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EVALUATION OF YIELD AND ITS COMPONENTS OF SOME PROMISING BREAD WHEAT GENOTYPES UNDER MIDDLE EGYPT CONDITIONS

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ABSTRACT

The present investigation was carried out at the experimental farm of Mallawy Agricultural Research Station, Minia Governorate during 2018/2019 and 2019/2020 seasons. The aim of this study was to find out the best wheat genotypes with high yield potential among 18 F_6 lines compared to three wheat cultivars in Egypt. The experimental design was randomized complete blocks design (RCBD) with three replicates. The analysis of variance showed significant differences among genotypes for all studied characters except biological yield in the first season. The advanced lines 8, 13 and 14 were the earliest genotypes either in heading (82.4, 80.7 and 81.5 days) or in maturity (135.5, 136.2 and 137.3 days), respectively. Line 4 had the tallest plants (125.8 cm). The highest number of spikes m^{-2} was recorded by line 16 (485 spikes m^{-2}). The highest number of kernels spike^{-1} was produced by line 3 (80.2 kernels). Line 8 gave the highest 1000-kernel weight (55.07 g). Line 7 produced the highest grain and biological yields and harvest index (28.08 ardab faddan^{-1}, 11.900 ton faddan^{-1} and 35.57 %, respectively). Furthermore, the highest mean grain yield/fed was obtained from lines 3, 10, 8, 11, 16 and 14 and they were the most important genotypes for showing excellent performance on grain yield/fed (26.52, 26.52, 26.37, 26.06, 26.06 and 26.05 ardab faddan^{-1} respectively). They were also better than the best performed released check cultivar Misr 2 (25.59 ardab faddan^{-1}). Besides, lines 10, 11, 14 and 16 in this study might be promising for developing heat stress tolerant cultivars. Therefore, the results of the present study concluded that Lines 7, 8, 10, 11, 12, 14, 16 and 18 were superior over the other genotypes in producing higher grain yield and yield attributes and can be used in future breeding programs for the development of superior wheat cultivars at El-Minia Governorate condition.

Key words: ***Triticum aestivum, Heat stress, promising lines, Yield, Yield components***

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a member of the family *Poaceae* which includes the major cereal crops of the world such as maize, wheat, and rice. Among the food crops, wheat is one of the most abundant sources of energy and proteins for the world population. According to the Food and Agriculture Organization of the United Nations (FAO), world production of wheat was more than 520 million tons in 2018. Moreover, it is a staple food, of which the average per-capita global consumption in 2018 was 64 kg and 95 kg in the developing and developed countries, respectively (FAOSTAT 2018). Wheat has a special importance in Egypt because the local production is not sufficient to face the annual requirements. The total consumption of wheat is about 16 million tons, while the total production is about 8.5 million tons (produced from 3.17 million fed) with an average grain yield of 17.85 ardab feddan^{-1} in season 2019/2020. Therefore, there is a gap between the national need and the local wheat production, which means that Egypt still imports about 7.5 million tons annually (Economic Affairs Annual Report 2020).

Wheat genotype is considered to be more adaptive or stable if it has a high mean yield with low degree of fluctuations in yielding ability grown a cross diverse climatic conditions. The different responses of genotypes from one environment to another is defined as genotype x environment (GE) interaction. Some wheat cultivars are adapted to a broader range of environments (stable cultivars) while others have limited environmental adaptation.

Bayisa *et al* (2019) reported that the performance of some bread wheat genotypes evaluated for all traits revealed highly significant differences among the genotypes for most traits and selection of the best promising genotypes showed excellent performance on grain yield/ha higher than the best performed released check variety. Also, Saleh and Alsarhan (2020) found that some bread wheat genotypes differed significantly for all the studied traits. The selection for superior genotypes was based on producing higher grain yield and weight of thousand grains comparing to two check cultivars with an increase rate of 30.20% from one check 32.73%, and from the other.

Ali *et al* (2008) and Farooq *et al* (2011) recorded that fertile tiller number, grain number per spike and thousand grain weight are very important traits to develop final production of such genotype. Therefore, the availability of high yielding genotypes might be promising in future in breeding programs for development of wheat varieties having the highest grain yield potential. The differences between tested wheat genotypes were significant in No. and weight of grain per spike (El-Hefnawy *et al* 1991), spike length (Shalaby *et a.* 1993) which affected grain yield. Wheat production can be increased by developing high yielding genotypes and selection for grain yield can be effective if sufficient genetic variation is present in the plant material. Grain yield is related to thousand grain weight and number of spikes per unit area. Moreover Raza *et al* (2018) found that number of tillers per plant exerted a substantial effect on grain yield.

Therefore, this study aimed to identify the best performing bread wheat genotypes that can be adapted to El-Minia Governorate condition and can be used in future breeding programs.

MATERIALS AND METHODS

A filed experiment was conducted at Mallawy Agricultural Research Station, Agricultural Research Center, during the two successive seasons 2018/2019 and 2019/2020 to find out the best promising genotypes with high yield potential from 18 diverse genotypes selected from F_6 lines in Mallawy breeding program (Hussein 2016). Eighteen selected lines and three check cultivars were evaluated in a randomized complete blocks design with three replicates (Table 1).

Table 1. Name, pedigree, selection history and origin of the studied bread wheat genotypes.

