications. The three sowing dates were the main plots and the eight genotypes were assigned to the sub-plot. The plot area was 8.4 m^2 of each (12 rows, 3.5 m long and spaced at 20 cm apart). The recommended package of cultural practices was followed.

The average of maximum and minimum temperatures and total rainfall from November to May at Sakha Agric. Res. Station during the two seasons are presented in Table 2.

Table 1. Name and pedigree of eight bread wheat genotypes

Genotypes	Pedigree
Sakha 93	Sakha 92/ TR 810328 S 8871-1S-2S-1S-0S
Giza 168	Mrl / Buc // Seri CM 93046-8M-0Y-0M-2Y-0B
Gemmeiza 11	BOW"S"/KVZ"S"//7C/SER182/3/GIZA168/SAKHA61 GM7892-2GM-1GM-2GM-1GM-0GM
Sids 12	BUC//7C/ALD/5/MAYA74/ON//1160.147/3/BB/GLL/4/CHAT"S"/6/ MAYA/VUL//CMH74A.630/4*SX SD7096-4SD-1SD-1SD-0SD
Shandweel 1	CAZO/KAUZ//KAUZ CMBW90 Y3279-OTOPM-010M-010Y-3M-0SH
Misr 1	OASIS / SKAUZ // 4*BCN /3/ 2*PASTOR CMSS00Y01881T-050M-030Y-030M-030WGY-33M-0Y-0S
Line 1	GIZA 168 /5/MAI "S" /FJ//ENU 'S' /3/ KITO/POTO 19// MO/ JUP /4/ K134 (60) VEE. S. 15410-19S-7S-2S-0S.
Line 2	IRENA // WL 7060/ TURACO. S. 15456-8S-1S-1S-0S.

Table 2. Monthly mean air temperature (°C) and total rainfall recorded during wheat crop growing at Sakha Agric. Res. Station during 2010/2011 and 2011/2012 seasons

Months	Temperature (°C) Maximum		Temperature (°C) Minimum		Relative Humidity (%)		Rainfall (mm)	
	10/11	11/12	10/11	11/12	10/11	11/12	10/11	11/12
November	26.8	24.0	11.0	10.2	68.1	69.9	٠.٠	0.0
December	22.0	20.2	8.3	6.4	70.4	73.6	2.5	3.6
January	21.0	18.2	5.8	8.4	64.1	68.9	3.1	0.0
February	21.7	17.5	6.9	9.6	70.5	68.8	4.6	5.5
March	22.5	20.5	6.9	12.3	67.9	68.5	2.7	7.1
April	26.5	27.1	10.0	17.1	66.4	63.5	1.9	0.0
May	30.0	30.8	13.2	20.8	57.4	62.9	٠.٠	0.0

At heading time, number of days to 50% heading was measured from each plot. After maturity, ten plants were randomly selected from each plot to determine plant height (cm) and number of days to maturity. At harvesting time, one square meter was randomly chosen from each plot to estimate number of kernels/spike, number of spikes/m^2 and 1000-kernel weight. Grain yield was estimated from the four central rows of each plot and converted into t/hectare. Straw yield was measured using the same way as grain yield and it was converted into t/ hectare.

Seeds were sown and subjected to standard germination test as the rules of International Seed Testing Association (ISTA, 1985). Counts of germinating seeds were taken daily up to eight days after the start of germination. Germination index (GI) was determined in this experiment. The germination index (GI) was calculated as described in the Association of Official Seed Analysis (AOSA, 1983) by following formula:

$$GI = \frac{\text{number of germinated seed}}{\text{days of first count}} + \ldots + \frac{\text{number of germinated seed}}{\text{days of final count}}$$

At the end of standard germination test after 8 days from sowing, germination percentage was defined as the total number of normal seedlings. Seedling length (cm) was measured for determined from 10 normal seedlings taken at random from each replicate, then dried in a forced air oven at 105^{o}C for 24 h to obtain seedlings dry weight (g). Seedling vigor index (SVI) was calculated depending on the following equation of Abdul-Baki and Anderson (1973):

SVI = Seedling length (cm) x Germination percentage

Samples of grains from field experiments were oven dried and ground finely for chemical analysis. Seed nitrogen percentage was estimated by using micro-kjeldahl apparatus and multiplied by the converting factor (5.75) to get seed protein percentage (Jackson, 1967). Wet and dry gluten were determined in fine air dried grain by hand – washing the meal according to the standard method of Pleshkof (1976) until starch was not detected in washing water, then dried and weighed. Wet and dry gluten were calculated as percentage of air dry grains.

Data in the two seasons were computed using (MSTATC, 1990) for analysis of variance (ANOVA) according to Gomez and Gomez (1984). The means of treatments were compared using the Least Significant Difference (LSD) method at 5% and 1% levels of probability as described by Snedecor and Cochran (1982).

