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Performance and Stability of Promising Bread Wheat Lines for Grain Yield and Yield Components

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Abstract: The present study was conducted to evaluate 50 wheat genotypes for their productivity and stability under eight environmental conditions. Wheat genotypes were sown at two planting dates under two nitrogen fertilization treatments during the winter seasons of 2018/2019 and 2019/202. The analysis of variance showed that the mean squares of genotypes, sowing dates, and nitrogen fertilization treatments were significant for the number of spikes/plant, the number of kernels/spike, 1000-kernel weight, and grain yield/plant. The results showed that sowing at the favorable date using 80 kg N/fed increased all studied traits. This study revealed that line numbers 9 and 10 exhibited general adaptability across different environments; hence, these lines are considered promising and could be exploited in breeding programs for wheat improvement.

1 Introduction

Wheat is a major cereal crop, contributing approximately 50% of the global grain trade and 30% of grain production (Aktar and Islam 2017). Moreover, wheat is considered a staple food crop in more than 40 countries worldwide. One of the most important national targets in Egypt is maximizing the wheat grain yield to narrow the large gap between its production and consumption through quantitatively and qualitatively improving wheat varieties. Increasing the unit productivity will help mitigate the difficulties in horizontally expanding wheat cultivation areas. The task at hand for breeders is gaining more information regarding genotypic performance under different environmental conditions and at different planting-time intervals; thereby screening out under-performing genotypes selecting the best-performing ones under diverse agroecological conditions.

Planting wheat in optimum sowing date gives the optimum season length and achieves high grain yield as a result of suitable weather conditions throughout different growth stages (Rahman et al 2009, Singh et al 2011, Mumtaz et al 2015, Uddin et al 2015).

Nitrogen is one of the most important elements that has a direct effect on plant growth and yield. In this respect, grain yield increased with increasing nitrogen fertilization (Abdel Nour and Fateh 2011, Mosslem et al. 2014, El-Marakby et al. 2015). Moreover, bio-fertilizers had a significant effect on grain yield and its components in wheat (Cisse et al 2019)

The effects of genotypic and environmental interaction are crucial in the evaluation of varieties in plant breeding programs because they reduce selection-related progress under diverse environments. If genotypes significantly interact with seasons, sowing dates, fertilization treatments, or a combination of them, the selection of superior genotypes becomes more complex. Crop breeders have been striving to develop genotypes with superior grain yield and yield components over a wide range of different environmental conditions to select stable genotypes unaffected by environmental changes.

The major objectives of this investigation are to (1) compare the performances of 40 promising bread wheat lines with those of their parental varieties (four varieties) and six commercial cultivars under eight different environments (two seasons, two sowing dates, and two N fertilization treatments); (2) estimate the phenotypic stability of genotypes for different studied traits; and (3) determine the most stable lines with the best performance to potentially be used as genetic sources in wheat breading programs.

2 Materials and Methods

2.1 Planting and treatments

The field experiment was carried out during two growing seasons (2018/2019 and 2019/2020) at the Experimental Farm of the Fac. of Agric., Ain Shams Univ. at Shalakan, Kalubia Governorate, Egypt. We compared 40 promising bread wheat lines developed by Saleh (2017) and their parental varieties with six commercial cultivars (namely, Sids 1, Sids 14, Giza 171, Gemmiza 12, Misr 2, and Shindwell 1) for their performance in grain yield, yield components, and phenotypic stability. Additionally, we recorded these attributes under the recommended sowing date (November 14th [D_1])and the late sowing date (December 13th [D_2]), and under two nitrogen fertilization treatments (biofertilizer + 40 kg N/fed. [N_1] and 80 kg N/fed. [N_2]). **Table 1** presents the pedigree code numbers and origins of the promising wheat lines used in this study.

Table 2 provides the physical and chemical properties of the two seasons' sites. **Table 3** summarizes the monthly average maximum and minimum temperatures (°C) and relative humidity (%) at Shalakan during the two growing seasons.

As recommended, seeds were inoculated directly before sowing with the biofertilizer commercially called “Cerealin," which was kindly obtained from the Microbial Dept. of Soils, Water and Environ., Res. Inst., Agric. Res. Center, Giza, Egypt. Seeds were also inoculated with the N_2-fixing bacteria strains *Azospirillum brasilense* and *Bacillus polymyxa*. Inoculation was performed by mixing seeds with the appropriate amounts of Cerealin (1 g/100 g wheat grains), using Arabic gum as adhesive material. The coated seeds were then air dried in the shade for 30 min and sown immediately. Mineral nitrogen fertilizer as ammonium nitrate (33.5% N) was applied in two portions. The first portion (2/3 of the total amount) was immediately applied before the first irrigation (3 weeks after sowing) and the second one (1/3 of the total amount) was applied before the second irrigation (7 weeks after sowing). One experiment was devoted to each sowing date. The plantings were laid out in a split-plot design with three replications for each experiment. The fertilization treatments were assigned in the main plots, and genotypes were randomly distributed in the subplots. Each experimental plot consisted of two rows, each measuring 3 m long and 20 cm wide. Seeds were spaced 10 cm apart within rows and thinned (about 3 weeks after sowing) to one plant per hill. Other cultural practices for wheat production were applied during each growing season. The preceding crop was maize (*Zea mays*, L) in both seasons.

2.2 Yield and yield components

At harvest, a random sample of ten guarded plants was collected from each plot. Data were collected for the following characteristics: number of spikes per plant, number of kernels for the main stem spike, 1000-kernel weight (g), and grain yield per plant (g).

2.3 Statistical analysis

The analysis of variance was performed according to Gomez and Gomez (1984). The comparison between sowing dates, N fertilization treatments, genotypes, and their interactions was performed using the least significant difference test. The combinations between two different N fertilization treatments, sowing dates, and seasons were considered eight variable environments. The stability analysis was computed as outlined by Eberhart and Russell (1966).

3 Results and Discussion

3.1 Analysis of variance

As shown in **Table** 4, the mean squares due to sowing dates and nitrogen fertilization treatments were highly significant for grain yield and its components in both seasons, indicating that these characteristics are influenced by the factors investigated in this study. Moreover, the mean squares for genotypes were highly significant in both growing seasons, indicating the presence of sufficient genetic variability in the wheat genotypes studied herein. Meanwhile, the interaction mean squares of sowing dates and genotypes

Table 1. Code number of pedigree and origin for promising wheat lines used in this study

Code no. of promising lines	Pedigree and origin
1–15	**(Giza168)** MRL/Buc// Seri CM93046-8M-oY-oM-2Y-oB **(Egypt)** × **(Cham 8)** JOPATI-COCM67458-F-73/BLUEAY/ **(Syria)**
16–27	**(Giza168)** MRL/Buc// Seri CM93046-8M-oY-oM-2Y-oB **(Egypt)** × **(Bohouth 6)** Crow`s CM 40457**(Syria)**
28–40	**(Sakha 94**) OPATA / RAYON // KAUZ **(Egypt)** × **(Bohouth 6)** Crow`s` CM 40457**(Syria)**

Table 2. Mechanical and chemical analyses of the soil at Shalakan region, Egypt, during two growing seasons (2018/2019 and 2019/2020)

Constituents	**2018/2019**		**2019/2020**	
Mechanical analysis	**0–15 cm**	**15–30 cm**	**0–15 cm**	**15–30 cm**
Clay%	52.40	50.10	53.45	50.18
Silt%	20.20	21.80	20.17	22.14
Sand%	27.40	28.10	27.20	28.19
Chemical analysis				
N^{2+}	108.00	104.00	112.00	107.00
Ca^{2+}	1.62	1.51	0.80	1.40
Mg^{2+}	0.88	0.80	2.40	2.20
Na^{+}	1.83	2.15	3.39	2.70
K^{+}	0.18	0.23	0.11	0.10
CI^{-}	3.70	3.90	2.40	2.20
$CO3^{=}$	0.00	0.00	0.00	0.00
HCO^{3-}	0.70	0.60	1.60	1.40
$SO^{4=}$	0.11	0.19	2.70	2.80
Available p	7.41	9.04	7.54	8.26
Available k	218.40	106.80	202.80	218.40
pH	7.11	7.18	8.00	8.10
EC	0.45	0.47	0.67	0.64

Table 3. Averages of maximum and minimum temperature (°C) and relative humidity (RH%) at Shalakan region, Egypt, during the two growing seasons (2018/2019 and 2019/2020)

Season	**2018/2019**			**2019/2020**		
Month	**Aver. RH (%)**	**Max temp. (°C)**	**Min temp. (°C)**	**Aver. RH (%)**	**Max temp. (°C)**	**Min temp. (°C)**
Nov.	55.87	26.5	14.16	51.79	28.53	14.92
Dec.	63.3	20.46	9.68	63.7	21.05	9.58
Jan.	50.08	18.85	6.17	67.4	18.05	7.31
Feb.	53.07	21.02	7.49	63.82	20.54	8.09
Mar.	51.46	23.71	9.05	56.64	24.69	9.98
Apr.	43.01	28.21	12.38	53.67	27.2	12.11
May	29.25	36.81	17.83	46.94	32.93	15.77

Table 4. Analysis of variance over two sowing dates (D) and two N fertilization treatments (N) of wheat genotypes (G) for the studied traits in the 2018/2019 and 2019/2020 growing seasons

SOV	df	No. of spikes/plant	No. of kernels/spike	1000-kernel weight (g)	Grain yield/plant (g)
			First season of 218/2019		
D	1	667.69**	2487.58**	45979.51**	10263.4**
N	1	180.25**	316.97**	7871.62**	3073.43**
DN	1	16.16	19.77**	1291.66**	0.89
Error	4	3.62	0.89	15.04	3.8
G	49	4.17**	10.27**	83.77**	165.25**
DG	49	1.87**	6.32**	59.33**	33.77**
NG	49	0.8	0.77	45.19**	11.73**
DNG	49	0.73	0.9	49.32**	9.88**
Error	392	0.65	1.16	7.06	3.06
			Second season of 2019/2020		
D	1	882.19**	1602.95**	44593.33**	9410.86**
N	1	236.45**	285.80**	7402.03**	2808.27**
DN	1	3.21	33.94**	736.51**	29.36**
Error	4	9.46**	1.32	2.86	0.19
G	49	2.15**	8.63**	89.91**	143.54**
DG	49	1.25**	5.70**	57.54**	29.17**
NG	49	0.66**	1.31**	32.37**	9.44**
DNG	49	0.61**	1.37**	38.25**	8.94**
Error	392	0.27	0.56	7.38	1.67

*,** denote significant differences at 0.05 and 0.01 levels of probability, respectively

were highly significant for all studied traits in both seasons. Furthermore, nitrogen treatments and genotypic interactions were highly significant for all studied traits in both seasons, except the number of spikes/plant and the number of kernels/spike in the first season. The significance of the D × N interaction for the number of kernels/spike and 1000-kernel weight in both seasons and grain yield/plant in the second season shows that the mean performance of wheat genotypes regarding these traits under the two N-levels differed significantly for both sowing dates. This result indicates the importance of sowing dates on nitrogen absorption and assimilation in wheat plants (El-Marakby et al 2015).

