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Effect of nitrogen fertilization on yield and its attributes of some bread wheat (*Triticum aestivum* L.) cultivars

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Abstract

Two field experiments were conducted at Al-Hussainiya District, Sharkia Governorate, Northeast Delta Region, Egypt during the two successive winter seasons 2019/2020 and 2020/2021. The aim of this study was to investigate the response of five wheat varieties (Giza 171 (C1), Gemmieza 12 (C2), Sids 14 (C3), Misr 1(C4) and Shandweel1 (C5) to four N levels (zero,35,70 and 105 kg /fad). The results of the combined analysis showed that the increase in N level up to 105 kg N/fad increased significantly spike length, number of spikelets and grains/spike, number of spikes/m^2, 1000-grain weight(g), grain yield (ardab/fad) and biological yield (Ton/fad). Raising N rate from zero to 30, 60 and 90 Kg N/ fed increased grain yield/ fed by 23.81, 38.37. and 47.20%, respectively. The results revealed significant differences among wheat cultivars for number of spikes/m^2, spike length, number of spikelets/spike and grains/spike,1000-grain weight, grain and biological yield/fad. Whereas harvest index did not affected significantly. Both Giza 171 and Gemmieza 12 cvs gave the highest value of, number of spikes/m2, 1000-grain weight, grain and biological yield/fad. Sids 14 recorded higher value spike length, number of spikelets/spike and number of grain/spike. The lowest values of yield and yield attributes recorded by Shandweel 1 variety.

Keywords: Wheat culivars, nitrogen fertilization

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1. Introduction

Egypt is the largest wheat importer in the world; however, it produces only half of the 20 million tons of wheat that it consumes annually. The population of Egypt is currently growing by 1.94% per year, and projections predict that the demand for wheat will be nearly doubled by 2050 [1].

To improve the production of wheat, as in any other crop, introduction of varieties with a high yield potential is essential. Variety contributes more than 50 percent of the increased production [2]. The next important component for increased production is the nutrient availability. Native fertility level of the tropical soils with special reference to nitrogen is invariably insufficient for touching the peak production mark of a variety and hence, the need for supplementing this nutrient is obvious with most varieties.

Nitrogen is one of the major nutrients which reduce the yield of wheat if not applied in the proper amount as it is needed for the fast growth of plants and to get high production per unit area. Nitrogen is playing important role in all the metabolic processes of plants. It's the main component and major constituent of plants, especially in living tissue formation [3]. Every single indispensable process in the plant is related to protein, of which nitrogen is a fundamental constituent. Nitrogen is an integral part of proteins, compounds, coenzymes, chlorophyll and nucleic acids. All the biochemical processes occurring in plants are mainly governed by nitrogen and its associated compounds which make it essential for the growth and development of wheat [4,5].

In Egypt, the optimum nitrogen fertilization level for wheat crops differs widely depending on characteristics and soil fertility level, fluctuating between 80 to 160 kg N fed^{-1} [6,7]. Several investigations reported that increasing N level up to 120 kg N/fad., significantly increased each of spike length, number of spikelets/spike, number of grains/ spike and grain and biological yields/fad., however, 1000-grain weight significantly decreased. On the other side, number of tillers and spikes /m^2, spike significantly increased due to application of nitrogen up to 90 kg N/fad.[8,9,10,11].

Wheat genotypes display different behavior with different levels of available nitrogen across locations and growing seasons [12,13,14,15,16,17,18]. Therefore, the wheat varieties Giza-171, Gemmiza-14, Sids 14, Misr 1and Shandawil1-1 are the new and important varieties in Egypt, with good study about the proper nitrogen fertilizer level. There it will make difference to do research about reasonable nitrogen fertilizer level on these varieties to improve wheat production. So, keeping of view the above mentioned facts, the present study was conducted to evaluate physiological and yield performance of some wheat varieties at different nitrogen levels. In this connection [19] found that Sakha 95 cultivar produced the highest values of all studied characteristics in both growing seasons. Meanwhile, the cultivar Misr 2 showed the highest number of spikelets/spike, additionally recorded the second best results after Sakha 95. On the other hand, Shandaweel 1 cultivar gave the longest spikes; Giza 171 cultivar recorded the highest values of 1000-grain weight. However, Sakha 95 under 50 kg N/fed ranked secondly in most treatments without significant differences between Sakha 95 under 75 kg N level /fad.[4], [20,21] showed that Shandaweel 1 was superior overall genotypes for plant height, No. of grains spike-1, 1000-kernel weight, grain yield, and biological yield followed by Misr 2. Furthermore, the nitrogen level of 125kg N fed-1 was the best fertilizer level followed by the nitrogen level of 100kg N fed-1 in sandy soil for recording the highest values for yield and its components under two locations.

