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AGRONOMIC AND GRAIN QUALITY CHARACTERS OF EARLY MATURING SELECTED BREAD WHEAT GENOTYPES UNDER OPTIMUM AND LATE SOWING DATES

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ABSTRACT

The primary goals of Wheat Reach Program at Agricultural Research Centre are to develop cultivars of high yielding, shorten life duration, rusts resistant with good quality grains. Twelve early bread wheat lines were selected from 2009 through 2015 seasons from hybrid segregations using pedigree selection. The selected lines beside three checks (a total of 15 genotypes) were evaluated for their agronomic and grain quality under optimum and late sowing dates in north delta in 2015/16 and 2016/17 growing seasons. The grain yield and kernel weight elucidated significant decreases associated with late sowing in the two seasons and relatively affected by growing season as well as genotypic effects and genetic adaption. Under the optimum sowing date, the wheat genotypes recorded high values for days to maturity, plant height, grain yield, kernel weight, carbohydrates % and electrical conductivity in wheat grain leach and low values of crude protein, dry and wet gluten. The Lines 7, 6, 9 and 10 produced high grain yield under optimum and late sowing dates and could be reevaluated on the national level to confirm these results. Lines 7, 9 and 10 were the appropriate genotypes for delaying sowing date. Line 6 had high grain quality and could be used in breeding program to improve wheat grain quality.

Key words: ***Triticum aestivum, Heading, maturity, Yield components***.

INTRODUCTION

Wheat is one of the most important cereals crops in Egypt. Due to limited area and poor supply of irrigation water, development of new early maturing cultivars could be introduced in the crop rotations to increase the number of cultivated crops in the year and to increase production as well as saving irrigation water. Earliness of wheat maturity affects wheat adaptation to current and new environments and as a result, continues to be one of wheat breeding objectives in Egypt.

Selection of the new wheat genotypes under different planting dates is one of the main tasks of wheat breeding for enhancing productivity on sustainable basis. The lateness in sowing dates in the north delta in Egypt exposes plants to the heat stress at the end of the season causing grain yield reduction. It has been reported that globally wheat production reduced with every 1^{o}C rise of temperature by 6% (Asseng *et al* 2015) or by 10% in China (You *et al* 2009) during the growing season.

Genetic gains in spring wheat yield now is about 0.5 to 1% per year (Fischer *et al* 2014 and Crespo-Herrera *et al* 2017) and due almost entirely to conventional approaches. By crossing lines with good yield and early maturing ones, the probability of achieving early maturing with acceptable increases in grain yield, is better compared to cross with late lines.

Climatic variation as a result of delaying sowing date is considered a main factor affecting gluten quality within a given variety when tested across different sites, seasons, or both (Bonfil *et al* 2015).

It has been recognized that wheat productivity and quality vary considerably as a result of genotype, environment and their interaction (Moldestad *et al* 2011). The sowing date and planted cultivar are very important factors affecting grain yield and its quality, where the optimum sowing date lead to an increase in1000-grain weight (El-Areed *et al* 2017), grain protein, wet and dry gluten content (Moldestad *et al* 2011). While, delaying sowing date reduces plant height, days to maturity and yield and its components (Al-Otayk 2010) and Hossain *et al* 2013). When delaying sowing date, the germination and initial growth of the crop is adversely affected due to prevailing low temperature and the plant grown may exposed to high temperature during maturity and resulted in low seed yield and 1000-grain yield (El-Areed *et al* 2017).

The objective of this study was to evaluate the quantity and quality of some early bread wheat genotypes under optimum and late sowing dates, and to investigate the interactive effects of sowing date and wheat genotypes.

MATERIALS AND METHODS

Five bread wheat (*Triticum aestivum* L.) parents varying in earliness of heading and maturity (Table 1) were grown in season 2009/2010 to obtain three crosses (Yasin 2013). The chosen crosses were Misr 2 x Gemmeiza 9 (Late × Late), Line 14 x Line 15 (Early × Early) and Gemmeiza 9 x Line 13 (Late × Early). In all selection procedures pedigree method were used and the selection was performed only on the three rusts resistant plants. Then selection was done in F_3 in season 2012/2013 and the 45 earliest plants from 2700 plants (each cross consisted of 900 plants) were selected (Aglan and Farhat 2014a). The same work was performed in F_4 (season 2013/2014) and the 30 earliest plants were obtained from 2700 plants in 45 families (Aglan and Farhat 2014b). The thirty early lines were evaluated in replicated trials (unpublished data) in F_5 (season 2014/2015) and the earliest 12 lines with acceptable grain yield were selected to the current study. The selected 12 early lines were only produced from the two crosses Line 14 x Line 13 (Early × Early) and Gemmeiza 9 x Line 13 (Late × Early), while plants from cross Misr 2 x Gemmeiza 9 were excluded for their lateness.

The twelve early lines as well as the late parent Gemmeiza 9, the early parent line 13 and Sids 12 as checks were used during 2015/16 and 2016/17 wheat growing seasons at the Experimental Farm and the lab of Seed Technology Res. Sec. of Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt (31° 5' 12" North, 30° 56' 49" East). The pedigree and selection history of the used genotypes are listed in Table (1).

In each season, the entries were evaluated at two sowing dates' experiments. The first experiment was conducted on 28 November as a recommended date for growing wheat, while the second experiment was carried out on 28 December as a late sowing date. Recommended cultural practices for wheat cultivation in delta region (old land) in Egypt were applied at the proper time. The preceding crop was maize in the two seasons. The meteorological data for the two winter growing seasons from Sakha meteorological station are given in Table (2).

A randomized complete block design with four replications was used for each sowing date. The plot area was 2.4 m^2 and consisted of four rows, 3 m long and 20 cm apart. Grains were manually drilled in the rows at the rate of 300 seeds m^{-2}.

Agronomic characters were: of no. of days to heading and maturity, plant height (cm), no. of spikes m^{-2}, no. of kernels $spike^{-1}$, 1000-kernel weight (g) and grain yield (g m^{-2}). Quality characters were estimated using seed samples taken randomly in bulk from each genotype and grounded to fine powder to pass through 2 mm mesh. Known weight of the fine powdered seeds (ca 0.1g) was digested using a micro kjeldahl apparatus and the crude protein (CP) was calculated by multiplying the total nitrogen by 5.85 (AOAC 1990). Wet (WG) and dry (DG) gluten percentage were determined by hand-washing weighted meal sample according to the standard method (Pleshkov, 1976) until starch was not detected in the washing water, then dried and weighed in gram. Fifty seed were weighted and soaked in 250 ml of distilled water for 24 h and the Electrical conductivity (EC) in the leach was measured in μ-mhos using conductivity meter, measured under optimum conditions according to the international rules of ISTA (1999).