The second-rank interaction of G × D × N was also significant for all traits, except for the number of spikes and number of kernels/spike in the first season, which indicates that the sowing date/nitrogen level combinations have either slight or significant influence on the performance for most of the investigated traits. These results indicate that the studied genotypes respond differently to various environmental conditions and suggest the importance of genotype assessment under different conditions to identify the best-performing genotypes for a particular environment. Other studies indicated significant interactions between wheat genotypes, sowing dates, and N fertilization treatments for one or more of these studied traits (El-Kalla et al 2010, Hamam et al 2015, Sharma et al 2019, and Gagliardi et al 2020).

3.2 Performance of wheat genotypes

Regarding the number of spikes/plant, **Tables 5 and 6** present the mean performance of 50 wheat genotypes under the two different sowing dates, N fertilization treatments, and growing seasons. The results reveal that the late sowing date caused 27.01 and 24.92% reduction in the number of spikes/plant compared with the recommended sowing in both growing seasons. The number of spikes/plant drastically decreased for late sowing because of the shorter growing period and, consequently, less photosynthesis production than in plants sown early (Badr et al 2018). Early sowing gave the plants better environmental conditions, especially temperature (Singh et al 2011, Hamam et al 2015). Timing of initiation of vegetative and reproductive organs depends upon temperature and photoperiod (Badr et al 2018), but the survival and subsequent size of such organs is dependent upon

Table 5. Performance of number of spikes/plant for 50 wheat genotypes (G) on two sowing dates (D) under two N-fertilization levels (N) in 2018/2019 growing season

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
1	12.07	15.97	14.02	10.23	11.20	10.72	11.15	13.59	12.37
2	17.00	17.50	17.25	9.53	10.87	10.20	13.27	14.19	13.73
3	14.17	16.27	15.22	10.33	11.40	10.87	12.25	13.84	13.04
4	13.13	15.87	14.50	10.40	12.80	11.60	11.77	14.34	13.05
5	13.47	14.27	13.87	10.67	12.40	11.53	12.07	13.34	12.70
6	17.40	18.60	18.00	12.67	13.87	13.27	15.04	16.24	15.63
7	15.03	18.23	16.63	11.03	12.33	11.68	13.03	15.28	14.16
8	14.93	16.13	15.53	11.23	12.47	11.85	13.08	14.30	13.69
9	13.67	15.87	14.77	9.77	10.07	9.92	11.72	12.97	12.34
10	13.80	16.67	15.23	10.47	11.13	10.80	12.14	13.90	13.02
11	16.47	17.50	16.98	10.93	11.20	11.07	13.70	14.35	14.03
12	14.87	17.00	15.93	10.93	11.47	11.20	12.90	14.24	13.57
13	16.13	17.80	16.97	9.93	11.47	10.70	13.03	14.64	13.83
14	11.80	14.07	12.93	9.63	10.20	9.92	10.72	12.14	11.43
15	12.27	14.67	13.47	9.60	9.80	9.70	10.94	12.24	11.58
16	14.67	15.70	15.18	10.73	12.67	11.70	12.70	14.19	13.44
17	15.73	16.67	16.20	10.53	10.60	10.57	13.13	13.64	13.38
18	14.40	14.93	14.67	9.67	10.73	10.20	12.04	12.83	12.43
19	15.57	17.57	16.57	9.83	11.07	10.45	12.70	14.32	13.51
20	14.60	15.93	15.27	10.80	11.33	11.07	12.70	13.63	13.17
21	15.47	15.93	15.70	9.53	10.00	9.77	12.50	12.97	12.73
22	13.40	15.60	14.50	8.87	9.60	9.23	11.14	12.60	11.87
23	13.60	15.93	14.77	11.27	13.00	12.13	12.44	14.47	13.45
24	16.23	18.20	17.22	11.00	11.80	11.40	13.62	15.00	14.31
25	13.13	16.03	14.58	9.07	10.40	9.73	11.10	13.22	12.16
26	12.13	14.93	13.53	9.33	11.07	10.20	10.73	13.00	11.87
27	15.40	17.13	16.27	10.60	12.33	11.47	13.00	14.73	13.87
28	13.33	16.53	14.93	11.07	11.47	11.27	12.20	14.00	13.10
29	14.60	15.53	15.07	10.87	12.40	11.63	12.74	13.97	13.35
30	14.63	15.93	15.28	10.67	11.07	10.87	12.65	13.50	13.08
31	15.60	16.40	16.00	10.60	13.00	11.80	13.10	14.70	13.90
32	14.47	15.87	15.17	10.93	12.80	11.87	12.70	14.34	13.52
33	13.80	15.73	14.77	10.27	11.13	10.70	12.04	13.43	12.73
34	12.60	15.13	13.87	11.80	13.60	12.70	12.20	14.37	13.28
35	12.73	14.53	13.63	10.87	11.27	11.07	11.80	12.90	12.35

Table 5. Cont.

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
36	13.67	15.23	14.45	11.20	12.07	11.63	12.44	13.65	13.04
37	13.30	15.47	14.38	11.10	11.60	11.35	12.20	13.54	12.87
38	15.80	18.47	17.13	10.87	11.33	11.10	13.34	14.90	14.12
39	16.20	16.60	16.40	11.20	12.60	11.90	13.70	14.60	14.15
40	15.60	17.20	16.40	11.00	12.20	11.60	13.30	14.70	14.00
Giza 168	10.00	12.20	11.10	8.83	9.67	9.25	9.42	10.94	10.18
Sakha 94	12.13	13.73	12.93	10.27	12.07	11.17	11.20	12.90	12.05
Sham 8	12.90	14.13	13.52	11.13	12.93	12.03	12.02	13.53	12.78
Boohoth 6	12.60	12.87	12.73	10.50	11.73	11.12	11.55	12.30	11.93
Giza 171	11.13	14.80	12.97	10.17	11.67	10.92	10.65	13.24	11.94
Sids 1	16.23	16.73	16.48	9.60	10.60	10.10	12.92	13.67	13.29
Sids 14	12.07	14.13	13.10	10.20	11.53	10.87	11.14	12.83	11.98
Gemmiza 12	15.10	16.67	15.88	10.37	11.23	10.80	12.74	13.95	13.34
Misr 2	15.00	17.67	16.33	10.33	11.47	10.90	12.67	14.57	13.62
Shindwell 1	14.00	16.33	15.17	10.13	10.40	10.27	12.07	13.37	12.72
average	14.16	15.98	15.07	10.45	11.54	11.00	12.31	13.76	13.03
% Reduction N	11.39			9.45			10.57		
% Reduction D						27.01			
D									0.36
N			0.65			0.13			0.21
DN									0.30
G	2.12	2.22	1.53	1.27	1.07	0.83			0.86
DG									1.22
NG			2.16			1.17			1.22
DNG									1.73

D1 and D2 = 14 Nov. and 13 Dec., respectively.
N1 and N2 = 40 + Bio and 80 N kg /fed., respectively.

Table 6. Performance of number of spikes/plant for 50 wheat genotypes (G) on two sowing dates (D) under two N-fertilization levels (N) in 2019/2020 growing season