2. Materials and Methods

2.1. Experimental Site and Treatments

Two field experiments were conducted at Al-Hussainiya District, Sharkia Governorate, Northeast Delta Region, Egypt during the two successive winter seasons 2019/2020 and 2020/2021. The study aimed to investigate the response of some wheat (*Triticum aestivum. L*) varieties i.e. Giza 171 (C_1), Gemmieza 12 (C_2), Sids 14 (C_3), Misr$_1$(C_4) and Shandweel$_1$ (C_5) at different levels of nitrogen fertilizer, i.e. 0 kg N/faddan (N_0), 35 kg N/faddan (N_1), 70 kg N/faddan (N_2), and 105 kg N/faddan (N_3) were applied as urea (46%N) as per treatment in three splits, 1/3 at the time of sowing ,1/3 at the time of first irrigation and 1/3 at the time of second irrigation.

2.2. Experimental Design and Agronomic Practices

A spilt plot design with three replications was used, where nitrogen fertilizer levels were allocated in the main plots, whereas wheat varieties were distributed in the sub plots. The area of each sub plot was 9 m^2 (3.0 m wide and 3.0 m in length) which included 20 rows 15 cm apart. The soil of the experimental site was clay in texture. Soil samples were collected from the experimental sites at the depth of 0 – 30 cm before planting to determine soil physical and chemical properties, whereas. Some soil mechanical and chemical properties of the experimental field in the two seasons are presented in table 1.

Table 1: Some physical and chemical properties of the experimental soil in the two seasons of investigation

Soil characteristics	Soil location 0-30 cm	
Soil particles distribution	1st season	2nd season
Sand %	13.24	13.19
Silt %	34.18	33.88
Clay %	52.58	52.93
Texture Class	Clay	Clay
Saturation point%	45.87	44.65
Field capacity %	22.93	22.32
Organic matter %	0.65	0.61
PH*	8.02	8.04
EC (dsm-1)**	1.87	1.92
CaCo3%	0.50	0.49
Soluble cations and anions		
Ca++	8.02	7.76
Mg++	5.31	5.49
Na+	3.45	3.65
K+	1.22	2.19
CO3=	0.00	0.00
HCO3-	9.45	7.78
Cl-	4.12	5.80
SO4=	4.43	5.42
Available N, (mg Kg-1 soil)	41.03	38.64
Available P, (mg Kg-1 soil)	19.13	17.98
Available K, (mg Kg-1 soil)	280	265
Available Fe, (mg Kg-1 soil)	1.33	1.21
Available Zn, (mg Kg-1 soil)	0.39	0.29
Available Cu, (mg Kg-1 soil)	0.67	0.60
Available Mn, (mg Kg-1 soil)	0.52	0.64

Source: Central Laboratory, Faculty of Agriculture, Zagazig University, Zagazig, Egypt

Wheat cultivars were sown at the seeding rate of 400 seeds/m^2. The sowing was done using drill hand machine on 17 November in the first season and 14 November in the second season. The preceding crop was maize in both seasons. Calcium super phosphate (15.5% P2O5) at rate of 100 kg/fad., and potassium sulphate (50% K2O) at rate of 100 kg. /fad were added during seedbed preparation. Surface irrigation using Nile water was used. Harvesting was practiced on April 22 and 23 for all cultivars in the first season and second season, respectively. The other culture practices were applied as recommended.

2.3. Recorded data

At harvest, 10 plants were randomly selected from central three rows of each treatment for measuring plant height (cm), spike length (cm), number of spikelet's/ spike number of spikes/m^2, number of grains/spike and thousand grain weight (g). Thereafter, a bulk sample including all plants in the five central rows was harvest manually to determine: biological and grain yield (ton/ha.). The harvest index (%) was calculated as a ratio of grain to biological yield and expressed as a percentage.