RESULTS

Results illustrated in Table 3 showed that a highly significant differences among sowing dates on days to heading, days to maturity in both seasons and plant height in the first season only. The lowest values of days to heading (81.1 and 93.5 days) were produced from sowing at 20th November (D1) in the first season and at 30th December (D3) in the second season, respectively compared with the other sowing dates. Also, the lowest values of days to maturity (138.3 and 136.2) were produced from 30th December (D3) in the first and second seasons, respectively and plant height (104.2 cm) in the first season only were obtained from sowing at 20th November (D1). The higher plant height (109.2 and 112.5 cm) was produced from sowing at D3 and D1 in the first and second seasons, respectively and there is no significant between the three sowing dates in the second season.

Table 3. Days to heading, days to maturity and plant height as affected by sowing dates and tested wheat genotypes during 2010/11 and 2011/12 seasons

Characters	Days to heading (day)		Days to maturity (day)		Plant height (cm)	
Treatments	**10/11**	**11/12**	**10/11**	**11/12**	**10/11**	**11/12**
A-Sowing Date (D):						
D 1	81.1	96.9	144.2	154.0	104.2	112.5
D 2	88.5	97.9	144.0	145.5	109.2	111.0
D 3	86.1	93.5	138.3	136.2	109.2	112.1
F test	**	**	**	**	**	NS
LSD at 0.05	1.3	1.5	1.6	1.2	2.2	-
0.01	2.1	2.4	2.6	1.9	3.6	-
B-Genotypes (G):						
Sakha 93	85.9	96.4	145.7	148.3	100.6	106.1
Giza 168	86.1	98.4	144.4	146.9	108.3	111.7
Gemmeiza 11	87.3	98.6	143.2	145.8	110.0	119.4
Sids 12	85.0	95.8	141.7	145.1	106.7	106.7
Shandweel 1	88.7	99.9	145.0	147.4	110.0	116.7
Misr 1	89.2	99.8	143.0	144.9	112.2	111.7
Line 1	77.8	88.7	135.2	140.0	105.0	108.9
Line 2	82.0	91.1	139.3	143.4	107.2	113.9
F test	**	**	**	**	**	**
LSD at 0.05	1.6	0.8	1.9	1.0	2.6	2.0
0.01	2.1	1.0	2.6	1.3	3.5	2.7
C-Interaction:						
D×G	**	**	**	NS	**	**

***and ** indicate significant at p ≤ 0.05 and p ≤ 0.01, respectively NS= non-significant D1= 20th November (optimum planting) D2= 10th December D3= 30thDecember**

With respect to genotypes performance, it was found that the eight tested genotypes significantly differed in earliness and plant height characters in both seasons whereas, Line 1 was the earliest heading and maturity genotype compared with the other genotypes. These results were 77.8 and 88.7, 135.2 and 140.0 for days to heading and days to maturity during the first and second seasons, respectively. The taller plants (112.2 and 119.4 cm) were resulted by Misr 1 in the first season and Gemmeiza 11 in the second season, respectively. While, the shorter plants (100.6 cm) was recorded by Sakha 93 cultivar during the first season. The interaction between the various factors had significant effects on days to heading and plant height in both seasons and days to maturity in the first season only except for days to maturity which did not reach the 5% level of significant in the second season (Table 3).

Regarding to effect of the interaction between planting dates and genotypes on earliest heading and mature as well as plant height (Table 4). Line 1 was the earliest heading genotype at three sowing dates in both seasons and earliest mature on all sowing dates in the first season. The results showed that the minimum plant height was mostly recorded by Sakha 93 variety under sowing dates in the two growing seasons and Line 1 on the second sowing date during the first season as well as on the first and two dates during the second season. On the other hand, Giza 168 and Misr 1 varieties had the taller genotypes under the late dates in the first season, while Gemmeiza 11 and Shandweel 1 varieties had taller ones on all sowing dates during the second season.

Table 4. Days to heading and plant height in two seasons and days to maturity in the first season as affected by the interaction between sowing dates and wheat genotypes