Table 1. Name and pedigree of the studied wheat genotypes.

Genotype	Pedigree	Selection history	Days to maturity
Used parents			
Gemmeiza 9	Ald “S” / Huac // C74A. 630 / Sx	CGM 4583-5GM-1GM-0GM	149-154
Misr 2	SKAUZ / BAV92	CMSS96M03611S-1M-010SY-010M-010SY-8M-0Y-0S	148-150
Line 13	ATTILA*2/GIZA168	S.15612-1S-1S-4S-0S	135-140
Line 14	GIZA168/5/MAI"S"/FJ//ENU"S"/3/KITO/POTO19//MO/JUP/4/K134(60)VEE	S.15410-19S-7S-2S-0SS.15410-19S-7S-2S-0S	137-142
Line 15	KAUZ/ATTILA/7/KVZ/4/CC/INIA/3/CNO//ELGAU/SON64/5/SPARROW"S"/BROCHIS"S"/6/BAYA"S"/IMU	S.15563-9S-3S-1S-0S	137-143
New lines			
Line 1	GIZA168/5/MAI"S"/FJ//ENU"S"/3/KITO/POTO19//MO/JUP/4/K134(60)VEE/8/KAUZ/ATTILA/7/KVZ/4/CC/INIA/3/CNO//ELGAU/SON64/5/SPARROW"S"/BROCHIS"S"/6/BAYA"S"/IMU	S. 17136 - 60S - 1S - 1S - 0S	135-138
Line 2	GIZA168/5/MAI"S"/FJ//ENU"S"/3/KITO/POTO19//MO/JUP/4/K134(60)VEE/8/KAUZ/ATTILA/7/KVZ/4/CC/INIA/3/CNO//ELGAU/SON64/5/SPARROW"S"/BROCHIS"S"/6/BAYA"S"/IMU	S. 17136 - 60S - 4S - 1S - 0S	130-137
Line 3	GIZA168/5/MAI"S"/FJ//ENU"S"/3/KITO/POTO19//MO/JUP/4/K134(60)VEE/8/KAUZ/ATTILA/7/KVZ/4/CC/INIA/3/CNO//ELGAU/SON64/5/SPARROW"S"/BROCHIS"S"/6/BAYA"S"/IMU	S. 17136 - 83S - 1S - 1S - 0S	138-141
Line 4	Gemmeiza9/2/ATTILA*2/GIZA168	S. 17137 - 26S - 1S - 1S - 0S	133-137
Line 5	Gemmeiza9/2/ATTILA*2/GIZA168	S. 17137 - 35S - 1S - 1S - 0S	133-138
Line 6	Gemmeiza9/2/ATTILA*2/GIZA168	S. 17137 - 49S - 1S -	134-137
Line 7	Gemmeiza9/2/ATTILA*2/GIZA168	S. 17137 - 55S - 6S -	135-141
Line 8	Gemmeiza9/2/ATTILA*2/GIZA168	S. 17137 - 55S - 6S -	130-137
Line 9	Gemmeiza9/2/ATTILA*2/GIZA168	S. 17137 - 55S - 6S -	132-136
Line 10	Gemmeiza9/2/ATTILA*2/GIZA168	S. 17137 - 61S - 1S -	133-137
Line 11	Gemmeiza9/2/ATTILA*2/GIZA168	S. 17137 - 61S - 1S - 2S - 0S	131-136
Line 12	Gemmeiza9/2/ATTILA*2/GIZA168	S. 17137 - 73S - 1S - 1S - 0S	132-143
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	144-146

Table 2. Monthly mean of air temperature (AT ^{O}C), relative humidity (RH %) and rainfed (mm/month) in the winter seasons 2015/2016 and 2016/2017 at Sakha site.

Month	AT ^{O}C 2015/2016		AT ^{O}C 2016/2017		RH%		Rainfed (mm)	
	Max.*	Min.**	Max.	Min.	2015/16	2016/17	2015/16	2016/17
November	26.8	10.9	23.6	10.1	67.6	65.8	-	-
December	22.6	8.5	20.4	6.4	72.5	60.0	90.0	14.6
January	21.0	5.7	10.1	8.6	71.3	63.1	18.3	32.5
February	21.6	7.0	11.3	9.5	65.7	70.7	22.9	32.7
March	22.5	6.7	14.1	12.1	70.1	91.5	13.6	42.8
April	26.4	9.9	19.0	17.0	66.1	89.7	11.1	-
May	30.1	13.3	22.6	20.8	59.2	100.1	-	-

*** Max = maximum temperature, ** Min = minimum temperature.**

The statistical analyses were performed using the statistical routines available in EXCEL (2016). However, the coefficients of variations in each sowing date in the two seasons was lower than 20 %, all sowing dates under the two seasons were included in the combined analysis (Gomez and Gomez 1984). The maximum, minimum, ranges and means of sowing dates and genotypes were obtained and differences between genotypes' means were assessed with LSD at 5% level of probability. Seasons were random, while the sowing dates and genotypes were fixed.

RESULTS AND DISCUSSION

Analysis of variances

Mean squares of the studied characters across the two sowing dates across the two seasons are illustrated in Tables (3 and 4). The mean squares due to years, sowing dates, genotypes and all interactions were significant (at 0.05 or 0.01 level of probability) for all agronomic characters, except plant height, no. of spikes m^{-2} and no. of kernels $spike^{-1}$ for interaction between genotypes, sowing dates and years and no. of spikes m^{-2} for interaction between genotypes and sowing dates.

Table 3. Mean squares of the agronomic characters across seasons 2015/2016 and 2016/2017.

SOV	df	DH	DM	PH	SM	KS	KW	GY
Years (Y)	1	1943.7**	2863.5**	5752.6**	290896.4**	8.3	5575.9**	262323.4**
Sowing dates (SD)	1	1712**	11385**	940.1**	177153.6**	830**	7481.2**	5770263.3**
Y x SD	1	297	319.7	0.94	782.1	25.2	55.2	105577.7
Error a	12	2.40	5.30	18.40	1386.40	11.90	6.30	7986.90
Genotypes (G)	14	405.9**	246.4**	1288.7**	59402.5**	1187.3**	101.9**	55609.1**
G x Y	14	14.6**	6.9**	14	9915.7**	18.5*	30.3**	21204.5**
G x SD	14	17.1**	27.3**	47.5**	2334.6	34.8**	21.3**	21513.7**
G x Y x SD	14	8.1**	6.6**	8.8	2465.3	3.8	15.9**	11557.1**
Pooled Error (Eb)	168	1.10	1.90	9.40	1552.00	8.50	5.80	3228.20
Total	239							
CV		1.27	1.06	2.88	8.15	5.78	4.81	7.85

DM = Days to heading, DM = Days to maturity, PH = Plant height, SM= no. of spikes m^{-2}, KS = no. of kernels $spike^{-1}$, KW = 1000 kernel weight, and GY = Grain yield.