2.4. Statistical analysis

Data of the two seasons and their combined analysis were statistically analyzed as mentioned by [22]. For comparison between means, Duncan's multiple range tests were used [23]. The combined analysis was calculated for all the studied characters in both seasons. Statistical analysis was performed by using analysis of variance technique of (MSTAT-C 1989) computer software package. In interaction Tables, capital and small letters were used to compare rows and columns means, respectively.

3. Results

3.1. Spike length and number of spikelets/spike

3.1.1. Nitrogen fertilizer levels effect

As shown from data presented in Table 2, show significant effect in the second seasons and highly significant in the first season and combined. Results of both seasons and combined cleared that the highest nitrogen fertilizer level (105 kg N/fad) recorded the highest mean values of spike length and number of spikelets /spike, while the control (without application) recorded the lowest mean values of spike length in the first, second seasons and the combined, respectively. The relative increased in spike length due to raising nitrogen fertilizer level from control to high level (105 kg N/fad) was 16.54% (combined data). Increasing number of spikelets/spike as a result of increasing nitrogen fertilizer level could attributed to role of nitrogen as an essential element in building wheat spikes due to the effect on photosynthetic activity in plant and its positive effects on wheat growth. There inferences are in line with the earlier researchers on wheat undertaken by [10,19,3] who recorded that number of spikelets/spike of wheat was significantly affected with applications of nitrogen fertilizer.

3.1.2. Wheat varieties effect

The obtained results showed significant differences between wheat varieties in spike length and number of spikelets/spike in two seasons and their combined analysis. Sids 14 variety had the highest mean value of spike length followed by, Gemmieza 12, Shandweel 1, Misr 1 and Giza 171 in the first, second season and combined. Respectively. These results may be due to Sids 14 variety can utilize soil nitrogen more than the other four varieties. Similar results were found by [14,10,19,21] who showed that wheat varieties were differed significantly in all yield characters. All varieties differed significantly in number of spikelets/spike, where Sids 14 had the greatest mean value than the other varieties. Data of combined cleared that Sids 14 was superior to the rest of the studied cultivars, where it had the highest mean value of 20.700. On contrast Shandweel 1 had the lowest mean value of (18.934.). These results are in harmony with those obtained by [18,19,3].

3.1.3. Interaction effect

The interaction effect between nitrogen fertilizer levels and wheat varieties on spike length and number of spikelets/spike was found to be non-significant.

3.2. Number of spikes/m^2 and number of grains/spike

3.2.1. Nitrogen fertilizer levels effect

Regarding the effect of nitrogen fertilizer levels effect (Table 3) it was quite evident that increasing nitrogen fertilizer had a significant effect on increasing number of spikes/m^2 and number of grains/spike in both seasons and their combined analysis. Combined analysis indicated that the highest number of spikes/m^2 and number of grains/spike were observed at highest nitrogen fertilizer level (105 kg N/fad.), while, the lowest number of spikes/m^2 and number of grains/spike were recorded by control (without nitrogen application). The highest number of spikes/m2 of wheat with maximum level of N could be attributed to availability of plant nutrients in abundant amount resulting in more fertile tillers and number of tillers/m^2. These results are confirmed by Iqbal et al. (2012) and Khalid et al. (2014, who concluded that Number of tillers /m^2 increased with increasing fertilizer levels. Also, [10,11,24,19,3] cleared that increasing nitrogen fertilizer levels increased number of spikes/m^2 significantly. Results of the combined indicated that the relative increase in number of grains/spike due to raising nitrogen level from control to highest level (105 kg N/fad.) was 13.62%. In terms of nitrogen, maximum number of grains/ spike (53.48) were recorded with the application of 105 kg N/fad and minimum number grains /spike (47.03) were recorded from control plots. These result are supported by [21] who stated that nitrogen application positively influenced number of grains/spike.