Characters	Days to heading (day)						Days to maturity (day)			Plant height (cm)					
Genotypes	10/11			11/12			10/11			10/11			11/12		
	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3
Sakha 93	79.3	89.7	88.7	97.7	97.3	94.3	146.0	150.0	141.0	93.3	100.0	108.3	106.7	106.7	105.0
Giza 168	80.7	91.7	86.0	99.0	101.0	95.3	146.3	148.3	138.7	101.7	113.3	110.0	113.3	110.0	111.7
Gemmeiza 11	81.0	91.3	89.7	99.7	100.0	96.0	144.7	144.7	140.3	108.3	113.3	108.3	120.0	118.3	120.0
Sids 12	80.3	87.3	87.3	96.3	98.3	92.7	143.0	142.7	139.3	103.3	108.3	108.3	108.3	106.7	105.0
Shandweel 1	84.7	94.3	87.0	102.0	102.0	95.7	149.0	148.7	137.3	106.7	115.0	108.3	118.3	116.7	115.0
Misr 1	92.3	94.0	81.3	103.7	100.3	95.3	148.3	144.3	136.3	111.7	115.0	110.0	111.7	111.7	111.7
Line 1	73.3	77.7	82.3	85.0	92.0	89.0	136.3	135.3	134.0	101.7	101.7	111.7	105.0	106.7	115.0
Line 2	77.3	82.0	86.7	91.7	92.0	89.7	140.0	138.3	139.7	106.7	106.7	108.3	116.7	111.7	113.3
LSD at 0.05		2.7			1.3			3.3			4.5			3.5	
0.01		3.6			1.8			4.4			6.0			4.7	

D = Sowing date D1= 20th November (optimum planting) D2= 10th December 3= 30th December

Results presented in Table 5 the three tested sowing dates significantly affected number of spikes/m^2 in 2010/2011 season, 1000-grain weight, grain and straw yields in 2010/2011 and 2011/2012 seasons. On contrary, number of kernels/ spike did not significantly response to sowing date in couple seasons. As seen in Table 5 the later sowing date of 30th December had the highest mean of number of spike m^{-2} while, the earlier sowing date of November, 20th (D1) possessed the heaviest 1000-kernels weight without significant differences with those produced by second sowing date of December, 10th (D2) . The highest grain yield values were produced when plants were sown at December, 10th (D2). The later sowing date of December, 30th (D3) produced the highest values straw yield without significant differences with those recorded in second sowing date in 2010/2011 season and first sowing date in 2011/2012 season.

The tested wheat genotypes markedly varied in the yield and yield components in both seasons (Table 5). Line 2 gave the higher number of spikes/m^2 (450.7) without significant differences with those produced by Sakha 93 and Giza 168 in the first season. Sids 12 had the lowest mean of number of spikes/m^2 (364.7). The heaviest 1000-grains weight were produced by Gemmeiza 11 (47.5 g) without significant differences with those obtained by Line 1 (44.0 g) while, the lowest values of 1000-grain weight were recorded by Giza 168 (37.6 g) in first season. As for number of kernels/spike, Sids 12 variety achieved higher number of kernels/spike without significant with Gemmeiza 11, Shandweel 1 and Giza 168 in both seasons. The highest grain yield was recognized with Misr 1 wheat variety without significant differences with Giza 168, Sids 12, Gemmeiza 11 and Line 2 in 2010/2011 and 2011/2012 seasons, respectively. Sakha 93 had the lowest mean of grain yield in the two seasons. Gemmeiza 11 and shandweel 1 varieties gave higher straw yield in both seasons. Shandweel 1 without significant with Giza 168, Gemmeiza 11 and Misr 1 for straw yield in 2010/2011 season. In the second season, Gemmeiza 11 had the highest values of straw yield without any significant differences with Misr 1

Results in Table 6 revealed that the interaction between sowing dates and wheat genotypes had significant effect on number of spike/m^2 in 2010/2011, number of kernels/spike in 2011/2012 grain and straw yields in both seasons. The best combination for number of spike/m^2 was Line 2 with December 30th (D3) . As for number of kernels/ spike, Sids 12 gave the highest mean of number of kernels/ spike when it was sown at earlier sowing date without significant differences with other sowing dates . Gemmeiza 11 gave the lowest values of number of spike/m^2 at earlier sowing date while Line 1 gave lowest values of number of kernels/spike at the same sowing date. Sids 12 had the highest grain yield when it was cultivated at December 10th (D2) in the first and second seasons, respectively. In the first season, Line 2 produced the lowest values of grain yield, while in the second season Sakha 93 recorded the minimum mean at later sowing date. Interestingly, Line 2 gave the maximum mean of straw yield at December, 10th (D2) and December, 30th (D3) in the first and second seasons, respectively.

Table 5. No. of spikes/ m^2, 1000-kernels weight, No. of kernels/spike, grain yield and straw yield as affected by sowing dates and tested wheat genotypes during 2010/11 and 2011/12 seasons