Table 4. Mean squares of the quality characters across seasons 2015/2016 and 2016/2017.

SOV	df	CP	CH	WG	DG	EC
Years (Y)	1	25.99**	206.08**	58.94**	61.48**	52.7**
Sowing dates (SD)	1	13.07**	257.57**	145.33**	21.42**	70.49**
Y x SD	1	0.04	0.001	0.51	0.32	0.53
Error a	8	0.29	11.75	0.68	0.57	0.28
Genotypes (G)	14	33.46**	37.11**	149.6**	28.15**	3.42**
G x Y	14	0.08	0.04	0.03	0.02	0.04
G x SD	14	0.19	1.29**	1.61**	0.74**	1.05**
G x Y x SD	14	0.05	0.001	0.01	0.02	0.02
Pooled Error (Eb)	112	0.18	0.21	0.15	0.11	0.12
Total	179					
CV		3.19	0.68	1.18	2.65	14.40

CP = crude protein%, CH = carbohydrate%, WG = wet gluten%, DG = dry gluten% and EC = electrical conductivity of wheat grain leach (µmohes).

Years, sowing dates and genotypes expressed significant mean squares on quality characters. Meanwhile, insignificant interaction variations between years and sowing dates, between genotypes and years and between genotypes, years and sowing dates were expressed in quality characters. Only carbohydrate %, wet gluten %, dry gluten % and electrical conductivity of wheat grain leach had significant interaction between genotypes and sowing dates (Table 4).

Mean performances

1- Agronomic characters

Table (5) shows the average values of the agronomic characters across the two sowing dates and seasons. For the new lines, days to heading were in range of 79.06 for Line 1 and 6 to 83.13 for Line 8, while the early and late parent (Line 13 and Gemmeiza 9) headed after 82.44 and 98.06 days, respectively.

Table 5. Effect of years, sowing dates and genotypes on agronomic characters.

Genotypes	DH	DM	PH	SM	KS	KW	GY
New lines							
Line 1	79.06	129.13	112.81	484.94	44.98	50.87	650.68
Line 2	80.56	127.06	121.88	478.22	44.07	52.70	679.87
Line 3	79.50	130.31	89.38	546.59	44.10	46.62	704.30
Line 4	82.38	128.25	111.56	441.70	47.21	50.36	705.52
Line 5	79.63	128.00	117.81	418.44	51.38	54.52	703.52
Line 6	79.06	129.00	100.31	464.78	49.29	53.67	792.47
Line 7	79.31	130.06	96.56	533.36	50.69	51.17	836.72
Line 8	83.13	127.88	103.44	504.75	45.00	48.28	661.43
Line 9	80.25	127.75	105.63	504.20	47.31	49.43	732.94
Line 10	82.44	129.88	110.31	510.40	47.84	50.46	749.74
Line 11	80.31	127.00	112.19	441.52	50.46	50.78	673.70
Line 12	79.88	129.50	98.13	562.36	49.27	46.55	697.53
Checks							
Sids 12	88.94	136.06	104.06	326.62	78.47	46.97	682.53
Gemmeiza 9	98.06	141.88	113.44	477.76	58.91	47.06	757.81
Line 13	82.44	131.44	97.19	553.66	47.19	49.26	833.72
Mean	82.33	130.21	106.31	483.29	50.41	49.91	724.16
Minimum	79.06	127.00	89.38	326.62	44.07	46.55	650.68
Maximum	98.06	141.88	121.88	562.36	78.47	54.52	836.72
$LSD_{(0.05)}$	0.73	0.96	2.14	27.50	2.03	1.68	39.66

DH = Days to heading, DM = Days to maturity, PH = Plant height (cm), SM = no. spikes m^{-2}, KS = no. kernels $spike^{-1}$, KW = 1000-kernel weight (g), and GY = Grain yield (g m^{-2}).

Days to maturity ranged from 127.00 days for Line 11 to 130.31 days for Line 3 in the new lines compare to 131.44 days in the early parent (Line 13) and 141.88 days for the late parent (Gemmeiza 9). The shortest line was Line 3 (89.38 cm) and the tallest one was Line 2 (121.88 cm), while plant height was between 97.19 cm in Line 13 and 113.44 cm in Gemmeiza 9. Number of spikes m^{-2} in the new lines given values between 418.44 in Line 5 and 562.36 in Line 12, whereas in checks they were between 326.62 in Sids 12 and 553.66 in Line 13. Number of kernels $spike^{-1}$ varied from 44.07 in Line 2 to 51.38 in Line 5, in comparing with 47.19 in Line 13 (the early parent) to78.47 in Sids 12 (check). The new lines give values of 1000 kernel weight from 46.55 g in Line 12 to 54.52 g in Line 5, while the checks were in the range of 46.97 g in Sids 12 and 49.26 g in Line 13. The most grain out yielding new line was Line 7 with 836.72 g m^{-2} followed by Line 6 with 792.47 g m^{-2} and Line 10 with 749.74 g m^{-2}, while Line 1 yielded the lowest one with 650.68 g m^{-2}, compared to Line 13 (the early parent) 833.72 and Sids 12 (check) with 682.53 g m^{-2}.

Table (6) illustrate the average values of the agronomic characters across the two sowing dates in the two seasons. As in Table (2), there were manifested declines in the temperature throughout the second season compared with the first one. The means of all characters for all genotypes were significantly decreased under the first season, representing seasonal differences. The same trend was observed for the minimum and maximum values, while the range was increased in the second season, only for plant height. In this context, grain growth was reported to be reduced due to the high temperatures during grain filling and consequently abnormal grain development and shortened the period for normal grain development (Seleem, and Abd El –Dayem, 2013 and El-Areed *et al* 2017). These results were in agreement with those obtained by Talukder *et al* (2014).

Period to heading was in the range of 76 days in Line 11 in 2015/16 and 86.4 days in Line 8 in 2016/17. Moreover, the values of days to maturity were between 122.9 in Line 2 in first season and 134.4 in Line 12 in the second one. In the same time, no. of spikes m^{-2} values were between 382.8 m^{-2} in Line 5 and 615.5 m^{-2} in Line 12 in the first and second season, respectively. In addition, no. of kernels $spike^{-1}$ values ranged from 41.4 in Line 2 and 52.1 in Line 5 in the first season.

Table 6. Effect of the interactions between years and genotypes on agronomic characters.