3.2.2. Wheat varieties effect

Respecting varietal differences, it is clear that wheat varieties were differed significantly in their number of spikes/ m^2 and number of grains/spike in both seasons and their combined analysis. According to combined analysis. Cemmieza 12, Giza 171 and Misr 1 gave the highest number of spikes/m2 (506.4, 505.7 and 496.1) and without significant difference between them, while both Sids 14 and Shandweel 1 recorded the lowest number of spikes/m^2 (442.3 and 461,0) and without significant difference between them. The reasons for differences in number of spikes/m^2 might be attributed to of genetic structure of the cultivars primarily affected by heredity. These results are in harmony with those obtained by [12,13,10,17]. According to combined analysis. Sids 14 gave the highest number of grains/spike (53.91), followed by each of Gemmieza 12, Giza 171, and Misr 1 (50.576,50.378 and 50.141) and without significant difference between them., while Shandweel 1 recorded the lowest number of grains/spike (48.955). These findings are in agreement with those obtained by [4].

Table 2. Spike length and number of spikelets/spike as affected by nitrogen fertilizer levels, wheat varieties and their interaction during two seasons (2019/2020 and 2020/2021) and their combined.

Main effects and interaction	Spike length (cm)			No. spikelets/spike		
	2019/2020	2020/2021	Combined	2019/2020	2020/2021	Combined
Nitrogen levels (N):						
Control	8.968 d	9.257 b	9.113 d	16.827 b	17.347 b	17.087 c
35 kg N/fad.	9.546 c	9.961 ab	9.754 c	18.627 a	19.640 ab	19.134 b
70 kg N/fad.	10.047 b	10.416 a	10.232 b	19.773 a	21.147 a	20.460 ab
105 kg N/fad.	10.453 a	10.789 a	10.621 a	20.533 a	22.027 a	21.280 a
F-test	**	*	**	**	*	**
Wheat varieties (V):						
Giza 171	9.171 d	9.749 b	9.460 c	18.400 b	19.550 b	18.975 c
Gemmieza 12	9.905 b	10.078 ab	9.992 b	19.300 b	20.100 b	19.700 b
Sids 14	10.620 a	10.552 a	10.586 a	20.081 a	21.317 a	20.700 a
Misr 1	9.611 bc	9.968 b	9.790 b	18.417 b	19.867 b	19.142 c
Shandweel 1	9.461 cd	10.183 ab	9.822 b	18.500 b	19.367 ab	18.934 c
F-test	**	**	**	**	**	**
Interactions:						
N*V	N.S	N.S	N.S	N.S	N.S	N.S

*,** and N.S. indicate significance at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Table 3. Number of spikes/m2 and number of grains/spike as affected by nitrogen fertilizer levels, wheat varieties and their interaction during two seasons (2019/2020 and 2020/2021) and their combined

Main effects and interaction	No. spikes/m^2			No. grains/spike		
	2019/2020	2020/2021	Combined	2019/2020	2020/2021	Combined
Nitrogen levels (N):						
Control	384.0 d	465.5 b	424.8 c	47.714 c	46.360 c	47.037 d
35 kg N/fad.	442.0 c	499.9 ab	471.0 b	50.754 b	50.240 b	50.497 c
70 kg N/fad.	481.7 b	528.7 a	505.2 ab	52.712 a	51.666 b	52.189 b
105 kg N/fad.	517.7 a	539.5 a	528.6 a	53.756 a	53.140 a	53.448 a
F-test	*	**	**	**	**	**
Wheat varieties (V):						
Giza 171	483.3 a	528.0 a	505.7 a	50.292 b	50.465 b	50.378 b
Gemmieza 12	475.4 a	537.3 a	506.4 a	52.327 a	48.825 bc	50.576 b
Sids 14	424.2 b	460.3 b	442.3 b	53.182 a	54.642 a	53.912 a
Misr 1	466.7 a	525.5 a	496.1 a	50.432 b	49.850 b	50.141 b
Shandweel 1	432.1 ab	490.7 ab	461.4 b	49.935 b	47.975c	48.955 c
F-test	*	**	**	**	**	**
Interactions:						
N*V	*	*	**	**	**	**

*,** and N.S. indicate significance at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

3.2.3. Interaction effect

Data in (Table 3-a) showed that the highest number of spikes/m2 value of 576.2 was obtained with Gemmieza 12 and N 105 level followed by Misr 1 (553.7), Giza 171 (543.2), Shandweel 1(512.2) and Sids 14 (457.7) with the same N level, respectively. On contrast the lowest value of 392.7was recorded with Shandweel 1 and N0 level. These results were in agreement with those obtained by [25] who indicated that number of spikes/m2 respond to N levels up to 105 kg N/fad., and the contribution of N fertilizer in yield production increased when N levels increase.