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
1	10.97	14.17	12.57	9.33	9.70	9.52	10.15	11.94	11.04
2	15.20	15.60	15.40	8.43	10.17	9.30	11.82	12.89	12.35
3	12.03	14.60	13.32	8.73	10.27	9.50	10.38	12.44	11.41
4	11.07	13.93	12.50	9.20	11.37	10.28	10.14	12.65	11.39
5	11.53	12.27	11.90	9.50	10.53	10.02	10.52	11.40	10.96
6	16.20	16.60	16.40	9.70	10.93	10.32	12.95	13.77	13.36
7	12.40	16.00	14.20	9.77	10.73	10.25	11.09	13.37	12.23
8	12.73	14.20	13.47	10.07	11.03	10.55	11.40	12.62	12.01
9	11.90	13.17	12.53	8.90	9.70	9.30	10.40	11.44	10.92
10	11.07	14.20	12.63	9.47	10.27	9.87	10.27	12.24	11.25
11	14.63	15.43	15.03	9.77	10.30	10.03	12.20	12.87	12.53
12	11.53	15.77	13.65	10.20	10.50	10.35	10.87	13.14	12.00
13	13.30	15.83	14.57	9.43	10.57	10.00	11.37	13.20	12.28
14	10.73	11.90	11.32	9.00	9.27	9.13	9.87	10.59	10.23
15	10.77	13.73	12.25	8.63	9.10	8.87	9.70	11.42	10.56
16	12.57	14.13	13.35	10.30	10.90	10.60	11.44	12.52	11.98
17	11.90	14.03	12.97	9.50	9.73	9.62	10.70	11.88	11.29
18	12.47	12.67	12.57	8.50	9.50	9.00	10.49	11.09	10.78
19	13.77	14.80	14.28	8.70	9.40	9.05	11.24	12.10	11.67
20	12.77	13.53	13.15	10.27	11.17	10.72	11.52	12.35	11.93
21	12.60	13.00	12.80	8.60	9.10	8.85	10.60	11.05	10.83
22	11.07	13.13	12.10	7.53	8.57	8.05	9.30	10.85	10.08
23	11.83	12.33	12.08	10.10	10.70	10.40	10.97	11.52	11.24
24	14.60	15.23	14.92	10.17	10.50	10.33	12.39	12.87	12.63
25	12.03	13.43	12.73	8.10	8.37	8.23	10.07	10.90	10.48
26	11.27	12.97	12.12	8.60	10.00	9.30	9.94	11.49	10.71
27	12.73	15.30	14.02	9.50	9.73	9.62	11.12	12.52	11.82
28	11.40	15.57	13.48	9.53	10.23	9.88	10.47	12.90	11.68
29	12.67	14.30	13.48	9.93	11.00	10.47	11.30	12.65	11.98
30	13.03	13.73	13.38	9.73	10.00	9.87	11.38	11.87	11.63
31	13.77	15.83	14.80	9.37	11.53	10.45	11.57	13.68	12.63
32	11.70	12.80	12.25	9.63	10.90	10.27	10.67	11.85	11.26
33	11.00	13.57	12.28	8.47	9.93	9.20	9.74	11.75	10.74
34	11.10	14.33	12.72	9.93	11.90	10.92	10.52	13.12	11.82
35	11.53	12.03	11.78	9.90	10.37	10.13	10.72	11.20	10.96

Table 6. Cont.

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
36	11.50	14.27	12.88	9.47	10.87	10.17	10.49	12.57	11.53
37	10.70	12.53	11.62	9.77	10.70	10.23	10.24	11.62	10.93
38	12.60	16.97	14.78	9.83	10.20	10.02	11.22	13.59	12.40
39	14.90	15.33	15.12	9.87	11.37	10.62	12.39	13.35	12.87
40	13.67	15.63	14.65	8.77	10.50	9.63	11.22	13.07	12.14
Giza 168	9.53	10.93	10.23	9.00	9.40	9.20	9.27	10.17	9.72
Sakha 94	9.30	11.20	10.25	8.67	10.50	9.58	8.99	10.85	9.92
Sham 8	10.63	11.83	11.23	9.87	10.80	10.33	10.25	11.32	10.78
Boohoth 6	10.50	10.90	10.70	9.63	10.00	9.82	10.07	10.45	10.26
Giza 171	10.70	13.50	12.10	10.33	10.97	10.65	10.52	12.24	11.38
Sids 1	14.37	14.73	14.55	11.43	12.23	11.83	12.90	13.48	13.19
Sids 14	10.50	13.10	11.80	9.23	10.03	9.63	9.87	11.57	10.72
Gemmiza 12	13.93	14.37	14.15	8.87	10.00	9.43	11.40	12.19	11.79
Misr 2	13.43	16.73	15.08	9.63	10.23	9.93	11.53	13.48	12.51
Shindwell 1	11.30	16.07	13.68	8.90	9.23	9.07	10.10	12.65	11.38
average	12.19	14.04	13.12	9.40	10.30	9.85	10.79	12.17	11.48
% Reduction N	13.18			8.74			11.34		
% Reduction D						24.92			
D									0.36
N			0.63			0.50			0.26
DN									0.37
G	1.45	1.54	1.05	0.91	0.75	0.58			0.60
DG									0.85
NG			1.49			0.83			0.85
DNG									1.20

D1 and D2 = 14 Nov. and 13 Dec., respectively. N1 and N2 = 40 + Bio and 80 N kg /fed., respectively.

the supply of assimilates (Aglan et al 2020). These results are consistent with those obtained by Mumtaz et al (2015) and Uddin et al (2015), who found that the number of spikes/plant decreased when the sowing date was delayed.

The number of spikes/plant was significantly affected by the level of N fertilization. Plants receiving lower nitrogen (biofertilizer + 40 kg N/fed.) showed a 10.57% and 11.34% reduction in the first and second seasons, respectively, when compared with plants receiving high-N levels (80 kg N/fed.). In the first season, a lower nitrogen level (biofertilizer + 40 kg N/fed.) caused reduction values of 11.39% and 9.45% when compared with high-N-treated plants at the normal and late sowing dates, respectively. Additionally, in the second season, the reduction values were 13.18% and 8.74% at the normal and late sowing dates, respectively. Nitrogen is an essential element that plays a prominent role in meristematic cell building, cell elongation, and increasing photosynthesis activity, in turn, enhancing spike number. These results are in accordance with those obtained by Al-Naggar et al (2015), who observed an increased number of spikes/plant with increasing N fertilization levels.

The 50 wheat genotypes showed wide significant differences in the number of spikes/plant in different treatments studied. The overall mean for the number of spikes/plant of 50 wheat genotypes ranged from 10.18 and 9.72 spikes for the check variety Giza 168, to 15.63 and 13.36 spikes for line six, with mean values of 13.03 and 11.48 spikes/plant in the first and second seasons, respectively. The highest spike numbers per plant were found in line 6, followed by lines 2, 11, 13, 24, 31, 38, and 39 and the CV. The Misr 2 variety had the highest spike number in both seasons; lines 7, 8, 12, 19, 27, 32, and 40 had the highest spike number in the first season, the CV, whereas Sids 1 had the highest spike numbers in the second season.

With respect to the number of kernels/spike, the mean performance of the 50 genotypes at the two sowing dates and nitrogen fertilization treatments in the two seasons is shown in **Tables 7 and 8**. Results illustrate that the late sowing date caused a significant reduction in the number of kernels/spike by 23.92% and 24.34% in the two seasons, respectively, compared with those sown on the recommended date. These differences may be attributed to the differences in the genetic background of the plant materials and/or climatic conditions prevailing through the growing seasons of different studies. For example, the number of kernels/spike for late planting was significantly affected by prevailing high temperatures during the spike development phase (Singh et al 2011, Hamam et al 2015 and Badr et al 2018). These results are consistent with those obtained by Begum and Nessa (2014), Mumtaz et al (2015), Uddin et al (2015), and Aglan et al (2020).

A low level of N caused a significant reduction in the number of kernels/spike by 10.65% and 10.69% in the first and second seasons, respectively, compared with plants receiving high-N. Moreover, in the first season, low-N treatment caused a significant reduction in this trait by 5.72% and 16.75% at the recommended and late sowing dates, respectively, compared with plants receiving high-N treatment. In this context, low-N treatment significantly reduced kernels/spike by 6.57% and 15.87% at the recommended and late sowing dates in the second season, respectively, compared with plants receiving high-N treatment. Increasing the N rate encourages an increase in the number of kernels/spike, thereby increasing the number of fertile florets/spikelet and seed set/spike. These results correspond with the findings of Mosslem et al (2014) and Al-Naggar et al (2015).

The mean values for the number of kernels/spike ranged from 57.29 and 54.58 kernels (lines 15–69) and 70 and 71.58 kernels (lines 10 and 38), respectively, with mean values of 64.40 and 62.22 kernels in the first and second seasons, respectively. The highest numbers of kernels/spike were found in lines 5, 9, 10, 28, and 38 in both seasons, line 8 in the first season, and line 40 in the second season.

Results in **Tables 9 and 10** reveal that plants sown at the later date showed significant reductions in 1000-kernel weight compared with those sown on the recommended sowing date. The late sowing date reduced 1000-kernel weight by 19.85% and 19.90% in the two seasons, respectively, compared with those sown on the recommended date. This reduction was due to temperature rises accompanying late sowing (Shpiler and Blum 1986, Begum and Nessa 2014 and Badr et al 2018). These results are consistent with those obtained by Singh et al (2011), Uddin et al (2015) and Hamam et al (2015).

Low-N level caused a reduction in 1000-kernel weight by 11.38% and 11.39% in the first and second seasons, respectively, compared with plants receiving high-N levels. Low-N significantly reduced this trait by 10.46% and 12.47% at the recommended and late sowing dates in the first season, respectively, compared with plants receiving high-N treatment. In this context, a low-N level significantly reduced 1000-kernel weight by 11.31% and 11.47% at the recommended and late sowing dates in the second season, respectively, compared with plants receiving high-N treatment. The favorable effects of mineral nitrogen on 1000-kernel weight may be due to the quick mineral nitrogen uptake by plant roots, which increases vegetative growth and photosynthetic area, resulting in more assimilated products. Consequently, this may increase the accumulation of dry matter and the translocation of photosynthesis to grain. These results correspond with those of Mosslem et al (2014) and Al-Naggar et al (2015).

The means of 1000-kernel weight ranged from 30.69 and 30.04 g (lines 19 and 1, respectively), to 45.42 and 43.89 g for line 9, with mean values of 37.53 and 35.84 g in the first and second seasons, respectively. The highest 1000-kernel weights were noticed in lines 9 and 28, followed by lines 10, 31, and 38 in the two seasons.