Characters / Treatments	No. of spikes/ m^2		1000-kernels weight(g)		No. of kernels/Spike		Grain yield (t/ha)		Straw yield (t/ha)	
	10/11	11/12	10/11	11/12	10/11	11/12	10/11	11/12	10/11	11/12
A-Sowing dates(D):										
D 1	330.2	375.0	44.7	50.3	58.3	57.8	9.2	8.3	12.0	12.8
D 2	353.1	522.5	42.1	48.8	58.3	56.3	9.8	9.1	14.3	9.0
D 3	465.3	466.8	37.4	45.1	56.6	55.3	7.8	8.0	14.6	12.9
F test	**	NS	**	**	NS	NS	**	*	**	**
LSD at 0.05	34.9	-	2.9	1.3	-	-	0.4	0.6	0.7	0.5
0.01	57.8	-	4.9	2.2	-	-	0.6	1.1	1.2	0.9
B-Genotypes(G):										
Sakha 93	421.8	464.2	39.0	46.7	48.9	51.1	8.3	7.9	13.4	11.8
Giza 168	402.7	522.7	37.6	46.7	51.8	58.7	9.3	8.3	14.1	11.6
Gemmeiza 11	264.4	442.0	47.5	49.5	63.4	58.9	8.4	8.6	14.1	13.0
Sids 12	364.7	411.0	41.7	47.7	66.8	63.2	9.3	8.6	12.7	10.6
Shandweel 1	389.0	426.9	38.7	48.4	66.0	59.7	8.8	8.3	14.8	12.5
Misr 1	396.7	426.2	41.3	48.6	56.8	56.8	9.4	9.1	14.2	11.7
Line 1	373.0	477.8	44.0	48.6	54.3	47.2	8.8	8.4	12.7	10.4
Line 2	450.7	467.2	41.4	48.5	54.0	56.1	9.3	8.5	13.1	10.9
F test	**	NS	**	NS	**	**	**	**	**	**
LSD at 0.05	49.0	-	4.6	-	7.4	5.0	0.5	0.4	0.9	0.6
0.01	65.5	-	7.0	-	9.9	6.7	0.7	0.6	1.2	0.8
C-Interaction:										
D×G	**	NS	NS	NS	NS	*	**	**	*	**

***and** indicate significant at p ≤ 0.05 and p ≤ 0.01, respectively NS= non-significant D = Sowing date**
D1= 20th November (optimum planting) D2= 10th December D3= 30th December

Table 6. No. of spikes/m^2 in the first season and number of kernels/spike in the second season and yield (grain & straw) in both seasons as affected by the interaction between sowing dates and wheat genotypes

Characters / Genotypes	No. of spikes/m^2			No. of kernels/spike			Grain yield (t/ha)						Straw yield (t/ha)					
	10/11			11/12			10/11			11/12			10/11			11/12		
	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3
Sakha 93	366.0	402.7	496.7	48.0	55.7	49.7	8.6	8.4	8.0	8.4	8.6	6.5	10.6	13.8	15.8	11.9	8.9	14.6
Giza 168	319.3	427.7	461.0	63.6	56.3	56.1	9.8	10.3	7.8	8.3	8.6	8.0	12.5	14.9	14.8	12.5	8.6	13.8
Gemmeiza 11	210.3	227.7	355.3	59.3	56.3	61.2	8.9	9.6	6.7	8.5	9.0	8.3	12.6	14.7	14.8	15.2	10.2	13.6
Sids 12	296.0	282.0	516.0	64.5	64.3	60.8	9.7	10.4	7.8	8.1	9.7	8.0	11.1	13.8	13.1	10.9	8.8	12.1
Shandweel 1	363.0	332.0	472.0	63.9	55.0	60.2	9.2	9.6	7.4	8.1	9.0	7.9	13.4	15.9	15.2	14.9	10.2	12.4
Misr 1	431.0	323.0	436.0	66.4	53.3	50.6	10.0	9.9	8.4	8.8	9.6	8.9	14.0	14.8	13.8	12.5	10.0	12.6
Line 1	311.0	375.3	432.7	44.0	51.0	46.7	7.7	9.8	8.8	7.4	9.1	8.7	10.3	13.2	14.5	11.6	7.7	12.1
Line 2	344.7	454.3	553.0	52.8	58.7	56.9	9.9	10.5	7.6	8.8	9.0	7.6	11.1	13.6	14.5	13.0	7.3	12.4
LSD at 0.05		84.8			8.7			0.9			0.7			1.6			1.0	
0.01		113.5			11.7			1.2			1.0			2.1			1.3	

D = Sowing date. D1= 20th November (optimum planting) D2= 10th December D3= 30th December

These results suggest that, it is possible to select genotypes that had about 5-7 days earlier than Misr 1 cultivar, Line 1 and Line 2 and gave higher grain yield under late planting or almost the same grain yield under optimum planting. In addition, suggest that some early genotypes might be more suitable to late planting than optimum date one.

In general, the weather conditions (Table 2) were suitable for wheat growth and development during each experimental year. Field had shown no stress with good vigor and retention. The weather is slightly hot and dry from March to April where maximum temperature could reach to about 24.5^{o}C and 23.8 ^{o}C at grain filling stage in the first and second season, respectively, which slightly affected the grain yield under the third sowing date in the two seasons while this temperature had positive effect on grain yield under the first and second sowing dates.