Regarding the significant interaction between nitrogen fertilizer levels and wheat varieties on number of grains/spike in the combined analysis (Table 3-b), the results showed that Sids 14 had the highest number of grains/spike when highest nitrogen fertilizer level (105 kg N/fad) was applied. While, Shandweel 1 recorded the lowest values of number of grains/spike under control.

Table (3-a). Number of spikes/m^{2}of wheat plants as affected by nitrogen fertilizer levels and wheat varieties interaction (combined analysis over seasons)

N-fertilizer levels	Wheat varieties				
	Giza 171	Gemmieza12	-Sids 14	Misr 1	Shandweel 1
Control	A 435. c	A 433.d	A 425.8 b	A 436.3 c	B 392.7 c
35 kg N/fad	A 511.2 b	AB 488.0 c	D 432.3 ab	BC 467.8 c	CD 455.3 b
70 kg N/fad	AB 533.2 ab	AB 527.7 b	A 453.1 a	B 526.5 b	C 485.3 ab
105 kg N/fad	AB 543.2a	A 576.2 a	C 457.7 a	A 553.7 a	B 512.2 a

Capital and small letters were used to denote significant differences among columns and rows means, respectively.

Table (3-b). Number of grains/spike of wheat plants as affected by nitrogen fertilizer levels and wheat varieties interaction (combined analysis over seasons)

N-fertilizer levels	Wheat varieties				
	Giza 171	Gemmieza 12	Sids 14	Misr 1	Shandweel 1
Control	BC 46.85 d	B 48.03c	A 50.55 c	CD 45.30	D 44.45 c
35 kg N/fad	B 49.75 c	B 49.83 bc	A 53.50 b	B 50.11	B 49.28 b
70 kg N/fad	B 51.71 b	B 51.55 b	A 55.36 a	B 51.71	B 50.60 ab
105 kg N/fad	B 53.20 a	B 52.88 a	A 56.23 a	C 50.60	BC 51.48 a

Capital and small letters were used to denote significant differences among columns and rows means, respectively.

3.3. 1000-grain yield and grain yield/fad

3.3.1. Nitrogen fertilizer levels effect

Results in Table 4 shows that 1000-grain weight and grain yield was significantly influenced by nitrogen fertilizer levels in both seasons and their combined analysis. The obtained results of both seasons and their combined analysis indicated that increasing nitrogen fertilizer level from control to 105 kg N/fad significantly decreased 1000-grain weight. These results are confirmed with that obtained by [10]. Data revealed that increasing nitrogen level from control to 70 kg N/fad significantly increased grain yield in both season and their combined analysis. These results are in harmony with those obtained by [9,24,19] who, reported that increasing nitrogen level more than 50 kg/fad., accompanied by a significant increase grain yield.

3.3.2. Wheat varieties effect

Concerning the influence of wheat varieties on 1000-grain weight and grain yield/fad, the statistical analysis revealed highly significant differences throughout two seasons and the combined analysis (Table 4). Data of combined analysis revealed that, Sids 14, Gemmieza 12 and Giza 171 recorded the highest thousand grain weight without significant difference between them, whereas Misr 1 gave the lowest thousand grain weight, value followed by Shandweel 1. The reasons for differences in 1000 grain weight might be attributed to of genetic structure of the cultivars primarily affected by heredity. [26,27] confirmed with our results and they found that, the wheat cultivars significantly differed in thousand grain weight. Gemmieza 12 was the highest variety followed by Giza 171 and Misr 1 respectively. Both Shandweel 1 and Sids 14 recorded the lowest value of grain yield and with insignificant differences. It could be concluded that varietal differences between wheat cultivars may be due to genetic differences between cultivars and differences between genotypes concerning partitioning of dry matter, where wheat cultivar differed in carbon equivalent, yield energy per plant and per feddan [28,29]. These results are in harmony with those obtained by [16,30,31].

3.3.3. Interaction effect

Furthermore, the significant interaction between nitrogen fertilizer levels and wheat varieties on 1000-grain weight (g) in the second (Table 4-a). Study on interaction effect revealed that among all the treatment combinations the variety Sids 14 recorded maximum 1000-grain weight (60.67 g) at control, While, Misr 1 recorded the lowest values of 1000-grain weight (49.33 g) at 105 kg N/fad.