Tables 11 and 12 show the mean values of grain yield/plant recorded at the two sowing dates, nitrogen fertilization treatments, and seasons for the 50 genotypes. The average reduction of grain yield/plant reached 31.88% and 33.75% at the late sowing date in

Table 7. Performance of number of kernels /spike for 50 wheat genotypes (G) on two sowing dates (D) under two N-fertilization levels (N) in 2018/2019 growing season

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
1	67.44	75.75	71.60	55.06	57.98	56.52	61.25	66.87	64.06
2	65.87	72.54	69.20	52.50	57.37	54.93	59.19	64.96	62.07
3	73.43	74.90	74.16	54.08	55.55	54.82	63.76	65.23	64.49
4	66.51	78.84	72.67	52.45	62.20	57.33	59.48	70.52	65.00
5	76.60	77.42	77.01	56.31	65.32	60.81	66.46	71.37	68.91
6	64.00	74.98	69.49	55.92	64.01	59.96	59.96	69.50	64.73
7	69.77	73.58	71.68	55.17	64.01	59.59	62.47	68.80	65.63
8	70.83	78.47	74.65	58.13	68.97	63.55	64.48	73.72	69.10
9	76.44	77.63	77.03	54.77	68.36	61.56	65.61	73.00	69.30
10	71.59	77.21	74.40	59.61	70.39	65.00	65.60	73.80	69.70
11	72.13	74.23	73.18	54.61	61.76	58.19	63.37	68.00	65.68
12	72.01	76.01	74.01	55.29	56.98	56.14	63.65	66.50	65.07
13	72.13	73.24	72.68	50.42	52.10	51.26	61.28	62.67	61.97
14	70.11	74.64	72.38	46.38	68.97	57.68	58.25	71.81	65.03
15	63.21	72.94	68.08	44.08	48.94	46.51	53.65	60.94	57.29
16	69.42	70.65	70.04	50.30	57.73	54.02	59.86	64.19	62.03
17	64.63	72.98	68.81	51.95	55.60	53.77	58.29	64.29	61.29
18	68.82	72.29	70.55	54.18	57.49	55.83	61.50	64.89	63.19
19	64.62	73.96	69.29	51.37	58.50	54.94	58.00	66.23	62.11
20	69.09	70.94	70.01	50.66	68.00	59.33	59.88	69.47	64.67
21	69.34	75.63	72.48	50.09	67.24	58.66	59.72	71.44	65.57
22	70.26	72.55	71.41	50.84	56.39	53.62	60.55	64.47	62.51
23	72.75	73.34	73.05	40.53	53.40	46.97	56.64	63.37	60.01
24	70.23	74.23	72.23	49.09	54.02	51.56	59.66	64.13	61.89
25	71.73	73.56	72.64	53.95	68.27	61.11	62.84	70.92	66.88
26	73.70	77.91	75.80	54.16	58.89	56.53	63.93	68.40	66.17
27	70.04	77.63	73.84	52.17	63.01	57.59	61.11	70.32	65.71
28	77.89	77.77	77.83	45.40	68.58	56.99	61.65	73.18	67.41
29	67.52	72.46	69.99	41.14	64.50	52.82	54.33	68.48	61.41
30	70.77	74.60	72.69	55.39	66.14	60.77	63.08	70.37	66.73
31	74.54	77.20	75.87	45.50	64.89	55.20	60.02	71.05	65.53
32	75.64	75.57	75.61	47.50	60.43	53.97	61.57	68.00	64.79
33	77.15	78.50	77.82	47.09	58.23	52.66	62.12	68.37	65.24
34	72.73	76.25	74.49	44.37	61.51	52.94	58.55	68.88	63.72

Table 7. Cont.

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
35	68.05	73.50	70.77	52.95	61.40	57.18	60.50	67.45	63.97
36	73.90	78.65	76.28	52.24	63.80	58.02	63.07	71.23	67.15
37	70.16	76.77	73.47	47.53	65.73	56.63	58.85	71.25	65.05
38	74.47	80.71	77.59	40.55	75.39	57.97	57.51	78.05	67.78
39	71.66	76.85	74.25	44.42	65.22	54.82	58.04	71.04	64.54
40	69.42	71.08	70.25	44.39	63.60	53.99	56.91	67.34	62.12
Giza 168	70.25	75.49	72.87	54.03	57.38	55.70	62.14	66.44	64.29
Sakha 94	69.16	73.27	71.22	45.23	47.59	46.41	57.20	60.43	58.81
Sham 8	68.55	71.26	69.90	57.00	54.20	55.60	62.78	62.73	62.75
Boohoth 6	72.38	77.07	74.73	46.22	50.04	48.13	59.30	63.56	61.43
Giza 171	77.28	77.66	77.47	51.63	60.13	55.88	64.46	68.90	66.68
Sids 1	75.68	78.53	77.10	48.84	52.88	50.86	62.26	65.71	63.98
Sids 14	68.90	70.09	69.49	47.83	57.77	52.80	58.37	63.93	61.15
Gemmiza 12	71.71	79.68	75.70	43.64	57.78	50.71	57.68	68.73	63.20
Misr 2	73.43	80.56	77.00	55.53	57.35	56.44	64.48	68.96	66.72
Shindwell 1	71.97	73.87	72.92	55.29	60.76	58.02	63.63	67.32	65.47
average	71.00	75.31	73.15	50.56	60.73	55.65	60.78	68.02	64.40
Reduction % N	5.72			16.75			10.65		
Reduction % D						23.92			
D									0.57
N			1.66			2.16			0.88
DN									1.24
G	4.24	4.40	3.04	4.55	4.01	3.02			2.13
DG									3.02
NG			4.29			4.26			3.02
DNG									4.27

D1 and D2 = 14 Nov. and 13 Dec. , respectively.
N1 and N2 = 40 + Bio and 80 N kg /fed., respectively.

Table 8. Performance of number of kernels /spike for 50 wheat genotypes (G) on two sowing dates (D) under two N-fertilization levels (N) in 2019/2020 growing season

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
1	65.83	73.22	69.52	52.63	55.05	53.84	59.23	64.14	61.68
2	63.70	70.83	67.27	48.24	54.60	51.42	55.97	62.72	59.34
3	70.23	72.36	71.29	51.69	52.94	52.31	60.96	62.65	61.80
4	65.52	76.56	71.04	50.22	60.25	55.23	57.87	68.41	63.14
5	72.43	75.57	74.00	53.40	62.98	58.19	62.92	69.28	66.09
6	61.87	72.65	67.26	51.48	62.54	57.01	56.68	67.60	62.13
7	66.38	70.18	68.28	52.49	62.03	57.26	59.44	66.11	62.77
8	63.64	67.83	65.74	54.12	58.71	56.42	58.88	63.27	61.08
9	72.40	74.66	73.53	52.50	66.05	59.27	62.45	70.36	66.40
10	69.72	75.62	72.67	58.07	64.01	61.04	63.90	69.82	66.85
11	67.43	72.13	69.78	52.03	59.29	55.66	59.73	65.71	62.72
12	71.53	74.41	72.97	52.21	54.60	53.40	61.87	64.51	63.19
13	68.23	70.76	69.49	48.34	50.12	49.23	58.29	60.44	59.36
14	69.07	71.27	70.17	44.32	66.77	55.54	56.70	69.02	62.86
15	60.43	69.98	65.21	41.65	46.23	43.94	51.04	58.11	54.58
16	64.84	67.85	66.34	47.15	54.95	51.05	56.00	61.40	58.70
17	64.95	70.41	67.68	48.77	53.67	51.22	56.86	62.04	59.45
18	65.80	70.10	67.95	52.81	55.27	54.04	59.31	62.69	60.99
19	64.92	72.19	68.56	49.59	57.32	53.46	57.26	64.76	61.01
20	67.05	68.22	67.63	47.73	66.04	56.88	57.39	67.13	62.26
21	67.05	73.07	70.06	49.33	63.62	56.48	58.19	68.35	63.27
22	67.95	70.13	69.04	49.13	53.98	51.56	58.54	62.06	60.30
23	68.37	71.09	69.73	46.24	51.25	48.74	57.31	61.17	59.24
24	69.53	73.03	71.28	46.10	51.10	48.60	57.82	62.07	59.94
25	69.67	72.00	70.83	50.33	65.23	57.78	60.00	68.62	64.31
26	71.20	74.85	73.03	51.53	56.29	53.91	61.37	65.57	63.47
27	66.05	75.82	70.93	49.05	59.01	54.03	57.55	67.42	62.48
28	72.05	76.74	74.40	42.86	67.36	55.11	57.46	72.05	64.75
29	66.97	70.57	68.77	38.62	62.53	50.57	52.80	66.55	59.67
30	65.01	72.08	68.55	53.83	61.70	57.77	59.42	66.89	63.16
31	70.59	75.63	73.11	43.92	63.08	53.50	57.26	69.36	63.31
32	71.30	72.96	72.13	44.57	60.20	52.38	57.94	66.58	62.26
33	75.05	77.54	76.29	44.75	55.94	50.34	59.90	66.74	63.32
34	69.74	74.88	72.31	42.38	59.73	51.06	56.06	67.31	61.68
35	66.68	71.28	68.98	50.04	59.34	54.69	58.36	65.31	61.84

Table 8. Cont.