No.	Name	Pedigree and selection history	Origin
1	**Line 1**	Sids 12/ Shandaweel 1. C.Mal2012-25-Mal-1Mal-1Mal-0Mal-0Mal.	**Egypt**
2	**Line 2**	Giza 168/ Shandaweel 1. C.Mal2012-15-Mal-2Mal-3Mal-0Mal-0Mal.	**Egypt**
3	**Line 3**	Sids 4 /Sids 12. C.Mal2012-36-Mal-4Mal-1Mal-1Mal-0Mal.	**Egypt**
4	**Line 4**	WHEAR/S0K0LL/ Sids 12. C.Mal2012-45-Mal-2Mal-1Mal-0Mal-0Mal.	**Egypt**
5	**Line 5**	Sids-4 /Shandaweel 1. C.Mal2012-59-Mal-2Mal-3Mal-0Mal-0Mal.	**Egypt**
6	**Line 6**	Giza 168 /Sids 12. C.Mal2012-99-Mal-1Mal-1Mal-0Mal-0Mal.	**Egypt**
7	**Line 7**	WAXWING*2/PBW343*2/KUKUNA // Sids 12. C.Mal2012-88-Mal-2Mal-4Mal-0Mal-0Mal.	**Egypt**

Table 1. Cont.

No.	Name	Pedigree and selection history	Origin
8	**Line 8**	Sids 4 /Giza 168. C.Mal2012-90-1Mal-2Mal-2Mal-1Mal-0Mal.	**Egypt**
9	**Line 9**	Sids 4 /Giza 168. C.Mal2012-90-Mal-3Mal-1Mal-0Mal-0Mal.	**Egypt**
10	**Line 10**	WHEAR/S0K0LL// Giza 168. C.Mal2012-75-Mal-2Mal-3Mal-1Mal-0Mal.	**Egypt**
11	**Line 11**	Sids 4 /Gemmiza 9. C.Mal2012-101-Mal-3Mal-1Mal-0Mal-0Mal.	**Egypt**
12	**Line 12**	Sids 4 /Gemmiza 9. C.Mal2012-101-Mal-2Mal-3Mal-0Mal-0Mal.	**Egypt**
13	**Line 13**	WAXWING*2//PBW343*2/KUKUNA// Sids 4. C.Mal2012-48-Mal-2Mal-1Mal-1Mal-0Mal.	**Egypt**
14	**Line 14**	WAXWING*2//PBW343*2/KUKUNA// Sids 4. C.Mal2012-49-Mal-1Mal-3Mal-0Mal-0Mal.	**Egypt**
15	**Line 15**	WHEAR/S0K0LL/ Sids 4. C.Mal2012-91-Mal-2Mal-3Mal-0Mal-0Mal.	**Egypt**
16	**Line 16**	WHEAR/S0K0LL/ Sids 4. C.Mal2012-63-2Mal-2Mal-1Mal-0Mal-0Mal.	**Egypt**
17	**Line 17**	WHEAR/S0K0LL/3/ WAXWING*2//PBW343*2/KUKUNA. C.Mal2012-87-Mal-2Mal-1Mal-0Mal-0Mal.	**Egypt**
18	**Line 18**	R0LF07*2/KIRITATI// Giza 168. C.Mal2012-29-Mal-2Mal-4Mal-1Mal-0Mal.	**Egypt**
19	**Shandaweel 1**	SITE//MO/4/NAC/TH.AC//3*PVN/3/MIRLO/BUC. CMSS93B00567S-72Y-010M-010Y-010M-0HTY-0SH.	**Egypt**
20	**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-OSD	**Egypt**
21	**Misr 2**	SKAUZ/BAV92. CMSS96M03611S-1M-010SY-010M-010SY-8M-0Y-0EGY.	**Egypt**

The experiment included 63 plots, each plot consisted of six rows, 2.5 m long and 20 cm apart. Seeds were drilled at the rate of 60 kg/fed. The sowing dates were on 25th and 28th of November in the first and second season, respectively, and harvesting dates were on 15th and 5th of May in the first and second seasons, respectively.

Collected data

A- Agronomic characters

Data were recorded from the four central rows in each plot of the experiment for the following traits:

1- **Days to heading:** were recorded when approximately (50%) of the spikes emerged completely from the sheath.
2- **Days to maturity:** were recorded when 50% of the top internodes were showing no green tissue in each plot.
3- **Plant height (cm):** plant height of each genotype was recorded on 10 random samples from each replication.

B- Yield and yield components

At harvest time, the two external rows were eliminated to avoid the border effect, and the four internal rows were harvested in each plot of the experiment for recording the following traits:

1- **Number of spikes m^{-2}**: was estimated as number of fertile spikes in a guarded square meter in each plot before harvesting.
2- **Number of kernels $spike^{-1}$:** ten spikes were randomly selected from the central rows, threshed individually and number of kernels was taken as the average of the ten spikes from each genotype.
3- **1000-kernel weight (g):** was recorded as the average of two random samples of 1000 kernels from clean grains of each plot.
4- **Grain yield (ardab $faddan^{-1}$):** was estimated as the weight of grains of each plot, which was converted to (ardab $faddan^{-1}$).
5- **Biological yield (ton $faddan^{-1}$):** was recorded as the weight of all dry matter above soil surface for each plot and converted to (ton $faddan^{-1}$).
6- Harvest index (%) was estimated according to Hühn (1990).

$$\textbf{Harvest index} = \frac{\text{Grain yield (kg/plot)}}{\text{Biological yield (kg/plot)}} \times 100$$

Statistical analysis

All data in each season and combined data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the randomized complete block design as mentioned by Gomez and Gomez (1984) using MSTAT-C program (1990) computer software package and least significant differences (L.S.D.) at 5% level of probability were calculated to compare between treatment means.

