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Egypt. J. Agron. **Vol. 46**, No. 1, pp: 61 - 73 (2024)

Egyptian Journal of Agronomy

http://agro.journals.ekb.eg/

Response Productivity and Grain Quality of New Wheat Cultivars to Seeding Rates and Nitrogen Levels under Different Sowing Dates

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Two field experiments were conducted at a private field in Qalin City, Kafr El sheikh Governorate, Egypt, during 2021/2022 and 2022/2023 seasons to study the response productivity and grain quality of some wheat cultivars (Sakha 95 and Misr-3) to seeding rates (30, 50 and 70 kg grains fed^{-1}) and nitrogen levels (50, 75 and 100 kg N fed^{-1}) under different sowing dates (25th Oct., 25th Nov. and 25th Dec.). Each sowing date was performed in separate experiment. Every experiment of sowing dates was carried out in split- split plot design with four replications. The main-plots were assigned to new Egyptian wheat cultivars. While, the sub-plots were randomly allocated to seeding rates. Whilst, the sub-sub plots were randomly distributed to nitrogen fertilizer levels. The obtained results revealed that the studied seasons, sowing dates, wheat cultivars, seeding rates and nitrogen fertilizer levels significantly affected No. of spikes m^{-2}, spike length, No. of spikelets spike^{-1}, No. of grains spike^{-1}, 1000-grain weight, biological and grain yields fed^{-1}, harvest index (HI) and crude protein percentage in most cases. From the achieved results of this study, it could be recommended that sowing wheat Sakha 95 cultivar on 25th November with 50 kg grains fed^{-1}and fertilizing with 100 kg N fed^{-1}to obtain the highest productivity and grains quality under the environmental conditions of Qalin City, Kafrelsheikh Governorate, Egypt.

Keywords: Wheat, sowing dates, cultivars, seeding rates, nitrogen levels, productivity, grain quality.

Introduction

Wheat (*Triticum aestivum* L.) is globally the major source of food for human nutrition after rice and maize and a part of daily dietary need in one form or more. It is the main winter cereal crop and an important staple food crop in Egypt. Wheat is the most widely grown crop in the world with its unique protein characteristics and serves as an important source of food and energy (Abedi *et al.*, 2010). It is easily processed into various types of food like bread, macaroni, biscuit and sweets. During 2021/2022 season in Egypt, wheat crop was grown on an area of 3.404 million feddan (one feddan = 4200 m^2) with an annual production of 9.700 million tons and average yield of 18.997 ardab (one ardab = 150 kg) per feddan (FAO, 2023).

Sowing date plays an important role in determining wheat productivity, where the final grain yield depended on the time of sowing. Jagjot *et al.* (2018) found that maximum plant height, effective tillers m^{-2}, spike length, grains No. per spike, 1000-grain weight and highest grain yield were attained by the crop planted on 10th Nov. Kalwar *et al.* (2018) recommended that farmers should complete their cultivation of wheat crop in first half of November to get more yield and financial benefits.

Chosen the high yielding ability cultivars undoubtedly is very important to raise wheat productivity per unit area (El-Hag, 2019). The wheat cultivars Sakha 95 and Misr-3 are the new cultivars for high quality bread in Egypt, with the little research indicating suitable sowing dates, seeding rates and nitrogen fertilizer levels.

The seeding rate (plant density) is one of the more important requirements in agronomic planting for achieving high yield with optimal quality. Seeding rate, wheat several researchers suggested positive effect of seeding rates on growth, yield components, yields and grain quality (Yang *et al.*, 2019). Ahmad *et al.* (2018) concluded that seed rate of 115 kg ha^{-1} produced maximum grain yield of wheat.

Nitrogen is often the most deficient of all the plant nutrients. Wheat is susceptible to insufficient nitrogen and very responsive to nitrogen fertilization. It is crucial for plant growth and final

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Received 21/1 /2024 ; Accepted 26/5 /2024
DOI: 10.21608/agro.2024.264453.1410

grain yield of wheat, and it should be applied at the optimum rate to meet the crop need. Several authors studied the response of wheat to nitrogen fertilizer. Gharib *et al.* (2016) and Kousar *et al.* (2015) found that increasing nitrogen levels from 0 up to 150 significantly increased the fertile tillers, plant height, spike length, No. of grains per spike, 1000 grain weight, grain yield per plot, and grain yield kg ha^{-1}. Khaled and El-rawy (2012) recommended that increasing nitrogen levels from 0 up to 105 kg N fed^{-1} led to rising of dry matter, LAI, plant height, No. of grains $spike^{-1}$, No. of spikes No. of spikes m^{-2}, 1000-grain weight, grain yield, straw yield, and grain protein %.

