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Response of some bread wheat cultivars to nitrogen fertilizer levels in newly reclaimed sandy soils

Ahmed H. A. Hussein, Mahmoud S. Mohamed, Ebaa M. A. Khalifa

Address:

Wheat Research Department, Field Crops Research Institute, Agriculture Research Center, Egypt.

*Corresponding author: ***AHMED HUSSEIN***, ahmed_heseen2003@yahoo.com

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ABSTRACT

The present study was carried out (on sandy soil under sprinkler irrigation) in two locations, Mallawy and Assiut (Middle and Upper Egypt) Agricultural Research Stations, Egypt, in two successive winter growing seasons of 2019/2020 and 2020/2021 to evaluate four bread wheat cultivars under four nitrogen levels for grain yield and its components and to identify response and suitability across 16 environments (combination of four soil N levels two years x two locations) on newly reclaimed sandy soils. In each season, a split-plot arrangement in a randomised complete block design with four replicates was used. The combined analysis of variance showed significant differences among environments, cultivars, and nitrogen levels for all studied characters. Misr 1 had the earliest heading and maturity dates, and the shortest plants. 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} (N4) was the best fertilizer level followed by the nitrogen level of 100kg N fed^{-1} (N3) in sandy soil for recording the highest values for yield and its components under two locations. The interaction (C x N) was significant for most studied traits under four environments. Cultivar Misr 2 followed by Shandaweel 1 was recorded with the highest values for No. of spikes m^{-2}, No. of kernel spike^{-1}, 1000-kernel weight, grain yield and biological yield with level 125 kg N fed^{-1} (N4) under Mallawy and Assiut locations. According to GGE-biplot, Shandaweel 1 (G1) was the most stable cultivar across all environments. This cultivar is the most suitable for the respective mega environments.

Keywords: Wheat, cultivars, varieties, N fertilizer, Yield and its components, GGE-biplot, sandy soil.

INTRODUCTION

Bread wheat (*Triticum aestivum* L.) is one of the first domesticated plants and has been the staple food for major civilizations in the world for many thousands of years. Domestication of wheat was probably the most important step in humanity's transition from hunter-gatherer and nomadic shepherd to a settled farmer (Curtis and Halford, 2014). Nowadays, wheat is an economically important crop cultivated worldwide (Shiferaw *et al.*, 2013; Shewry and Hey, 2015). It is one of three cereal species (wheat, rice and corn) that are the most important food sources for people.

Increasing wheat production to reduce the gap between production and consumption is the main target of wheat breeders. Despite many efforts of wheat breeders, yield losses due to a biotic stresses such as water stress, salinity, or high temperature and/or biotic stresses (diseases, insects, etc.) are still considered the main constants to high grain yield of importance (Thanaa, H. A., and El-Hussin, 2013 and Alnusairi *et al.*, 2022).

The total annual national production of wheat can be mainly increased by increasing the wheat area, especially in newly reclaimed soils and introducing high-yielding wheat genotypes that show a high response to macro and micronutrients. In newly reclaimed sandy soils irrigation and fertilization and their interaction are the most important factors for increasing grain yield production (Shaaban, 2006; Thanaa and El-Hussin, 2013). The sandy soils are poor in N as well as low exchange capacity (Sayed *et al.*, 2003). Wheat crop is known to have a high nitrogen requirement, and the applied nitrogen fertilization level significantly affects the grain yield produced. 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} (Atta Allah and Mohamed, 2003). Wheat genotypes display different behavior with different levels of available nitrogen across locations and growing seasons (Mahjourimajd *et al.*, 2016; Ali, 2017).

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 (Mohamed *et al*., 2022). 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 (Kutman *et al.*, 2011; Ullah *et al.*, 2018), but is costly to supply and can adversely affect the environment. Up to 50%–70% of the nitrogen applied to the wheat cropping system is not utilized by the plants (Tyagi *et al.*, 2020); moreover, globally, wheat accounts for nearly one-third of crop fertilizer use.

The application of the appropriate level of N fertilizer is considered to be a primary means of increasing wheat grain yield, improving N uptake, use efficiency and consequently nitrogen harvest index (Fageria, 2014). Many studies have shown a genetic variation of wheat in nitrogen utilization efficiency and nitrogen uptake efficiency and nitrogen recovery efficiency (Kichey *et al.*, 2007) and that the use of the best cultivars can contribute to improved efficiency in how cereal crops acquire and use soil N or fertilizer N. Various studies detected significant genotype x nitrogen (G × N) interactions for agronomic characters so the best wheat cultivars at high nitrogen may not be the best at low nitrogen (Cormier *et al.,* 2013; Ali, 2017). In addition, studies indicate that the development and use of wheat cultivars with higher nitrogen use efficiency can contribute to reducing the amount of nitrogen to be applied without decreasing grain yield (Barraclough *et al.*, 2014). Therefore, the selection of wheat cultivars with high nitrogen use efficiency based on agricultural practices could increase economic return and reduce environmental pollution. Such overuse of nitrogenous fertilizers can be a major source of environmental pollution (groundwater pollution), due to nitrate leaching and runoff (Belete *et al.*, 2018), and is costly. (Noureldin *et al.*, 2013; Ayadi *et al.*, 2015) obtained those results showed significant differences among the tested wheat cultivars in the two seasons for yield and its components, moreover increasing N up to 75 kg fad^{-1} increased yield and its attributes of wheat in both growing seasons. These drawbacks have motivated in making of important changes in recent fertilization practices such as the use of a reduced amount of nitrogen fertilizer in combination with wheat cultivars with elevated nitrogen use efficiency. However, limited research has been done on the effects of N level concerning genetic variations for wheat cultivars in sandy soil.

Therefore, the objectives of the present study were; 1) to evaluate the response of four bread wheat cultivars under different nitrogen fertilizer levels. 2) to estimate the rank of environments based on discriminating ability and representativeness by using the GGE-biplot analysis of four bread wheat cultivars under sixteen environments (two locations x two years x four nitrogen levels) for selecting widely adapted cultivars and the best dose of nitrogen level to indicate superior grain yield under newly reclaimed sandy soils at Mallawy and Assiut conditions.

MATERIAL AND METHODS

Experimental site:

During the 2019/2020 and 2020/2021 wheat growing seasons, a field experiment was conducted at two locations (Mallawy and Assiut Agriculture Research Stations), to evaluate four bread wheat (*Triticum aestivum* L.) cultivars under sprinkler irrigation in the newly reclaimed lands. The geographical Mallawy location is 27° 86' N latitude, 30° 98' E longitude, in Middle Egypt, and Assiut is 27° 22′ latitude, 31° 21′ E longitude, in Upper Egypt.

Experimental design and treatments:

Four bread wheat (*Triticum aestivum* L.) cultivars namely; C1=Shandaweel 1, C2=Sids 14, C3=Misr 1 and C4=Misr 2, were evaluated under four nitrogen fertilizer levels; N_1=50, N_2=75, N_3=100 and N_4 =125 Kg fed^{-1} represented the studied treatments for grain yield and its components and to identify response and suitable across 16 environments (combination of four N levels × two years x two locations). The name, pedigree and selection history of the used wheat cultivars were presented in Table (1) A solid set rotary sprinkler irrigation system was used to irrigate the experiment. A split-plot arrangement in Randomized Complete Block Design (RCBD) with four replicates was used in each season, where wheat cultivars were assigned to the main plots and nitrogen levels were assigned to the sub-plots. Each sub-plot consisted of 12 rows, 3.5 m long and 20 cm apart (plot size = 8.4m^2).

Table 1. Name, pedigree and selection history of the four bread wheat cultivars used in the study.

No	Cultivar	Pedigree and selection history
1	**Shandaweel 1**	CAZO/KAUZ//KAUZ. CMBW90 Y3279-OTOPM-02010M-02010Y-3M-OSH.
2	**Sids 14**	Bow"s"/Vee"s"//Bow"s"/TSI/3/Bani Sewef 1. SD293-1SD-2SD- 4SD – OSD.
3	**Misr 1**	OASIS/SKAUZ//4*BCN/3/2*PASTOR. CMSS00Y01881T -050M-030Y-030M-030WGY-33M-0Y-0EGY.
4	**Misr 2**	Rohf 07*2/Kiriti. CGSS 05 B00123T-099T-0PY-099M-099NJ-6WGY-0GZ.