RESULTS AND DISCUSSION

Analysis of variance

Results of the present study showed that all genotypes significantly differed ($P \leq 0.05$) for all the studied traits in the two seasons except biological yield (ton $faddan^{-1}$) and harvest index in the first season which showed insignificant differences (Table 2). In addition, Table 2 showed significant differences for biological yield and highly significant difference for harvest index in the second season.

Mean performance

A- Agronomic characters

1- Days to heading

Highly significant differences in the mean values of number of days to heading were observed among all genotypes. The average values in Table 4 reveal that the earliest heading was recorded for lines 8, 13 and 14[(90.7, 74), (88.3, 73) and (87, 76 days)] in the first and second seasons, respectively, whereas maximum number of days to heading was recorded for the genotype Misr 2 (108.3 and 92 days) in the first and second seasons, respectively. These results could be explained by the fact that genotypes remarkably differed in their genetic constitutions. The present findings are in agreement with Irfaq *et al* (2005). Moreover, number of days to heading in the second season was less than those in the first season, this finding is mainly due to high temperature dominated Middle Egypt region at heading time (Table 3).

Table 2. Mean squares of the studied characters in the two seasons 2018/2019 and 2019/2020 and combined over two seasons.

Season	Treatments	df	M.S.			
			Days to heading	Days to maturity	Plant height (cm)	No. of spikes m^{-2}
2018/ 2019	Replication	2	4.333	5.778	36.111	144.444
	Genotype	20	104.171**	39.221**	166.944**	394.444**
	Error	40	6.933	3.661	16.528	127.778
2019/ 2020	Replication	2	0.968	0.397	19.444	11.111
	Genotype	20	93.978**	111.187**	148.849**	114.921**
	Error	40	3.052	4.713	11.111	347.778
Combined analysis	Year (Y)	1	7421.341 **	4287.50 **	1790.675 **	578.571 NS
	Error	4	2.651	3.09	27.778	77.778
	Genotype(G)	20	194.458 **	129.98 **	288.452 **	1219.127 **
	Y x G	20	3.691 NS	20.43 **	27.341 *	290.238 NS
	Error	80	4.992	4.19	13.819	237.778

Season	Treatments	df	M.S.				
			No. of kernels $spike^{-1}$	1000-kernel weight (g)	Grain yield (ardab $faddan^{-1}$)	Biological yield (ton $addan^{-1}$)	Harvest index (%)
2018/ 2019	Replication	2	110.302	0.165	0.054	0.46	3.554
	Genotype	20	230.287**	67.835**	0.133**	0.749 NS	4.477 NS
	Error	40	44.735	7.221	0.053	0.52	3.270
2019/ 2020	Replication	2	11.476	0.027	0.058	0.579	0.036
	Genotype	20	214.571**	73.161**	0.147*	0.820*	10.983**
	Error	40	42.926	3.526	0.064	0.441	2.409
Combined analysis	Year (Y)	1	71.627 NS	240.507 **	275.143**	18.73*	90.748**
	Error	4	60.889	0.096	4.913	1.018	1.795
	Genotype(G)	20	430.448 **	114.456 **	14.396**	1.964*	7.343**
	Y x G	20	14.41 NS	26.54 **	9.995*	1.111 NS	8.117**
	Error	80	43.831	5.374	5.068	0.941	2.840

*** Significant at 5%, ** significant at 1% and NS= Not significant.**

Table 3. Maximum, minimum and average temperature dominated the experimental site in 2018/2019 and 2019/2020 seasons.

Average temperature						
Season	**2018/2019**			**2019/2020**		
Month	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**
15th Nov.	**26.32**	**11.75**	**19.04**	**27.72**	**13.71**	**20.72**
December	**22.56**	**7.22**	**14.89**	**23.35**	**7.98**	**15.67**
January	**20.02**	**6.19**	**13.10**	**23.52**	**5.79**	**14.66**
February	**22.11**	**7.61**	**14.86**	**24.49**	**9.26**	**16.88**
March	**23.67**	**9.46**	**16.57**	**26.38**	**11.85**	**19.12**
April	**27.45**	**13.21**	**20.33**	**29.67**	**14.19**	**21.93**
May	**31.64**	**15.82**	**23.73**	**34.87**	**17.72**	**26.30**

Source: The data introduced from Meteorological station, El-Minia, Egypt, during 2018/2019 and 2019/2020.

The average increases of temperature in February and March were 2.02 and 2.55 C° which accelerated the physiological processes in wheat plants and decreased number of days to heading. Although the increase in temperature was only around two degrees but heat stress resulted in 15.3 days earlier in the second season than the first (99.9 vs. 84.6) in 2019/2020 (Table 4), indicating the sharp effects of abiotic stresses on plants. These results are in agreement with those obtained by Jagadish (2012) and Bayisa *et al* (2019).

2- Days to maturity:

The mean values for all the genotypes with respect to days to maturity differed from one to the other (Table 4). Highly significant differences in the mean values for the character under consideration were observed as a result of genetic diversity among the genotypes. The average values revealed that minimum number of days to maturity were recorded for lines 8, 13 and 14[(143.7, 127.3), (146, 126.3) and (147.3, 127.3 days)] in the first and second seasons, respectively.

Table 4. Means of number of days to heading, days to maturity and plant height (cm) of 21 bread wheat genotypes in 2018/2019 and 2019/2020 seasons.