Thus, the present study was conducted to determine the response productivity and grain quality of some wheat cultivars to seeding rates and nitrogen levels under different sowing dates under the environmental conditions of Qalin City, Kafrelsheikh Governorate, Egypt.

Materials and Methods:

Two field experiments were conducted at a private field in Qalin City, KafrElsheikh Governorate, Egypt, (the site was located at 25.21° N, 28.51°E and 125 m level above sea level) during 2021/2022 and 2022/2023 winter seasons.

Each sowing date was performed as a separate experiment *i.e.* three experiments (25^{th} Oct., 25^{th} Nov. and 25^{th} Dec.). Every experiment of sowing dates was carried out in split- split plot design with four replications. The main-plots were assigned to two new Egyptian wheat cultivars (Sakha 95 and Misr-3). While, the sub-plots were randomly allocated to three seeding rates (30, 50 and 70 kg grains fed^{-1}). The sub-sub plots were randomly distributed to nitrogen fertilizer levels (50, 75 and 100 kg N fed^{-1}). Nitrogen fertilizer in the form of urea (46.5 % N) was applied in two equal doses. The first dose was added before the first irrigation and the other was added before the second irrigation.

Each experimental unit was 2 × 2.1 m occupying an area of 4.2 m^2 and each plot included ten rows with 50 cm between plots. The preceding summer crop was rice (*Oryza sativa* L.) in both seasons.

Random soil samples were taken from the experimental field at a depth of 0 - 30 cm from soil surface before soil preparation to measure the physical and chemical soil properties as described by Page (1982) as shown in Table 1.

TABLE 1: Physical and chemical soil properties of the experimental soil at the experimental site during both seasons.

Soil analyses		2021/2022	2022/2023
A: Mechanical analysis:			
Sand (%)		12.14	11.80
Silt (%)		35.54	36.05
Clay (%)		52.32	52.15
Texture class		Clay loam	Clay loam
B: Chemical analysis:			
E.C. dS m^{-1} (1 : 5)		1.30	1.35
pH (1 : 2.5)		7.80	7.95
Organic matter (%)		1.50	1.55
Available (mg kg^{-1})	N	18.00	20.00
	P	13.80	14.50
	K	260.00	265.00

The experimental field was well prepared through two ploughings, compaction, division and then divided into the experimental units with dimensions as previously mentioned. Phosphorus fertilizer in the form of calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 200 kg fed^{-1}.

The cultivation of wheat was took place on the aforesaid studied sowing dates of the seeding rates by using broadcasting (a fir method). The first irrigation was applied at 25 days after sowing and then plants were irrigated every 21 days until the dough stage.

The potassium fertilizer in the form of potassium sulphate (48 % K_2O) was broadcasted at the rate of 50 kg fed^{-1} in the first irrigation. Common agricultural practices for growing wheat according to the recommendations of Ministry of Agriculture, except the factors under study.

At harvesting, one square meter was randomly selected from each plot to estimate the following yield components; No. of spikes m-^{2}, spike length (cm), No. of spikelets $spike^{-1}$, No. of grains $spike^{-1}$ and 1000 – grains weight (g).

Biological yield (ton fed^{-1}) was calculated by harvesting whole plants in each plot and air dried and weighted (kg $plot^{-1}$), which was converted to ton per feddan. Grain yield (ardab fed^{-1}) was calculated by harvesting whole plants in each plot and air dried, then threshed and the grains at 13 % moisture were weighted in kg and converted to ardab per feddan (one ardab = 150 kg). Harvest index (HI) was calculated by using the following equation:

$$\text{Harvest index (HI)} = \frac{\text{Grain yield (ardab fed} - 1\text{)}}{\text{Biological yield (ton fed} - 1\text{)}}$$

Total nitrogen in wheat grains was estimated by the improved Kjeldahl – method according to A.O.A.C. (2007). Crude protein percentage as grain quality was calculated by multiplying the total nitrogen values in wheat flour by 5.75.