Results in Table 7 indicated that the germination %, germination index, seedling length, seeding vigor and 10-seedling dry weight were significantly affected by sowing dates. The maximum values of above-mentioned characters were obtained from sowing at 20th Nov (D1) followed by that of 10th Dec (D2). 1n contrast, sowing date in 30th Dec (D3) gave the lowest values of previous characters in both seasons

Table 7. Germination percentage, germination index, seedling length, seedling vigour index (SVI) and 10-seedlings dry weight as affected by sowing dates and genotypes during 2010/2011 and 2011/2012 seasons

Characters / Treatments	Germination %		GI		Seedling length (cm)		SVI		10-Seedlings dry weight (g)	
	10/11	11/12	10/11	11/12	10/11	11/12	10/11	11/12	10/11	11/12
A-Sowing dates (D):										
D 1	82.2	82.5	11.7	11.9	21.5	19.8	17.7	16.4	0.218	0.200
D 2	79.2	81.3	11.3	11.3	19.7	17.7	15.6	14.5	0.203	0.195
D 3	79.2	76.6	9.8	10.9	17.4	16.8	13.8	12.9	0.156	0.149
F test	**	**	**	**	**	**	**	**	**	**
LSD at 0.05	1.9	1.7	0.4	0.3	0.7	0.5	0.7	0.5	0.016	0.007
0.01	2.6	2.2	0.5	0.4	0.9	0.6	0.9	0.7	0.022	0.009
B-Genotypes (G):										
Sakha 93	76.9	76.9	10.7	10.9	18.7	16.9	14.3	13.1	0.155	0.171
Giza 168	76.0	78.9	10.8	11.3	18.8	17.6	14.3	13.8	0.180	0.174
Gemmeiza 11	79.6	81.3	10.9	11.6	19.9	18.4	15.9	15.0	0.198	0.183
Sids 12	80.9	80.9	10.8	11.4	19.4	18.2	15.8	14.9	0.199	0.181
Shandaweel 1	79.1	77.3	10.7	11.1	18.6	17.6	14.7	13.7	0.182	0.178
Misr 1	88.4	86.7	11.6	12.1	21.7	20.0	19.2	17.3	0.235	0.200
Line 1	79.6	79.6	10.7	11.5	19.2	18.3	15.6	14.6	0.210	0.178
Line 2	80.9	79.6	11.1	11.3	19.7	17.9	15.9	14.3	0.181	0.186
F test	**	**	**	**	**	**	**	**	**	**
LSD at 0.05	3.2	2.7	0.6	0.5	1.1	0.8	1.2	0.8	0.026	0.011
0.01	4.2	3.6	0.8	0.7	1.4	1.0	1.6	1.1	0.035	0.015
C- Interaction:										
D×G	**	**	**	**	**	**	**	**	**	**

D = Sowing date. D1= 20th November (optimum planting) D2= 10th December D3= 30th December

Germination percentage, germination index, seedling length, seeding vigor index and 10-seedling dry weight were significantly affected by studied genotypes in both seasons (Table 7). In this connection, Misr 1 variety significantly increased aforementioned traits compared to other genotypes. Gemmiza 11, Line 2 and Line 1 came in the second rank after Misr 1 variety in the most traits. On the other hand, the lowest values of the aforementioned traits were recorded by Sakha 93, Giza 168 and Shandweel 1 varieties in the most traits

Remarkable impact of the interaction between sowing dates and wheat genotypes on germination %, germination index, seedling length, seeding vigor and 10-seedlings dry weight were obtained as presented in Tables 8 and 9. In this regard, sowing date on 20th November (D1) with Sids 12 variety achieved was highest increases in germination %, germination index, seedling length and seedling dry weight compared with the other treatments in both seasons and seedling vigor index in the second season. While, sowing date on 20th November (D1) gave the highest values of germination index and seedling vigor index in both seasons when Misr 1 variety was used. On the other hand, Misr 1 variety gave the maximum values of germination % in the first season only when sown at 30th December (D3). Also, sowing date in 10th December (D2) with Misr 1 produced the maximum values of germination %, germination index, seedling length, seeding vigor and 10-seedlings dry weight in the first and second seasons. Vice versa, Line 1 gave the lowest values of the most characters under investigation when sown on 30th December (D3) in both seasons.

