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Research Article

Effect of some Nitrogen Fertilization Rates on the Yield and Its Components for some New Egyptian Bread Wheat Cultivars

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Abstract:

To examine the effect of nitrogen fertilization rates 40, 60 and 80 kg N/fed on growth and yield of the four bread wheat cultivars namely Giza 171, Sids 14, Sakha 95 and Misr 3 a field experiment was carried out at the experimental farm of Etai El-Baroud, Agricultural Research Station (ARC), El-Beheira Gov-ernorate, Egypt, during the two successive wheat growing seasons 2021/2022 and 2022/2023. Split plot design with four replicates was used, the main plots were assigned by three levels nitrogen. The subplots were assigned by four wheat cultivars. The obtained results revealed that, all tested cultivars differ in their response to nitrogen rates. Sakha 95 that fertilized with 40 kg N/fed recorded the lowest number of days to heading in the first season and maturity in both seasons, while Giza 171 that fertilized with 40 kg N/fed recorded the lowest number of days to heading in the second season. Giza 171 that fertilized with 80 kg N/fed had the highest values of plant height, spike length, number of grains/spike, 1000-kernel weight, grain yield/plot and biological yield/plot in both seasons. Sakha 95 that fertilized with 80 kg N/fed recorded the highest straw yield/plot in both seasons as well as number of spikes/m2.Sakha 95 that fertilized with 60 kg N/fed recorded the highest harvest index without any significant difference with Misr 3 under 80 kg N/fed in the first season. Sids 14 that fertilized with 80 kg N/fed had the highest number of spikes/m2 in the second season. Sids 14 under 40 kg N/fed had the highest harvest index in the second season. It could be recommended to fertilize the wheat cultivar Giza 171 with 80 kg N/fed to maximize both of grains and straw yield under west Delta conditions.

1. Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops in the world and is a major food of about one third across the world's population. In Egypt, wheat is the first strategic cereal crop where their bread is stable food that used daily by the hole Egyptian citizens. According to FAOSTAT 2022, in the 2021/2022 season, the Egyptian wheat cultivated area was approximately 3.6 million feddans 1. The total cereal output in 2022 is estimated at a slightly above-average level of 24 million tons. With a large increase in the Egyptian population Egypt safer from serious gab between wheat production and consumption. The Egyptian government covered this gab by importing about 50% of wheat requirements. In the past decided the Egyptian government faced large difficulties to provide the hard currency that used for im-port wheat grains and several industrial materials. Therefore, increasing local wheat production is considered a necessary goal to reduce the gap between production and consumption through expanding the wheat cultivated area and increasing productivity per unit area. Consequently, increasing wheat production under Egyptian conditions is major concern of Agronomist (Gheith et al., 2018). Moreover, wheat yield is almost affected by many factors such as nitrogen fertilization and varieties that are considered the most important one. The Egyptian wheat clan is characterized by great variation in its characteristics due to the large genetic diversity between the genotypes and the presence of precise and targeted breeding programs. Many previous studies showed that some Egyptian wheat varieties are superior to their counterparts in many growth and yield characteristics, such as the results obtained by El–Hag and Shahein (2017) who found that Sakha 94 recorded the highest values for number of days to heading and maturity, plant height and Gemmeiza 11 recorded the highest values in number of spikes/m2 in both seasons. Sakha 94 and Gemmeiza 11 recorded the highest values for 1000 grain weight in 2014/15 and 2015/16 seasons, respectively. Sakha 94 recorded the highest values for grain/spike in 2015/16 season. Gemmeiza 11 superior the other cultivars for both of grain and straw yield. Also, Osman and Nour El-Dein (2017) found that Misr2 gave higher grain, straw, biological yield and harvest index. Saboon et al., (2022) indicated that Gi-za-171, Gemmeiza-12 and Shandawil-1 were significantly differed in all spike characters in both seasons except number and weight of grains/spike in the first season where Gemmeiza-12 variety surpassed in the second season.

Therefore, the present study aimed to evaluate the effect of three nitrogen rates (40, 60 and 80 kg N/fed) on growth and yield of the four bread wheat cultivars (Giza 171, Sids14, Sakha 95 and Misr 3) in the old, cultivated

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land at west Delta.

2. Materials and Methods

To evaluate the effect of nitrogen fertilization rates 40, 60 and 80 kg N/fed on growth and yield of four bread wheat cultivars i.e., Giza 171, Sids 14, Sakha 95 and Misr 3, a field experiment was carried out at the experimental Farm of Etai El-Baroud, Agricultural Re-search Station (ARC), El-Beheira Governorate, Egypt, during the two wheat growing seasons 2021/2022 and 2022/2023.

The preceding crop was soybean for the two seasons. Physical and chemical properties analysis for the experimental soil were done according to the method described by Chapman and Pratt (1978). De-tailed results of the experimental soil chemical and physical properties are presented in Table 1.

Table 1: The experimental soil physical and chemical properties during 2021/2022 and 2022/2023.

Properties	Season 2021/2022	2022/2023
Particle size distribution		
Clay %	60.41	59.61
Slit %	32.5	31.8
Sand %	7.09	8.59
Texture	Clay	
$CaCO_3$ %	3.15	2.45
Soluble cations (meq/L)		
Ca^{++}	6.12	5.1
Mg^{++}	3.54	2.61
K^+	1.56	1.64
Na^+	8.17	6.89
Soluble Anions (meq/L)		
Cl^-	10.11	8.42
HCO_3^{--}	0.85	0.7
SO_4^{--}	8.43	7.02
Available nutrient mg/kg		
K^+	74.11	68.34
P	2.66	2.34
N	41.78	40.09
OM%	0.68	0.54
pH	7.7	7.75
E.C dS/m	1.93	1.88
SAR	3.73	3.53

2.1. Experimental Design:

The field experiment was laid out in split plot design with three replications, where the nitrogen levels were allocated in the main plots and wheat cultivars were randomly distributed in the sub plots.

2.2. Agriculture procedures:

The grains of the four cultivars were sown in the prepared soil in 25^{th} and 28^{th} of November during 2021/2022 and 2022/2023, respectively in plots and irrigated after sowing. The plot size was 9 m2 (3 m long and 3 m width). Seeding rate was 70 kg/fed. The soil was irrigated immediately post sowing and the three nitrogen fertilization rates (40, 60 and 80 kg N/fad) were applied in the form of urea (46.5%N) in equal two doses, the first pre the second irrigation (21 days after sowing) and the second one was applied pre the second irrigation (21 days later). All the other recommended practices for wheat crop were done in the proper time.

2.3 Data recorded:

Days to heading and days to maturity were determined as number of days from sowing to 50 % spike emergence and 50 % physiological maturity for all plants/ plot for the two studied traits, respectively. At the harvest, one meter square was taken from each plot to determine Plant height (cm), no of spikes/m2, spike length (cm), number of grains/spikes, 1000–grain weight (g), grain yield (kg/plot), straw yield (kg/plot), biological yield (kg/plot) and harvest index (HI) (%).