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
36	70.40	75.08	72.74	48.59	61.15	54.87	59.50	68.12	63.81
37	68.22	73.44	70.83	44.19	63.94	54.07	56.21	68.69	62.45
38	74.03	78.57	76.30	62.70	71.03	66.87	68.37	74.80	71.58
39	69.09	73.62	71.36	43.16	59.69	51.43	56.13	66.66	61.39
40	73.10	81.27	77.19	52.68	62.26	57.47	62.89	71.77	67.33
Giza 168	66.70	74.55	70.62	52.66	55.57	54.11	59.68	65.06	62.37
Sakha 94	65.68	74.53	70.11	42.56	46.20	44.38	54.12	60.37	57.24
Sham 8	64.42	68.13	66.28	55.51	51.34	53.42	59.97	59.74	59.85
Boohoth 6	69.34	75.84	72.59	44.80	52.72	48.76	57.07	64.28	60.68
Giza 171	74.43	75.61	75.02	49.48	58.51	54.00	61.96	67.06	64.51
Sids 1	74.49	76.73	75.61	47.40	51.00	49.20	60.95	63.87	62.40
Sids 14	67.65	69.02	68.34	44.68	55.07	49.88	56.17	62.05	59.11
Gemmiza 12	71.62	77.02	74.32	41.50	56.14	48.82	56.56	66.58	61.57
Misr 2	70.69	77.48	74.09	52.82	55.22	54.02	61.76	66.35	64.05
Shindwell 1	68.62	72.75	70.68	53.91	57.19	55.55	61.27	64.97	63.12
average	68.43	73.24	70.84	48.98	58.22	53.60	58.70	65.73	62.22
Reduction N%	6.57			15.87			10.69		
Reduction D%						24.34			
D			1.10			0.44			0.38
N									0.54
DN	4.70	3.92	3.04	4.39	4.55	3.14			2.18
G									3.08
DG			4.30			4.44			3.08
NG									4.36

D1 and D2 = 14 Nov. and 13 Dec., respectively.
N1 and N2 = 40 + Bio and 80 N kg /fed., respectively.

Table 9. Performance of number of 1000-kernal weight (g) for 50 wheat genotypes (G) on two sowing dates (D) under two N-fertilization levels (N) in 2018/2019 growing season

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
1	31.15	34.08	32.61	28.53	29.88	29.21	29.84	31.98	30.91
2	35.70	40.53	38.12	31.41	32.76	32.09	33.56	36.65	35.10
3	43.36	45.37	44.37	33.10	39.01	36.06	38.23	42.19	40.21
4	32.51	34.82	33.67	29.37	30.94	30.16	30.94	32.88	31.91
5	36.19	43.19	39.69	31.47	33.79	32.63	33.83	38.49	36.16
6	42.77	45.51	44.14	35.15	40.47	37.81	38.96	42.99	40.98
7	41.55	43.61	42.58	34.58	38.49	36.53	38.07	41.05	39.56
8	38.65	43.28	40.97	36.63	37.61	37.12	37.64	40.45	39.04
9	46.58	50.52	48.55	40.77	43.81	42.29	43.68	47.17	45.42
10	43.91	50.48	47.19	40.39	41.40	40.90	42.15	45.94	44.04
11	42.31	44.17	43.24	35.43	40.27	37.85	38.87	42.22	40.54
12	41.07	49.53	45.30	32.54	38.68	35.61	36.81	44.11	40.46
13	40.74	42.08	41.41	29.59	33.72	31.66	35.17	37.90	36.53
14	38.25	44.90	41.58	27.75	36.68	32.22	33.00	40.79	36.90
15	35.89	41.93	38.91	29.46	30.53	30.00	32.68	36.23	34.45
16	33.72	35.32	34.52	29.43	31.49	30.46	31.58	33.41	32.49
17	38.63	41.36	39.99	33.21	37.04	35.12	35.92	39.20	37.56
18	32.67	37.88	35.28	27.86	30.06	28.96	30.27	33.97	32.12
19	30.69	34.83	32.76	27.94	29.31	28.63	29.32	32.07	30.69
20	34.72	37.43	36.07	29.44	33.42	31.43	32.08	35.43	33.75
21	31.95	37.41	34.68	28.77	29.35	29.06	30.36	33.38	31.87
22	37.29	40.29	38.79	29.39	36.68	33.03	33.34	38.49	35.91
23	42.39	43.29	42.84	30.95	35.51	33.23	36.67	39.40	38.03
24	37.65	48.38	43.01	28.02	31.36	29.69	32.84	39.87	36.35
25	39.97	43.14	41.56	32.83	38.64	35.73	36.40	40.89	38.65
26	43.95	51.07	47.51	34.76	39.13	36.95	39.36	45.10	42.23
27	40.37	43.50	41.94	32.42	39.56	35.99	36.40	41.53	38.96
28	47.30	50.57	48.93	38.11	44.37	41.24	42.71	47.47	45.09
29	40.66	45.40	43.03	35.43	37.16	36.30	38.05	41.28	39.66
30	41.55	44.05	42.80	36.80	39.56	38.18	39.18	41.81	40.49
31	44.94	48.61	46.78	37.40	40.13	38.77	41.17	44.37	42.77
32	43.70	45.57	44.63	28.27	38.71	33.49	35.99	42.14	39.06
33	36.88	41.26	39.07	29.79	32.65	31.22	33.34	36.96	35.15
34	41.99	46.54	44.26	27.38	33.57	30.48	34.69	40.06	37.37

Table 9. Cont.

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
35	38.48	43.14	40.81	31.16	34.84	33.00	34.82	38.99	36.91
36	46.22	50.47	48.34	28.50	35.76	32.13	37.36	43.12	40.24
37	34.77	43.44	39.11	27.97	31.45	29.71	31.37	37.45	34.41
38	45.73	54.08	49.91	30.38	42.28	36.33	38.06	48.18	43.12
39	42.08	48.75	45.42	28.09	37.16	32.62	35.09	42.96	39.02
40	34.72	38.81	36.76	26.49	32.06	29.28	30.61	35.44	33.02
Giza 168	38.27	43.83	41.05	29.21	32.03	30.62	33.74	37.93	35.84
Sakha 94	39.84	48.61	44.22	29.68	31.99	30.84	34.76	40.30	37.53
Sham 8	39.83	41.48	40.65	30.02	37.44	33.73	34.93	39.46	37.19
Boohoth 6	43.53	50.08	46.80	27.81	34.99	31.40	35.67	42.54	39.10
Giza 171	40.31	47.62	43.97	30.79	38.51	34.65	35.55	43.07	39.31
Sids 1	34.85	38.01	36.43	27.82	30.64	29.23	31.34	34.33	32.83
Sids 14	34.23	39.62	36.92	28.65	30.47	29.56	31.44	35.05	33.24
Gemmiza 12	36.93	38.47	37.70	29.43	31.23	30.33	33.18	34.85	34.02
Misr 2	44.95	53.38	49.17	32.40	35.16	33.78	38.68	44.27	41.47
Shindwell 1	41.66	48.51	45.09	25.51	38.99	32.25	33.59	43.75	38.67
average	39.36	43.96	41.66	31.17	35.61	33.39	35.26	39.79	37.53
Reduction % N	10.46			12.47			11.38		
Reduction % D						19.85			
D									0.68
N			0.64			1.21			0.44
DN									0.62
G	3.14	3.05	2.17	2.54	2.56	1.79			1.40
DG									1.99
NG			3.08			2.53			1.99
DNG									2.81

D1 and D2 = 14 Nov. and 13 Dec., respectively.
N1 and N2 = 40 + Bio and 80 kg N /fed., respectively.

Table 10. Performance of number of 1000-kernal weight (g) for 50 wheat genotypes (G) on two sowing dates (D) under two N-fertilization levels (N) in 2019/2020 growing season

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
1	30.06	33.54	31.80	27.68	28.88	28.28	28.87	31.21	30.04
2	34.57	38.36	36.46	29.35	30.97	30.16	31.96	34.67	33.31
3	40.50	43.02	41.76	32.73	36.63	34.68	36.62	39.83	38.22
4	31.01	33.40	32.21	29.02	29.17	29.10	30.02	31.29	30.65
5	34.10	42.82	38.46	30.48	32.14	31.31	32.29	37.48	34.89
6	40.55	43.69	42.12	32.07	38.44	35.26	36.31	41.07	38.69
7	39.39	41.21	40.30	33.10	36.68	34.89	36.25	38.95	37.60
8	37.81	42.92	40.37	34.13	37.59	35.86	35.97	40.26	38.11
9	45.66	48.45	47.06	38.83	42.62	40.73	42.25	45.54	43.89
10	41.60	48.60	45.10	38.13	38.80	38.47	39.87	43.70	41.78
11	40.23	42.23	41.23	30.90	38.47	34.69	35.57	40.35	37.96
12	39.16	46.73	42.95	31.08	35.85	33.47	35.12	41.29	38.21
13	38.60	40.26	39.43	28.28	32.30	30.29	33.44	36.28	34.86
14	36.31	42.18	39.25	26.98	32.69	29.83	31.65	37.44	34.54
15	33.67	39.50	36.59	27.59	28.52	28.06	30.63	34.01	32.32
16	31.62	33.57	32.60	27.61	30.37	28.99	29.62	31.97	30.79
17	36.82	40.85	38.83	32.01	33.38	32.70	34.42	37.12	35.76
18	32.03	36.62	34.33	27.39	30.07	28.73	29.71	33.35	31.53
19	30.50	33.48	31.99	27.24	29.20	28.22	28.87	31.34	30.11
20	32.99	35.89	34.44	29.29	31.82	30.56	31.14	33.86	32.50
21	30.15	35.52	32.83	28.40	27.99	28.20	29.28	31.76	30.51
22	35.76	39.80	37.78	28.93	33.36	31.15	32.35	36.58	34.46
23	39.05	40.68	39.87	28.56	34.60	31.58	33.81	37.64	35.72
24	36.17	46.85	41.51	28.81	31.17	29.99	32.49	39.01	35.75
25	36.90	41.57	39.23	29.81	35.76	32.78	33.36	38.67	36.01
26	40.44	48.49	44.46	32.89	37.25	35.07	36.67	42.87	39.77
27	38.74	42.03	40.38	30.92	36.41	33.66	34.83	39.22	37.02
28	46.51	48.81	47.66	36.64	41.41	39.02	41.58	45.11	43.34
29	37.92	43.47	40.70	33.36	34.92	34.14	35.64	39.20	37.42
30	39.70	41.82	40.76	34.49	38.05	36.27	37.10	39.94	38.52
31	42.51	46.07	44.29	35.32	38.18	36.75	38.92	42.13	40.52
32	40.97	44.67	42.82	27.14	37.79	32.47	34.06	41.23	37.64
33	34.60	39.45	37.03	27.84	30.58	29.21	31.22	35.02	33.12
34	40.85	45.31	43.08	27.17	31.45	29.31	34.01	38.38	36.19
35	34.70	39.79	37.25	29.69	32.60	31.15	32.20	36.20	34.20

Table 10. Cont.