Lines	Days to heading			Days to maturity			Plant height (cm)		
	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.
1	101.0 b-e	84.0 c	92.5	155.3 a-c	143.0 b-d	149.2	98.3 g	95.0 gh	96.7
2	103.7 a-c	90.0 ab	96.9	155.7 ab	144.0 bc	149.9	103.3 fg	98.3 e-h	100.8
3	102.3 b-d	88.3 b	95.3	152.0 b-f	140.7 c-e	146.4	106.7 ef	93.3 h	100.0
4	98.0 d-f	83.3 cd	90.7	145.7 hi	139.7 de	142.7	128.3 a	123.3 a	125.8
5	95.3 f	80.0 e	87.7	152.7 a-f	137.7 e	145.2	111.7 c-e	100.0 e-g	105.9
6	100.0 c-f	82.3 c-e	91.2	151.7 c-f	140.3 c-e	146.0	103.3 fg	106.7 b-d	105.0
7	104.7 a-c	89.7 ab	97.2	151.7 c-f	143.3 b-d	147.5	116.7 bc	108.3 bc	112.5
8	90.7 g	74.0 f	82.4	143.7 i	127.3 f	135.5	105.0 e-g	103.3 c-e	104.2
9	97.0 ef	80.3 de	88.7	155.7 ab	143.7 b-d	149.9	105.0 e-g	95.0 gh	100.0
10	104.0 a-c	88.3 b	96.2	154.0 a-e	142.7 b-d	148.4	101.7 fg	95.0 gh	98.4
11	104.7 a-c	88.0 b	96.4	154.7 a-d	143.0 b-d	148.9	101.7 fg	95.0 gh	98.4
12	98.7 d-f	83.0 c-e	90.9	155.0 a-c	142.7 b-d	148.9	108.3 d-f	101.7 d-f	105.0
13	88.3 g	73.0 f	80.7	146.0 hi	126.3 f	136.2	103.3 fg	98.3 e-h	100.8
14	87.0 g	76.0 f	81.5	147.3 gh	127.3 f	137.3	111.7 c-e	101.7 d-f	106.7
15	97.3 ef	82.7 c-e	90.0	150.3 e-g	140.7 c-e	145.5	116.7 bc	103.3 c-e	110.0
16	105.0 a-c	89.3 ab	97.2	155.3 a-c	146.7 ab	151.0	108.3 d-f	100.0 e-g	104.2
17	104.3 a-c	87.0 b	95.7	150.0 fg	140.7 c-e	145.4	105.0 e-g	96.7 f-h	100.9
18	97.0 ef	83.3 cd	90.2	151.0 d-f	137.7 e	144.4	111.7 c-e	98.3 e-h	105.0
19	105.0 a-c	89.0 ab	97.0	153.0 a-f	144.0 bc	148.5	121.7 ab	108.3 bc	115.0
20	105.7 ab	92.0 a	98.9	152.0 b-f	143.7 b-d	147.9	103.3 fg	96.7 f-h	100.0
21	108.3 a	92.0a	100.2	156.0 a	148.7 a	152.2	115.0 b-d	110.0 b	112.5
Mean	99.9	84.6	92.3	151.8	140.2	146.0	108.9	101.4	105.2
LSD 0.05	4.35	2.88	NS	3.16	3.58	3.32	6.71	5.50	6.04

Comb. = Combined
NS = Not significant.

When data were combined across seasons, number of days to maturity was 135.5, 136.2 and 137.3 days, respectively. However, maximum number of days to maturity was recorded for the genotype Misr 2 (156 and 148.7 days in the first and second seasons, respectively) and the mean of the two seasons was 152.2 days. Days to maturity data in Table (4) revealed existence of two sources of differences, one is due to differences among genotypes in their genetic constitution and the second due to weather conditions where high temperature dominated the site of the experiment resulted in early maturity in the second season. Average temperature in April was 20.33 °C in 2019 while it recorded 21.93 °C in 2020 and in May 2019 recorded 23.73 °C vs. 26.30 °C in 2020. These differences in temperature in the two years resulted in 7.3 days earlier in maturity in 2020. Higher temperature in April and May in 2020 (Table 3) decreased grain filling period and resulted in early maturity of wheat genotypes under investigation. Similar results were also reported by Tammam and Tawfelis (2004), Rahman *et al* (2005), Mahgoub and Amin (2006) and Bayisa *et al* (2019).

3- Plant height (cm)

Data in Table (4) show that the average of plant height in the two years ranged from 96.7 cm for genotype number 1 to 125.8 cm for genotype number 4 with an average of 105.2 cm for all genotypes. These heights are considered medium tall plants which are preferable to farmers to obtain enough straw for their livestock in addition to grain yield. However, plant height of the twenty one genotypes decreased in the second year due to higher temperature dominated the region during the growing season (108.9 cm vs. 101.4 cm) in 2019/2020 (Table 4). These findings may be due to the optimum temperatures in the first season resulting in longer vegetative growth period compared to high temperatures in the second season (Table 2), which gave plants opportunity to build more tissues and increases in plant height. It was reported from the study that line 4 produced taller plants than the other genotypes which was mainly associated with the genetic makeup of parental material of the line. It was further observed that differences in varieties for plant height were significant. The results are in accordance with the findings of Shah and Akmal (2002), Soomro and Oad (2002) and Bayisa *et al (*2019).