Soil Analysis:

The soil mechanical and chemical analysis of the experimental sites is illustrated in Table (2) according to Jackson (1973).

Table 2. Average of the two seasons for soil analysis at 0-30 cm depth in the experimental sites in two locations (Mallawy and Assiut Agricultural Research Stations).

Soil characteristic	Mallawy location	Assiut location
Physical analysis		
Sand %	92.3	94.6
Silt %	2.6	4.2
Clay %	5.1	1.2
Soil Type	**Sandy**	**Sandy**
pH water (H_2O)	7.19	7.41
Organic matter %	0.25	0.24
Total N (%)	0.04	0.05
Chemical analysis		
pH (paste extract) [1:2.5]	7.97	8.37
EC (dSm^{-1}) [1:5]	1.83	2.47
Total $CaCo_3$ %	34.7	35.2
Soluble anions (meq/l00g soil(1:5))		
HCO_3^-	0.47	1.68
CL^-	15.34	1.34
SO_4^{--}	1.21	2.69
Soluble cations (meq/l00g soil(1:5))		
Ca^{++}	5.12	1.73
Mg^{++}	2.61	1.00
Na^+	8.9	0.56
K^+	0.57	0.17

Source: Central Lab for Soil Analysis, Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt.

Data of soil analyses Table (2) showed that sand represents 92.3 and 94.6% of soil texture indicating that the experimental sites at Mallawy and Assiut, respectively are sandy soil characterized by the low holding capacity of irrigation water, and pH water was moderate validity irrigation water (7.19 and 7.41). Moreover, the soil fertility is very low where the organic matter is only 0.25 and 0.24%, total nitrogen 0.04 and 0.05% and soluble ions of potassium are 0.57 and 0.17%. However, a low value of EC (1.83 and 2.47 ds/m), indicated that the type of soil is good for planting wheat. Calcium carbonate percentage was high as it reached 34.7 and 35.2% indicating that the soil type is sandy calcareous soil and pH was high (7.97 and 8.37) at Mallawy and Assiut, respectively. These two factors decrease the availability of phosphorus to the plants which affects the absorption of other macro-nutrients, especially nitrogen uptake leading to unbalanced plant nutrition. These characterizations may help in the results interpretation.

The planting dates were the 28th and 25th of November at the two locations (Mallawy and Assiut Agriculture Research Stations), respectively in the two growing seasons. Grains were drilled in rows at the rate of 80 kg fed^{-1}. Calcium superphosphate (15.5% P_2O_5) and potassium sulfate (48.5% K_2O) were broadcasted before sowing at the rate of 200 and 50 kg fed^{-1}., respectively. After planting, nitrogen fertilizer treatments were applied at eight equal doses and added before irrigation at 10 days intervals. Other cultural practices were performed as recommended for wheat production in sandy soil conditions. Irrigation stopped after 140 days from sowing in both seasons.

Studied characters and data collection:

From each plot, days to heading (DH) and days to maturity (DM) were recorded when 50% of the heads emerged from the boots and when the top internodes were showing no green tissue, respectively. The No. of spikes m^{-2} was calculated from the ten central rows, of each plot, and was adjusted to the number of spikes m^{-2} **(**SPM^{-2}). The average plant height **(**PH) in cm was recorded from ten randomly selected plants.

At harvest time, 10 random spikes were collected from each plot and threshold to count the average No. of grains spike^{-1} (GS^{-1}) and 1000-grain weight (g) (TGW). The 12 rows were harvested, and weighed, to get the biological yield (BY), and threshold to get grain yield (GY). The two weights were adjusted to a ton and arddab faddan^{-1}, respectively. The harvest index (HI %) was estimated according to Huhn (1990).

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

Statistical analysis:

All analyses of variance were computed using the "GEN STAT" microcomputer program, VSN International (2016). The least significant differences (L.S.D.) at the level of 0.05 probabilities were employed to compare the differences among the treatment means **(**Gomez and Gomez**,** 1984). The genotype main effect plus G×E interaction (GGE-biplot) (Akcura and Kaya, 2008) was used to visualize the G×E interaction. The GGE-biplot of grain yield for the studied wheat cultivars was done for the sixteen environmental conditions.

RESULTS

The analysis of variance:

The analysis of variance for studied characters under the four nitrogen levels and different environments is presented in Table 3. The combined analysis of variance showed significant or highly significant differences among the four environments of the two seasons and the two locations, for all studied characters. Furthermore, significant differences between the four nitrogen levels were detected for all characters. More importantly, genotypes and their interactions showed highly significant differences in most cases. Also, the interaction between environments and wheat cultivar (E x C) was significant for most of the studied characters except the harvest index. The interaction between environments and nitrogen levels (E x N) was significant for all studied characters. The interaction between cultivars and N levels (C x N) was significant for days to maturity, plant height, No. of spikes m^{-2}, grain yield and harvest index. In addition, the interaction between environments, cultivars and N levels (E x C x N) was significant for all studied characters. Cultivars and their interactions showed highly significant differences in most cases.

Table 3. Combined analysis of variance for, the studied characters of the four bread wheat cultivars under the four nitrogen levels and four environments (two seasons x two locations).

S.O.V.	Df.	MS				
		DH	DM	PH	SPM^{-2}	GS^{-1}
Environment(E)	**3**	562.86 **	253.51 **	2065.52 **	48917.21 **	11974.65 **
Error	**12**	2.01	1.97	9.61	138.52	16.40
Cultivar (C)	**3**	284.24 **	36.86 **	1066.39 **	1337.75 **	649.31 **
E x C	**9**	39.16 **	22.05 **	184.56 **	2708.83 **	83.40 **
Error	**36**	8.22	3.49	10.85	92.98	9.50
Nitrogen (N)	**3**	294.58 **	82.71 **	849.82 **	26749.01 **	748.14 **
E x N	**9**	92.39 **	23.03 **	141.24 **	2947.80 **	116.68 **
C x N	**9**	3.54 **NS**	5.88 **	35.53 *	225.92 **	9.67 **NS**
E x N x G	**27**	7.42 **	2.76 *	24.38 *	223.96 **	13.86 *
Error	**144**	3.21	1.67	14.14	62.86	8.14

S.O.V.	Df.	MS			
		TGW	GY	BY	HI %
Environment(E)	**3**	662.76 **	93.50 **	26.80 **	1214.63 **
Error	**12**	3.00	1.87	0.14	11.22
Cultivar (C)	**3**	120.03 **	10.70 **	2.17 **	19.21 *
E x C	**9**	115.03 **	35.28 **	2.43 **	69.51 **
Error	**36**	3.54	0.67	0.12	4.95
Nitrogen (N)	**3**	419.44 **	106.64 **	21.38 **	25.53 *
E x N	**9**	37.04 **	3.26 **	1.02 **	32.59 **
C x N	**9**	3.03 **NS**	3.40 **	0.14 **NS**	27.57 **
E x N x G	**27**	5.85 **	1.28 **	0.19 **	13.62 *
Error	**144**	2.50	0.62	0.078	7.26

(DH) days to heading, (DM) days to maturity, (PH) plant height, (SPM^{-2}) No. of spikes m^{-2}, (GS^{-1}) No. of kernel spike^{-1}, (TGW) 1000-kernel weight, (GY) grain yield, (BY) biological yield, (HI %) harvest index, (*) significant at 0.05, (**) significant at 0.01 levels of probability and (NS) insignificant, respectively.

I-Mean performance:

I-1: Seasons and locations effect:

The data in Table (4) illustrate the main effect of seasons and locations for all studied traits. Mallawy location recorded the highest mean values for days to heading (102 days), days to maturity (143 days), and plant height (96 cm) in the second season, moreover it produced the highest values for No of spikes m^{-2} (304 and 305 spikes m^{-2}), 1000-grain weight (40.72 and 42.75 g), grain yield (14.645 and 14.619 arddab faddan^{-1}) and biological yield (4.264 and 6.179 ton faddan^{-1}) in the first and second seasons, respectively compared with Assiut location which recorded the lowest values of these traits.