All obtained data were statistically analyzed by analysis of variance (ANOVA) for the split-split plot design to each experiment (sowing dates), then combined analysis was done among sowing dates experiment as published by Gomez and Gomez (1984) by using "MSTAT-C " computer software package. Bartlett's test was done to test the homogeneity of variances error. Means of the treatments were compared using Duncan's multiple range tests at 5 % level of probability as described by Duncan (1955).

Results and Discussion:

Effects of cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons:

1. No. of spikes m^{-2}:

The results in Table 2 indicate that No. of spikes m^{-2} significantly differed due to various studied cultivars (Sakha 95 "C_1" and Misr-3 "C_2") under three studied sowing dates in both seasons. Where, C_2 cultivar surpassed other studied cultivar and resulted in the highest No. of spikes m^{-2} under three studied sowing dates in both seasons. While, C_1 cultivar recorded the lowest No. of spikes m^{-2} under three studied sowing dates in both seasons. The former results might be related to genetic factors make up by the used cultivars. These results are in conformity with those reported by Baqir and Al-Naqeeb (2018), Gomaa *et al.* (2018) and Hassanein *et al.* (2018)

Increasing seeding rates from 30 to 50 and 70 kg grains fed^{-1} associated with significant increase in No. of spikes m^{-2} under three studied sowing dates in both growing seasons (Table 2). The highest No. of spikes m^{-2} produced from sowing with the highest seeding rate (70 kg grains fed^{-1}) under three studied sowing dates in both seasons. However, the lowest No. of spikes m^{-2} were obtained from sowing with the lowest seeding rate (30 kg grains fed^{-1}) under three studied sowing dates in both seasons. The increase in No. of spikes m^{-2} due to increasing seeding rate might be ascribed to increase No. of plants, total tillers, non-effective tillers as well as No. of effective tillers that formed spikes per square meters. Comparable results were stated by Ahmad *et al.* (2018), Yang *et al.* (2019), Iqbal *et al.* (2020) and Matsuyama and Ookawa (2020).

TABLE 2: Mean squares and mean performance of No. of spikes m^{-2} as affected by cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons.

Studied factors	No. of spikes m^{-2}					
	2021/2022 season			2022/2023 season		
	25^{th} Oct. (SD_1)	25^{th} Nov. (SD_2)	25^{th} Dec. (SD_3)	25^{th} Oct. (SD_1)	25^{th} Nov. (SD_2)	25^{th} Dec. (SD_3)
Cultivars (C):						
Sakha 95 (C_1)	697.78b	760.39b	745.00b	676.67b	710.78b	722.36b
Misr-3 (C_2)	704.89a	762.42a	767.39a	680.92a	751.64a	724.50a
Seeding rates (SR):						
Mean square	6504*	6504*	5338.72*	5160.54**	5160.54**	1867.35*
30 kg fed^{-1} (SR_1)	682.33b	732.83b	739.25b	662.29b	699.17b	715.63b
50 kg fed^{-1} (SR_2)	710.33a	774.71a	762.00a	683.75a	747.17a	721.67ab
70 kg fed^{-1} (SR_3)	711.33a	776.67a	767.33a	690.33a	747.29a	733.00a
Nitrogen fertilizer levels (N): :						
Mean square	424.5*	564.76*	2696.06*	485.54*	858.38*	242.26*
50 kg N fed^{-1} (N_1)	698.08b	756.13b	744.17b	673.67b	727.21b	720.54b
75 kg N fed^{-1} (N_2)	699.83b	762.42ab	760.25ab	680.63a	728.33ab	722.92b
100 kg N fed^{-1} (N_3)	706.08a	765.67a	764.17a	682.08a	738.08a	726.83a
Interactions MS:						
C × SR	2328.22*	7214.18*	13068.06**	1771.79*	7343.35**	1230.68*
C × N	206.72	6442.1*	8.39	361.79	2543.43	348.93
SR × N	53.75	2730.56	309.81	115.65	2128.25	419.14
C × SR × N	442.47	3368.64	71.97	178.15	1023.06	111.64
CV	4.07	5.09	4.33	3.39	4.44	3.51

Data in Table 2 show that studied nitrogen fertilizer levels (50, 75 and 100 kg N fed^{-1}) had a significant effect on No. of spikes m^{-2} under three studied sowing dates in both seasons. It was observed that application of 100 kg N fed^{-1} resulted in the highest No. of spikes m^{-2} under three studied sowing dates in both seasons. In contrast, the lowest No. of spikes m^{-2} resulted from application of 50 kg N fed^{-1} under three studied sowing dates in both seasons. Such increases in the No. of spikes per square meter as a result of increasing nitrogen fertilizer levels may be due to the roles of nitrogen in encouragement meristem division which increases plant ability to produce more tillers which give more spikes. Parallel results were obtained by Yang *et al.* (2019) and Seadh *et al.* (2020).