2.4. Statistical analysis

All collected data were subjected to analysis of variance according to Gomez and Gomez (1984). All statistical analysis was performed using analysis of variance technique by means of Co-stat (2005) computer software package.

3. Results

3.1. Effect of nitrogen rates, wheat cultivars and their interactions on earliness attributes.

The data illustrated in Tables 2 and 3 confirmed that number of days to heading and maturity significantly affected by nitrogen fertilization rates, different wheat cultivars and their interactions in both seasons of the study.

3.1.1. Heading date (days):

The results in Table 2 showed that the increase of nitrogen fertilizer rate led to significant delayed in heading date. Number of days to heading was 95.06 and 90.32 days in the wheat plants that receive 40 kg N then increased to 96.67 and 93.00 days with the increase of nitrogen rate to 60 kg/fed in the first and the second season, respectively. Number of days to heading of wheat plants reached their peak (101.50 and 97.74 days) under the highest nitrogen rate (80 kg/fed) in both seasons, respectively. Increasing nitrogen fertilization rates leads to an increase in the growth rate and concentration of green matter in the leaves, thus increasing the period of vegetative growth and delaying the dates of heading and maturity.

For the effect of wheat cultivars in heading date the presented data in Table 2 revealed a wide diversity in the four tested wheat cultivars in their heading dates. Sakha 95 was the earliest among all tested genotypes in the first season where it recorded the lowest number of days to heading (95.16 days) followed by Misr 3 (96.15 days). While, Giza 171 was the earliest in heading dates in the second season (90.68 days) followed by Sakha 95 (93.50 days). On the other hand, Sids 14 was the latest in heading date (103.40 and 96.51 days) in both seasons, respectively. The difference in the dates of heading and maturity for wheat varieties is primarily due to genetic variation, but sometimes the surrounding environmental conditions may lead to delaying or accelerating maturity.

Respect to the interaction effect on heading date, the obtained data in Table 2 indicated that all tested cultivars differ in their response to nitrogen rates. The increase of nitrogen rate resulted in significantly delayed heading date of all tested cultivars in both seasons. Sakha 95 that fertilized with 40 kg N/fed recorded the lowest number of days to heading (93.10 days) in the first season, while Giza 171 that fertilized with 40 kg N/fed recorded the lowest number of days to heading (87.55 days) in the second season. In contrast, Sids 14 that received 80 kg N/fed had the highest number of days to heading (109.90 and 100.45 days) in the first and second season, respectively.

Table 2: Mean effects of nitrogen rates, wheat cultivars and their interactions on heading date during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed) 40	60	80	Cultivars mean
		2021/2022		
Giza 171	94.73	95.33	98.70	96.26 b
Sids 14	98.98	101.33	109.90	103.40 a
Sakha 95	93.10	93.67	98.70	95.16 c
Misr 3	93.43	96.33	98.70	96.15 b
Nitrogen rates mean	95.06 c	96.67 b	101.50 a	
LSD 5% N		0.87		
LSD 5% C		0.88		
LSD 5% NxC		1.27		
		2022/2023		
Giza 171	87.55	90.00	94.50	90.68 c
Sids 14	93.43	95.67	100.45	96.51 a
Sakha 95	89.51	93.00	98.00	93.50 b
Misr 3	90.81	93.33	98.00	94.05 b
Nitrogen rates mean	90.32 c	93.00 b	97.74a	
LSD 5% N		1.30		
LSD 5% C		0.60		
LSD 5%NxC		0.86		

3.1.2. Maturity date (days):

Data showed in Table 3 cleared that the increase of nitrogen fertilizer rate led to significant increase in number of days to maturity where number of days to maturity was 147.80 and 134.03 days in the wheat plants that fertilized with 40 kg N/fed then increased to 158.17 and 142.58 days with the increase of nitrogen rate up to 60 kg/fed in the first and second season, respectively. Number of days to maturity of wheat plants reached their largest values (162.27 and 147.01 days) in both seasons, respectively when plants were fertilized with 80 N kg/fed. Our results are in the same line with those of Ibrahim et al. (2004), Tammam and Tawfils (2004) and Abo-Marzoka (2005) revealed that increasing nitrogen levels from up to 75 kg N/fed significantly increased number of days to heading and maturity. Also, Abo El–Ela (2006) and Abo-Marzoka (2009) reported that increasing nitrogen up to 90 kg / fed significantly delaying heading and maturity date. In general, El-Hag (2011) and El–Hag and Shahein (2017) indicated that, days to heading, days to maturity increased with increasing nitrogen rates. On the other hand, El-Shaarawy (2003) Saleh (2003) found that 75 kg. N./fad. gave the short period of heading and maturity date.

Regarding the effect of wheat cultivars in maturity date, the data in Table 3 stated significant differences in maturity dates of the four tested wheat cultivars. Sakha 95 was the earliest among all tested genotypes where it had least number of days to maturity (153.58 and 139.94 days) followed by Misr 3 (155.04 and 140.38 days) in the first and second season, respectively. On the other side, Sids 14 was the latest cultivar in this study where it recorded the highest number of days to maturity (157.33 and 143.02 days) in both seasons, respectively. In many previous studies, a noticeable discrepancy was found in the dates of heading and maturity of Egyptian wheat varieties, such as the study of Khaled and Hammad (2014) indicated that Gemmiza 11 was the earliest in heading and maturity in the two seasons. Also, El–Hag and Shahein (2017) indicated that significant differences among the studied wheat cultivars in all agronomic studied traits and seeds technology were observed. Sakha 94 recorded the highest number of days to heading and maturity.

For the interaction effect on maturity dates the data in Table 3 revealed that all maturity dates of tested cultivars differ in respect to nitrogen rates. The increase of nitrogen rate led to significantly delayed of all tested cultivars in both seasons. Sakha 95 that fertilized with 40 kg N/fed recorded the lowest number of days to maturity (146.30 and 133.32 days) followed by Misr 3 under the same nitrogen fertilization rate (146.30 and 133.63 days) in both seasons, respectively. In contrast, Giza 171 that fertilized with 80 kg N/fed had the highest number of days to maturity (166.95 and 149.45 days) in the first and second seasons, respectively.

The response of wheat varieties in this study to different levels of nitrogen fertilization varied, which led to differences in the dates of heading and maturity. Similar results were obtained by El-Hag (2011) and El–Hag and Shahein (2017) indicated that, days to heading, days to maturity increased with increasing nitrogen rates. Also, El–Hag and Shahein (2017) indicated that significant differences among the studied wheat cultivars in all agronomic studied and seeds technology were observed. Sakha 94 recorded the highest number of days to heading and maturity.