Genotypes	DH		DM		PH		SM		KS		KW		GY	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
New lines														
Line 1	77.6	80.5	125.8	132.5	86.3	92.5	414.0	555.9	46.1	43.9	42.9	58.9	555.2	746.1
Line 2	77.9	83.3	122.9	131.3	105.6	117.5	408.1	548.4	41.4	46.8	48.6	56.8	649.6	710.2
Line 3	76.5	82.5	127.6	133.0	113.8	121.9	529.4	563.7	42.6	45.6	42.3	51.0	718.5	690.1
Line 4	79.5	85.3	125.4	131.1	95.0	105.6	387.1	496.4	48.5	45.9	47.8	52.9	678.8	732.3
Line 5	76.6	82.6	124.3	131.8	90.6	102.5	382.8	454.1	52.1	50.7	50.2	58.8	616.9	790.1
Line 6	77.1	81.0	125.6	132.4	98.1	108.8	451.3	478.3	48.5	50.0	49.5	57.8	790.1	794.8
Line 7	78.4	80.3	126.1	134.0	100.6	110.6	488.0	578.7	50.9	50.5	47.1	55.3	740.4	933.1
Line 8	79.9	86.4	124.0	131.8	106.3	114.4	477.8	531.7	43.9	46.1	41.3	55.3	653.9	669.0
Line 9	77.8	82.8	124.8	130.8	108.8	115.6	497.4	511.0	47.8	46.9	44.5	54.4	738.8	727.1
Line 10	79.3	85.6	126.5	133.3	92.5	103.8	502.3	518.5	48.4	47.3	44.9	56.0	728.1	771.4
Line 11	76.0	84.6	123.3	130.8	105.6	119.4	426.5	456.6	50.9	50.1	46.2	55.4	650.8	696.6
Line 12	77.3	82.5	124.6	134.4	116.3	127.5	509.2	615.5	49.4	49.2	42.8	50.3	654.4	740.6
Checks														
Sids 12	85.3	92.6	133.0	139.1	100.0	109.4	299.2	354.1	78.1	78.9	43.1	50.8	659.6	705.4
Gemmeiza 9	93.5	102.6	138.4	145.4	108.1	118.1	403.9	551.6	57.8	60.0	42.2	51.9	696.6	819.0
Line 13	79.8	85.1	129.3	133.6	90.6	103.1	550.2	557.2	47.0	47.3	43.1	55.4	834.9	832.6
Mean	79.5	85.2	126.8	133.7	86.3	92.5	448.5	518.1	50.2	50.6	45.1	54.7	691.1	757.2
Minimum	76.0	80.3	122.9	130.8	116.3	127.5	299.2	354.1	41.4	43.9	41.3	50.3	555.2	669.0
Maximum	93.5	102.6	138.4	145.4	30.0	35.0	550.2	615.5	78.1	78.9	50.2	58.9	834.9	933.1
$LSD_{(0.05)}$	1.03		1.36		3.02		38.89		2.88		2.37		56.08	

DH = Days to heading, DM = Days to maturity, PH = Plant height (cm), SM = no. spikes m^{-2}, KS = no. kernels $spike^{-1}$, KW = 1000-kernel weight (g) and GY = Grain yield (g m^{-2})

The estimates of 1000-kernel weight ranged from 41.3 g in Line 8 in the first season and 58.9 g for Line 1 in the second season. Grain yield was in the range from (555.2 g m^{-2}) for Line 1 in the first season to (933.1 g m^{-2}) in Line 7 and (794.8 g m^{-2}) for Line 6 to (790.1 g m^{-2}) for Line 5 in the second season.

The Means of the agronomic characters across the two seasons under the two sowing dates are presented in Table (7). The optimum sowing date showed the highest values for all characters, while, late sowing date showed the lowest values.

Table 7. Effect of the interactions between sowing dates and genotypes on agronomic characters.

Genotypes	DH		DM		PH		SM		KS		KW		GY		Red. %
	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	
New lines															
Line 1	81.0	77.1	136.3	122.0	115.6	110.0	439.7	390.5	45.3	44.6	56.5	45.3	820.3	481.0	41.4
Line 2	82.5	78.6	133.3	120.9	122.5	121.3	466.3	397.2	45.4	42.8	57.2	48.2	815.9	543.9	33.3
Line 3	82.1	76.9	138.8	121.9	90.6	88.1	479.4	416.8	45.2	43.0	51.8	41.5	918.0	490.6	46.6
Line 4	84.8	80.0	134.3	122.3	112.5	110.6	492.9	444.1	48.4	46.0	54.9	45.8	894.9	516.1	42.3
Line 5	81.8	77.5	134.9	121.1	120.0	115.6	512.0	450.2	52.7	50.1	58.4	50.7	845.3	561.7	33.5
Line 6	81.0	77.1	135.0	123.0	101.3	99.4	512.3	457.9	50.5	48.1	58.8	48.5	982.3	602.7	38.6
Line 7	82.0	76.6	137.9	122.3	97.5	95.6	524.2	463.2	51.6	49.8	57.7	44.6	1010.4	663.0	34.4
Line 8	85.3	81.0	132.9	122.9	106.3	100.6	542.6	478.2	47.5	42.5	54.4	42.2	766.7	556.2	27.5
Line 9	81.8	78.8	133.9	121.6	107.5	103.8	545.2	485.3	48.2	46.4	54.7	44.2	839.1	626.8	25.3
Line 10	85.1	79.8	134.6	125.1	111.3	109.4	556.0	510.7	49.2	46.5	56.1	44.8	845.6	653.9	22.7
Line 11	82.0	78.6	133.1	120.9	113.8	110.6	575.5	517.7	52.8	48.1	56.8	44.7	791.9	555.5	29.9
Line 12	83.4	76.4	137.0	122.0	98.1	98.1	594.0	530.7	51.2	47.4	51.1	42.0	873.2	521.9	40.2
Checks															
Sids 12	93.3	84.6	144.6	127.5	106.3	101.9	335.2	318.0	85.0	72.0	55.5	38.4	874.9	490.1	44.0
Gemmeiza 9	103.3	92.9	151.1	132.6	120.6	106.3	519.3	436.2	62.1	55.7	52.4	41.7	929.4	586.2	36.9
Line 13	85.9	79.0	139.0	123.9	100.6	93.8	562.2	545.1	49.0	45.4	56.1	42.4	980.5	687.0	29.9
Mean	85.0	79.7	137.1	123.3	108.3	104.3	510.5	456.1	52.3	48.6	55.5	44.3	879.2	569.1	35.1
Minimum	81.0	76.4	132.9	120.9	90.6	88.1	335.2	318.0	45.2	42.5	51.1	38.4	766.7	481.0	22.7
Maximum	103.3	92.9	151.1	132.6	122.5	121.3	594.0	545.1	85.0	72.0	58.8	50.7	1010.4	687.0	46.6
$LSD_{(0.05)}$	1.03		1.36		3.02		38.89		2.88		2.37		56.08		

OS = Optimum sowing date, LS = Late sowing date, DH = Days to heading, DM = Days to maturity, PH = Plant height (cm), SM = no. spikes m^{-2}, KS = no. kernels $spike^{-1}$, KW = 1000-kernel weight (g), GY = Grain yield (g m^{-2}) and Red.% = Reduction %

These results may be due to the appropriate temperature at different developmental stages and consequently increased net assimilation rate. These results are in harmony with the findings of Riaz- Ud-Din *et al* (2010) and Talukder *et al* (2014). Under the late sowing date, there were high heat stress, especially during grain filling period, and resulted in the reduction in grain yield, which could be due to the reduction in grain weight and shortened period to maturity (Riaz- Ud-Din *et al* 2010).