I-2: Nitrogen levels effect:

The nitrogen levels had a significant or highly significant effect on all studied traits (Table 4). N4 fertilizer level (125 kg N fed^{-1}), recorded the maximum number of days to heading (101 days) and days to maturity (143 days). Furthermore, The N4 fertilizer level, increased, plant height (96 cm), No. of spikes m^{-2} (311 spikes m^{-2}), No. of grains spike^{-1} (59 kernels), 1000-grain weight (42.12 g), grain yield (15.166 arddab faddan^{-1}) and biological yield (5.894 ton faddan^{-1}), while the lowest nitrogen fertilizer level N1 (50 kg fed^{-1}) recorded the lowest mean values for all studied traits because sandy soils are poor in organic matter and nitrogen content as shown in soil analysis (Table 2).

I-3: Cultivars effect:

Cultivars showed highly significant differences in all studied traits when the data were combined across seasons and locations (Table 4). Misr 1 was the earliest cultivar, it recorded the least number of DH (98 days), DM (140 days), and the shortest plants (87 cm), while Shandaweel 1 was superior overall genotypes, which recorded the highest plants (96 cm), and the highest value for No. of spikes, m^{-2} (304 spikes m^{-2}) followed by Sids 14 and Misr 2, but with insignificant differences, and achieved the highest value of GS^{-1} (58 kernels), the heaviest TGW (40.73 g), the highest GY (14.922 arddab $faddan^{-1}$), BY (5.477 ton $faddan^{-1}$), and harvest index (40.87 %) followed by Sids 14.

Table 4. Main effects for the studied characters under four environments (two seasons × two locations) (E), the four nitrogen levels (N) and the four bread wheat cultivars (C).

Variable	DH	DM	PH	SPM^{-2}	GS^{-1}	TGW	GY	BY	HI %
Environment (E)									
Mallawy. 1st season	99	143	91	304	44	40.72	14.645	5.264	41.73
Assiut. 1st season	99	140	95	246	64	35.26	12.153	4.812	37.88
Mallawy 2nd season	102	143	96	305	44	42.75	14.619	6.179	35.49
Assiut 2nd season	95	139	84	293	70	38.37	13.474	4.801	42.10
Mean	**99**	**141**	**91**	**287**	**55**	**39.27**	**13.723**	**5.264**	**39.30**
LSD 0.05 %	**0.5**	**0.5**	**1.2**	**4.5**	**1.6**	**0.67**	**0.527**	**0.143**	**1.29**
Nitrogen level (N)									
N1= 50kg/fed.	97	140	87	263	51	36.22	12.158	4.563	39.97
N2=75kg/fed.	100	142	92	295	57	40.44	13.382	5.063	39.65
N3=100kg/fed.	98	141	90	278	55	38.33	14.187	5.536	38.44
N4=125kg/fed.	101	143	96	311	59	42.12	15.166	5.894	38.60
Mean	**99**	**141**	**91**	**287**	**55**	**39.27**	**13.723**	**5.264**	**39.16**
LSD 0.05 %	**0.6**	**0.5**	**1.3**	**2.8**	**1.0**	**0.55**	**0.276**	**0.097**	**0.94**
Cultivar (C)									
Shandaweel 1	99	141	96	289	58	40.73	14.922	5.477	40.87
Sids 14	100	142	88	289	51	39.04	14.057	5.205	40.51
Misr 1	98	140	87	280	55	37.50	12.191	5.044	36.25
Misr 2	101	142	94	289	58	39.83	13.722	5.331	38.61
Mean	**99**	**141**	**91**	**287**	**55**	**39.27**	**13.723**	**5.264**	**39.06**
LSD 0.05 %	**1.0**	**0.7**	**1.2**	**3.5**	**1.1**	**0.68**	**0.294**	**0.125**	**0.80**

(DH) days to heading, (DM) days to maturity, (PH) plant height, (SPM^{-2}) No. of spikes m^{-2}, (GS^{-1}) No. of kernel $spike^{-1}$, (TGW) 1000-kernel weight, (GY) grain yield, (BY) biological yield and (HI %) harvest index, respectively.

I-4: Interaction between environments and cultivars (E x C) Effects:

The data in Table (5) illustrate the main effect of locations and cultivars for all studied traits. Misr 1 was the earliest cultivar; it recorded the least number of DH (93 days) and DM (138 days) under the Assiut location in the second season. Sids 12 recorded the highest plants (101 cm) at Mallawy without significant difference with Misr 2 (99 cm) at Assiut in the second season. On the other hand, Shandaweel 1 was superior overall cultivars and recorded the highest values for No. of spikes m^{-2}, No. of kernel $spike^{-1}$, grain yield, and biological yield under the four environments, and it is recorded the highest values for SPM^{-2} (314 spikes m^{-2}), GY (16.63 arddab $faddan^{-1}$) and BY (6.499 ton $faddan^{-1}$) at Mallawy in the two growing seasons followed by Assiut. Also, it recorded the highest value for GS^{-1} (76 kernels) under Assiut in the first season. While Sids 14 recorded the heaviest 1000-grain weight (45.90 g) and Misr 2 had the highest value for harvest index (46.71 %) under the Mallawy location.

Table 5. Mean effects for the studied characters under the interaction between environments and the four bread wheat cultivars (E x C).

Treatment	DH				DM				PH (cm)			
	Cultivar (C)											
Environment	**C1**	**C2**	**C3**	**C4**	**C1**	**C2**	**C3**	**C4**	**C1**	**C2**	**C3**	**C4**
M. 1st season	98	99	97	103	143	144	143	144	80	89	79	87
A. 1st season	104	103	100	102	139	139	139	139	90	96	95	98
M. 2nd season	97	100	95	104	143	142	142	143	85	101	84	92
A. 2nd season	95	96	93	97	139	142	138	142	95	97	95	99
LSD 0.05 %	**1.8**				**1.3**				**2.3**			
Treatment	**SPM-2**				**GS-1**				**TGW(g)**			
Environment	**C1**	**C2**	**C3**	**C4**	**C1**	**C2**	**C3**	**C4**	**C1**	**C2**	**C3**	**C4**
M. 1st season	311	308	290	307	46	43	42	44	38.82	43.06	42.31	38.69
A. 1st season	261	246	224	253	76	70	64	71	34.25	37.27	38.28	31.24
M. 2nd season	314	307	295	301	46	44	41	45	44.90	45.32	39.95	40.82
A. 2nd season	305	298	273	295	69	64	58	65	41.36	37.27	35.60	39.25
LSD 0.05 %	**7.3**				**2.4**				**1.31**			
Treatment	**GY (arddab faddan-1)**				**BY (ton faddan-1)**				**HI %**			
Environment	**C1**	**C2**	**C3**	**C4**	**C1**	**C2**	**C3**	**C4**	**C1**	**C2**	**C3**	**C4**
M. 1st season	16.63	14.91	12.19	14.85	6.499	6.317	5.454	6.446	38.38	35.40	33.53	34.56
A. 1st season	14.08	13.41	12.71	13.69	5.394	5.378	5.045	5.237	39.15	37.40	37.79	39.21
M. 2nd season	15.09	14.74	13.74	14.90	5.047	4.898	4.473	4.787	44.85	45.14	46.08	46.69
A. 2nd season	13.88	13.16	9.88	11.45	5.383	4.313	5.202	4.348	38.68	45.77	28.49	39.50
LSD 0.05 %	**0.71**				**0.25**				**1.82**			

(M) Mallawy, (A) Assiut locations, (C1) Shandaweel 1, (C2) Sids 14, (C3) Misr 1, (C4) Misr 2, (DH) days to heading, (DM) days to maturity, (PH) plant height, (SPM^{-2}) No. of spikes m^{-2}, (GS^{-1}) No. of kernel spike^{-1}, (TGW) 1000-kernel weight, (GY) grain yield, (BY) biological yield and (HI %) harvest index, respectively.

I-5: Interaction between environments and nitrogen levels (E x N) Effects:

Data recorded in Table (6) represent the effect of interaction between environments and nitrogen levels. Increasing nitrogen fertilizer levels from 50 to 125kg N fed^{-1} significantly increased all of the studied traits in both growing seasons in the two locations. Nitrogen level of 50 kg fed^{-1} (N1) produced the earliest DH (90 days) and DM (137 days) under Assiut in the second season compared with the nitrogen level of 125 kg fed^{-1} (N4) at Mallawy which gave the latest DH and DM in the second season. Moreover, the tallest plants (104 cm) were achieved under a nitrogen rate of 125 kg fed^{-1} (N4) at Assiut in the second season. Nitrogen level of 125 kg fed^{-1} (N4) produced the highest values for spikes per square meter, grains per spike, 1000 kernel weight (g), grain yield (arddab faddan^{-1}) and biological yield (ton faddan^{-1}) under four environments (two seasons x two locations), while nitrogen level of 50 kg fed^{-1} recorded the lowest values for grain yield and its components under the four environments. Increasing nitrogen fertilizer levels up to 125 Kg N fed^{-1} significantly increased grain yield and its components in both seasons at the two locations.