Table 3: Mean effects of nitrogen rates, wheat cultivars and their interactions on maturity date during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed) 40	60	80	Cultivars mean
		2021/2022		
Giza 171	149.15	159.00	166.95	158.37 b
Sids 14	149.47	159.33	163.20	157.33 a
Sakha 95	146.30	156.00	158.44	153.58 d
Misr 3	146.30	158.33	160.48	155.04 c
Nitrogen rates mean	147.80 c	158.17 b	162.27 a	
LSD 5% N		1.07		
LSD 5% C		1.01		
LSD 5% NxC		1.43		
		2022/2023		
Giza 171	133.00	142.00	149.45	141.48 b
Sids 14	136.17	144.67	148.24	143.02 a
Sakha 95	133.32	141.33	145.18	139.94 c
Misr 3	133.63	142.33	145.18	140.38 c
Nitrogen rates mean	134.03 c	142.58 b	147.01 a	
LSD 5% N		2.03		
LSD 5% C		0.83		
LSD 5% NxC		1.19		

3.2. Effect of nitrogen rates, wheat cultivars and their interactions on growth and yield attributes during 2021/2022 and 2022/2023 seasons.

The data in Tables 5 to 12 showed that growth and yield traits of wheat plants significantly affected by nitrogen fertilization rates, different wheat cultivars and their interactions in the two seasons of the study.

3.2.1. Plant height (cm)

The results in Table 4 observed that the height of wheat plants gradually increased with the increase of nitrogen fertilizer rate in both seasons. Plant height values were 107.35 and 100.06 cm in wheat plants that fertilized with 40 kg N/fed then increased to 115.42 and 106.89 cm with the increase of nitrogen rate up to 60 kg/fed. The highest plant height (120.33 and 111.43 cm) were found under the highest nitrogen rate (80 kg/fed) in both seasons, respectively. Nitrogen increases vegetative growth and cell elongation, which leads to an increase in plant height. These findings are in the same way with those of Abo El–Ela (2006) and Abo-Marzoka (2009) who reported that increasing nitrogen up to 90 kg / fed significantly increased plant height. Also, Hafez (2007) found that, plant height gradually increased by in-creasing nitrogen levels up to 105 kg. N./fed. El-Hag (2011) and El–Hag and Shahein (2017) indicated that, plant height increased with increasing nitrogen rates.

Regarding the effect of wheat cultivars in plant height, the data presented in Table 4 showed a significant difference in the heights of the four tested wheat cultivars in both seasons. Giza 171 was the tallest among all tested genotypes in both seasons where it recorded the highest values for plant height (118.39 and 108.25 cm) in both seasons, respectively without any significant difference with Sakha 95 (117.35 cm) in the first season and Misr 3 (107.28 cm) in the second season. On the other side, Misr 3 was the shortest in the first season (105.19 cm) while Sids 14 had the lowest plant height (103.38 cm) among all tested genotypes in the second season. A wide diversity in plant height of wheat genotypes were reported before by, El-Shaarawy (2003) who found that Giza 168 recorded the highest plant height followed by Gemmeiza 9. Also, Allam (2005) results showed that, wheat cultivar Gemmeiza 1 produced the highest values of plant height. In the same way, Abd El-Hameed (2012) found that wheat cultivar Sakha 94 gave the highest plant height. While, Sadak et al. (2014) showed significant differences between the two cultivars (Sids 12 and Sids13) in morphological criteria (plant height (cm). El–Hag and Shahein (2017) indicated that significant differences among the studied wheat cultivars in all agronomic studied were observed, Sakha 94 recorded the highest plant height.

Regarding interaction effects on plant height, results in Table 4 confirmed that all tested cultivars differ in their response to nitrogen rates. The increase of nitrogen rate resulted in a significant increase in wheat plant height of all tested cultivars in both seasons. Giza 171 that fertilized with 80 kg N/fed had the highest plant heights (126.35 and 115.27 cm) followed by Sakha 95 under the same nitrogen rate (123.76 and 111.40 cm) in both seasons respectively. The exceeded of Sakha 95 did not differ significantly with Sids 14 in the first season and were lower than Misr 3 in the second season. In contrast, Misr 3 that received 40 kg N/fed was the shortest in the first season (99.75 cm) while, Sids 14 had the shortest plants (98.16 cm) in the second season. The diversity in plant height of the Egyptian wheat cultivars under different nitrogen fertilization rates were observed before by, El-Shaarawy (2003) who found that Giza 168 recorded the highest plant height followed by Gemmeiza 9. Giza 168 that received 125 kg N/fed recorded the highest plant height. Also, Saleh (2003) found that Gemmeiza 5 that fertilized with 96 kg N/fed. had the highest plant height.

Table 4: Mean effects of nitrogen rates, wheat cultivars and their interactions on plant height during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed) 40	60	80	Cultivars mean
		2021/2022		
Giza 171	110.83	118.00	126.35	118.39 a
Sids 14	110.52	117.67	121.38	116.52 b
Sakha 95	108.30	120.00	123.76	117.35 ab
Misr 3	99.75	106.00	109.82	105.19 c
Nitrogen rates mean	107.35 c	115.42 b	120.33 a	
LSD 5% N			2.21	
LSD 5% C			1.41	
LSD 5% NxC			2.01	
	2022/2023			
Giza 171	102.49	107.00	115.27	108.25 a
Sids 14	98.16	104.66	107.32	103.38 c
Sakha 95	98.37	107.00	111.40	105.59 b
Misr 3	101.23	108.89	111.74	107.28 a
Nitrogen rates mean	100.06 c	106.89 b	111.43 a	
LSD 5% N			2.28	
LSD 5% C			1.58	
LSD 5%NxC			2.26	

3.2.2. Number of spikes/m2

The obtained data in Table 5 indicated that the number of spikes/m2 increased step by step with the increase of nitrogen fertilizer rate in both seasons where the lowest number of spikes/m2 (349.84 and 350.55 were observed in the wheat plants that fertilized with 40 kg N/fed then increased to 436.67 and 392.67 with the increase of nitrogen rate up to 60 kg/fed in the first and the second season, respectively. Number of spike/m2 of wheat plants reached their largest values (472.69 and 403.90) in both seasons, respectively when plants were fertilized with 80 N kg/fed. The increase of nitrogen fertilization rates in this study resulted in a large increase in number of spikes/m2. These results are in harmony with those of, Saleh (2003b), Ali et al. (2004), Tammam and Tawfils (2004), Hafez (2007) and Waraich et al. (2010) found that number of spikes/m2 increased with increasing N. levels. But the optimal rate of nitrogen fertilizers differed from study to another where, Ibrahim et al. (2004) mentioned that, increasing nitrogen levels from 0 to 25, 50 and 75 kg N/fed significantly increased number of spikes/m2. While, Allam (2005) and Abo-Marzoka (2009) found that, nitrogen levels of 90 kg N/fed gave the best results for number of spikes/m2. El-Awady (2006) and Gheith et al. (2013) indicated that, increasing N. fertilizer rates from 75 to 100 kg N/fed significantly increased number of spikes /m2.

With respect to the effect of wheat cultivars in number of spikes/m2 the results illustrated in Table 5 revealed significant differ in number of spikes/m2 of the four tested wheat cultivars in both seasons. Sakha 95 recorded the highest number of spikes/m2 among all tested genotypes (466.43 and 379.13) in both seasons, respectively and without any significant differences with Giza 171 (395.97) and Sids 14 (379.99) in the second season. On the other side, Giza 171 in the first season and Misr 3 in the second season recorded the lowest number of spikes/m2 with averages of 383.11 and 374.39 for the two cultivars, respectively.