B- Yield and yield components:-

1- Number of spikes m^{-2}

The results presented in Table (5) revealed that line 2 and line 16 produced comparatively greater number of spikes m^{-2} (483.3 and 490 spikes) in first and second seasons more than the other genotypes, respectively. While the minimum number of spikes m^{-2} (433.3 and 403.3 spikes) was recorded for line 13 in the two seasons. The finding of Prabhakar *et al* (2003) is relatively comparable to the present results; they obtained varied number of spikes m^{-2} capacity in different wheat genotypes. The average number of spikes m^{-2} in 2018/2019 was 467.8 for the 21 genotypes which in 2019/2020 decreased slightly to 463.5 spikes m^{-2}. These results indicate that this character was not affected by high temperature in the second season on the average level, however, some genotypes had not been affected by heat stress as genotypes 1, 2, 6, 7, 9, 12, 14, 17, 19, 20 and 21. On the other hand, other genotypes were highly affected by heat stress and produced less spikes in 2019/2020 than in 2018/2019, i.e; 3, 4, 5, 8, 10, 11, 13, 15. The increase in yield and its attributes under optimum temperature in the first season may be due to prolonging vegetative growth stage resulting in more tillers formation, leaf numbers and photosynthetic area (leaf area), which resulted in more photosynthetic production and consequently increased yield attributes (number of spikes m^{-2}, number of grains spike^{-1}, 1000-grain weight) and in turn increased grain yield in the first season compared to the second season. The results are in harmony with El Hag (2011) and Mumtaz *et al* (2015).

2- Number of kernels spike^{-1}:

Data in Table (5) showed that wheat genotypes differed significantly in No. of kernels spike^{-1} in both seasons.

Table 5. Means of No. of spikes m^{-2}, No. of kernels spike^{-1} and 1000-kernel weight (g) of 21 bread wheat genotypes in 2018/2019 and 2019/2020 seasons.

Lines	No. of spikes m^{-2}			No. of kernels spike^{-1}			1000-kernel weight (g)		
	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.
1	466.7 a-d	470.0 a-c	468.4	66.3 a-e	66.3 b-e	66.3	40.12 j	46.52 e-g	43.32
2	483.3 a	480.0 ab	481.7	61.0 c-f	61.0 c-g	61.0	40.01 j	43.74 fg	41.88
3	476.7 a-c	453.3 a-c	465.0	78.7 a	81.7 a	80.2	43.85 hi	45.73 e-g	44.79
4	460.0 b-d	450.0 bc	455.0	77.0 ab	70.3 a-d	73.7	47.92 d-g	47.41 df	47.67
5	470.0 a-d	446.7 bc	458.4	73.7 ab	71.3 a-c	72.5	53.13 ab	56.06 ab	54.60
6	456.7 cd	470.0 a-c	463.4	70.0 a-c	61.0 c-g	65.5	47.46 e-g	47.12 d-g	47.29
7	470.0 a-d	476.7 ab	473.4	65.3 b-e	65.3 c-f	65.3	45.71 gh	47.41 df	46.56
8	466.7 a-d	436.7 c	451.7	77.3 ab	77.3 ab	77.3	52.56 a-c	57.58 a	55.07
9	476.7 a-c	473.3 a-c	475.0	68.0 a-d	64.7 c-f	66.4	41.46 ij	42.09 g	41.78
10	480.0 ab	466.7 a-c	473.4	59.7 c-g	53.0 f-h	56.4	49.47 c-f	42.89 fg	46.18
11	476.7 a-c	466.7 a-c	471.7	54.3 e-g	54.3 e-h	54.3	47.44 e-g	46.91 e-g	47.18
12	463.3 a-d	476.7 ab	470.0	65.7 b-e	59.0 c-h	62.4	46.31 f-h	53.24 a-c	49.78
13	433.3 e	403.3 d	418.3	57.0 c-g	57.0 e-h	57.0	54.51 a	55.23 ab	54.87
14	450.0 de	450.0 bc	450.0	54.7 e-g	54.7 e-h	54.7	51.78 a-c	55.66 ab	53.72
15	473.3 a-c	460.0 a-c	466.7	60.7 c-f	60.7 c-g	60.7	50.34 b-e	53.76 a-c	52.05
16	480.0 ab	490.0 a	485.0	57.7 c-g	57.7 d-h	57.7	41.61 ij	47.54 d-f	44.58
17	466.7 a-d	476.7 ab	471.7	61.0 c-f	61.0 c-g	61.0	38.46 j	49.15 c-e	43.81
18	463.3 a-d	456.7 a-c	460.0	59.3 c-g	59.3 c-h	59.3	50.99 b-d	55.34 ab	53.17
19	473.3 a-c	480.0 ab	476.7	47.7 g	47.7 h	47.7	45.10 gh	52.16 b-d	48.63
20	473.3 a-c	480.0 ab	476.7	55.3 d-g	55.3 e-h	55.3	51.66 a-c	45.65 e-g	48.66
21	463.3 a-d	470.0 a-c	466.7	51.3 fg	51.3 gh	51.3	40.56 ij	47.28 d-f	43.92
Mean	467.8	463.5	465.7	62.9	61.4	62.2	46.69	49.45	48.07
LSD 0.05	18.65	30.77	NS	11.04	10.81	NS	3.10	4.43	3.77

Comb. = Combined
NS = Not significant.