Days to heading ranged from 76.38 days in Line 12 under the late sowing date to 83.4 days in Line 12 at the optimum sowing date. In the same time, days to maturing were in the range of 120.88 in Line 2 at the late sowing date to 138.75 in Line 3 under the optimum sowing date. In addition, no. of kernels spike^{-1} were between 42.54 in Line 8 and 52.82 in Line 11 in the late and optimum sowing date, respectively. The values of 1000 kernel weight ranged from 41.48 g in Line 3 in the first season to 58.84 g for Line 6 in the late and optimum sowing date, respectively. Grain yield was in the range of 481.04.2 g m^{-2} for Line 1 under the late sowing date to 1010.42 g m^{-2} in Line 7 and 982.29 g m^{-2} for Line 6 under the late and optimum sowing date, respectively.

The reduction% in grain yield due to late sowing reached the maximum value in Line 3 (46.6 %) followed by Line 4 (42.3%) and Line 1 (41.4%), while the minimum value was showed by Line 10 (22.7%) then Line 9 (25.3%) and Line 8 (27.5 %). While, reduction% ranged from 22.7% in Line 13 (the early parent) to 44.0 % in Sids 12 (check).

The effect of interactions among seasons, sowing dates and genotypes on agronomic characters are shown in Table (8). The late sowing date in the two growing seasons showed a reduction in the means for days to heading, days to maturity, 1000-kernel weigh and grain yield. The maximum and minimum values of these characters tended to decrease under late sowing date in the two seasons. In this respect, ShenYunze (2014) reported that the growth period of wheat was largely extended by shorter photoperiod before flowering, particularly the number of days from tillering to jointing and from jointing to heading. Also the period from flowering to maturity was extended by shorter Photoperiod after flowering.

The all studied genotypes had shortened duration of pre-heading and maturing under the late sowing date in the two seasons. Under the optimum sowing date, the studied genotypes were earlier in 2015/2016 season comparing to the second one, while, late sowing date was vice versa. These results reflected the differences in climatic conditions during the two growing seasons (Table 2).

Table 8. Means of the agronomic characters for the 15 studied genotypes under optimum (OS) and late sowing dates (LS) during 2015/2016 and 2016/2017 seasons.

Genotype	DH				DM				PH				SM			
	2015/2016		2016/2017		2015/2016		2016/2017		2015/2016		2016/2017		2015/2016		2016/2017	
	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS
New lines																
Line 1	81.5	73.8	80.5	80.5	134.5	117.0	138.0	127.0	110.0	103.8	121.3	116.3	426.3	401.7	597.6	514.1
Line 2	81.3	74.5	83.8	82.8	129.8	116.0	136.8	125.8	117.5	115.0	127.5	127.5	442.7	373.4	581.9	514.8
Line 3	80.8	72.3	83.5	81.5	137.3	118.0	140.3	125.8	87.5	85.0	93.8	91.3	559.4	499.5	591.5	535.9
Line 4	82.8	76.3	86.8	83.8	132.3	118.5	136.3	126.0	107.5	103.8	117.5	117.5	450.4	323.7	535.4	457.3
Line 5	80.8	72.5	82.8	82.5	132.5	116.0	137.3	126.3	115.0	112.5	125.0	118.8	383.6	381.9	495.7	412.6
Line 6	81.0	73.3	81.0	81.0	133.8	117.5	136.3	128.5	95.0	95.0	107.5	103.8	462.3	440.3	496.5	460.1
Line 7	82.8	74.0	81.3	79.3	134.8	117.5	141.0	127.0	91.3	90.0	103.8	101.3	525.4	450.6	586.5	570.9
Line 8	82.8	77.0	87.8	85.0	129.5	118.5	136.3	127.3	100.0	96.3	112.5	105.0	494.1	461.4	554.3	509.1
Line 9	80.8	74.8	82.8	82.8	132.0	117.5	135.8	125.8	102.5	98.8	112.5	108.8	535.6	459.2	554.8	467.2
Line 10	83.0	75.5	87.3	84.0	132.5	120.5	136.8	129.8	106.3	106.3	116.3	112.5	506.7	498.0	578.6	458.3
Line 11	78.3	73.8	85.8	83.5	130.5	116.0	135.8	125.8	110.0	107.5	117.5	113.8	462.4	390.6	470.2	442.9
Line 12	81.3	73.3	85.5	79.5	131.8	117.5	142.3	126.5	92.5	92.5	103.8	103.8	556.0	462.4	632.1	599.0
Checks																
Sids 12	89.8	80.8	96.8	88.5	143.3	122.8	146.0	132.3	102.5	97.5	110.0	106.3	304.3	294.0	366.1	342.1
Gemmeiza 9	98.3	88.8	108.3	97.0	148.8	128.0	153.5	137.3	117.5	100.0	123.8	112.5	439.6	368.2	599.0	504.2
Line 13	84.3	75.3	87.5	82.8	139.0	119.5	139.0	128.3	95.0	88.8	106.3	98.8	558.6	541.8	565.9	548.4
Mean	83.3	75.7	86.7	83.6	134.8	118.7	139.4	127.9	103.3	99.5	113.3	109.2	473.8	423.1	547.1	489.1
Minimum	78.3	72.3	80.5	79.3	129.5	116.0	135.8	125.8	87.5	85.0	93.8	91.3	304.3	294.0	366.1	342.1
Maximum	98.3	88.8	108.3	97.0	148.8	128.0	153.5	137.3	117.5	115.0	127.5	127.5	559.4	541.8	632.1	599.0
LSD0.05	1.46				1.93				4.27				54.99			

Table 8. Cont.