I-6: Interaction between nitrogen levels and cultivars (N x C) Effects:

The interaction between nitrogen levels and wheat cultivars had a significant or highly significant effect on days to maturity, plant height, No. of spikes m^{-2}, grain yield and harvest index, while days to heading, No. of kernel spike^{-1}, 1000-grain weight and biological yield which showed insignificant differences (Table 3). Data presented in Table 7 indicated that Misr 1 had the earliest cultivar for days to maturity (139 days) without significant differences with Shandaweel 1 and Misr 2 under the N1 (50 Kg N fed^{-1}). Sids 14 recorded the tallest plants (102 cm) with the N4 (125 Kg N fed^{-1}), while Misr 1 had the shortest plants (83 cm) with N1 (50 Kg N fed^{-1}). The highest No. of spikes m^{-2} (316 spikes m^{-2}) was recorded by the cultivar Misr 2 followed by Sids 14 and Shandaweel 1 under N4 (125 Kg N fed^{-1}). The highest grain yield was recorded with Sids 14 (15.68 arddab faddan^{-1}) followed by Shandaweel 1 and Misr 2 under the N4 (125 Kg N fed^{-1}), while Misr 1 had the lowest grain yield (10.92 arddab faddan^{-1}) under the N1 (50 Kg N fed^{-1}). The higher harvest index value, the greater the physiological potential of the crop for converting dry matter to grain yield. Under different levels of nitrogen and wheat cultivars harvest index significantly differed (Table 7). The maximum harvest index (42.07) was calculated by Misr 2 with N1 (50 Kg N fed^{-1}) followed by Shandaweel 1 (40.86) with the same nitrogen level and (40.47) with N2 (75 Kg N fed^{-1}), while the minimum value (37.60) was calculated by Misr 1 with N1 (50 Kg N fed^{-1}**).**

Table 6. Mean effects for the studied characters under the interaction between environments and the four nitrogen levels.

Treatment	DH				DM				PH (cm)			
	Nitrogen levels (N)											
Environment	N1	N2	N3	N4	N1	N2	N3	N4	N1	N2	N3	N4
M. 1st season	99	99	99	100	143	143	144	144	83	82	83	86
A. 1st season	100	102	103	105	138	138	140	142	88	93	95	103
M. 2nd season	98	98	100	99	142	143	142	143	89	90	92	91
A. 2nd season	90	92	97	102	137	140	141	143	90	95	98	104
LSD 0.05 %	**1.2**				**0.9**				**2.5**			
Treatment	**SPM-2**				**GS-1**				**TGW(g)**			
Environment	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**
M. 1st season	291	300	306	318	41	44	45	44	38.35	40.35	41.52	42.66
A. 1st season	203	227	262	293	63	68	71	78	30.38	32.60	37.19	40.87
M. 2nd season	291	300	311	315	42	44	44	46	40.99	42.03	43.51	44.47
A. 2nd season	268	287	299	318	58	62	67	69	35.15	38.34	39.53	40.46
LSD 0.05 %	**6.4**				**2.3**				**1.37**			
Treatment	**GY (arddab faddan-1)**				**BY (ton faddan-1)**				**HI %**			
Environment	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**
M. 1st season	13.37	14.18	15.15	15.76	4.441	4.691	4.887	5.187	45.16	45.34	46.50	45.58
A. 1st season	10.50	11.05	12.59	14.22	3.839	4.487	5.138	5.782	41.03	36.94	36.76	36.89
M. 2nd season	12.00	13.30	13.82	14.78	4.717	5.008	5.639	5.690	38.16	39.84	36.76	38.96
A. 2nd season	12.61	14.89	15.19	15.90	5.256	6.067	6.477	6.917	35.99	36.81	35.18	34.48
LSD 0.05 %	**0.690**				**0.215**				**2.02**			

(M) Mallawy, (A) Assiut location, (N1)=50, N2=75, N3=100, N4=125 Kg fed^{-1}, (DH) days to heading, (DM) days to maturity, (PH) plant height, (SPM^{-2}) No. of spikes m^{-2}, (GS^{-1}) No. of kernel spike^{-1}, (TGW) 1000-kernel weight, (GY) grain yield, (BY) biological yield and (HI %) harvest index, respectively.

Table 7. Mean effects for the studied characters under the interaction between the four bread wheat cultivars and the four nitrogen levels.

Treatment	DH				DM				PH (cm)			
	Nitrogen levels (N)											
Cultivar (C)	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**
C1	97	98	99	101	140	140	141	143	86	85	88	91
C2	97	98	101	102	141	142	142	142	89	95	97	102
C3	94	95	97	100	139	140	141	142	83	88	89	93
C4	100	100	103	104	140	142	143	144	91	92	94	98
LSD 0.05 %	**NS**				**1.0**				**2.5**			
Treatment	**SPM-2**				**GS-1**				**TGW(g)**			
Cultivar (C)	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**
C1	266	286	293	310	53	55	60	62	36.85	39.42	40.75	42.31
C2	267	283	295	312	51	54	56	60	37.08	39.63	42.31	43.9
C3	256	268	290	306	47	51	52	54	36.48	37.93	39.78	41.96
C4	264	277	300	316	54	58	59	61	34.46	36.34	38.91	40.29
LSD 0.05 %	**5.9**				**NS**				**NS**			
Treatment	**GY (arddab faddan-1)**				**BY (ton faddan-1)**				**HI %**			
Cultivar (C)	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**
C1	12.82	13.74	14.01	15.11	4.706	5.093	5.529	5.996	40.86	40.47	38.01	37.80
C2	12.03	13.84	14.67	15.68	4.664	5.239	5.808	6.195	38.69	39.63	37.89	37.97
C3	10.92	12.65	13.91	14.84	4.356	4.982	5.281	5.556	37.60	38.09	39.51	40.06
C4	12.70	13.19	14.15	15.03	4.528	4.939	5.523	5.829	42.07	40.06	38.43	38.68
LSD 0.05 %	**0.556**				**NS**				**1.88**			

(C1) Shandaweel 1, (C2) Sids 14, (C3) Misr 1, (C4) Misr 2, N1=50, N2=75, N3=100 and N4=125 Kg fed^{-1}, (DH) days to heading, (DM) days to maturity, (PH) plant height, (SPM^{-2}) No. of spikes m^{-2}, (GS-1GS-1) No. of kernel spike^{-1}, (TGW) 1000-kernel weight, (GY) grain yield, (BY) biological yield, (HI %) harvest index and NS= insignificant, respectively.

I-7: Interaction between environments, nitrogen levels and cultivars (E x N x C) Effects:

Yield and its components are important criteria in evaluating the adaptability of a crop to environmental variation. Mean values of the data indicated that all studied traits were significantly affected by different environments, cultivars and fertilizer levels (Tables 8 and 9). The cultivar Shandaweel 1 performed well in all of the four environments without significance with Misr 2 and Sids 14. It is produced higher No. of spikes m^{-2}, No. of grains spike^{-1}, 1000-grain weight (g), grain yield (arddab faddan^{-1}) and biological yield (ton faddan^{-1}) compared to the other cultivars under high levels of nitrogen fertilizer (125 kg fed^{-1}) at Mallawy and Assiut conditions. While Misr 1 recorded the lower No. of spikes m^{-2}, No. of grains spike^{-1}, 1000-grain weight (g), grain yield (arddab faddan^{-1}) and biological yield (ton faddan^{-1}) under four nitrogen levels (N1, N2, N3 and N4) in Mallawy and Assiut locations. Cultivar Shandaweel 1 gave a higher grain yield than the other cultivars in all four environments.