Table 4. 1000-grain weight and grain yield/fad as affected by nitrogen fertilizer levels, wheat varieties and their interaction during two seasons (2019/2020 and 2020/2021) and their combined

Main effects and interaction	1000-grain weight (g)			Grain yield/fad		
	2019/2020	2020/2021	Combined	2019/2020	2020/2021	Combined
Nitrogen levels (N):						
Control	49.235 a	58.467 a	53.851 a	13.774 d	15.860 c	14.817 c
35 kg N/fad.	48.443 a	57.733 ab	53.088 ab	16.300 c	20.430 b	18.346 b
70 kg N/fad.	47.289 ab	56.867 bc	52.078 bc	18.508 b	22.498 ab	20.503 a
105 kg N/fad.	46.649 c	55.267 c	50.958 c	19.850 a	23.774 a	21.812 a
F-test	**	**	**	**	**	**
Wheat varieties (V):						
Giza 171	48.556 a	58.000 a	53.278 a	17.173 b	22.143 a	19.657 ab
Gemmieza 12	47.709 a	59.000 a	53.355 a	18.825 a	22.470 a	20.647 a
Sids 14	49.405 a	58.750 a	54.078 a	15.593 c	19.360 b	17.476 c
Misr 1	45.279 b	55.083 b	50.181 c	17.240 b	20.933 a	19.068 b
Shandweel 1	48.571 a	54.583 b	51.577 b	16.710 c	18.295 b	17.502 c
F-test	**	**	**	**	**	**
Interactions:						
N*V	N.S	**	N.S	N.S	**	**

*,** and N.S. indicate significance at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Table (4-a). 1000-grain weight (g) of wheat plants as affected by nitrogen fertilizer levels and wheat varieties interaction (second season data)

N-fertilizer levels	Wheat varieties				
	Giza 171	Gemmieza 12	Sids 14	Misr 1	Shandweel 1
Control	AB 59.33 a	BC 57.00 a	A 60.67 a	AB 60.33 a	C 55.00 a
35 kg N/fad	AB 58.67 a	A 60.33 a	A 59.33 a	BC 55.33 b	C 55.00 a
70 kg N/fad	AB 57.33 a	A 59.67 a	AB 57.67 a	B 55.33 b	B 54.33 a
105 kg N/fad	AB 56.67 a	A 59.00 a	AB 57.33 a	C 49.33 c	B 54.00 a

Capital and small letters were used to denote significant differences among columns and rows means, respectively.

The interaction studies (Table 4-b) have shown that Gemmieza 12 recorded significantly higher grain yield (24.29 ardab/fad) followed by Giza 171 (22.33 ardab/fad) at 105 kg N/fad which is in turn significantly higher than Sids 14 at 105 kg N/fad. on the other hand, Shandweel 1recorded the lowest values of grain yield (12.91 ardab/fad) at control.

Table (4-b). 1000-grain weight (g) of wheat plants as affected by nitrogen fertilizer levels and wheat varieties interaction (second season data)

N-fertilizer levels	Wheat varieties				
	Giza 171	Gemmieza 12	Sids 14	Misr 1	Shandweel 1
Control	A 15.94 d	A 16.48 c	C 13,88 c	BC 14.86 c	C 12.91 c
35 kg N/fad	A 19.28 c	A 20.12 b	B 16.47 b	A 19.16 b	B 16.78 b
70 kg N/fad	A 21.07 b	A 21.69 b	B 19.71 a	AB 20.28 b	B 19.76 a
105 kg N/fad	B 22.33 a	A 24.29 a	C 19.84 a	B 22.04 a	C 20.54 a

Capital and small letters were used to denote significant differences among columns and rows means, respectively.

3.4. Biological yield and harvest index

3.4.1. Nitrogen fertilizer levels effect

The results of both seasons and their combined analysis (Table 5), showed that increasing nitrogen fertilizer level from control to 105 kg N/fad significantly increased biological yield. The favorable effect of increasing nitrogen fertilizer levels on the dry matter might be due to the fact that nitrogen fertilizer is considered as one of the essential nutrients for wheat growth and subsequently the grain and straw yield. These results are confirmed with that obtained by [8,9,10] who stated that N application linearly increased biological yield. Data in (Table 5) revealed that harvest index were significantly (P 0.05) affected by different nitrogen fertilizer level in first season and insignificant in second season and the combined. Harvest index recorded highest value (36.58%) at control in the first season. These results are in general agree with those reported by [7,11,18] who, reported that increasing nitrogen fertilizer level leads to reducing wheat harvest index.