Table 8. Germination percentage, GI and seedling length as affected by the interaction between sowing dates and genotypes during 2010/2011 and 2011/2012 seasons

Characters / Genotypes	Germination %						GI						Seedling length (cm)					
	10/11			11/12			10/11			11/12			10/11			11/12		
	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3
Sakha 93	77.3	73.3	٨٠.٠	78.7	74.7	77.3	11.3	10.9	9.9	11.7	10.4	10.8	20.5	17.8	17.7	18.6	16.6	15.8
Giza 168	81.3	68.0	78.7	77.3	84.0	75.3	11.3	١١.١	٩.9	١١.٧	١١.5	١٠.٨	20.2	19.8	16.5	18.5	17.8	16.5
Gemmeiza 11	85.3	73.3	80.0	81.3	84.0	78.7	11.5	١١.2	١٠.١	١١.9	١٢.٠	١٠.9	20.7	20.6	18.5	19.3	18.4	17.7
Sids 12	80.0	85.4	77.3	89.3	81.3	72.0	12.1	١١.١	٩.٣	١٢.٣	١١.2	١٠.٦	23.4	19.3	15.7	21.7	17.4	15.6
Shandweel 1	78.7	81.3	77.3	81.3	78.7	72.0	١١.3	١١.١	٩.٨	١١.٨	١٠.8	١٠.٧	20.8	18.9	16.1	19.5	17.3	15.9
Misr 1	88.0	85.3	92.0	86.7	86.7	86.7	١٢.١	١١.٩	١٠.٨	١٢.3	١٢.٣	١١.6	22.4	22.2	20.5	20.9	19.5	19.6
Line 1	88.0	84.0	66.7	84.0	84.0	70.7	١٢.٠	١١.٨	٨.٢	١٢.٠	١٢.٠	١٠.٦	21.9	20.8	14.8	20.3	17.4	17.2
Line 2	78.7	82.7	81.3	81.3	77.3	80.0	١٢.٠	١١.٠	١٠.3	١٢.٠	١٠.٥	١١.4	21.8	١٨.٠	١٩.٢	19.8	17.4	16.6
LSD at 0.05		5.5			4.7			1.1			0.9			1.9			1.3	
0.01		7.3			٦.3			1.5			1.1			2.5			1.7	

D = Sowing date D1= 20th November (optimum planting) D2= 10th December D3= 30th December

Protein, wet gluten and dry gluten percentages were appreciably influenced by sowing date as shown in Table 10. In this respect, maximum values of above-mentioned characters were obtained at early sowing wheat genotype on 20th November (D1) followed sow on 10th December (D2) in both seasons. However, the lowest values of these characters were obtained at planting wheat genotype on 30th December (D3) in the first and the second seasons, respectively.

Table 9. Seedling vigor index (SVI) and 10-seedlings dry weight as affected by the interaction between sowing dates and genotypes during 2010/2011 and 2011/2012 seasons

Characters	SVI						10-seedlings dry weight (g)					
Genotypes	10/11			11/12			10/11			11/12		
	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3
Sakha 93	15.8	13.1	14.2	14.6	١٢.4	١٢.٢	0.179	0.119	0.165	0.193	0.168	0.150
Giza 168	16.5	13.5	12.9	14.3	14.9	12.4	0.167	٠.٢١٣	0.161	0.175	0.197	0.149
Gemmeiza 11	17.7	15.1	14.8	15.7	15.4	13.9	0.199	٠.٢٢٨	٠.١٦٦	٠.١٩٤	0.201	0.155
Sids 12	18.7	16.5	12.1	19.4	14.2	11.2	0.257	0.204	٠.١٣٥	0.216	0.195	0.133
Shandweel 1	16.4	15.3	12.4	15.9	13.7	11.5	0.219	0.181	٠.١٤٥	0.200	0.193	0.140
Misr 1	19.7	18.9	18.8	18.1	16.9	17.0	0.257	0.267	٠.١٨٠	0.214	0.212	0.175
Line 1	19.4	17.5	9.9	17.0	14.6	12.2	0.241	٠.٢٦٣	0.126	0.205	0.212	0.116
Line 2	17.2	14.9	15.6	16.1	13.5	13.3	0.225	0.147	0.171	0.204	0.180	0.174
LSD at 0.05		2.1			1.5			0.046			0.020	
0.01		2.8			1.9			0.061			0.026	

D = Sowing date. D1= 20th November (optimum planting) D2= 10th December D3= 30th December

Table 10. Percentages of protein, wet gluten and dry gluten percentages as affected by sowing dates and genotypes during 2010/2011 and 2011/2012 seasons