In general, in the new land, the grain yield of cultivar Shandaweel 1 increased by 3.24, 5.94 and 2.98 % over the grain yields of Sids 14, Misr 1 and Misr 2, respectively under high nitrogen levels at the Mallawy location. Also, increased by 5.97, 22.13 and 16.09 % over the grain yields at the same cultivars, respectively under the Assiut location. Moreover, it is increased by 4.66, 16.81 and 9.82 % over the grain yields of Sids 14, Misr 1 and Misr 2, respectively when combined in all of the four environments (two seasons x two locations) under high nitrogen levels (125 kg fed^{-1}).

Table 8. Mean effects for the interaction between environments (E), the four bread wheat cultivars (C) and the four nitrogen levels (N) for days to heading (DH), days to maturity (DM), plant height (PH) (cm), No. of spikes m^{-2} (SPM^{-2}) and No. of grains spike^{-1} (GS^{-1}).

Treatment		DH				DM				PH (cm)				SPM^{-2}				GS^{-1}			
		Nitrogen levels (N)																			
E. (E).	Cultivar (C)	N1	N2	N3	N4	N1	N2	N3	N4	N1	N2	N3	N4	N1	N2	N3	N4	N1	N2	N3	N4
Mallawy. 1st season	Shandaweel 1	98	99	98	97	143	141	143	144	81	77	80	81	298	315	310	322	41	44	45	44
	Sids 14	99	98	99	101	144	144	144	142	88	88	87	92	290	302	315	322	40	42	45	45
	Misr 1	96	98	98	97	144	142	144	142	76	79	79	82	285	284	288	305	41	44	41	41
	Misr 2	104	101	102	103	144	145	145	144	88	85	88	89	292	300	312	322	43	47	48	46
Assiut. 1st season	Shandaweel 1	102	103	105	107	138	137	140	142	84	88	88	100	209	228	273	303	64	69	74	77
	Sids 14	99	102	104	107	137	138	140	141	82	99	99	104	208	230	248	298	62	67	70	81
	Misr 1	98	99	100	102	136	138	140	142	89	92	98	102	186	219	238	255	55	63	65	71
	Misr 2	100	102	104	105	136	138	140	141	95	92	98	105	210	231	290	315	71	74	74	84
Mallawy 2nd season	Shandaweel 1	96	96	99	98	142	143	143	144	85	85	87	85	302	318	318	320	45	43	47	48
	Sids 14	100	101	101	99	143	142	141	142	99	101	102	102	298	305	312	312	43	44	43	46
	Misr 1	94	92	96	97	141	142	142	143	81	83	86	86	280	285	302	312	38	41	43	42
	Misr 2	104	104	104	102	142	144	143	145	92	92	92	93	285	292	312	315	44	46	45	46
Assiut. 2nd season	Shandaweel 1	91	93	95	101	137	138	140	140	92	91	99	98	280	294	307	340	61	65	73	77
	Sids 14	90	92	100	101	140	142	143	145	88	94	99	109	274	293	306	316	60	63	66	66
	Misr 1	88	90	94	102	137	138	138	140	88	96	95	101	250	272	279	292	54	56	59	63
	Misr 2	91	92	100	104	139	141	144	146	91	98	99	108	269	287	303	322	57	64	68	70
LSD 0.05 %		2.8				2.0				2.6				11.9				4.2			

N1=50 kg N fed^{-1}, N2=75 kg N fed^{-1}, N3=100 kg N fed^{-1}and N4 =125 kg N fed^{-1}.

Table 9. Mean effects for the interaction between environments (E), the four bread wheat cultivars (C) and the four nitrogen levels (N) for 1000-grain weight (TGW) (g), grain yield (GY) (arddab faddan^{-1}), biological yield (BY) (ton faddan^{-1}) and harvest index (HI%).

Treatment		TGW (g)				GY (arddab faddan^{-1})				BY (ton faddan^{-1})				HI %			
		Nitrogen levels (N)															
E. (E).	Cultivar (C)	N1	N2	N3	N4	N1	N2	N3	N4	N1	N2	N3	N4	N1	N2	N3	N4
Mallawy. 1st season	Shandaweel 1	41.06	41.89	41.73	44.56	14.00	14.83	15.63	15.92	4.712	4.912	4.987	5.575	44.57	45.29	47.01	42.83
	Sids 14	36.71	36.92	39.78	41.36	13.57	13.83	15.56	16.00	4.650	4.650	5.056	5.237	43.77	44.61	46.16	45.83
	Misr 1	35.79	39.73	39.83	39.94	11.75	13.40	14.35	15.47	3.862	4.512	4.606	4.912	45.64	44.55	46.73	47.24
	Misr 2	39.84	42.87	44.73	44.79	14.17	14.67	15.08	15.67	4.537	4.687	4.900	5.025	46.85	46.95	46.16	46.78
Assiut. 1st season	Shandaweel 1	31.58	33.67	40.28	43.55	11.18	12.58	15.17	16.58	3.626	4.201	4.630	5.076	46.25	44.92	49.15	49.00
	Sids 14	31.47	32.93	34.66	37.95	11.25	11.78	13.47	16.13	3.968	4.971	5.700	6.614	42.53	35.55	35.45	36.58
	Misr 1	24.90	28.79	33.56	37.71	9.96	9.38	9.96	11.21	4.092	4.871	5.585	6.257	36.51	28.89	26.75	26.87
	Misr 2	33.57	35.02	40.27	44.28	10.21	10.88	11.75	12.96	3.670	3.906	4.637	5.180	41.73	41.78	38.01	37.53
Mallawy 2nd season	Shandaweel 1	43.01	42.63	46.43	47.53	13.25	13.67	13.83	15.58	4.900	5.075	5.750	5.850	40.56	40.40	36.08	39.95
	Sids 14	42.39	45.93	45.50	47.45	11.63	13.58	13.97	14.48	4.725	4.956	5.919	5.911	36.92	41.10	35.40	36.75
	Misr 1	38.25	39.54	40.22	41.80	10.73	12.70	13.25	14.16	4.650	5.000	5.206	5.325	34.61	38.10	38.18	39.89
	Misr 2	40.31	40.01	41.88	41.09	12.38	13.25	14.23	14.89	4.594	5.000	5.681	5.675	40.42	39.75	37.57	39.36
Assiut. 2nd season	Shandaweel 1	37.14	42.40	42.08	43.84	14.65	17.51	16.64	17.73	5.585	6.183	6.747	7.482	39.35	42.48	36.99	35.55
	Sids 14	34.49	36.04	38.72	39.81	11.68	16.17	15.68	16.13	5.312	6.380	6.559	7.018	32.98	38.02	35.86	34.48
	Misr 1	33.03	35.27	36.91	37.18	10.04	11.91	12.88	13.91	4.818	5.543	5.728	5.730	31.26	32.23	33.73	36.41
	Misr 2	35.94	39.63	40.41	41.03	14.07	13.97	15.54	15.83	5.310	6.163	6.872	7.437	39.75	34.00	33.92	31.93
LSD 0.05 %		2.30				1.777				0.417				3.765			

N1=50 kg N fed^{-1}, N2=75 kg N fed^{-1}, N3=100 kg N fed^{-1}and N4 =125 kg N fed^{-1}.

II- Nitrogen Response:

For this nitrogen response study, the Nitrogen fertilizer levels x wheat cultivars interaction of grain yield at Mallawy and Assiut were of particular interest. Cultivar Shandaweel 1 is the most suitable and highly responsible for increasing nitrogen fertilizer levels at Mallawy and Assiut locations. The other cultivar Misr 1 lying on the vertices did not respond to any of the nitrogen levels at the two locations (Fig.1 and 2).