The highest No. of this character (78.7 and 81.7 kernels spike^{-1}) were produced by wheat genotype line 3 in the first and second seasons, respectively. However, Shandaweel 1 had the lowest No. of kernels spike^{-1} (47.7 kernels spike^{-1}) in both seasons and when data were combined (47.7

kernels spike^{-1}). Average number of kernels spike^{-1} in the first season did not differ from that of the second season (62.9 vs. 61.4) indicating that heat stress did not affect this trait. The behavior of genotypes could be attributed to their different genetic systems. These results are similar to those of Mahgoub and Amin (2006) and Tawfelis *et al* (2010).

3- 1000-kernel weight (g):

The results regarding 1000-kernel weight (seed index) of wheat genotypes are reported in Table (5). Line 13 in the first season and line 8 in second season produced comparatively greater seed index (54.51 and 57.58 g, respectively). However, both lines produced heavier kernels than the general means of all genotypes in the two seasons (46.69 and 49.54g). However, line 17 in first season and line 9 in the second season recorded the lightest grain weight (38.46 and 42.09 g), respectively. These results are in line with the findings of Akdamar *et al* (2002), who reported that different wheat genotypes varied in seed index values. These differences between genotypes could be referred to their genetic constitutions and their interaction with the prevailing environmental conditions (Moustafa *et al* 1997 and Sadek 2000). An important notice in data of 1000-kernel weight that all genotypes produced heavier kernels in the second season (2019/2020) than that in the first season except lines 4,6,10 and 20 indicating that heat stress in the second season did not affect kernel weight. This finding may help breeders in selection under heat stress by selecting higher 1000-kernel weight for high grain yield. These results are in harmony with those obtained by Shefazadeh *et al* (2012) and Bayisa *et al* (2019).

4- Grain yield (ardab faddan^{-1}):

The main target of this investigation was to evaluate the 21 genotypes for their yield potential. The results pertaining to grain yield per faddan is presented in Table (6).

Table 6. Means of grain yield (ardab faddan^{-1}), biological yield (ton faddan^{-1}) and harvest index (%) of 21 bread wheat genotypes in 2018/2019 and 2019/2020 seasons.

Lines	Grain yield (ardab faddan^{-1})			Biological yield (ton faddan^{-1})			Harvest index (%)		
	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.
1	24.57 b-d	24.43 a-c	24.50	11.294 ab	10.966 a-d	11.130	32.59 bc	33.39 b-f	32.99
2	22.24 d	19.91 cd	21.08	9.520 b	9.800 cd	9.660	35.04 a-c	30.51 f-h	32.76
3	29.71 a	23.33 a-d	26.52	12.694 a	10.640 a-d	11.667	35.11 ab	32.89 b-f	34.01
4	25.97 a-d	20.53 b-d	23.25	11.854 a	10.360 a-d	11.107	32.86 a-c	29.62 gh	31.24
5	24.57 b-d	23.03 a-d	23.80	10.920 ab	9.894 b-d	10.407	33.75 a-c	34.92 a-c	34.35
6	27.69 ab	20.23 b-d	23.96	11.574 a	10.314 a-d	10.944	35.89 ab	29.24 h	32.55
7	29.71 a	26.76 a	28.08	12.226 a	11.574 a-c	11.900	36.45 a	34.32 a-e	35.57
8	28.47 ab	24.27 a-c	26.37	12.274 a	10.546 a-d	11.410	34.79 a-c	34.52 a-d	34.70
9	25.83 a-d	22.87 a-d	24.35	11.854 a	11.106 a-d	11.480	32.86 a-c	30.89 f-h	31.85
10	27.53 ab	25.51 a	26.52	11.666 a	10.826 a-d	11.246	35.40 ab	35.35 ab	35.42
11	26.76 a-c	25.36 a	26.06	11.386 ab	11.666 ab	11.526	35.50 ab	32.61 b-j	34.02
12	26.91 a-c	24.73 ab	25.82	11.760 a	11.434 a-c	11.597	34.54 a-c	32.50 b-j	33.52
13	25.83 a-d	19.60 d	22.72	11.386 ab	9.334 d	10.360	34.03 a-c	31.50 e-h	32.81
14	28.77 ab	23.33 a-d	26.05	12.554 a	10.734 a-d	11.644	34.38 a-c	32.60 b-j	33.50
15	25.97 a-d	23.03 a-d	24.50	11.854 a	10.920 a-d	11.387	32.86 a-c	31.63 d-h	32.28
16	26.60 a-c	25.51 a	26.06	11.666 a	12.134 a	11.900	34.20 a-c	31.54 e-h	32.90
17	25.51 a-d	24.43 a-c	24.97	11.480 a	11.200 a-c	11.340	33.43 a-c	32.72 b-f	33.07
18	28.31 ab	22.87 a-d	25.59	12.694 a	10.640 a-d	11.667	33.45 a-c	32.24 c-h	32.84
19	26.13 a-d	24.73 ab	25.43	11.666 a	12.134 a	11.900	33.60 a-c	30.57 f-h	32.07
20	22.87 cd	26.76 a	24.82	10.920 ab	11.014 a-d	10.967	31.41 c	36.43 a	33.96
21	27.07 a-c	24.11 a-d	25.59	11.854 a	11.667 ab	11.760	34.25 a-c	30.90 f-h	32.59
Mean	26.53	23.57	25.05	11.671	10.900	11.286	34.13	32.43	33.28
LSD 0.05	0.380	0.418	3.66	NS	1.096	NS	NS	2.561	2.74

Comb. = Combined
NS = Not significant.