Significant variations in number of spikes/m2 among the Egyptian wheat genotypes were observed previously by Allam (2005) who showed that, wheat cultivar Gemmeiza 1 produced the highest number of spikes/m2. Nour El-Din et al. (2013) showed significant differences among the tested wheat cultivars in the two seasons in a number of spikes/m2. While, Sadak et al. (2014) showed significant differences between the two cultivars Sids 12 and Sids13 in morphological criteria (number of spikes per plant). In the same line, El–Hag and Shahein (2017) indicated that Sakha 94 recorded the highest number of spikes/m2 in both seasons. Also, El-Seidy et al. (2017) showed that, wheat genotype Gemmeiza-10 recorded the highest number of spikes/m2 in both seasons. Moreover, Shahin, (2020) showed significant differences among wheat varieties in both seasons for yield and its components. Misr-1 gave the highest values of number of spikes m2.

Table 5: Mean effects of nitrogen rates, wheat cultivars and their interactions on number of spikes/m2 during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed) 40	60	80	Cultivars mean
		2021/2022		
Giza 171	337.25	383.33	428.75	383.11 c
Sids 14	332.50	435.00	487.90	418.47 b
Sakha 95	371.13	526.67	501.50	466.43 a
Misr 3	358.47	401.67	472.60	410.91 b
Nitrogen rate mean	349.84 c	436.67 b	472.69 a	
LSD 5% N		21.38		
LSD 5% C		24.42		
LSD 5% NxC		34.91		
		2022/2023		
Giza 171	369.23	405.33	413.35	395.97 a
Sids 14	332.82	392.00	415.14	379.99 ab
Sakha 95	359.73	386.67	391.00	379.13 ab
Misr 3	340.42	386.67	396.10	374.39 b
Nitrogen rate mean	350.55 c	392.67 b	403.90 a	
LSD 5% N		7.99		
LSD 5% C		18.23		
LSD 5% NxC		26.12		

Regarding to the interaction effect on number of spikes/m2 the results in Table 5 indicated that number of spikes/m2 of tested cultivars differ in response to nitrogen rates. The increase of nitrogen rate resulted in significantly increase number of spikes/m2 for all tested cultivars in both seasons. Sakha 95 that fertilized with 80 kg N/fed recorded the highest number of spikes/m2 (501.50) in the first season while Sids 14 under the same nitrogen fertilization rate had the highest number of spikes/m2 (415.14) in the second season. In contrast, Sids 14 that fertilized with 40 kg N/fed had the lowest number of spikes/m2 (332) in both first and second season. In previous studies, Egyptian wheat genotypes produced different number of spikes/m2 under different nitrogen rates such the study of, El-Shaarawy (2003) who found that Giza 168 recorded the highest number of spikes/m2 followed by Gemmeiza 9. Giza 168 that received 125 kg N/fed recorded the highest number of spikes/m2. Saleh (2003) found that Gemmeiza 5 that fertilized with 230 kg N/ha. had the highest number of spikes/m2.

3.2.3. Spike length (cm)

The results in Table 6 showed that increasing nitrogen fertilizer rate resulted in significant spike length in both seasons. Spike length was 10.64 and 9.98 cm in the wheat plants that receive 40 kg N/fed then increased to 11.71 and 10.77 cm with the increase of nitrogen rate up to 60 kg/fed. Spike length of wheat plants reached their peak (12.34 and 11.32 cm) under the highest nitrogen rate (80 kg/fed) in both seasons, respectively. Our results are in agree with those found by Hafez (2007) who found that spike length gradually increased by increasing nitrogen levels up to 105 kg N/fed Abo-Marzoka (2009) reported that, increasing N. levels up to 90 kg/fed increased spike length. Also, Gheith et al. (2013) found that spike length produced the highest values at 100 kg N/fed while, Saboon et al. (2022) indicated that significant effect on spike length produced at the rate of 100 kg N/fed in both seasons.

The tested four cultiars showed low significant difference for spike length in both seasons. Misr 3 had the longest spike (11.90 cm) followed by Giza 171 (11.82 cm) in the first season, but in the second season, Giza 171 had the longest spik followed by Misr 3. On the other hand, Sakh 95 recorded the lowest spike length (10.31 and 10.32 cm) in both seasons, respectively but these values did not differ significantly with those of Sids 14 in the two seasons. The differences in spike length in the Egyptian wheat population were recorded before by, El-Gizawy (2005) who found significant differences among wheat varieties in all studied traits, except spike length. Also, Abd El-Hameed (2012) found that wheat cultivar Sids 13 followed by Sids12 and Misr 1 recorded the highest values for spike length (cm). Nour El-Din et al. (2013) recorded significant differences among the tested wheat cultivars in the two seasons in a spike length.

With respect to the interaction effect on spike length the obtained data in Table 6 indicated that all tested cultivars differ in their response to nitrogen rates in both seasons. The increase of nitrogen rate resulted in significantly increase of spike length of all tested cultivars in both seasons. Giza 171 fertilized with 80 kg N/fed recorded the highest spike length (13.24 and 12.19 cm) in both seasons, respectively. While Sids 14 that fertilized with 40 kg N/fed recorded the lowest spike length (10.37 and 9.81 cm) in the first and second seasons, respectively. The response of wheat varieties to levels of nitrogen fertilization varies, and this is mostly reflected in many of the yield characteristics, especially spike length. In this regard El-Shaarawy (2003) found that Giza 168 that received 125 kg N/fed recorded the highest spike length values. While, Saleh (2003) found that Gemmeiza 5 that fertilized with 230 kg N/ha. had the highest spike length.

Table 6: Mean effects of nitrogen rates, wheat cultivars and their interactions on spike length (cm) during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed) 40	60	80	Cultivars mean
		2021/2022		
Giza 171	10.55	11.66	13.24	11.82 a
Sids 14	10.37	11.69	11.61	11.22 b
Sakha 95	10.66	11.33	11.95	11.31 b
Misr 3	10.97	12.15	12.57	11.90 a
Nitrogen rate mean	10.64 c	11.71 b	12.34 a	
LSD 5% N		0.24		
LSD 5% C		0.35		
LSD 5% NxC		0.49		
		2022/2023		
Giza 171	10.39	10.66	12.19	11.08 a
Sids 14	9.81	10.69	10.59	10.36 b
Sakha 95	9.71	10.33	10.93	10.32 b
Misr 3	10.02	11.39	11.55	10.99 a
Nitrogen rate mean	9.98 c	10.77 b	11.32 a	
LSD 5% N		0.25		
LSD 5% C		0.38		
LSD 5% NxC		0.55		

3.2.4. Number of grains/spike:

Data showed in Table 7 cleared that the increase of nitrogen fertilizer rate led to significant increase in number of grains/spike where the lowest number of grains/spike (54.10 and 48.93) were recorded in the wheat plants that fertilized with 40 kg N/fed then increased to 59.94 and 53.25 with the increase of nitrogen rate up to 60 kg/fed. Number of grains/spike reached their largest values (61.33 and 57.63) in both seasons, respectively when plants were fertilized with 80 N kg/fed. Our findings are in the same way of those founded by Bahrani and Sarvestani (2005), they showed that number of grains/spike increased by increasing N. fertilizer rates. Hafez (2007) found that, number of grains/spike gradually increased by increasing nitrogen levels up to 105 kg N/fed. Moreover, Abo-Marzoka (2009) reported that, increasing N. levels up to 90 kg N/fed increased number of grains/spike. Also, El-Hag (2011) indicated that, number of grains/spike increased with increasing nitrogen rates. While, Saboon et al. (2022) indicated a significant effect on number of grains/spike produced at the 100 kg N/fed in both seasons but the highest number of grains/spike was obtained at 80 kg N/fed in one season.