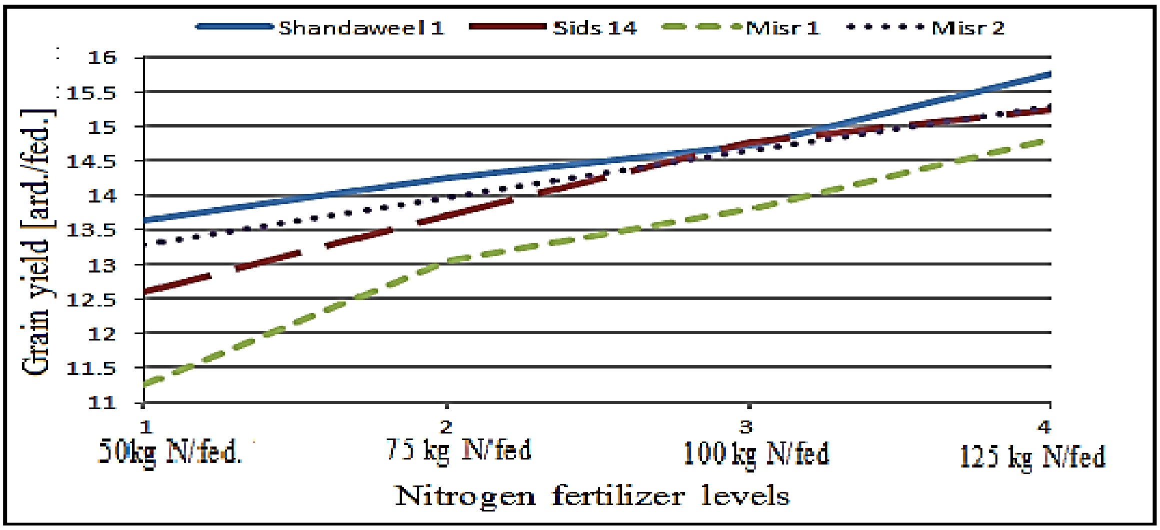

Fig. 1. Response of the four bread wheat cultivars to the four nitrogen fertilizer levels for grain yield (GY) (arddab faddan^{-1}) over two growing seasons (2019/2020 and 2020/2021) at the Mallawy location.

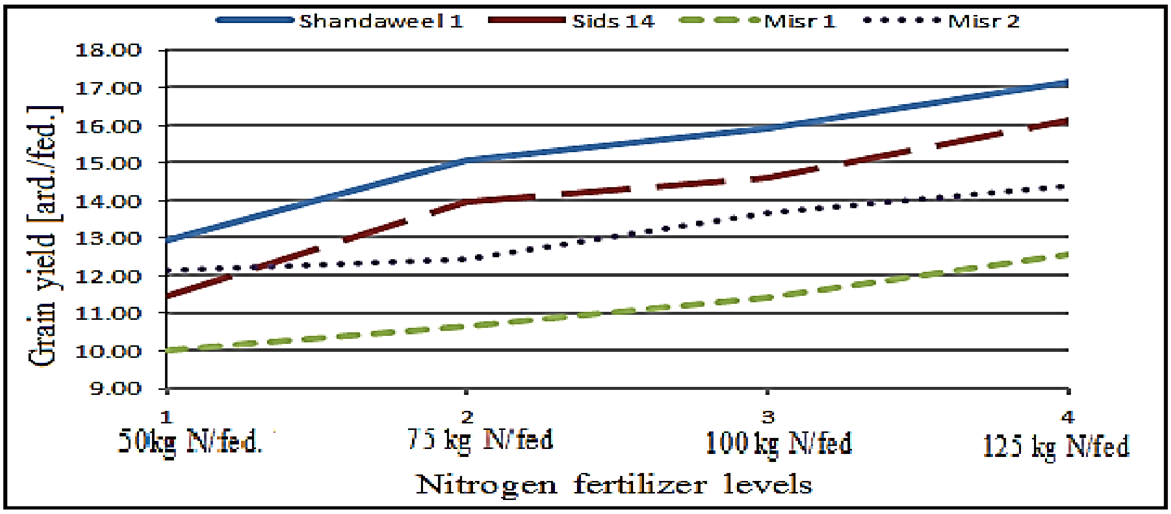

Fig. 2. Response of the four bread wheat cultivars to the four nitrogen fertilizer levels for grain yield (GY) (arddab faddan^{-1}) over two growing seasons (2019/2020 and 2020/2021) at the Assiut location.

III- GGE-Biplot:

Relationships between the four cultivars and the sixteen environments for grain yield:

Genotype-by-environment (G×E) interaction is reflected in inconsistent crop yield across environments. Variations in the environmental conditions and soil properties and the inherent potential of genotypes are among the major factors for variable crop yield (Yan and Hunt 2001, Yan *et al.*, 2002; Al-Naggar *et al.*, 2020). GGE-biplot analyses for comparison of cultivars were performed to detect the ideal and desirable cultivars (Fig. 3). An ideal cultivar should have both high mean yield performance and high suitability across environments (Kaya *et al.*, 2006; Yan and Tinker, 2006). The ideal cultivars should be in the center of concentric circles. In this study, Shandaweel 1 was the ideal cultivar (desirable cultivar) as it was grouped in the centric circle next to the ideal one in the newly reclaimed lands at El-Minia and Assiut governorate.

The ranking biplot for cultivars and nitrogen levels (Figs.4 and 5) showed that nitrogen level (E4, E8, E12 and E16) 125 kg N fed^{-1} in the two growing seasons at two locations was the best level. Thus, Fig. 5 showed the rank of cultivar's performance. From the graph, the highest yielder cultivar was Shandaweel 1 showed more stability. In the contrast, Misr 1 was the lowest. One of the most attractive features of GGE-biplot is its ability to show the "which-won-where" pattern of a cultivar by nitrogen level dataset as it graphically addresses important concepts such as cross-over GE, mega-environment differentiation, specific adaptation, etc. (Yan and Tinker, 2006).

The winning cultivar and Mega-environment to visualize the "which-won-where" pattern of MET data (Fig. 6) is important for studying the possible existence of different mega-environments in a region (Yan *et al.*, 2007). Biplots were divided into four sectors in Fig. 4; genotypes that fall in the same sector as with environment are said to be adapted to those environments**.** The result Fig. 4 indicated one mega environment, the winning genotypes for mega-environment are those positioned at the vertex. G1 (Shandaweel 1) is the winning genotype for the mega-environment which consists of E1 to E16. This cultivar is the most suitable and highly responsible for increasing nitrogen fertilizer levels. The other cultivar Misr 1 lying on the vertices did not respond at any of the nitrogen levels.

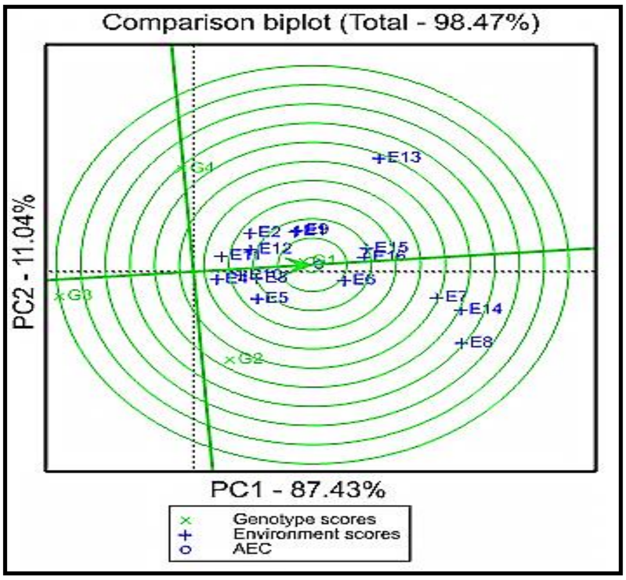

Fig. 3. GGE-biplot focused scaling for comparison of the cultivars. E1 – E16 are the nitrogen levels and G1 – G4 are the cultivars.

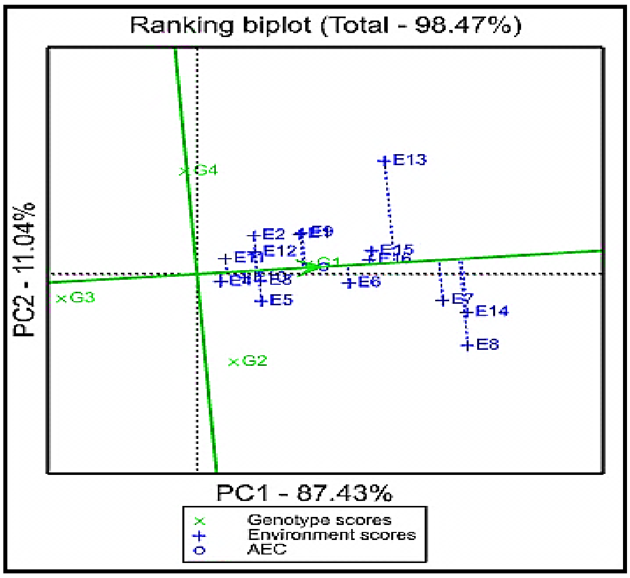

Fig. 4. Ranking biplot for nitrogen levels. E1 – E16 are the nitrogen levels and G1 – G4 are the cultivars.