Genotype	KS				KW				GY			
	2015/2016		2016/2017		2015/2016		2016/2017		2015/2016		2016/2017	
	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS	OS	LS
New lines												
Line 1	46.6	45.5	44.1	43.7	48.5	37.3	64.4	53.3	659.9	450.5	980.7	511.6
Line 2	41.8	40.9	48.9	44.6	54.7	42.6	59.7	53.9	783.9	515.3	847.9	572.4
Line 3	42.8	42.5	47.6	43.5	46.9	37.7	56.6	45.3	888.5	548.4	947.4	432.8
Line 4	49.2	47.9	47.6	44.1	53.3	42.3	56.6	49.3	887.2	470.3	902.6	562.0
Line 5	52.6	51.5	52.7	48.7	53.7	46.8	63.1	54.6	703.6	530.2	987.0	593.2
Line 6	49.8	47.3	51.1	48.9	53.5	45.5	64.2	51.5	1002.1	578.1	962.5	627.2
Line 7	51.0	50.8	52.2	48.8	51.7	42.4	63.7	46.8	901.6	579.2	1119.3	746.9
Line 8	46.3	41.6	48.6	43.5	46.8	35.7	62.0	48.7	737.5	570.2	795.8	542.2
Line 9	47.9	47.6	48.5	45.3	49.3	39.6	60.0	48.8	834.4	643.2	843.8	610.4
Line 10	49.1	47.7	49.3	45.2	51.2	38.5	61.1	51.0	767.7	688.5	923.4	619.3
Line 11	53.3	48.4	52.4	47.8	51.8	40.5	61.9	48.9	741.1	560.4	842.7	550.5
Line 12	51.0	47.7	51.3	47.0	46.6	39.0	55.6	44.9	831.8	477.1	914.6	566.7
Checks												
Sids 12	84.7	71.5	85.3	72.5	50.6	35.7	60.5	41.1	821.9	497.4	928.0	482.8
Gemmeiza 9	61.8	53.9	62.5	57.5	46.5	37.9	58.3	45.5	834.9	558.3	1024.0	614.1
Line 13	48.5	45.6	49.6	45.1	47.8	38.4	64.4	46.4	981.8	688.0	979.2	685.9
Mean	51.8	48.7	52.8	48.4	50.2	40.0	60.8	48.7	825.2	557.0	933.3	581.2
Minimum	41.8	40.9	44.1	43.5	46.5	35.7	55.6	41.1	659.9	450.5	795.8	432.8
Maximum	84.7	71.5	85.3	72.5	54.7	46.8	64.4	54.6	1002.1	688.5	1119.3	746.9
LSD0.05	4.07				3.35				79.31			

DH = Days to heading, DM = Days to maturity, PH = Plant height (cm), SM = no. spikes m^{-2}, KS = no. kernels $spike^{-1}$, KW = 1000-kernel weight (g) and GY = Grain yield (g m^{-2}).

Heading duration was in the range of 72.25 days in Line 3 at the late sowing date in 2015/16 and 87.75 days in Line8 at the optimum sowing date in 20.16/17. In addition, Days to maturing gave values between 116 in Line 2, 5 and 11 at late sowing in first season and 142.2 in Line 12 at optimum sowing in second season. The values of 1000 kernel weight were in the range of 35.72 g in Line 8 under the late sowing date in the first season and 64.44 g for Line 1 at the optimum sowing date in the second season. The grain yield of all the studied genotypes was higher under the optimum sowing date than the late one in the two seasons. Grain yield ranged from 432.81 g m^{-2} for Line 3 under the late sowing date in the second season to 1119.27 g m^{-2} in Line 7 and 1002.08 g m^{-2} for Line 6 under the optimum sowing date in the second and first season, respectively. Similar results were obtained by El-Sarag and Ismaeil (2013); Hossain *et al* (2013); Rahmani *et al* (2013) and Talukder *et al* (2014).

The means and ranges of reduction percentage for the agronomic characters of the tested new early lines are listed in Table 9. The average reduction due to late sowing date ranged from 2.49% and 2.69 % for plant height and days to heading to 32.69% and 38.31% for grain yield in the first and second season, respectively (Table 9). Grain yield in the two seasons was the most affected character by late sowing date. Moreover, plant height in the two seasons and days to heading in the second season were the least affected characters by late sowing date. The range of the reduction due to late sowing date extended from 1.78 and 1.90 % for days to maturity to 10.84 and 12.53 % for no. of spikes m^{-2} in the first season and second season, respectively.

Table 9. Means and ranges of reduction due to late sowing date for the agronomic characters of the new lines (12 lines) in seasons 2015/16 and 2016/2017.

Characters	Reduction%			
	Mean		Range	
	2015/2016	2016/2017	2015/2016	2016/2017
Days to heading	8.90	2.69	2.99	2.80
Days to maturity	11.57	8.05	1.78	1.90
Plant height	2.49	2.89	3.75	6.67
No. of spikes m^{-2}	10.89	10.73	10.84	12.53
No. kernels $spike^{-1}$	4.68	7.83	6.92	7.61
1000-kernel weight	20.59	19.19	8.96	4.90
Grain yield	32.69	38.31	6.66	12.34

Grain quality characters

Table (10) showed the average values of the grain quality characters under the two sowing dates in the two seasons. As in Table (4), there were highly significant differences between the two seasons for all grain quality characters. The late sowing date caused decreasing values for crude protein%, dry gluten%, wet gluten% and electrical conductivity of wheat grain leach% and increasing values for carbohydrate%. The effect of sowing date on grain quality was in accordance with EL-Sayed *et al* (2018). The delay in sowing date was associated with a decrease in main grain weight but not in grain nitrogen content, thus leading to an overall increase of crude protein percentage.

The genotype' means across seasons and sowing dates showed that Line 8 (11.04), and Line 4 (11.38) had the lowest crude protein %, while Gemmeiza 9 (15.97) showed the reverse trend. Line 13, Line 5 and Line 2 showed the minimum carbohydrates % (64.78-64.99), where Line 8 had the maximum values (69.55). Line 1 and Line 6 possessed the lowest (26.32) and highest (38.86) dry gluten, respectively. Line 8, Line 12 and Line 1 had the lowest wet gluten (10.38-10.52), while Line 6 had the highest values (15.28). Moreover, the lowest electrical conductivity of wheat grain leach percentages were detected by Gemmeiza 9, Line 7, Line 6, Line 13 (1.61-1.88), while Line 10 (3.71) had high values). Only the significant interaction effects were discussed, specially the most interesting one.

Table (11) showed the interaction between the genotypes and sowing dates across the two growing seasons. Carbohydrate % and electrical conductivity % were decreased under the late sowing date in all genotypes. The opposite trend was observed for the dry and wet gluten. Also, the minimum and maximum values were decreased for Carbohydrate % and electrical conductivity and increased for dry and wet gluten, while the range was decreased for all quality characters, except for wet gluten.