Line 3 and line 7 produced significantly the maximum grain yield (29.71 ardab faddan^{-1}) in the first season, and the line 7 produced the highest grain yield in the second season (26.76 ardab faddan^{-1}). Line 7 also recorded the highest grain yield at the level of the average of the two seasons producing 28.08 ardab faddan^{-1} (Table 6) followed by lines 3, 10, 8, 11, 14 and 16. All these lines produced more than 26.0 ardab faddan^{-1} indicating high yield potential of their genotypes. It is worthy also to notice that grain yield of some of these lines (10, 11, 14 and 16) did not decrease sharply in the second season (2019/2020) due to high temperature during growth stages. Check cultivar Misr 2 (No. 21) recorded higher grain yield (27.07 ardab faddan^{-1}) than Shandaweel 1 (No. 19) 26.13 ardab faddan^{-1} while, Sids 12 produced lower grain yield (22.87 ardab faddan^{-1}) than the other two check cultivars in the first season. However, Sids 12 produced the highest grain yield over the other two check cultivars producing 26.44 ardab faddan^{-1} in the second season. The average grain yield of the two years of check cultivars were 25.43 ardab faddan^{-1} for Shandaweel 1, 24.82 ardab faddan^{-1} for Sids 12 and 25.59 ardab faddan^{-1} for Misr 2 indicating the superiority of Misr 2 with high yield potential. The average of the three check cultivars were 25.27 ardab faddan^{-1} which was higher than the general mean of the whole 21 genotypes (25.05 ardab faddan^{-1}) as shown in Table (6). The superiority of these genotypes over the check cultivars indicate the possibility of testing these genotypes in the preliminary yield trail of the national program. Lines 7, 8, 10, 11, 12, 14, 16 and 18 can be candidates to be evaluated under the national level. Average of all wheat lines under investigation was superior in grain yield over the general mean significantly except line 2 which recorded the lowest grain yield in the two years (22.24 and 19.91 ardab faddan^{-1}) and in the average of the two years (21.08 ardab faddan^{-1}). The higher temperature in the second season caused significant reduction of final grain weight as compared to optimum temperature in the first season (Table 2). These results are in agreement with those reported by Rahman *et al* (2009) and Jagadish (2012) who revealed that grain yield was reduced by 12.5 to 38.9% due to high temperature of 5°C above the optimum during maturity stage. Also, many authors revealed that the grain yield varied in different wheat genotypes which may be attributed to gentical factors (Rahman *et al* 2010, Kandil *et al* 2016, Hendawy, 2017 and Saleh and Alsarhan 2020).

5- Biological yield (ton faddan^{-1})

The results pertaining to biological yield (ton faddan^{-1}) are presented in Table (6). The mean biological yield ranged between 11.671 and 10.900 ton fed^{-1} with an average of 11.286 ton faddan^{-1}. Line 3 and line 18 produced higher biological yield (12.694 ton faddan^{-1}) in the first season without significant differences from all other genotypes, and line 16 and Shandaweel 1 (12.134 ton faddan^{-1}) in the second season. However, lines 7, 16 and Shandaweel 1 recorded the maximum biological yield (11.900 ton faddan^{-1}) when data was combined. While, line 2 had the lowest biological yield (9.520 ton faddan^{-1}) in the first season and line 13 (9.334 ton faddan^{-1}) in the second season. Furthermore, the average indicated that the lowest biological yield was recorded by line 2 (9.660 ton faddan^{-1}). Check cultivar Misr 2 (No. 21) recorded the highest biological yield (11.854 ton faddan^{-1}) followed by Shandaweel 1 (11.666 ton faddan^{-1}) while, Sids 12 had the lowest biological yield (10.920 ton faddan^{-1}) as compared to the other two check cultivars in the first season. However, Shandaweel 1 produced the highest biological yield (12.134 ton faddan^{-1}) over the other two checks. The average biological yield of the two years of check cultivars was 11.900 ton faddan^{-1} for Shandaweel 1 followed by Misr 2 (11.760 ton faddan^{-1}) and Sids 12 (10.967 ton faddan^{-1}) indicating the superiority of Shandaweel 1 with high biological yield. The average of the three check cultivars was 11.543 ton faddan^{-1} which was higher than the general mean of the whole 21 genotypes (11.286 ton faddan^{-1}) as shown in Table (6). Biomass yield is one of the required traits by agro-pastoral community for their livestock feed during dry season where forage is inadequate. Therefore, identification of higher biomass genotypes might fit with the need of agro-pastoral community of study area. Biomass is affected by leaves area, plant growth and environments. When the developmental pattern of genotypes is so different between growth stages may be determined by comparisons with their biomass production over a long growth period. These results are in accordance with the findings reported by El-Hendawy *et al* (2005) and Bayisa *et al* (2019) who reported varied quantities of total biomass for lines developed in the diversified region.

6- Harvest index (%)