Regarding to the effect of wheat cultivars in number of grains/spike the data in Table 7 stated significant differences in number of grains/spike of the four tested wheat cultivars in the first season only. Giza 171 had the highest values for grains number/spike among all tested genotypes (61.50) in the first season. On the other side, Sakha 95 recorded the lowest number of grains/spike (56.62) in the first season without any significant differ with Misr 3 and Sids 14. Similar results confirmed previously the differences in number of grains/spike of the Egyptian wheat genotypes such as Allam (2005) who showed that, wheat cultivar Gemmeiza 1 produced the highest values of number of grains/spike. Also, Abu-Grab et al. (2006) found that Gemmeiza 7 and Gemmeiza 9 surpassed Sakha 93 in number of grains/spike. While, Abd El-Hameed (2012) found that wheat cultivar Sids 13 followed by Sids12 and Misr 1 recorded the highest values regarding number of grains per spike. El-Seidy et al. (2017) showed that Gemmeiza-11 recorded the highest values for number of grains/spike, followed by Gemmeiza-9. On the other hand, Sohag- 3 (durum wheat cultivar) recorded the lowest values for number of grains/spike. Moreover, Shahin, (2020) showed significant differences among wheat varieties in both seasons for yield and its components. Misr-1 gave the highest o number of grains spike-1 and grains yield fed-1.

For the interaction effect on number of grains/spike, the data in Table 7 revealed that number of grains/spike of tested cultivars differ in response to nitrogen rates. The increase of nitrogen rate led to significant increment in number of grains/spike of all tested cultivars in both seasons. Giza 171 that fertilized with 80 kg N/fed recorded the highest number of grains/spike (65.80 and 61.67) in both seasons, respectively. In contrast, Sakha 95 that fertilized with 40 kg N/fed had the lowest number of grains/spike (51.93 and 48.32) in the first and second season, respectively. Also, Abo-Marzoka (2009), El-Hag (2011) and Saboon et al. (2022) found a significant increment in number of grains/spike with the increase of nitrogen fertilization rate. While, Abd El-Hameed (2012), El-Seidy et al. (2017) and Shahin, (2020) found a wide diversity on number of grains/spike of the Egyptian wheat genotypes.

Table 7: Mean effects of nitrogen rates, wheat cultivars and their interactions on number of grains/spike of wheat plants during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed) 40	60	80	Cultivars mean
		2021/2022		
Giza 171	56.37	62.33	65.80	61.50 a
Sids 14	54.89	57.11	60.75	57.58 b
Sakha 95	51.93	59.67	58.25	56.62 b
Misr 3	53.20	60.63	60.52	58.12 b
Nitrogen rate mean	54.10 b	59.94 a	61.33 a	
LSD 5% N		1.61		
LSD 5% C		2.62		
LSD 5% NxC		3.75		
		2022/2023		
Giza 171	48.01	52.07	61.67	53.91
Sids 14	50.73	55.40	56.92	54.35
Sakha 95	48.32	52.87	56.17	52.45
Misr 3	48.64	52.67	55.76	52.36
Nitrogen rate mean	48.93 c	53.25 b	57.63 a	
LSD 5% N		1.96		
LSD 5% C		2.01 (ns)		
LSD 5% NxC		2.87		

3.2.5. 1000-kernel weight (g):

The results in Table 8 reflected that, 1000-kernel-weight gradually increased with increasing of nitrogen fertilizer rate in both seasons. 1000-kernels weight was 45.85 and 47.94 g in the wheat plants that fertilized with

40 kg N/fed then increased to 48.68 and 51.96 g with the increase of nitrogen rate to 60 kg/fed in the first and the second season, respectively. The highest 1000-kernel weight values (51.50 and 55.56 g) were found under the highest nitrogen rate (80 kg/fed) in both seasons, respectively. Our results are in harmony with Gholami et al. (2011) who demonstrated that, 1000-kernel weight significantly affected by amounts of urea application. Also, Gheith et al. (2013) found that 1000-grain weight produced the highest values at 100 kg N/fed. In the same way, El–Hag and Shahein (2017) indicated that increases in nitrogen fertilizer increased 1000-grain weight. Litke et al. (2017) showed that nitrogen fertilizer significantly affected 1000-grain weight. Meanwhile, Saboon et al. (2022) indicated that the heaviest 1000-grain weight were produced at the 100 kg N/fed.

Table 8: Mean effects of nitrogen rates, wheat cultivars and their interactions on 1000-kernel weight (g) during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed)			Cultivars mean
	40	60	80	
		2021/2022		
Giza 171	48.23	51.47	56.28	51.99 a
Sids 14	45.54	47.88	50.75	48.06 b
Sakha 95	44.44	46.80	48.86	46.70 c
Misr 3	45.20	48.55	50.10	47.95 b
Nitrogen rate mean	45.85 c	48.68 b	51.50 a	
LSD 5% N		0.94		
LSD 5% C		0.48		
LSD 5% NxC		0.69		
		2022/2023		
Giza 171	53.83	58.37	69.93	60.71 a
Sids 14	45.33	49.63	50.58	48.51 c
Sakha 95	46.99	51.37	52.29	50.22 b
Misr 3	45.58	48.48	49.45	47.84 d
Nitrogen rate mean	47.94 c	51.96 b	55.56 a	
LSD 5% N		0.89		
LSD 5% C		0.41		
LSD 5% NxC		0.62		