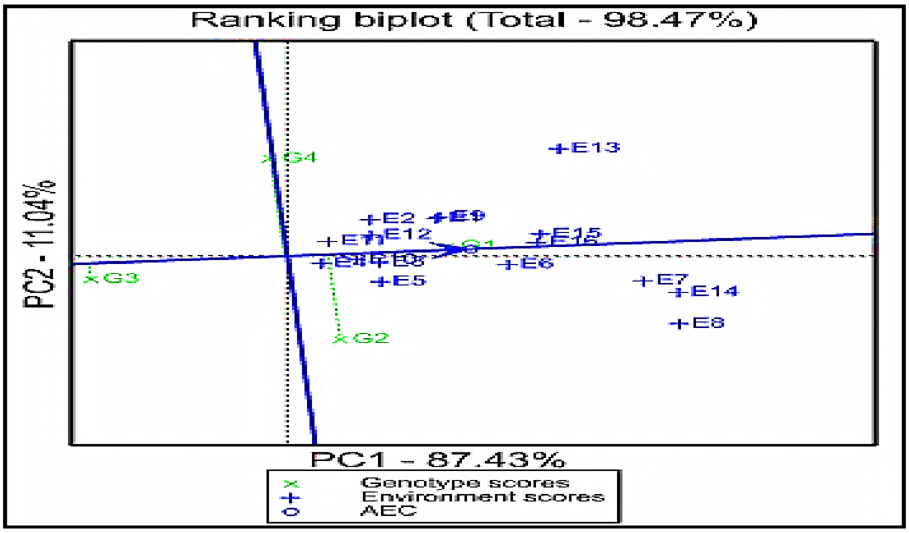

Fig. 5. Identification of winning cultivars across 8 environments. E1 – E16 are the nitrogen levels and G1 – G4 are the cultivars.

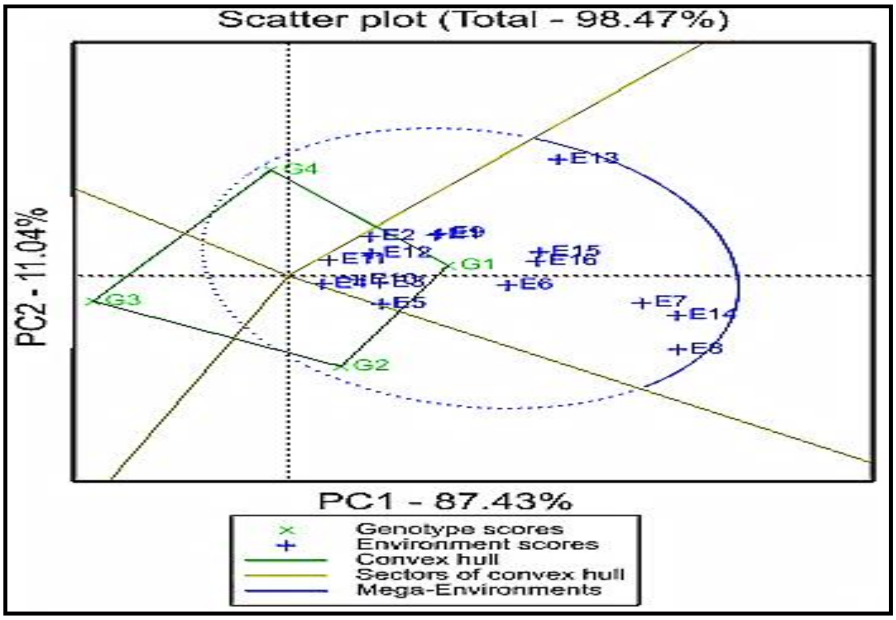

Fig. 6. The which-won-where view of the GGE-biplot to show which cultivars performed better in which nitrogen levels for grain yield. Cultivars ; G1= Shandaweel 1, G2= Sids 14, G3= Misr 1 and G4= Misr 2. Nitrogen levels; (E1 and E9) = 50 kg fed^{-1}, (E2 and E10) =75 kg fed^{-1}, (E3 and E11) =100 kg fed^{-1}, (E4 and E12) =125 kg fed^{-1}, in 2019/2020 and 2020/2021 seasons, respectively at Mallawy location, and (E5, and E13) = 50 kg fed^{-1}, (E6 and E14) =75 kg fed^{-1}, (E7 and E15) =100 kg fed^{-1}, (E8 and E16) =125 kg fed^{-1}, in 2019/2020 and 2020/2021 seasons, respectively at Assiut location.

DISCUSSION

The combined analysis of variance showed significant or highly significant differences among the four environments of the two seasons and the two locations, for all studied characters. These results suggested that the measurement of differences among wheat cultivars was adequate to provide a possibility to characterize the effect of different nitrogen levels. Similar results were reported by Ullah *et al.* (2018) and Tyagi *et al.* (2020).

The data in Table (4) illustrate the main effect of seasons and locations for all studied traits. This may be due to that wheat cultivars responded differently when they are grown at different seasons, different temperatures, and different soil fertility at the two locations in most growth characters (Table 2). Similar results were also reported by Kandil *et al.* (2016) and Hendawy (2017).

The nitrogen levels had a significant or highly significant effect on all studied traits (Table 4). These results indicate that nitrogen has a key role in the growth and development of grain. These results are similar to those reported by Ayadi *et al.* (2015), Belete *et al.* (2018) and Mohamed *et al*. (2022) who concluded that a higher dose of nitrogen significantly increased the process of cell division and also help to uptake other nutrients from the soil through a synergistic effect which increases the shoot length of plant and increased No. of spikes m^{-2} due to the ability of wheat plants to produce more tillers and consequently more spikes and increased No. of grains spike^{-1}. Meanwhile, the plants had suitable and longer environmental conditions for vegetative growth, which resulted in the active photosynthesis and maximum translocation of the assimilates to the grains and thus had heavier grains, which led to a maximum grain yield. These results are in agreement with many researchers (Kutman *et al.*, 2011; Ullah *et al.*, 2018; Tyagi *et al.*, 2020).

The cultivars showed highly significant differences in all studied traits when the data were combined across seasons and locations Table (4). Shandaweel 1 was superior overall genotypes for all the studied characters followed by Sids 14. These results are similar to those reported by Thanaa and El-Hussin (2013) and Rahman *et al.* (2014) who concluded that the cultivars differences in all studied characteristics may be attributed to the genetic factors and the interaction with the prevailing environmental conditions which affected yield attributes. These results are in harmony with those reported by Ullah *et al.* (2018), Maysoun and Alsarhan (2020) and Mohamed *et al*. (2022)..

Shandaweel 1 was superior overall cultivars which recorded the highest values for No. of spikes m^{-2}, No. of kernel spike^{-1}, grain yield, and biological yield under the four environments Table (5). These results indicated that studied cultivars differently responded to the different environmental conditions suggesting the importance of the assessment of cultivars under different environments to identify the best cultivars that make up for a particular environment. Similar results were also reported by Mahjourimajd *et al.* (2016) and Ali (2017).

Increasing nitrogen fertilizer levels up to 125 Kg N fed-1 significantly increased grain yield and its components in both seasons compared with the other nitrogen levels at the two locations Table (6). This may be due to that, the higher N levels promoted vegetative growth as apparent leaf area which results in a high level of photosynthesis, more production of assimilates and gave more No. of spikes m^{-2}, more No. of kernel spike^{-1} and the heaviest 1000-kernel weight, which ultimately led to a maximum grain and biological yield. These results are in agreement with that obtained by Abdel Nour and Fateh (2011), Thanaa and El-Hussin (2013), Ullah *et al.* (2018) and Tyagi *et al.* (2020).

Data presented in Table 7 indicated that Misr 1 had the earliest cultivar without significant differences with Shandaweel 1 and Misr 2 under the N1 (50 Kg N fed^{-1}). The maturity of the crop was delayed when increasing N levels and vice versa. Similar results were also reported by Kutman *et al.* (2011) and Ullah *et al.* (2018).