The reduction due to late sowing date ranged from 53.36% and 32.43% for EC to -6.08% and -5.43% for dry gluten and wet gluten in the first and second season, respectively (Table 12). Electrical conductivity in wheat grain leach % in the two seasons was the character most affected by late sowing date. Moreover, dry and wet gluten in the two seasons were the least affected characters by late sowing date. The range of the reduction due to late sowing date extended from 4.63 % and 4.48 % for carbohydrate to 58.43 and 50.58 for electrical conductivity in wheat grain % in the first and second, respectively (Table 12).

Table 10. Effect of years, sowing dates and genotypes on the grain quality characters.

Treatment	Crude protein%	Carbohydrate %	Wet gluten%	Dry gluten%	Electrical conductivity%
Year					
2015/16	12.76	66.42	33.24	13.12	1.87
2016/17	13.52	68.56	32.10	11.95	2.95
Sowing date					
Optimum sowing	12.87	68.68	31.77	12.19	3.04
Late sowing	13.41	66.29	33.57	12.88	1.78
Genotype					
New lines					
Line 1	11.50	67.80	26.32	10.52	2.91
Line 2	15.48	64.99	38.17	14.03	2.59
Line 3	11.41	69.69	29.59	10.75	2.82
Line 4	11.38	69.73	33.79	12.89	2.39
Line 5	14.79	64.79	32.67	12.28	2.34
Line 6	13.70	66.88	38.86	15.28	1.87
Line 7	12.22	69.05	35.36	13.90	1.80
Line 8	11.04	69.55	28.26	10.38	2.08
Line 9	11.82	68.61	34.37	13.42	2.39
Line 10	13.80	67.33	34.00	13.77	3.71
Line 11	13.71	66.47	32.80	12.63	2.59
Line 12	12.23	68.36	27.95	10.46	2.73
Checks					
Sids 12	12.66	68.13	31.84	11.48	2.48
Gemmeiza 9	15.97	66.10	32.71	13.74	1.61
Line 13	15.37	64.78	33.41	12.53	1.88
LSD	0.34	0.37	0.31	0.27	0.28

Table 11. Effect of the interactions between sowing dates and genotypes on grain quality characters.

Genotype	Ccarbohydrate %		Wet gluten%		Dry gluten%		Eelectrical conductivity µmohes	
	Optimum	Late	Optimum	Late	Optimum	Late	Optimum	Late
New lines								
Line 1	69.07	66.53	25.53	27.11	9.43	11.60	3.49	2.33
Line 2	66.14	63.84	37.33	39.00	13.64	14.42	3.31	1.86
Line 3	70.99	68.39	28.93	30.25	10.36	11.15	3.51	2.13
Line 4	71.03	68.43	32.96	34.62	12.27	13.50	3.26	1.51
Line 5	65.94	63.64	31.99	33.35	12.01	12.55	3.06	1.61
Line 6	68.28	65.48	37.75	39.97	15.10	15.45	2.18	1.55
Line 7	70.20	67.90	34.12	36.60	13.85	13.96	2.08	1.51
Line 8	70.80	68.30	27.26	29.25	10.12	10.65	2.19	1.98
Line 9	69.91	67.31	33.21	35.53	13.35	13.48	3.29	1.50
Line 10	68.48	66.18	33.30	34.70	13.49	14.05	4.60	2.82
Line 11	67.62	65.32	31.93	33.67	12.27	12.98	3.24	1.93
Line 12	69.63	67.09	26.51	29.38	10.06	10.87	2.90	2.55
Checks								
Sids 12	69.88	66.38	30.26	33.41	11.30	11.65	3.65	1.30
Gemmeiza 9	66.25	65.95	32.50	32.92	13.42	14.06	2.18	1.03
Line 13	65.98	63.58	33.01	33.80	12.20	12.85	2.60	1.16
Minimum	65.94	63.58	25.53	27.11	9.43	10.65	2.08	1.03
Maximum	71.03	68.43	37.75	39.97	15.10	15.45	4.60	2.82
$LSD_{0.05}$	0.53		0.44		0.38		0.40	

Table 12. Means and ranges of reduction due to late sowing date for the grain quality characters of the 15 wheat genotypes in seasons 2015/16 and 2016/17.

Characters	Reduction%			
	Mean		Range	
	2015/2016	2016/2017	2015/2016	2016/2017
Crude Protein%	-4.08	-4.29	9.76	7.71
Carbohydrate%	3.54	3.43	4.63	4.48
Wet gluten%	-5.90	-5.41	9.66	9.40
Dry gluten%	-6.08	-5.20	24.28	20.52
EC µmohes	53.36	32.43	58.43	50.58

CONCLUSION

It could be suggested according to this study that Lines 7, 6, 9 and 10 could be reevaluated on the national level to confirm these results. Lines 7, 9 and 10 were appropriate genotypes to be cultivated under late sowing dates. Line 6 could be used in the breeding program to improve wheat grain quality.

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REFERENCES

A.O.A.C. (1990). Official Methods of Analysis of the Association of Official Analytical Chemists 15th ed. Published by Association of Official Analytical Chemists Arlington, Virginia USA.

Aglan, M. A. and W. Z. E. Farhat (2014a). Genetic studies on some earliness and agronomic characters in advanced generations in bread wheat (*Triticum aestivum* L.). Int. J. Pl. and Soil Sci. 3(6): 790-798.

Aglan, M. A. and W. Z. E. Farhat (2014b). Genetic studies on some F_4 families of three bread wheat (*Triticum aestivum*) crosses under optimum and late sowing dates. J. Agric. Res. Kafr El-Sheikh Univ. 40 (4): 884-904

Al-Otayk, S. M. (2010). Performance of yield and stability of wheat genotypes under high stress environments of the central region of Saudi Arabia. JKAU: Met., Env. Arid Land Agric. Sci. 21 (1): 81-92

Asseng, S., F. Ewert, P. Martre, R. P. Rötter, D. B. Lobell, D. Cammarano, B. A. Kimball, M. J. Ottman, G.W.Wall, J.W. White, M. P. Reynolds, P. D. Alderman, P. V. V. Prasad, P. K. Aggarwal, J. Anothai1, B. Basso, C. Biernath, A. J. Challinor, G. De Sanctis, J. Doltra, E. Fereres, M. Garcia-Vila, S. Gayler, G. Hoogenboom, L. A. Hunt, R. C. Izaurralde, M. Jabloun, C. D. Jones, K. C. Kersebaum, A-K. Koehler, C. Müller, S. Naresh Kumar, C. Nendel, G. O'Leary, J. E. Olesen, T. Palosuo, E. Priesack, E. Eyshi Rezaei, A. C. Ruane, M. A. Semenov, I. Shcherbak, C. Stöckle, P. Stratonovitch, T. Streck, I. Supit, F. Tao, P. J. Thorburn, K.Waha, E.Wang, D.Wallach, J.Wolf, Z. Zhao and Y. Zhu (2015). Rising temperatures reduce global wheat production. Nat. Clim. Chang. 5: 143-147.