With respect to the interactions, the interaction between C × SR under three studied sowing dates in both seasons and the interaction between C × N in 25th November sowing date in the first season had a significant effect on No. of spikes m^{-2}, vice versa with regard to other interactions (Table 2).

2. Spike length (cm):

As shown from data in Table 3, there were significant differences among studied cultivars (Sakha 95 "C_1" and Misr-3 "C_2") in spike length in the first sowing date (25th October "SD_1") in both seasons, while these differences were insignificant in both sowing dates on 25th November (SD_2) and 25th December (SD_3) in both seasons. The highest values of spike length were obtained from C_1 cultivar, which were 12.14 and 11.83 cm in the first and the second seasons, respectively. The variation among wheat cultivars in spike length may be due to the genetical variation of them. Comparable results were obtained by Hassan *et al.* (2017).

Seeding rates of 30, 50 and 70 kg grains fed^{-1} insignificantly affected spike length under three studied sowing dates in both seasons, except third sowing date (25th December) in both seasons as shown from data in Table 3. Sowing wheat plants with the lowest seeding rate (30 kg grains fed^{-1}) resulted in the highest values of spike length under three studied sowing dates in both seasons. Such increase in spike length as a result of decreasing seeding rate might be due to better interception and utilization of solar radiations and the increase in photosynthetic processes in case of lowest seeding rate, which led to an increase in all yield and its components. These results are coincidence with those obtained by Ahmad *et al.* (2018).

Data listed in Table 3 show that nitrogen fertilizer levels markedly affected spike length under three studied sowing dates in both seasons. Application of 100 kg N fed^{-1} produced the highest values of spike length under three studied sowing dates in both seasons. In contrast, the lowest values of spike length under three studied sowing dates were resulted from application of 50 kg N fed^{-1} in both seasons. This increase in spike length as a result of increasing nitrogen fertilizer levels may be recognized to the role of nitrogen in protoplasm and chlorophyll formation, enhancement meristematic activity and cell division, consequently increases cell size which caused increase in internodes length, accordingly increases in spike length. Analogous results were reported by Seadh *et al.* (2020).

TABLE 3: Mean squares and mean performance of spike length as affected by cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons.

Studied factors	Spike length (cm)					
	2021/2022 season			2022/2023 season		
	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)
Cultivars (C):						
Sakha 95 (C_1)	12.14a	13.26a	12.14a	11.83a	13.10a	11.89a
Misr-3 (C_2)	11.56b	13.17a	11.99a	11.41b	13.06a	11.80a
Seeding rates (SR):						
Mean square	0.07	0.07	1.11**	0.20	0.20	0.25*
30 kg fed^{-1} (SR_1)	11.91a	13.60a	12.31a	11.68a	13.28a	11.96a
50 kg fed^{-1} (SR_2)	11.83a	13.05b	11.97b	11.67a	13.00b	11.79b
70 kg fed^{-1} (SR_3)	11.81a	13.00b	11.91b	11.52a	12.97b	11.79b
Nitrogen fertilizer levels (N):						
Mean square	1.31*	2.49**	1.25**	1.05*	1.31**	0.36**
50 kg N fed^{-1} (N_1)	11.62b	12.88c	11.82b	11.39b	12.89b	11.72b
75 kg N fed^{-1} (N_2)	11.85ab	13.25b	12.09a	11.69ab	13.02b	11.86a
100 kg N fed^{-1} (N_3)	12.08a	13.52a	12.28a	11.79a	13.34a	11.96a
Interactions MS:						
C × SR	0.25	0.35	0.15	0.05	0.35*	0.13
C × N	0.12	0.21	0.12	0.2	0.38*	0.04
SR × N	0.13	0.10	0.06	0.17	0.25	0.04
C × SR × N	0.02	0.06	0.02	0.36	0.09	0.02
CV	5.06	3.27	2.96	6.09	2.48	1.95

With concern to the interactions, the interactions among studied factors were insignificant under three studied sowing dates in both seasons, with exception the interaction between C × SR and the interaction between C × N in 25th November sowing date in the second season only (Table 3).