Table 5. Biological yield/fad and harvest index as affected by nitrogen fertilizer levels, wheat varieties and their interaction during two seasons (2019/2020 and 2020/2021) and their combined

Main effects and interaction	Biological yield/fad (ton)			Harvest index		
	2019/2020	2020/2021	Combined	2019/2020	2020/2021	Combined
Nitrogen levels (N):						
Control	5.648 d	7.765 d	6.706 b	36.58 a	30.63	33.60
35 kg N/fad.	7.405 c	9.414 c	8.406 c	33.08 b	32.55	32.78
70 kg N/fad.	8.756 b	10.534 b	9.723 b	31.70 b	32.03	31.86
105 kg N/fad.	9.517 a	11.394 a	10.455 a	31.28 b	31.29	31.29
F-test	**	**	**	*	N.S	N.S
Wheat varieties (V):						
Giza 171	8.045 a	10.463 ab	9.255 a	32.01 b	31.47	31.87
Gemmieza 12	8.345 a	11.022 a	9.684 a	33.83 a	30.57	32.20
Sids 14	7.568 ab	9.234 c	8.452 b	30.90 c	31.44	31.17
Misr 1	7.993 a	10.009 b	9.000 ab	32.35 b	31.36	31.86
Shandweel 1	7.203 b	8.155 d	7.722 c	34.79 a	33.65	34.22
F-test	**	**	**	*	N.S	N.S
Interactions:						
N*V	N.S	*	*	N.S	N.S	N.S

*,** and N.S. indicate significance at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

3.4.2. Wheat varieties effect

Respecting varietal differences, it is clear that wheat varieties were differed significantly in their biological yield in both seasons and their combined analysis (Table 5. According to combined analysis, wheat variety Giza 171 and Gemmieza 11 and Misr1 recorded the highest value for biological yield, whereas Shandweeel 1 produced least biological yield. These results are in agreement with those obtained by [24,18.19.3]. Respecting varietal differences, it is clear that wheat varieties were differed significantly in their harvest index in the first season and insignificantly affected in the second season and combined (Table 5). Results of the first season cleared that the highest harvest index value was recorded by Shandweeel 1 (34.79%) and Gemmieza 12 (33.83%), while the lowest one was observed with Sids 14 (30.90%). These results are in harmony with those obtained by [20,16].

3.4.3. Interaction effect

The interaction between nitrogen fertilizer levels and wheat varieties had a significant effect on biological yield in the combined (Table 5-a). The highest biological yield (11.902 ton/fad) was attained in wheat variety Gemmeiza 12 and application of 105 kg N//fad. Whereas, the lowest value (5.906 ton/fad) was occurred in Shandweel 1without application of nitrogen fertilizer.

Table (5-a). Biological yield/fad of wheat plants as affected by nitrogen fertilizer levels and wheat varieties interaction (second season data)

N-fertilizer levels	Wheat varieties				
	Giza 171	Gemmieza 12	Sids 14	Misr 1	Shandweel 1
Control	A 6.881 c	A 7.112 d	AB 6.592 c	A 7.039 c	B 5.906 c
35 kg N/fad	A 9.180 b	A 9.158 c	B 7.605 b	A 8.814 b	B 7.277 b
70 kg N/fad	A 10.100 a	A 10.563 b	AB 9.656 a	AB 9.562 b	B 8.734 a
105 kg N/fad	B 10.859 a	A 11.902 a	CD 9.562 a	B 10.585 a	D 8.975 a

Capital and small letters were used to denote significant differences among columns and rows means, respectively.

4. Conclusions

Depending on the results obtained in current study, it can be concluded that performance of both Giza 171 and Gemmieza 12 cvs, greatly responded to nitrogen fertilization and had maximum grain yield under experimental site conditions. Therefore, for higher wheat grain yield production, the recommendation of N at the rate of 70 Kg N/fad are the appropriate application strategy for improving wheat grain yield under local environmental conditions of this study.

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