Genotypes	D1			D2			Combined		
	N1	**N2**	**Mean**	**N1**	**N2**	**Mean**	**N1**	**N2**	**Average**
36	43.28	49.66	46.47	27.83	33.64	30.73	35.56	41.65	38.60
37	32.64	42.26	37.45	26.60	30.02	28.31	29.62	36.14	32.88
38	43.37	51.73	47.55	30.04	41.48	35.76	36.71	46.61	41.66
39	41.29	46.40	43.85	27.46	36.43	31.94	34.38	41.42	37.90
40	32.15	36.46	34.30	26.05	30.49	28.27	29.10	33.48	31.29
Giza 168	35.50	41.20	38.35	28.15	30.36	29.26	31.83	35.78	33.80
Sakha 94	37.01	45.31	41.16	28.60	30.07	29.34	32.81	37.69	35.25
Sham 8	36.93	39.18	38.06	29.80	35.03	32.41	33.37	37.11	35.23
Boohoth 6	41.13	48.02	44.58	26.94	33.37	30.16	34.04	40.70	37.37
Giza 171	40.27	46.83	43.55	30.93	36.41	33.67	35.60	41.62	38.61
Sids 1	33.69	37.83	35.76	27.96	30.40	29.18	30.83	34.12	32.47
Sids 14	33.52	38.82	36.17	27.59	29.33	28.46	30.56	34.08	32.32
Gemmiza 12	35.46	36.72	36.09	29.15	30.41	29.78	32.31	33.57	32.94
Misr 2	43.17	50.96	47.07	30.67	32.33	31.50	36.92	41.65	39.28
Shindwell 1	39.15	46.18	42.67	25.19	35.15	30.17	32.17	40.67	36.42
average	37.41	42.18	39.80	29.94	33.82	31.88	33.68	38.00	35.84
Reduction % N	11.31			11.47			11.39		
Reduction % D						19.90			
D									0.41
N			0.30			0.07			0.10
DN									0.14
G	2.45	2.39	1.70	1.86	1.56	1.20			1.04
DG									1.47
NG			2.40			1.70			1.47
DNG									2.08

D1 and D2 = 14 Nov. and 13 Dec., respectively.
N1 and N2 = 40 + Bio and 80 kg N/fed., respectively.

Table 11. Performance of grain yield/plant (g) for 50 wheat genotypes (G) on two sowing dates (D) under two N-fertilization levels (N) in 2018/2019 growing season

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
1	14.53	17.24	15.89	12.94	14.11	13.53	13.74	15.68	14.71
2	16.15	20.51	18.33	13.19	15.73	14.46	14.67	18.12	16.40
3	26.67	28.57	27.62	14.23	16.57	15.40	20.45	22.57	21.51
4	16.24	18.13	17.19	14.93	15.67	15.30	15.59	16.90	16.25
5	17.81	18.76	18.28	15.36	17.44	16.40	16.59	18.10	17.34
6	16.40	19.36	17.88	12.77	15.99	14.38	14.59	17.68	16.13
7	18.39	22.74	20.56	13.49	17.49	15.49	15.94	20.12	18.03
8	23.32	28.04	25.68	16.95	20.89	18.92	20.14	24.47	22.30
9	25.69	27.58	26.63	16.56	19.91	18.23	21.13	23.75	22.43
10	22.10	25.64	23.87	15.87	20.00	17.94	18.99	22.82	20.90
11	23.52	25.19	24.36	17.00	19.87	18.43	20.26	22.53	21.39
12	24.54	26.82	25.68	13.94	16.06	15.00	19.24	21.44	20.34
13	22.87	27.59	25.23	13.50	14.51	14.00	18.19	21.05	19.62
14	20.63	21.64	21.13	15.60	19.24	17.42	18.12	20.44	19.27
15	16.68	18.18	17.43	13.79	14.81	14.30	15.24	16.50	15.86
16	19.27	21.29	20.28	15.07	16.11	15.59	17.17	18.70	17.93
17	21.14	22.93	22.04	13.95	15.75	14.85	17.55	19.34	18.44
18	16.46	21.16	18.81	13.74	15.99	14.87	15.10	18.58	16.84
19	15.34	17.46	16.40	14.13	15.07	14.60	14.74	16.27	15.50
20	21.02	21.35	21.18	15.65	20.77	18.21	18.34	21.06	19.70
21	17.72	19.33	18.53	14.14	16.92	15.53	15.93	18.13	17.03
22	18.82	20.62	19.72	14.79	16.35	15.57	16.81	18.49	17.65
23	20.85	27.12	23.98	14.02	14.77	14.39	17.44	20.95	19.19
24	22.91	27.50	25.20	13.63	15.67	14.65	18.27	21.59	19.93
25	20.44	23.81	22.13	14.62	20.31	17.47	17.53	22.06	19.80
26	26.79	28.46	27.62	14.46	17.32	15.89	20.63	22.89	21.76
27	22.39	24.70	23.55	15.64	18.18	16.91	19.02	21.44	20.23
28	26.77	27.98	27.37	14.20	17.76	15.98	20.49	22.87	21.68
29	22.86	23.83	23.35	14.42	19.12	16.77	18.64	21.48	20.06
30	23.27	24.08	23.67	15.21	19.43	17.32	19.24	21.76	20.50
31	26.54	27.77	27.16	14.64	19.91	17.27	20.59	23.84	22.21
32	20.27	23.32	21.79	13.77	17.02	15.40	17.02	20.17	18.60
33	25.36	26.73	26.05	14.80	18.76	16.78	20.08	22.75	21.41
34	23.81	25.65	24.73	13.81	18.22	16.02	18.81	21.94	20.37
35	16.66	25.03	20.85	13.69	15.66	14.67	15.18	20.35	17.76

Table 11. Cont.

Genotypes	**D1**			**D2**			**Combined**		
	N1	**N2**	**Mean**	**N1**	**N2**	**Mean**	**N1**	**N2**	**Average**
36	24.60	27.39	26.00	12.40	14.87	13.64	18.50	21.13	19.82
37	22.83	25.28	24.06	13.11	15.60	14.36	17.97	20.44	19.21
38	24.57	27.69	26.13	12.65	20.48	16.57	18.61	24.09	21.35
39	23.75	26.16	24.96	12.55	16.98	14.76	18.15	21.57	19.86
40	19.71	23.77	21.74	12.08	17.47	14.78	15.90	20.62	18.26
Giza 168	22.67	23.63	23.15	12.51	16.45	14.48	17.59	20.04	18.81
Sakha 94	25.58	27.83	26.71	12.15	16.80	14.47	18.87	22.32	20.59
Sham 8	25.53	26.47	26.00	13.32	17.94	15.63	19.43	22.21	20.81
Boohoth 6	26.84	27.56	27.20	12.19	16.72	14.46	19.52	22.14	20.83
Giza 171	17.62	25.36	21.49	12.39	17.34	14.87	15.01	21.35	18.18
Sids 1	18.01	21.64	19.83	10.51	14.63	12.57	14.26	18.14	16.20
Sids 14	19.08	22.25	20.66	12.01	16.48	14.25	15.55	19.37	17.46
Gemmiza 12	20.13	21.88	21.01	10.39	14.03	12.21	15.26	17.96	16.61
Misr 2	25.37	26.26	25.82	13.21	15.95	14.58	19.29	21.11	20.20
Shindwell 1	18.89	19.11	19.00	9.27	16.90	13.08	14.08	18.01	16.04
average	21.39	23.97	22.68	13.78	17.12	15.45	17.59	20.54	19.07
Reduction % N	10.76			19.51			14.40		
Reduction % D						31.88			
D									0.76
N			0.82			1.48			0.55
DN									0.77
G	2.61	2.97	1.96	2.80	2.04	1.72			1.30
DG									1.84
NG			2.78			2.43			1.84
DNG									2.60

D1 and D2 = 14 Nov. and 13 Dec., respectively.
N1 and N2 = 40 + Bio and 80 kg N /fed., respectively.

Table 12. Performance of grain yield/plant (g) for 50 wheat genotypes (G) on two sowing dates (D) under two N-fertilization levels (N) in 2019/2020 growing season