Characters	Protein %		Wet gluten %		Dry gluten %	
Treatments	10/11	11/12	10/11	11/12	10/11	11/12
A-Sowing dates (D):						
D1	12.1	13.3	24.4	24.9	13.3	13.6
D2	11.3	11.9	21.1	22.8	10.2	11.5
D3	10.6	11.1	20.6	21.4	9.5	11.6
F test	**	**	**	**	**	**
LSD at 0.05	0.3	0.3	1.2	1.0	0.8	0.6
0.01	0.5	0.5	2.0	1.7	1.3	0.9
B-Genotypes (G):						
Sakha 93	10.1	10.7	19.1	19.7	9.1	10.5
Giza 168	11.3	11.9	21.6	22.9	10.5	11.9
Gemmeiza 11	11.2	11.7	21.0	22.4	10.3	11.0
Sids 12	10.7	11.4	20.5	21.1	9.8	10.6
Shandaweel 1	11.9	12.7	23.9	24.7	11.9	13.8
Misr 1	11.9	12.7	23.9	25.0	11.8	13.4
Line 1	11.6	12.4	22.2	23.4	11.4	12.2
Line 2	12.1	13.1	23.9	25.2	12.9	14.3
F test	**	**	**	**	**	**
LSD at 0.05	0.5	0.5	1.1	1.1	1.0	0.6
0.01	0.7	0.7	1.5	1.5	1.3	0.8
C- Interaction:						
D×G	*	**	**	**	NS	**

***and** indicate significant at p ≤ 0.05 and p ≤ 0.01, respectively NS= non-significant**
D = Sowing date D1= 20th November (optimum planting) D2= 10th December D3= 30th December

Protein, wet gluten and dry gluten percentages of wheat grains have been estimated for different studied genotypes as shown in Table 10. The highest values of protein %, wet gluten % and dry gluten % were obtained by Line 2 followed by Misr 1 and Shandweel 1 varieties in both seasons. Contrarily, the lowest values of the previous traits were obtained from Sakha 93 variety.

The results in Table 11 showed that there were a significant interaction effect between sowing dates and studied genotypes on protein %, wet gluten % in both seasons and dry gluten % in the second season only. Maximum values of protein and wet gluten % (13.40, 14.39 and 26.12, 26.46 %) were obtained from sowing date on 20th November (D1) integrated with Line 1 in the first and second seasons, respectively and 15.50 % for dry gluten in the second season only. On the other hand, the lowest values of protein % and wet gluten % were produced from sowing date on 30th December (D3) of Sakha 93 variety (9.60, 10.03 and 17.75, 17.10 %) in both seasons. While, sowing date on 30th December (D3) of Sids 12 variety gave the lowest values of dry gluten (8.34 %) in the second season.

Table 11. Protein, wet gluten percentages during first and second seasons and dry gluten percentage in the second season as affected by the interaction between sowing dates and genotypes

Characters	Protein %						Wet gluten %						Dry gluten %		
	10/11			11/12			10/11			11/12			11/12		
Genotypes	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3
Sakha 93	10.6	10.2	٩.٦	11.6	10.6	10.0	20.5	١٨.٩	17.8	٢١.٥	20.5	17.1	10.8	8.9	11.9
Giza 168	11.6	11.4	10.8	12.9	11.3	11.3	24.1	٢٠.5	٢٠.١	٢٤.7	٢١.6	٢٢.٤	١٢.4	11.5	11.7
Gemmeiza 11	12.3	10.6	10.8	13.4	10.9	10.9	24.4	١٩.٣	١٩.٣	٢٤.6	٢٠.7	٢١.٨	١٣.9	9.4	9.7
Sids 12	11.2	11.1	9.8	12.5	11.1	10.5	٢٣.9	١٩.5	١٨.٠	٢٤.5	٢٠.٧	١٨.2	١٢.6	11.0	8.3
Shandweel 1	12.5	11.8	11.4	13.9	12.6	11.7	٢٥.٤	21.9	٢٤.٣	٢٦.٠	٢٤.٢	٢٣.٩	١٤.6	12.5	14.1
Misr 1	12.4	12.2	11.2	13.5	13.5	11.3	٢٥.٣	٢٥.2	٢١.٣	٢٥.8	٢٦.3	٢٣.1	١٣.9	13.7	12.7
Line 1	13.4	11.4	10.0	14.4	12.0	10.7	٢٦.١	٢١.3	١٩.3	٢٦.5	٢٣.٣	٢٠.٣	١٥.٥	11.5	9.7
Line 2	12.9	11.8	11.5	13.9	13.1	12.1	٢٥.٧	٢١.٩	٢٤.3	٢٦.٣	٢٤.8	٢٤.٦	15.2	13.5	14.3
LSD at 0.05		0.9			0.9			1.9			1.9			0.9	
0.01		1.2			1.1			2.5			2.6			1.3	