Regarding the effect of wheat cultivars in 1000-kernel weight the data in Table 8 showed a significant difference in the weight of 1000-kernel in the four tested wheat cultivars in both seasons. Giza 171 recorded the highest 1000-kernel weight values (51.99 and 60.71 g) in both seasons, respectively followed by Sids 14 (48.06 g) in the first season and Sakha 95 (50.22 g) in the second season. On the other side, Sakha 95 in the first season and Misr 3 in the second season recorded the lowest 1000-kernel weight with averages of 46.70 and 47.84 g for both cultivars, respectively. In the previous studies the Egyptian wheat genotypes ranked differences 1000-grain weight. From this studies, Allam (2005) who found that, Sids 7 produced the tallest spikes, heaviest,1000-grain weight. Abu-Grab et al. (2006) revealed that Gemmeiza 7 and Gemmeiza 9 surpassed Sakha 93 in 1000-grain weight. Where, Nour El-Din *et al.* (2013) found significant differences among the tested wheat cultivars in the two seasons in a weight of 1000-kernel. Gemmeiza-10 along with Sids-12 produced the heaviest weight of 1000-kernel surpassing the other cultivars in that study. Also, Khaled and Hammad (2014) indicated that Sids 13 cultivar gave the highest values of 1000-grain weight. While, Radwan et al.(2014) found that Sakha 94 cultivar gave higher 1000-grain weight. El–Hag and Shahein (2017) indicated that Sakha 94 and Gemmeiza 11 recorded the highest 1000 grain weight. El-Seidy et al. (2017) mentioned that Gemmeiza-11 recorded the highest values for number of grains/spike, 1000–grain weight. On the other hand, Sohag- 3 recorded the lowest 1000–grain weight in both seasons. In the same line, Shahin (2020) results showed significant differences among wheat varieties in both seasons for yield and its components. Sid-12 recorded the highest straw yield and the heaviest 1000 grain weight obtained by Gemmiza-11.

Concerning the interaction effect on the 1000-kernel weight of wheat plants, the results in Table 8 confirmed that all tested cultivars differ in their response to nitrogen rates. The increase of nitrogen rate resulted in significantly increase in 1000-kernel weight of all tested cultivars in both seasons. Giza 171 that fertilized with 80 kg N/fed had the highest 1000-kernel weight values (56.28 and 69.93 g). In contrast, Misr 3 that received 40 kg N/fed had the l0west 1000-kernel weight in the first season (44.44 g) while, Sids 14 that fertilized with 40 kg N/fed had the lowest 1000-kernel weight (45.33 g) in the second season. In previous studies, Allam (2005), Abu-Grab et al. (2006), Nour El-Din et al. (2013), Khaled and Hammad (2014), Radwan et al. (2014), El–Hag and Shahein (2017), El-Seidy et al. (2017) and Shahin (2020) results showed significant differences among wheat varieties in both seasons for 1000 grain weight. Also, Gholami et al. (2011), Gheith et al. (2013), El–Hag and Shahein (2017), Litke et al. (2017) and Saboon et al. (2022) indicated that increases in nitrogen fertilizer increased 1000-grain weight. In the same way of our results, Abd El-Kreem and El-Hussin (2013) showed that Gemmeiza 11 gave the heaviest 1000 kernel weight under the highest nitrogen level while Sids 12 recorded the lowest 1000-kernel weight under the lowest nitrogen level. The interaction between irrigation treatments, nitrogen rate and wheat cultivar were significant for 1000-kernel weight, number of kernels/spike and biological yield in the first season.

3.2.6. Grain yield/plot (kg)

The obtained data in Table 9 indicated that the grain yield/plot increased step by step with the increase of nitrogen fertilizer rate in both seasons where the lowest grain yield/plot (2.57 and 2.70 kg) were recorded in the wheat plants that fertilized with 40 kg N/fed then increased to 3.03 and 2.93 kg with the increase of nitrogen rate up to 60 kg/fed in both seasons, respectively. Grain yield/plot of wheat plants reached their largest values (3.33 and 2.95 kg) in both seasons, respectively when plants were fertilized with 80 N kg/fed. Our results are in agreement with those obtained by Seadh et al. (2009) who indicated that, the highest values of grain yield resulted from increasing nitrogen levels up to 90 kg N/fed. Also, Waraich et al. (2010) found that grain yield, number of spikes/m2, grains/spike and grain weight responses were greater at the higher N. rates. Gheith et al. (2013) found that grain yield/fed produced the highest values at 100 kg N/fed. While, Haileselassie, et al. (2014)

found that grain yield of wheat significantly increased by 46% and 15% in Field 1 and Field 2, respectively at nitrogen application rate of 46 kg N/ha than the control. Abd El-khalek et al. (2015) found that nitrogen fertilizer in ammonia up to 90 kg N fed decreased all characters studied except grain yield. Whereas, Litke et al. (2017) showed that the nitrogen fertilization significantly increased winter wheat grain yield. With respect to the effect of wheat cultivars in grain yield/plot the results illustrated in Table 9 revealed significant differences in grain yield/plot of the four tested wheat cultivars in the first season only. Among all tested cultivars, Sakha 95 recorded the highest grain yield/plot values (3.21 kg) in the first season without any significant differences with Giza 171 (3.14 kg). On the other side, Sids 14 recorded the lowest values of grain yield/plot with an average of 2.57 kg in the first season. The differences on grain yield of Egyptian genotypes were recorded before by, Abd El-Hameed (2012) whom found that wheat cultivar Sids 13 followed by Sids 12 and Misr 1 recorded the highest grain yield (ardab per fed) while wheat cultivar Sakha 94 gave the lowest values. Nour El-Din et al. (2013) recorded significant differences among the tested wheat cultivars in the two seasons in grain and straw yields/fed. Gemmeiza-10 along with Sids-12 produced the highest grain yield. Also, Seleem and Abd El -Dayem (2013) found that the highest significant value of grain yield was obtained by Gemmeiza 9 , Misr 1 , Sakha 94 and Giza 168 in first season only. Khaled and Hammad (2014) indicated that Shandaweel 1 gave the highest grain yield/fed. While, Taher et al. (2015) showed that Gemmeiza-9 cultivar recorded the highest observed grain yield in the 1st and 2nd seasons the highest predicted grain yield as compared to other wheat cultivars Misr-1, Sakha-93 and Giza-168. Moreover, El-Seidy et al. (2017) found that Gemmeiza-11 recorded the highest grain yield/plot, followed by Gemmeiza-9.

Table 9: Mean effects of nitrogen rates, wheat cultivars and their interactions on grain yield/plot during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed) 40	60	80	Cultivars mean
		2021/2022		
Giza 171	2.48	3.15	3.80	3.14 ab
Sids 14	2.58	2.43	2.72	2.57 c
Sakha 95	2.77	3.43	3.42	3.21 a
Misr 3	2.44	3.11	3.39	2.98 b
Nitrogen rate mean	2.57 c	3.03 b	3.33 a	
LSD 5% N			0.16	
LSD 5% C			0.18	
LSD 5% NxC			0.24	
		2022/2023		
Giza 171	2.68	2.96	2.99	2.88
Sids 14	2.70	2.92	2.89	2.84
Sakha 95	2.72	2.91	2.99	2.88
Misr 3	2.70	2.93	2.92	2.85
Nitrogen rate mean	2.70 b	2.93 a	2.95 a	
LSD 5% N			0.14	
LSD 5% C			0.15 (ns)	
LSD 5% NxC			0.21	

Regarding, the interaction effect on grain yield/plot the results in Table 9 indicated that grain yield/plot of tested cultivars differed in respect to nitrogen rates. The increase of nitrogen rate resulted in significantly increase grain yield/plot of all tested cultivars in both seasons. Giza 171 that fertilized with 80 kg N/fed recorded the highest grain yield/plot (3.80 and 2.99 kg) in both seasons, respectively. The exceeded of Giza 171 in the second season did not differ significantly with Sakha 95. In contrast, Sids 14 that received 60 kg N/fed in the first season and Giza 171 that fertilized with 40 kg N/fed had the lowest grain yield/plot (2.43 and 2.68 kg) for the two cultivars, respectively. In previous studies of Seadh et al. (2009), Waraich et al. (2010), Gheith et al. (2013), Haileselassie, et al. (2014), Abd El-khalek et al.(2015) and Litke et al. (2017) showed that increasing nitrogen fertilization level, significantly increased winter wheat grain yield .As for cultivars effect, Abd El-Hameed (2012), Nour El-Din et al. (2013), Seleem and Abd El - Dayem (2013), Khaled and Hammad (2014), Taher et al. (2015) and El-Seidy et al. (2017) found a wide diversity in grain yield of the Egyptian wheat genotypes.