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
1	13.54	15.20	14.37	12.68	13.30	12.99	13.11	14.25	13.68
2	14.31	19.25	16.78	11.95	13.63	12.79	13.13	16.44	14.78
3	25.70	26.48	26.09	13.14	15.62	14.38	19.42	21.05	20.24
4	14.24	17.70	15.97	13.64	14.05	13.85	13.94	15.88	14.91
5	14.86	16.83	15.85	13.42	14.28	13.85	14.14	15.56	14.85
6	15.43	18.01	16.72	11.93	14.60	13.27	13.68	16.31	14.99
7	16.37	20.98	18.68	13.35	14.67	14.01	14.86	17.83	16.34
8	20.91	26.70	23.81	13.91	16.61	15.26	17.41	21.66	19.53
9	24.68	25.74	25.21	14.86	18.15	16.51	19.77	21.95	20.86
10	23.80	24.10	23.95	14.59	17.65	16.12	19.20	20.88	20.04
11	21.70	23.07	22.38	14.74	16.05	15.40	18.22	19.56	18.89
12	22.58	24.92	23.75	12.60	14.77	13.69	17.59	19.85	18.72
13	21.17	23.47	22.32	12.07	16.03	14.05	16.62	19.75	18.18
14	18.60	20.01	19.30	14.06	17.49	15.77	16.33	18.75	17.54
15	15.20	16.70	15.95	12.33	12.97	12.65	13.77	14.84	14.30
16	16.84	19.63	18.24	14.20	14.42	14.31	15.52	17.03	16.28
17	19.71	20.90	20.31	12.67	13.20	12.94	16.19	17.05	16.62
18	15.09	20.04	17.56	11.49	14.92	13.21	13.29	17.48	15.38
19	14.02	15.83	14.93	11.75	13.60	12.68	12.89	14.72	13.80
20	18.43	18.94	18.68	14.14	17.91	16.03	16.29	18.43	17.35
21	16.64	17.75	17.20	13.17	14.93	14.05	14.91	16.34	15.62
22	17.23	19.33	18.28	14.43	15.45	14.94	15.83	17.39	16.61
23	20.35	24.45	22.40	13.96	14.22	14.09	17.16	19.34	18.25
24	21.13	26.12	23.63	11.80	13.27	12.53	16.47	19.70	18.08
25	17.78	21.70	19.74	12.84	16.98	14.91	15.31	19.34	17.32
26	21.70	26.58	24.14	13.00	15.53	14.27	17.35	21.06	19.20
27	21.07	23.22	22.15	14.06	15.90	14.98	17.57	19.56	18.56
28	24.27	26.16	25.22	13.23	15.30	14.27	18.75	20.73	19.74
29	19.42	21.70	20.56	12.84	17.01	14.93	16.13	19.36	17.74
30	20.96	22.12	21.54	13.05	16.92	14.99	17.01	19.52	18.26
31	23.79	26.07	24.93	13.47	17.51	15.49	18.63	21.79	20.21
32	18.62	20.98	19.80	13.82	15.48	14.65	16.22	18.23	17.23
33	23.79	24.82	24.31	13.40	16.19	14.80	18.60	20.51	19.55
34	23.74	24.43	24.09	12.84	15.54	14.19	18.29	19.99	19.14
35	15.23	20.94	18.08	12.20	13.57	12.89	13.72	17.26	15.49

Table 12. Cont.

Genotypes	D1			D2			Combined		
	N1	N2	Mean	N1	N2	Mean	N1	N2	Average
36	24.11	25.23	24.67	14.22	17.06	15.64	19.17	21.15	20.16
37	20.01	23.33	21.67	11.47	13.77	12.62	15.74	18.55	17.15
38	24.24	26.18	25.21	12.01	18.69	15.35	18.13	22.44	20.28
39	24.03	25.39	24.71	10.77	15.17	12.97	17.40	20.28	18.84
40	16.96	22.14	19.55	10.70	15.56	13.13	13.83	18.85	16.34
Giza 168	20.96	21.97	21.47	11.39	14.40	12.90	16.18	18.19	17.18
Sakha 94	24.32	25.97	25.15	11.24	14.63	12.93	17.78	20.30	19.04
Sham 8	23.03	24.30	23.66	12.18	15.57	13.88	17.61	19.94	18.77
Boohoth 6	24.09	26.11	25.10	11.28	14.96	13.12	17.69	20.54	19.11
Giza 171	15.90	23.17	19.53	10.85	14.60	12.73	13.38	18.89	16.13
Sids 1	15.89	19.80	17.85	8.89	11.75	10.32	12.39	15.78	14.08
Sids 14	17.62	20.10	18.86	10.61	14.17	12.39	14.12	17.14	15.62
Gemmiza 12	18.94	19.83	19.38	9.20	11.59	10.40	14.07	15.71	14.89
Misr 2	22.56	23.62	23.09	12.00	12.84	12.42	17.28	18.23	17.75
Shindwell 1	17.77	17.93	17.85	8.50	14.05	11.27	13.14	15.99	14.56
average	19.67	22.12	20.89	12.54	15.13	13.84	16.10	18.62	17.36
Reduction N%	11.08			17.12			13.54		
Reduction D%						33.75			
D									0.26
N			0.60			1.01			0.38
DN									0.54
G	2.37	2.37	1.66	1.96	1.64	1.27			1.04
DG									1.48
NG			2.35			1.80			1.48
DNG									2.09

D1 and D2 = 14 Nov. and 13 Dec., respectively.
N1 and N2 = 40 + Bio and 80 N kg /fed., respectively.

both seasons. This is an exception because grain yield is considered a complex trait with low heritability; hence, it is strongly influenced by changes in environmental conditions, especially temperature. The wheat-yield increases for plants sown on the recommended date may be due to the environmental conditions being seemingly more favorable for the majority of the growth periods; consequently, plants might be more efficient in utilizing the growth factors, nutrients, water, and light, thereby resulting in better growth and higher yield potential (Begum and Nessa 2014 and Mumtaz et al 2015). Conversely, the reduction in grain yield associated with the delayed sowing date may be due to the wide changes in weather conditions between the two sowing dates, especially the rise in temperature during the late (reproductive) stage of plant growth, causing the forced maturity of the crop, thereby indirectly reducing yield by directly affecting various yield contributors (Shpiler and Blum 1986 and Hamam et al 2015). These results are consistent with those of Rahman et al (2009), Singh et al (2011) and Uddin et al (2015).

Low-N treatment significantly reduced grain yield/plant by 14.40% and 13.54% in the first and second seasons, respectively, compared with high-N treatment. In the first season, low-N treatment significantly reduced grain yield/plant by 10.76% and 19.51% at the recommended and late sowing dates, respectively, compared with high-N treatment. In this context, in the second season, low-N treatment significantly reduced grain yield/plant by 11.08% and 17.12% at the recommended and late sowing dates, respectively, compared with high-N treatment. The greater influence of sowing dates on grain yield/plant and its components compared with the effects of N fertilization were emphasized by the large magnitude of mean squares. This is due to the interaction of sowing dates with genotypes compared with those due to the effects of interaction between N-levels and genotypes. The greater influence of climatic factors associated with sowing dates, such as temperature, rainfall, and humidity, on grain yield/plant and its components than those associated with N fertilization is thus illustrated. These results correspond with the findings of Mosslem et al (2014), Al-Naggar et al (2015), and El-Marakby et al (2015).

The mean of grain yield/plant ranged from 14.71 and 13.68 g (line 1) to 22.43 and 20.86 g (line 9) in the first and second seasons, respectively, with respective mean values of 19.07 and 17.36 g in the first and second seasons. The highest grain yields/plant were noticed in lines 3, 9, and 31 in both seasons; lines 8, 26, 28, and 33 in the first season; and lines 10, 36, and 38 in the second season. These lines demonstrated the highest grain yield and yield components and may thus be considered promising lines for new cultivar selection.

3.3 Phenotypic stability

The analysis of variance (**Table 13**) revealed highly significant differences among genotypes for grain yield/plant and yield components, reflecting the influence of genetic diversity regarding studied characteristics. The mean squares of environmental factors were highly significant for all studied traits, suggesting that the environment affects the studied wheat traits differently. Environmental factors (E) + (G × E) and pooled deviation were highly significant for all the studied traits for pooled deviation, indicating the presence of genetic differences among genotypes for their regression on the environmental index. Highly significant G × E interaction was detected for all characteristics, evidencing the studied wheat genotypes exhibiting different responses to different environmental conditions. Genotypic and environmental interaction (linear) was significant; thus, stability analysis could proceed (Eberhart and Russell 1966). Other researchers also found highly significant genotypic and environmental interactions for many wheat traits (El Ameen 2012, Wardofa et al 2019, Sharma et al 2019, and Wardofa and Ararsa 2020).

3.3.1 Stability parameters

In executing selection programs, most plant breeders prefer to select genotypes with high average performance exhibiting the greatest stability across various environments. The mean values over environments ($\bar{x}$), the regression coefficient (b_i), and deviation from regression (S^2di) for the studied traits are presented in **Table 14**. According to the definition of Eberhart and Russell (1966), a stable genotype is one with a high mean performance and unit regression coefficient ($b_i = 1$) and deviation from regression equal to 0 ($S^2di = 0$). In this context, b_i values significantly identify greater genotypic benefit responses to more inputs than do unit values, whereas genotypes having bi values significantly >1.0 do not respond to more inputs of favorable environmental factors.

Table 13. Mean squares of stability for studied traits in 50 wheat genotypes under eight environments

SOV	Df	No. of spikes/plant	No. of kernels/spike	1000-kernel weight (g)	Grain yield/plant (g)
Genotype (G)	49	5.92**	52.05**	102.21**	32.11**
Environments (E) + (G × E)	350	6.02**	118.08**	30.08**	21.13**
Environments (linear)	1	1822.57**	36435.70**	8813.76**	6153.41**
G × E (linear)	49	2.82**	32.40**	24.09**	16.71**
Pooled deviation	300	0.49**	11.02**	1.79**	1.42**
Pooled error	800	0.29	2.41	0.79	0.72

** denotes significant differences at the 0.01 level of probability.

Table 14. Stability parameters for No. of spikes/plant, No. of kernels /spike, 1000-kernal weight (g) and grain yield/plant (g) of 50 wheat genotypes under 8 environments