The relationship between total biological yield and grain yield of a crop is expressed in term of harvest index which ultimately determines the ability of converting the dry matter into economic yield. The analysis of variance pertaining to harvest index for the different genotypes is given in Table (2) and the results indicated that mean squares for harvest index was highly significant in the second season only. The highest harvest index was recorded from line 7 (36.45%) without significant differences from the other genotypes in the first season. In the second season, Sids 12 recorded the highest harvest index (36.43%) followed by lines 10, 5, 8 and 7 which recorded (35.35, 34.92, 34.52and 34.32 %), respectively (Table 6). The highest harvest index was recorded from line 7 (35.57 %) when data were combined. On the other hand, the lowest harvest index was recorded from line 4 (31.24 %) when data were combined. Check cultivar Misr 2 (No. 21) recorded the highest harvest index (34.25 %) followed by Shandaweel 1 (No. 19) (33.60 %) while, Sids 12 produced the lower harvest index than the other two check cultivars in the first season. However, Sids 12 produced the highest harvest index (36.43 %) over the other two checks in the second season. The average harvest index of the two years of the check cultivars was 33.96% for Sids 12 followed by Misr 2 (32.59 %) and Shandaweel 1 (32.07 %) as shown in Table (6). Harvest index (HI) has been used to describe the proportion of harvestable biomass. Hence it is more efficient when this genotype was selected so as to promote the harvest index. Alagarswany and Seetharama (1982) reported that biomass and harvest index could be used as indicators of nutrients uptake and translocation to the grain in different genotypes. Selection for high biomass and harvest index is sufficient to ensure high nutrients uptake and translocation of assimilate to the spike. These results are in harmony with those obtained by Shefazadeh *et al* (2012) and Bayisa *et al* (2019).

CONCLUSION

Based on this study performance of bread wheat genotypes under Middle Egypt conditions evaluated for their traits revealed highly significant differences among the genotypes for most traits and significant differences among genotypes for remaining traits were observed. Current results it was suggest that the lines 8, 13 and 14. They were earlier than the other genotypes and can be used in an earliness breeding program. The line 7 gave the highest grain, biological yield and harvest index. Furthermore, the highest mean of grain yield/fed. was obtained from lines 3, 10, 8, 11, 16 and 14; they are the most important genotypes for showing excellent performance on grain yield ard/fed, respectively than the best performed released check variety Misr 2. Besides, Lines 10, 11, 14 and 16 in this study might be considered promising for developing heat stress tolerant new entries and can be used in future bread wheat breeding for tolerance to high temperature stress condition. Therefore, the identified of high yielding genotypes might be promising and can be utilized in breeding programs for the development of wheat varieties having high grain yield under El-Minia Governorate conditions.

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تقييم المحصول ومكوناته في بعض التراكيب الوراثية المبشرة من قمح الخبز تحت ظروف منطقة مصر الوسطى

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أجريت هذه الدراسة فى محطة البحوث الزراعية بملوى – مركز البحوث الزراعية – محافظة المنيا خلال الموسمين الزراعيين ٢٠١٨/٢٠١٩ و ٢٠١٩/٢٠٢٠م وذلك لتحديد أفضل التراكيب الوراثية المبشرة من قمح الخبز ذات المحصول العالى من ٢١ تركيب وراثى (١٨ تركيب وراثى تم انتخابهم فى الجيل السادس و٣ أصناف محلية

للمقارنة) وكان التصميم المستخدم هو القطاعات الكاملة العشوائية فى ٣ مكررات. وبينت النتائج أن التباين لجميع الصفات محل الدراسة كان معنويا" فيما عدا صفتى المحصول البيولوجى ودليل الحصاد كانتا غير معنوية فى الموسم الأول. وكانت التراكيب الوراثية ٨ ، ١٣ ، ١٤ أبكر التراكيب الوراثية (٨٢،٤ و ٨٠،٧ و ٨١،٥ يوم على التوالى) فى صفة طرد السنابل ونفس التراكيب الوراثية كانت أبكرها فى النضج (١٣٥،٥ و١٣٦،٢ و١٣٧،٣ يوم على التوالى). وكانت السلاله ٤ أطول التراكيب الوراثية (١٢٥,٨سم) وسجلت السلاله ١٦ أعلى متوسط لصفة عدد السنابل فى المتر المربع (٤٨٥ سنبلة) والسلاله ٣ سجلت أعلى متوسط فى صفة عدد حبوب السنبلة (٨٠،٢ حبة) وأعطت السلاله ٨ أعلى وزن لصفة وزن الألف حبة (٥٥،٠٧ جم) وكان أعلى محصول حبوب ومحصول حيوى ودليل الحصاد للسلاله ٧ حيث سجلت (٢٨،٠٨ أردب/ فدان و ١١،٩٠٠ طن/فدان و ٣٥،٥٧ % على التوالى). علاوة على ذلك، كان أعلى متوسط لمحصول الحبوب للفدان سجل بواسطة السلالات (٣ ، ١٠ ، ٨ ، ١١، ١٦ و ١٤) حيث كانوا من التراكيب الوراثية الهامة التي أعطت متوسط إنتاجية عالى للحبوب (٢٦،٥٢ ، ٢٦،٥٢ ، ٢٦،٣٧ ، ٢٦،٠٦ ، ٢٦،٠٦ و ٢٦،٠٥ أردب/فدان على التوالى) مقارنة بأفضل صنف للمقارنة مصر٢ (٢٥،٥٩ أردب/فدان). وأظهرت الدراسة أن السلالات (١٠ ، ١١ ، ١٤ و ١٦) من السلالات المبشرة المتحملة للإجهاد الحرارى التى يمكن إستعمالها في المستقبل في برامج التربية لتحمل الحرارة. لذلك أثبتت هذه الدراسة تفوق السلالات (٧ ، ٨ ، ١٠ ، ١١ ، ١٢ ، ١٤ ، ١٦ و ١٨) حيث تفوقوا في صفة محصول الحبوب ومكوناته مقارنة بباقى التراكيب الوراثية ويمكن استخدامهم في المستقبل فى برامج التربية لتحسين إنتاجية أصناف القمح تحت ظروف محافظة المنيا.

المجلة المصرية لتربية النبات ٢٤(٣): ٦٧٥- ٦٩٦ (٢٠٢٠)