Sids 14 recorded the tallest plants (102 cm) with the N4 (125 Kg N fed^{-1}). This is because N fertilizer has played a vital role in vegetative growth and resulted in a significant influence on plant height and increases leaf area which resulted in a high level of photosynthesis, more production of assimilates and plant dry matter. These results are similar to the results of Rahman *et al.* (2014) and Sakatu (2017).

Misr 2 recorded the highest No. of spikes m^{-2} followed by Sids 14 and Shandaweel 1 under N4 (125 Kg N fed^{-1}). The highest No. of spikes m^{-2} with a maximum level of N could be attributed to the availability of plant nutrients in abundant amounts resulting in more fertile tillers which ultimately led to a maximum No. of spikes m^{-2}. These results are in harmony with those reported by Noureldin *et al.* (2013) and Ayadi *et al.* (2015).

The highest grain yield was recorded with Sids 14 followed by Shandaweel 1 and Misr 2 under the N4 (125 Kg N fed^{-1}). Among all the essential nutrients applied to plants, nitrogen is the major one that has a key role in the process of photosynthesis and an increased level of photosynthesis by the high dose of nitrogen gives more yield because a large amount of dry matter is more assimilated were produced and transported to fill the seeds as a result of more applied nitrogen. These results are similar to those reported by Kutman *et al.* (2011) and Fageria (2014) and Mohamed *et al*. (2022).

The maximum harvest index (42.07) was calculated by Misr 2 with N1 (50 Kg N fed^{-1}) followed by Shandaweel 1 (40.86) with the same nitrogen level and (40.47) with N2 (75 Kg N fed^{-1}). The harvest index is directly associated with the plant dry matter and grain weight which ultimately depends upon the availability and uptake of nutrients, especially nitrogen. The more will be nitrogen amount the more will be growth and development but up to a certain limit beyond that limit, it can cause toxicity to the plant and reduce its yield (Ali *et al.*, 2016; Maysoun and Alsarhan 2020). Mean values of the data indicated that all studied traits were significantly affected by different environments, cultivars and fertilizer levels Tables (8 and 9). The cultivar Shandaweel 1 performed well in all four environments, it gave a higher grain yield than the other cultivars under four nitrogen levels (N1, N2, N3 and N4).

In general, in the new land, the data confirm the results we got from this study, which support the superiority of Shandaweel 1 over the most dominating wheat cultivars. Shandaweel 1 surpassed the overall mean of the dominating cultivars by an average of 16.70%. Among all the essential nutrients applied to plants nitrogen is the major one that has a key role in the process of photosynthesis and the increased level of photosynthesis by the high dose of nitrogen gave more No. of spikes m^{-2}, No. of grains, $spike^{-1}$, heaviest 1000-grain weight and reflected on an increase in grain yield because a large amount of dry matter, more assimilates were produced and transported to fill the seeds as a result of more applied nitrogen. These results are similar to those reported by Kutman *et al.*, 2011; Fageria, 2014; Ullah *et al.*, 2018 and Tyagi *et al.*, 2020.

The cultivar Shandaweel 1 is the most suitable and highly responsible for increasing nitrogen fertilizer levels at Mallawy and Assiut locations. These results indicate that a higher dose of nitrogen significantly increased the process of cell division and also help to uptake other nutrients from the soil through a synergistic effect which increases the shoot length of the plant and increased No. of spikes m^{-2} due to the ability of wheat plants to produce more tillers and consequently more spikes and increased No. of grains $spike^{-1}$. Meanwhile, the plants had suitable and longer environmental conditions for vegetative growth, which resulted in the active photosynthesis and maximum translocation of the assimilates to the grains and thus had heavier grains, which led to a maximum grain yield. These results are in agreement with many researchers (Kutman *et al.*, 2011, Ullah *et al.*, 2018; Tyagi *et al.*, 2020). The ideal cultivars should be in the center of concentric circles. In this study, Shandaweel 1 was the ideal cultivar (desirable cultivar) as it was grouped in the centric circle next to the ideal one in the newly reclaimed lands at El-Minia and Assiut governorate. This result agreed with the previous reports by Moustafa and Hussein (2020) However, Misr 1 seems to be undesirable.

The winning cultivar and mega-environment to visualise the “which-won-where” pattern of MET data Fig. 6 is important for studying the possible existence of different mega-environments in a region (Yan and Tinker 2006, Yan et al., 2007; Al-Naggar *et al*., 2020). These results conform with the findings of Gebre and Mohammed (2015), who observed high-yielding and stable genotypes. Biplots were divided into four sectors in Fig. 4, and genotypes that fall in the same sector as the environment are said to be adapted to those environments.The result in Fig. 4 indicated one megaenvironment; the winning genotypes for megaenvironments are those positioned at the vertex. Shandaweel 1 (G1) is the winning genotype for the mega-environment, which consists of E1 to E16. This cultivar is the most suitable and highly responsible for increasing nitrogen fertiliser levels. The other cultivar, Misr 1, lying on the vertices, did not respond to any of the nitrogen levels.

CONCLUSION

In general, the grain yield of cultivar Shandaweel 1 in the new land exceeded the overall mean of the dominant cultivars and achieved the highest grain yield under a high nitrogen level of 125 kg fed-1.The data confirm the results we got from this study, which support the superiority of Shandaweel 1 over the most dominant wheat cultivars and can be recommended for planting in the Mallawy and Assiut regions under newly reclaimed sand soils.

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إستجابة بعض أصناف قمح الخبز لمستويات التسميد النتروجينى في الأراضى الرملية حديثة الإستصلاح

أحمد حسين أحمد حسين* و محمود شمروخ محمد و إباء محمد علي خليفة
معهد بحوث المحاصيل الحقليه، قسم بحوث القمح ، مركز البحوث الزراعية،- مصر
* بريد المؤلف المراسل ahmed_heseen2003 @yahoo.com

أجريت تجربة حقلية فى محطتى البحوث الزراعية بملوى وأسيوط (مصر الوسطى والعليا على التوالي) بالأراضى الجديدة تحت نظام الرى بالرش خلال موسمي النمو 2020/2019 و2021/2020م حيث تم تقييم أربعة أصناف من قمح الخبز تحت أربع مستويات من النيتروجين وتحديد أفضل هذة الأصناف إستجابة وثبات عبر ستة عشر بيئة (موسمين x أربعة مستويات تسميد x موقعين) وصممت التجربة بنظام القطع المنشقة مرة واحدة فى أربع مكررات وتم جمع البيانات على المحصول ومكوناتة. وقد أظهرالتحليل المشترك بأن هناك أختلافات معنوية بين الأصناف في معظم الصفات محل الدراسة في كلا الموسمين حيث كان الصنف مصر1 أبكر الأصناف في صفة طرد السنابل والنضج الفسيولوجى. وسجل الصنف شندويل 1 أطول النباتات وأعلى القيم لصفات عدد حبوب السنبلة ووزن اللألف حبة ومحصول الحبوب ومحصول البيولوجى. وأوضحت الدراسة أن مستويات النيتروجين سجلت اختلافات عالية المعنوية لكل الصفات محل الدراسة. وكان مستوى النيتروجين 125كجم/فدان أفضل معدل تسميد متبوع بمستوى النيتروجين 100 كجم/فدان حيث سجل أعلى محصول للحبوب. التفاعل بين الأصناف ومستويات النيتروجين كان معنوى لمعظم الصفات محل الدراسة في الموقعين. حيث سجل الصنف مصر2 يلية شندويل 1 أعلى قيم لعدد سنابل فى المتر المربع وعدد حبوب السنبلة ووزن الألف حبة وأعلى محصول حبوب وأعلى محصول بيولوجى تحت المستوى النيتروجينى 125كجم/فدان فى كلا الموقعين. وأظهرت النتائج أن الصنف شندويل1 سجل أعلى درجات الإستجابة فى جميع البيئات، بينما أظهر الصنف مصر1 أقل درجات الإستجابة لمستويات النيتروجين الأربعة. ومن خلال النتائج أظهر الصنف شندويل1 إستجابة عالية لمستويات النيتروجين الأربعة فى كل الموقعين مما يدل على إمكانية زراعته فى الأراضى الرملية لتعظيم الإنتاجية.

الكلمات المفتاحية: القمح ، التسميد النيتروجينى ، المحصول ومكوناته ، التفاعل، الأراضى الرملية.