Genotypes	No. of spikes/plant			No. of kernels /spike			1000-kernal weight (g)			Grain yield / plant (g)		
	X¯	bi	S²di	X¯	bi	S²di	X¯	bi	S²di	X¯	bi	S²di
1	11.71	0.95	0.36*	62.87	0.83**	5.73**	30.48	0.45**	-0.50	14.19	0.31**	-0.15
2	13.04	1.52**	1.30**	60.71	0.85*	1.04	34.21	0.75**	-0.04	15.59	0.65**	1.08*
3	12.23	1.12	-0.23	63.15	0.96	11.46**	39.22	0.92	0.35	20.87	1.51**	2.13**
4	12.22	0.87	0.45*	64.07	0.96	7.20**	31.28	0.41**	-0.47	15.58	0.34**	0.23
5	11.83	0.66**	0.05	67.50	0.92	-1.12	35.52	0.93	2.05**	16.10	0.36**	0.76
6	14.50	1.34**	0.79**	63.43	0.68**	11.42**	39.83	0.86*	0.70	15.56	0.56**	-0.03
7	13.19	1.27**	-0.08	64.20	0.71**	-0.55	38.58	0.70**	-0.15	17.19	0.77**	0.76
8	12.85	0.91	-0.24	65.09	0.68**	16.36**	38.58	0.58**	0.48	20.92	1.15*	0.93*
9	11.63	1.05	-0.11	67.85	0.92	3.00*	44.66	0.78**	-0.62	21.65	1.15	-0.23
10	12.14	1.06	0.01	68.28	0.67**	1.66	42.91	0.84*	2.05**	20.47	0.95	0.37
11	13.28	1.29**	0.47*	64.20	0.83**	-1.55	39.25	0.79**	2.33**	20.14	0.90	-0.10
12	12.78	1.13	0.22	64.13	0.95	8.50**	39.33	1.27**	0.16	19.53	1.35**	0.44
13	13.06	1.38**	-0.04	60.67	1.04	13.44**	35.70	1.04	1.49**	18.90	1.30**	1.35**
14	10.83	0.73**	-0.19	63.94	1.03	27.86**	35.72	1.25**	0.50	18.41	0.58**	0.13
15	11.07	0.96	0.02	55.93	1.16**	8.47**	33.39	1.02**	1.33*	15.08	0.47**	-0.44
16	12.71	0.86	-0.17	60.36	0.88*	-0.81	31.64	0.49**	-0.41	17.10	0.61	-0.16
17	12.34	1.19*	0.19	60.37	0.86*	2.92*	36.66	0.69**	-0.21	17.53	0.96**	0.00
18	11.61	1.01	0.12	62.10	0.76**	1.53	31.82	0.75**	-0.16	16.11	0.69**	1.35**
19	12.59	1.41**	0.11	61.56	0.86*	1.57	30.40	0.51**	-0.39	14.65	0.35**	0.06
20	12.55	0.86	-0.1	63.47	0.77**	18.82**	33.13	0.57**	-0.51	18.53	0.51**	1.84**
21	11.78	1.21*	0.50*	64.42	0.92	7.86**	31.19	0.64**	1.38*	16.33	0.48**	-0.41
22	10.97	1.23**	-0.24	61.40	0.94	1.45	35.19	0.83*	0.67	17.13	0.54**	-0.59
23	12.35	0.74**	0.42*	59.62	1.26**	8.23**	36.88	1.03	1.99**	18.72	1.19*	2.33**
24	13.47	1.28**	0.18	60.92	1.13*	5.95**	36.05	1.51**	4.79**	19.00	1.45**	0.85*
25	11.32	1.22**	-0.07	65.59	0.81**	7.20**	37.33	0.86*	0.95*	18.56	0.81*	1.58**
26	11.29	0.88	-0.06	64.82	1.02	3.00*	41.00	1.27**	-0.05	20.48	1.46**	0.52
27	12.84	1.24**	-0.15	64.10	1.00	1.27	37.99	0.85*	0.93*	19.40	0.95	-0.61
28	12.39	1.05	0.40*	66.08	1.31**	24.02**	44.22	0.99	0.34	20.71	1.45**	0.74
29	12.66	0.87	-0.21	60.54	1.19**	25.79**	38.54	0.83*	0.28	18.90	0.91	0.24
30	12.35	0.99	-0.05	64.94	0.72**	1.67	39.50	0.59**	-0.27	19.38	0.93	0.04
31	13.26	1.10	0.23	64.42	1.26**	7.77**	41.65	0.92	-0.31	21.21	1.33**	-0.11
32	12.39	0.85	0.23	63.52	1.20**	3.27*	38.35	1.34**	5.74**	17.91	0.83**	-0.49
33	11.74	1.04	-0.16	64.28	1.39**	3.02*	34.13	0.95	-0.48	20.48	1.25**	0.04
34	12.55	0.61**	0.91**	62.70	1.29**	2.37	36.78	1.53**	1.99**	19.76	1.23**	0.40
35	11.65	0.62**	-0.12	62.91	0.83**	-1.69	35.55	0.90	-0.01	16.62	0.91	3.94**

Table 14. Cont.

Genotypes	No. of spikes/plant			No. of kernels /spike			1000-kernal weight (g)			Grain yield / plant (g)		
	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di
36	12.29	0.83	-0.06	65.48	1.07	-1.33	39.42	1.80**	2.45**	19.99	1.34**	3.59**
37	11.90	0.75**	0.19	63.75	1.11	11.42**	33.64	1.21**	1.87**	18.18	1.26**	-0.27
38	13.26	1.44**	0.22	69.68	1.00	71.50**	42.39	1.69**	3.92**	20.81	1.39**	1.72**
39	13.51	1.08	0.35*	62.96	1.24**	6.76**	38.46	1.53**	1.53**	19.35	1.44**	0.97*
40	13.07	1.27**	-0.05	64.73	1.05	25.06**	32.15	0.89	-0.30	17.30	1.05	0.91*
Giza 168	9.95	0.45**	-0.04	63.33	0.90	4.52**	34.82	1.15*	0.23	18.00	1.15*	-0.02
Sakha 94	10.98	0.58**	0.87**	58.03	1.30**	17.09**	36.39	1.48**	2.94**	19.82	1.60**	0.76
Sham 8	11.78	0.52**	0.51*	61.30	0.64**	16.23**	36.21	0.82**	1.59**	19.79	1.35**	0.26
Boohoth 6	11.09	0.44**	0.17	61.05	1.32**	10.63**	38.23	1.74**	0.31	19.97	1.61**	1.27*
Giza 171	11.66	0.60**	0.68**	65.59	1.15**	2.61	38.96	1.24**	0.70	17.15	1.10	3.68**
Sids 1	13.24	1.01	1.68**	63.19	1.33**	17.60**	32.65	0.80*	-0.28	15.14	1.08	-0.43
Sids 14	11.35	0.70**	0.01	60.13	0.99	-0.14	32.78	0.89	0.25	16.54	0.95	-0.38
Gemmiza 12	12.57	1.20*	0.17	62.39	1.45**	-0.95	33.48	0.72**	0.63	15.75	1.18*	-0.09
Misr 2	13.06	1.34**	0.22	65.39	1.06	10.87**	40.38	1.73**	4.36**	18.98	1.40**	1.64**
Shindwell 1	12.05	1.26**	0.54**	64.30	0.81**	0.35	37.54	1.67**	3.75**	15.30	0.93	2.69**
Average	12.26			63.31			36.68			18.21		

*,** denote significant differences at 0.05 and 0.01 levels of probability, respectively.

Concerning the number of spikes/plant, the estimates of phenotypic stability parameters are recorded in **Table 14** and show that the mean values of this trait ranged from 9.95 spikes for the check variety Giza 168 to 14.50 spikes for line 6, with an average of 12.26 spikes. Results indicate that nine promising lines (i.e., 8, 12, 16, 20, 29, 30, 31, 32, and 36) were stable and gave bi and S^2di values that did not differ significantly from unit values and 0, respectively. Meanwhile, lines 7, 13, 17, 19, 24, 27, 38, and 40 and the two check varieties Gemmiza 12 and Misr 2 had high mean values compared with the general mean and performed better in favorable environments ($b_i > 1$) for this trait.

The estimates of phenotypic stability parameters for the number of kernels/spike in **Table 14** indicate that the mean values of this trait ranged from 55.93 kernels for line 15 to 69.68 kernels for line 38, with an average of 63.31 kernels. Lines 5, 27, and 36 were stable and gave high means compared with the grand mean and had insignificant b_i and S^2di from unit values and 0, respectively. Lines 7, 10, 11, and 30 and the check variety Shindwell 1 had high mean values and performed better in poor environments ($b_i < 1$), whereas the check variety Giza 171 gave high mean values and performed better in favorable environments ($b_i > 1$).

Results in **Table 14** indicate that the 1000-kernel weight means of genotypes ranged from 30.40 g for line 19 to 44.66 g for line 9, with an average of 36.68 g. Concerning stability parameters: three lines out of 50 genotypes (3, 28, and 31) were stable because their respective b_i and S^2di values, which did not differ significantly from a unit and 0; hence, these lines exhibited general adaptability across different environments. The genotypes 12, 26, Boohoth 6, and Giza 171 gave high mean values and performed better in favorable environments ($b_i > 1$). Conversely, lines 6, 7, 8, 9, 29, and 30 had high mean values and performed better in poor environments ($b_i < 1$) for this trait.

Table 14 records the mean values of genotypes and stability parameters for grain yield/plant. The results indicate that the mean values of this trait ranged from 14.19 g (line 1) to 21.65 g (line 9), with an average of 18.21 g. Concerning stability parameters, six promising lines out of 50 wheat genotypes (9, 10, 11, 27, 29, and 30) were stable because of their respective b_i and S^2di values, which did not differ significantly from unit and 0; hence, these lines exhibited general adaptability across different environments. The genotypes 12, 26, 28, 31, 33, 34, Sakha 94, and Cham 8 gave high mean values compared with the grand mean, and performed better in favorable environments ($b_i > 1$), whereas line 14 gave a high mean value and performed better in unfavorable environments ($b_i < 1$). We can conclude that lines 27, 29, and 30 performed well for the stability of grain yield and its components. This study revealed that lines 9 and 10 are considered to be promising and could be used in breeding programs for wheat improvement.

4 Conclusions

Yield and yield components increased by planting wheat genotypes at the recommended sowing date in mid-November under optimum nitrogen levels (80 kg N/fed.). Conversely, planting under delayed sowing dates and low nitrogen conditions led to a drastic reduction in grain yield/plant and its components. This study revealed that lines 9 and 10 exhibited general adaptability across different environments; thus, such two lines are considered to be promising and could be used in breeding programs for wheat improvement.

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