3.2.7. Straw yield/plot (kg)

Data presented in Table 10 cleared that, the increase of nitrogen fertilizer rate led to significant increment in straw yield/plot, where straw yield/plot was 5.02 and 5.26 kg in the wheat plants that fertilized with 40 kg N/fed, then increased to 5.86 and 5.60 kg with the increase of nitrogen rate to 60 kg/fed in both first and second season, respectively Straw yield/plot reached their largest values (6.37 and 5.84 kg) in both seasons, respectively when plants were fertilized with 80 N kg/fed. Similar results were reported before by, Abo-Marzoka (2009) who reported that, increasing N. levels up to 90 kg/fed increased straw yield. Also, El-Hag (2011) indicated that, straw yield increased with increasing nitrogen rates. While, El–Hag and Shahein (2017) indicated that increasing of nitrogen fertilizer increased significantly straw yield.

Concerning the effect of wheat cultivars on straw yield/plot, the data in Table 10 stated significant differences in straw yield/plot of the four tested wheat cultivars in both seasons. Sakha 95 was the most yielded for straw among all tested genotypes, where it had the highest straw yield/plot (6.03 and 5.70 kg) followed by Giza 171 (6.09 and 5.53 kg) in both seasons, respectively and without any significant differences between the two genotypes. On the other side, Sids 14 recorded the lowest values for straw yield/plot (5.19 and 5.48 kg) in both seasons, respectively.

A noticeable variation in straw yield were showed in the Egyptian wheat genotypes previously by, Allam (2005) who showed that, wheat cultivar Gemmeiza 1 produced the highest straw yields/fed. Nour El-Din et al. (2013) showed significant differences among the tested wheat cultivars in the two seasons in a straw yields/fed. Straw yield of Giza-168 was higher than each of other cultivars in the first season. Gemmeiza-10 along with Sids-12 gave the maximum straw yield in the 2nd season. Meanwhile, El–Hag and Shahein (2017) indicated that Gemmeiza 11 superior the other cultivars for both of grain and straw yield. Also, Shahin, (2020) showed significant differences among wheat varieties in both seasons for yield and its components, Sid-12 recorded the highest straw yield.

For the interaction effect on straw yield/plot the data in Table 10 revealed that, straw yield/plot of the tested cultivars differ in respect to nitrogen rates. The increase of nitrogen rate led to a significant increment in straw yield/plot values for all tested cultivars in both seasons. Giza 171 that fertilized with 80 kg N/fed recorded the highest value of straw yield/plot (7.05 kg), followed by Sakha 95 (6.44 kg) under the same nitrogen fertilization rate in the first season. Meanwhile, Sakha 95 followed by Giza 171 cultivar showed the highest values under rate of 80 kg N/fed (6.13 and 5.80, respectively) in the second season. In contrast, Giza 171 that fertilized with 40 kg N/fed had the lowest straw yield/plot (4.90 kg) in the first season. Meanwhile, in the second season, the cultivar Sids 14 recorded the lowest value (5.06 kg) under the rate of 40 kg N/fed . The effects of nitrogen rates on straw yield were recorded before by, Abo-Marzoka (2009), El-Hag (2011), El–Hag and Shahein (2017) whom indicated that increases in nitrogen fertilizer increased significantly straw yield. Also, A large variation in straw yield were showed in the Egyptian wheat genotypes previously by, Allam (2005), Nour El-Din et al. (2013), El–Hag and Shahein (2017), Shahin, (2020). These findings are in agree with these of El-Shaarawy (2003) who found that Giza 168 that received 125 kg N/fed recorded the highest straw yield/fed.

Table 10: Mean effects of nitrogen rates, wheat cultivars and their interactions on straw yield/plot (kg) during 2021/2022 and 2022/2023 seasons.

Cultivars	**Nitrogen rate (kg/fed)**			**Cultivars mean**
	40	**60**	**80**	
		2021/2022		
Giza 171	4.90	6.32	7.05	6.09 a
Sids 14	5.02	4.81	5.75	5.19 c
Sakha 95	5.30	6.34	6.44	6.03 a
Misr 3	4.87	5.99	6.24	5.70 b
Nitrogen rate mean	5.02 c	5.86 b	6.37 a	
LSD 5% N		0.33		
LSD 5% C		0.27		
LSD 5% NxC		0.40		
		2022/2023		
Giza 171	5.24	5.54	5.80	5.53 ab
Sids 14	5.06	5.68	5.71	5.48 b
Sakha 95	5.45	5.52	6.13	5.70 a
Misr 3	5.28	5.67	5.72	5.56 ab
Nitrogen rate mean	5.26 b	5.60 a	5.84 a	
LSD 5% N		0,26		
LSD 5% C		0.19		
LSD 5% NxC		0.32		

3.2.8. Biological yield/plot (kg):

The results in Table 11 reflected that, biological yield/plot gradually increased with the increase of nitrogen fertilizer rate in both seasons. Biological yield/plot was 7.59 and 7.96 kg in the wheat plants that fertilized with 40 kg N/fed then increased to 8.89 and 8.54 kg with the increase of nitrogen rate to 60 kg/fed in the first and second season, respectively. The highest biological yield/plot values (9.70 and 8.79 kg) were found under the highest nitrogen rate (80 kg/fed) in both seasons, respectively. Our results are in the same way with those of Seleem and Abd El -Dayem (2013) who found that the best significant values of grain, straw and biological yields were obtained by adding 60 and/or 90 kg/fed. Also, Osman and Nour El-Dein (2017) indicated that application of both nitrogen levels (80 or 60 kg N fed-1) gave the highest significant values of biological yield. Overall, the application of 80 or 60 kg N fed-1 to any of the four tested bread wheat cultivars gave a significant increase of wheat biological yield in both seasons.