Bonfil, D. J., S. Abbo, and T. Svoray (2015). Sowing date and wheat quality as determined by gluten index. Crop Sci. 55(5): 2294-2306.

Crespo-Herrera, L. A., J. Crossa, J. Huerta-Espino, E. Autrique, S. Mondal, G. Velu, M. Vargas, H. J. Braun, R. P. Singh (2017). Genetic yield gains in CIMMYT's international elite spring wheat yield trials by modeling the genotype 9 environment interaction. Crop Sci. 57:789-801.

El-Areed, Sh. R. M., M. M. Mohamed, Sh. Th. I. El-Sherif and A. S. Abd El-Hamed (2017). Response of some Egyptian bread wheat cultivars to different sowing dates. Egypt. J. Plant Breed. 21(7):1297– 1307.

El-Sarag, Eman I. and R. I.M. Ismaeil (2013). Evaluation of some bread wheat cultivars productivity as affected by sowing dates and water stress in semi-arid region. Asian Journal of Crop Science, 5: 167-178.

EXCEL (2016). Microsoft EXCEL Computer user's guide.

Fischer R. A., D. Byerlee and G. O. Edmeades (2014). Crop yields and global food security: will yield increases continue to feed the world? ACIAR Monogr., vol 158. Australian Centre for Int. Agric. Res., Canberra.

Gomez, K. M. and A. A. Gomez (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons, New York, 2nd ed.

Hossain A., M. A. Z. Sarker, M. Saifuzzaman, J. A. Teixeira da Silva, M. V. Lozovskaya and M. M. Akhter (2013). Evaluation of growth, yield, relative performance and heat susceptibility of eight wheat (*Triticum aestivum* L.) genotypes grown under heat stress. International Journal of Plant Production 7 (3): 615- 636.

I.S.T.A (1999). International rules for Seed Testing Association. Seed Sci. and Technol. 27: 155-165.

Moldestad, A., E. M. Fergestad, B. Hoel, A. O. Skjelvåg, and A. K. Uhlen (2011). Effect of temperature variation during grain filling on wheat gluten resistance. J. Cereal Sci. 53: 347–354.

Pleshkov, B. P. (1976). Plant Biochemistry. Kolas, Moscow.

Rahmani, A., A. Jafarnezhad, G. Taheri, M. Armin and M. Tajabadi (2013). Effect of planting date on growth and assimilate contribution of assimilates on seed yield of six wheat cultivars. Adv. Agri. Biol. 1 (4): 94-100

Riaz- Ud-Din, R., G. M. Subhani, N Ahmad, M. Hussain and A. Ur- Rehman (2010). Effect of temperature on development and grain formation in spring wheat. Pak. J. Bot. 42 (2): 899-906.

Seleem, S. A. and S. M. Abd El –Dayem (2013). Response of some wheat cultivars to nitrogen fertilizer levels, J. Plant Production, Mansoura Univ. 4 (5): 721 – 731.

ShenYunze, G. S. (2014). Effects of photoperiod on wheat growth, development and yield in CELSS. Acta Astronautica, 105 (1): 24-29.

EL-Sayed, Soad A., Eman N. M. Mohamed, Dalia A. A. El Hag and Amany M. Mohamed (2018). Sowing dates effect on yield and grain quality of some wheat cultivars. J. Plant Production, Mansoura Univ. 9 (2): 203-213.

Talukder, A. S. M. H. M., G. K. McDonald and G. S. Gill (2014). Effect of short-term heat stress prior to flowering and early grain set on the grain yield of wheat. Field Crops Research 147 (7): 1-11.

Yassin M. M. M. (2013). Breeding for drought tolerance in bread wheat. Ph. D. Thesis, Mansoura Univ., Egypt.

You, L., M.W. Rosegrant, S. Wood, D. Sun (2009). Impact of growing season temperature on wheat productivity in China. Agric Meteor. 149: 1009-1014.

الصفات المحصولية وجودة الحبوب لبعض التراكيب الوراثية المنتخبة مبكرة النضج من قمح الخبز تحت الزراعة المناسبة والمتأخرة

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لقد تم استنباط أصناف مرتفعة المحصول، قصيرة العمر، مقاومة للأصداء وجيدة في صفات جودة الحبوب، وكان ذلك هو الهدف الأهم لبرنامج بحوث القمح بمركز البحوث الزراعية. في ضوء ذلك تم انتخاب ١٢ سلالة جديدة من قمح الخبز مبكرة النضج من إنعزالات هجينية باستخدام الانتخاب المنسب، وذلك من عام ٢٠٠٩ وحتى عام ٢٠١٥. تم تقييم هذه السلالات مع ٣ أصناف مقارنة (١٥ تركيب وراثي) لبعض صفات المحصول وجودة الحبوب تحت ميعاد الزراعة المناسب والمتأخر في شمال الدلتا في موسمي ٢٠١٥/٢٠١٦ و٢٠١٦/٢٠١٧. انخفض المحصول ووزن الحبوب معنويا مع التأخر في ميعاد الزراعة وتأثر نسبيًا باختلاف موسم النمو بالإضافة إلى تأثيرات التراكيب الوراثية والتأقلم الوراثي. وقد سجلت التراكيب الوراثية من القمح تحت ميعاد الزراعة المناسب قيما مرتفعة من صفات عدد الأيام من الزراعة حتى النضج، ارتفاع النبات، محصول الحبوب، وزن الحبوب، نسبة الكربوهيدرات في الحبوب والتوصيل الكهربي لمنقوع حبوب القمح، بينما أعطت قيما منخفضة من نسبة البروتين الخام ونسبة الجلوتين الصلب والطري. وكانت السلالات المبكرة رقم٧، ٦، ٩ و١٠ هي الأعلى في محصول الحبوب تحت الميعاد المناسب والمتأخر للزراعة لذا يمكن الدفع بهم في تجارب مقارنة المحصول على المستوى القومي لتأكيد النتائج. وتعد السلالات رقم ٧، ٩ و١٠ مناسبة للزراعة تحت ظروف الزراعة المتأخرة. في حين أعطت السلالة رقم ٦ أعلى قيم من جودة الحبوب لذا يمكن الاستفادة منها في برنامج التربية لتحسين جودة حبوب القمح.

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