D1= 20th November (optimum planting) D2= 10th December D3= 30th December

DISCUSSION

Decrease in plant height on late sowing was due to shorter growing period. Early sown crop may have enjoyed the better environmental conditions which resulted to tallest plants also less number of grains/spike in late sowing was due to less production of photosynthates due to shorter growing period (Shahzad *et al*., 2002). Differences in plant height and number of grains/spike among varieties might be attributed to their genetic diversity (Ahmad, 1991 and Haider, 2004). The early sowing resulted in better development of the grains due to longer growing period (Spink *et al*., 2000 and Shahzad *et al*., 2002), who had also reported decreased 1000-grain weight with delay in sowing.. Lower grain yield in late sowing was mainly due to lower germination count/m^2, less number of tillers/m^2, less number of grains/spike and lower 1000-grain weight. These results are in accordance with those of Aslam *et al*., 2003 and Sattar *et al*., 2015 who agree with planting at inappropriate time may cause drastic reduction in wheat yield. They also reported that late sowing results in less grain yield per hectare. Hossain *et al* (2012) reported 58% yield penalty in late planted wheat (25th Dec) than wheat planted on 10th Nov due to severe cutback in entire yield related trait. Higher straw yield in early sowing was mainly due to higher germination count/m^2, more number of tillers/m^2 and more plant height (Donaldson *et al*., 2001). They reported that early sowing resulted in higher straw yield due to more number of tillers. Delay in sowing of wheat can cause severe reduction germination% and seedling characters may be due to favorable environmental conditions to germination of wheat genotype. The second sowing date, December, 10th might be improved photosynthesis rate and assimilates as a result of optimum thermal accumulative and sunshining duration. The variation among wheat varieties might be attributed to their genetic diversity. Confirming results in this respect were cited by Shahzad *et al*., 2002 and Mumtaz *et al*., 2015. The grain protein content of wheat is a critical factor in bread making and high protein content of wheat is associated with good bread making characteristics. It genetically controlled but may vary widely depending upon the variety, climatic conditions, location, soil, fertility, etc. and the complex interaction between these factors. In general, high protein flours give rise to better results since they have a high loaf volume potential with higher water absorption. Previous studies also pointed out that the protein content of wheat was mainly dependent upon genotype (Tayyar and Gul, 2008), which was reflected in this study too with differences in gluten content among different varieties. These results are in agreement with those obtained by Spink *et al*., 1993 and Hussain *et al*., 1994.

It could be concluded that, Misr 1 variety could be selected to obtain plants having high yield, germination and seedling growth when planted under all sowing dates. Moreover, Line 1 and Line 2 are promising for planting at late sowing date without decreasing of grain yield and with high grain quality. In general, better grain yield and quality were obtained when sown Misr 1 and Line 1 at 20th November (optimum planting).

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استجابة محصول وجودة حبوب بعض التراكيب الوراثية لقمح الخبز لمواعيد الزراعة المختلفة

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[١]قسم بحوث القمح ـ معهد بحوث المحاصيل الحقلية ـ مركز البحوث الزراعية ـ الجيزة- مصر

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يهدف هذا البحث إلى دراسة تأثير مواعيد زراعة بعض التراكيب الوراثية للقمح على صفات المحصول والنمو والإنبات ونمو البادرة والجودة . اقيمت تجارب حقلية ومعملية خلال موسمي ٢٠١٠ /٢٠١١ و ٢٠١١/٢٠١٢. حيث تم اختبار استجابة ٨ تراكيب وراثية لثلاث مواعيد زراعية بداية من العشرين من نوفمبر حتى الثلاثون من ديسمبر بفارق ٢٠ يوم . أوضحت الدراسة ان التأخير في ميعاد الزراعة حتى ٣٠ ديسمبر نتج عنه اقل أيام حتى النضج ومحصول الحبوب والنسبة المئوية للإنبات وسرعة الانبات ونمو البادرة ودليل قوة البادرة والوزن الجاف للبادرة وكذلك النسبة المئوية للبروتين وجودة الجلوتين في كلا الموسمين. وأظهرت النتائج ان الصنف مصر١ كان معنوي وأعطى أعلى محصول حبوب مقارنة بالتراكيب الوراثية الاخرى في كلا الموسمين . وكذلك أعطى أعلى زيادة معنوية في النسبة المئوية للإنبات وصفات البادرة ويتبعه في ذلك التراكيب الوراثية جميزة ١١ والسلالة ٢ والسلالة ١. أشارت النتائج إلى أن السلالة ١ أعلى قيم لمحتوى البروتين والنسب المئوية للجلوتين الرطب والجاف ويتبعها في ذلك أصناف مصر١ وشندويل ١ في كلا الموسمين. كما أظهرت النتائج أن أعلى محصول حبوب / هكتار من زراعة الصنف مصر١ تحت كل مواعيد الزراعة . وأوضحت النتائج أن أعلى صفات جودة نتجت من السلالة ١ عند الزراعة في العشرين من نوفمبر في كلا الموسمين . توصى الدراسة بزراعة الصنف مصر ١ لتعظيم إنتاجية وحدة المساحة وفى حالة التأخير في ميعاد الزراعة يوصى بزراعة السلالة ١ أو ٢ لتعظيم إنتاجية وحدة المساحة كماً ونوعاً.