Table 11: Mean effects of nitrogen rates, wheat cultivars and their interactions on biological yield/plot (kg) during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed)			Cultivars mean
	40	60	80	
			2021/2022	
Giza 171	7.38	9.47	10.85	9.23 a
Sids 14	7.60	7.23	8.47	7.77 c
Sakha 95	8.08	9.77	9.86	9.23 a
Misr 3	7.32	9.10	9.62	8.68 b
Nitrogen rate mean	7.59 c	8.89 b	9.70 a	
LSD 5% N			0.48	
LSD 5% C			0.39	
LSD 5% NxC			0.55	
			2022/2023	
Giza 171	7.92	8.50	8.79	8.40 b
Sids 14	7.76	8.60	8.61	8.32 b
Sakha 95	8.17	8.44	9.12	8.58 a
Misr 3	7.98	8.60	8.64	8.41 b
Nitrogen rate mean	7.96 c	8.54 b	8.79 a	
LSD 5% N			0.21	
LSD 5% C			0.14	
LSD 5% NxC			0.25	

Regarding the effect of wheat cultivars in biological yield/plot the data in Table 11 showed a significant difference in biological yield/plot of the four tested wheat cultivars in both seasons. Sakha 95 recorded the highest biological yield/plot values (9.23 and 8.58 kg) in both seasons, respectively, without any significant differ with Giza 171 (9.23 kg) in the first season. While, Sids 14 had the lowest values for biological yield/plot (7.77 and 8.32 kg) compared with the other tested cultivars in both seasons, respectively. It was recorded varied biological yield with respect to the different wheat genotypes before by, Abd El-Kreem and El-Hussin (2013) whom showed that Gemmeiza 11 gave the highest biological yield. Also, Radwan et al. (2014) found that Sakha 94 cultivar gave higher biological yields tons/fed, than Misr 1 and Giza 168 cultivars in both seasons. Meanhile, El-Seidy et al. (2017) found that the highest means of biological yield were detected for Banei Sweif 6, followed by Gemmeiza 9, while Gemmeiza-10 recorded the lowest values for biological yield in both seasons. Moreover, Osman and Nour El-Dein (2017) indicated that Misr 2 gave higher biological yield values. Meanwhile, the biological yield was significantly improved by planting Misr1 compared to the other cultivars in the second season.

For the interaction effect on biological yield/plot, the results in Table 11 confirmed that all tested cultivars differ in their response to nitrogen rates. The increase of nitrogen rate resulted in significant increment in biological yield/plot of all tested cultivars in both seasons. The highest biological yield/plot values were observed in Giza 171 that fertilized with 80 kg N/fed (10.85 and 8.79 kg) and Sakha 95 under the same nitrogen rate (9.86 and 9.12 kg) in both seasons respectively. In contrast, Sids 14 and Misr 3 that received 40 kg N/fed were the lowest in biological yield/plot in both seasons, respectively. Similar results were reported by Seleem and Abd El -Dayem (2013) whom found that the best significant values of grain, straw and biological yields were obtained by adding 60 and/or 90 kg/fed. Also, Osman and Nour El-Dein (2017) indicated that application of both nitrogen level (80 or 60 kg N fed-1) gave the highest significant values of biological yield. Over all, the application of 80 or 60 kg N fed-1 to any of the tested bread wheat cultivars, gave a significant increment of wheat biological yield in both seasons. Also, Abd El-Kreem and El-Hussin (2013), Radwan et al. (2014), El-Seidy et al. (2017) and Osman and Nour El-Dein (2017) found significant difference in biological yield of different Egyptian wheat genotypes.

3.2.9. Harvest index:

The obtained data in Table 12 indicated that harvest index (HI%) increased step by step with the increase of nitrogen fertilizer rate in both seasons, where the lowest harvest index values (33.83 and 33.99%) were observed in the wheat plants that fertilized with 40 kg N/fed, then increased to 34.01 and 34.35 with the increase of nitrogen rate up to 60 kg/fed. Harvest index values of wheat plants were 34.25 and 33.54 in both seasons, respectively when plants were fertilized with 80 N kg/fed. Similar results were showed before by, Abo-Marzoka (2009) who reported that, increasing N. levels up to 90 kg N/fed increased harvest index. Also, Gholami et al. (2011) demonstrated that harvest index significantly affected by amounts of urea foliar application. While, Gheith et al. (2013) found that harvest index exhibted the highest values at 100 kg N/fed. Osman and Nour El-Dein (2017) indicated that application both of nitrogen levels (80 or 60 kg N fed-1) gave the highest significant harvest index values.

Table 12: Mean effects of nitrogen rates, wheat cultivars and their interactions on harvest index (%) during 2021/2022 and 2022/2023 seasons.

Cultivars	Nitrogen rate (kg/fed) 40	60	80	Cultivars mean
		2021/2022		
Giza 171	33.67	33.28	35.01	33.99 b
Sakha 95	34.34	35.15	34.71	34.73 a
Misr 3	33.43	34.13	35.16	34.24 ab
Sids 14	33.90	33.47	32.13	33.17 c
Nitrogen rate mean	33.83 c	34.01 b	34.25 a	
LSD 5% N		0.12		
LSD 5% C		0.51		
LSD 5% NxC		0.95		
		2022/2023		
Giza 171	33.87	34.81	34.02	34.23 a
Sakha 95	33.34	34.56	32.77	33.56 c
Misr 3	33.90	34.06	33.79	33.92 b
Sids 14	34.86	33.96	33.60	34.14 a
Nitrogen rate mean	33.99 c	34.35 b	33.54 a	
LSD 5% N		0.10		
LSD 5% C		0.19		
LSD 5% NxC		0.27		

With respect to the effect of wheat cultivars in harvest index, the results illustrated in Table 12 revealed significant differences in harvest index values for the four tested wheat cultivars in both seasons. Sakha 95 recorded the highest harvest index value among all tested genotypes (34.73%) and without any significant differences with Misr 3 (34.24%) in the first season. Meanwhile, Giza 171 in the second season had the highest harvest index value (34.23%) without any significant difference with Sids 14 (34.14%). On the other side, Sids 14 in the first season and Sakh 95 in the second season recorded the lowest harvest index values with averages of 33.17% and 33.56% for the two cultivars, respectively. The diversity of harvest index in Egyptian wheat population was observed before by El-Seidy et al. (2017) who indicated that the genotype Gemmeiza-11 recorded the highest harvest index followed by Gemmeiza-9. Also, Osman and Nour El-Dein (2017) indicated that Misr 2 gave higher harvest index.

Regarding to the interaction effect on harvest index, the results in Table 12 indicated that harvest index of tested cultivars difference with respect to nitrogen rates. Sakha 95 that fertilized with 60 kg N/fed recorded the highest harvest index value (35.15%) without any significant difference with Misr 3 under 80 kg N/fed (35.16%) in the first season, while Sids 14 under 40 kg N/fed had the highest harvest index value (34.86%) in the second season. In the same way, Abo-Marzoka (2009), Gholami et al. (2011), Gheith et al. (2013), El-Seidy et al. (2017) and Osman and Nour El-Dein (2017) found significant increase of wheat harvest index with the increase of nitrogen fertilization rates. Respect to cultivars effect, El-Seidy et al. (2017) and Osman and Nour El-Dein (2017) found significant diversity in harvest index among Egyptian wheat genotypes.

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