3. No. of spikelets spike^{-1}:

Wheat cultivars under study (Sakha 95 "C_1" and Misr-3 "C_2") were significantly differed in No. of spikelets spike^{-1} under three studied sowing dates in both seasons as shown in Table 4. C_1 cultivar surpassed other studied cultivar and resulted in the highest No. of spikelets spike^{-1} in the first sowing date in both seasons. While, C_2 cultivar recorded the highest No. of spikelets spike^{-1} in the second and third sowing dates in both seasons. These results might be related to genetic factors and genetic makeup of the wheat studied cultivars.

Corresponding results listed in Table 4 which revealed that there was insignificant effect on No. of spikelets spike^{-1} due to studied seeding rates (30, 50 and 70 kg grains fed^{-1}) under three studied sowing dates in both seasons, except third sowing date (25th December) in the first season. The highest No. of spikelets spike^{-1} were recorded due to sow with the lowest seeding rate (30 kg grains fed^{-1}) under three studied sowing dates in both seasons. On opposition to, the lowest No. of spikelets spike^{-1} were produced from sowing with the highest seeding rate (70 kg grains fed^{-1}) under three studied sowing dates in both seasons. This increase in No. of spikelets spike^{-1} due to decreasing seeding rate might have been due to the same reasons that mentioned and discussed in spike length. These results are in line with those reported by Matsuyama and Ookawa (2020).

TABLE 4: Mean squares and mean performance of No. of spikelets spike^{-1} as affected by cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons.

Studied factors	No. of spikelets spike^{-1}					
	2021/2022 season			2022/2023 season		
	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)
Cultivars (C):						
Sakha 95 (C_1)	21.16a	21.15b	20.26b	20.54a	21.56b	19.85b
Misr-3 (C_2)	19.14b	22.11a	21.25a	18.84b	22.04a	20.61a
Seeding rates (SR):						
Mean square	2.16	2.16	3.1**	0.45	0.45	1.46
30 kg fed^{-1} (SR_1)	20.38a	21.95a	21.13a	19.82a	22.3a	20.45a
50 kg fed^{-1} (SR_2)	20.26a	21.63ab	20.73b	19.72a	21.79ab	20.27ab
70 kg fed^{-1} (SR_3)	19.81b	21.31b	20.41b	19.55a	21.30b	19.96b
Nitrogen fertilizer levels (N)::						
Mean square	5.03**	6.08**	2.84**	5.36**	3.92*	1.3
50 kg N fed^{-1} (N_1)	19.74b	21.08b	20.39b	19.31b	21.40b	20.05a
75 kg N fed^{-1} (N_2)	20.07b	21.75a	20.80a	19.55b	21.79ab	20.14a
100 kg N fed^{-1} (N_3)	20.65a	22.06a	21.08a	20.22a	22.2a	20.49a
Interactions MS:						
C × SR	0.53	1.38	0.56	1.28	1.12	0.27
C × N	0.43	0.24	0.09	0.35	0.07	0.25
SR × N	0.54	0.13	0.11	0.43	0.51	0.41
C × SR × N	0.44	0.73	0.44	0.54	1.66	0.35
CV	2.95	3.25	3.15	3.58	4.35	3.56

Concerning the effect of nitrogen fertilizer levels on No. of spikelets spike^{-1}, the results indicated that No. of spikelets spike^{-1} was significantly affected by nitrogen fertilizer levels (50, 75 and 100 kg N fed^{-1}) under three studied sowing dates in both seasons, except in the third sowing date (25th December "SD_1") in the second season (Table 4). Application of 100 kg N fed^{-1} resulted in the highest No. of spikelets spike^{-1}, while application of 50 kg N fed^{-1} resulted in the lowest No. of spikelets spike^{-1} under three studied sowing dates in both seasons. Such increase in No. of spikelets spike^{-1} as a result of increasing nitrogen fertilizer levels may be imputed to its effective role in enhancement spike length and nutritive status of wheat plant. Alike results were reported by Seadh *et al.* (2020).

No. of spikelets spike^{-1} was insignificantly affected by various interactions among studied factors *i.e.* cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates in both seasons (Table 4).

4. No. of grains spike^{-1}:

The results in Table 5 indicate that No. of grains spike^{-1} significantly differed due to various studied cultivars (Sakha 95 "C_1" and Misr-3 "C_2") under three studied sowing dates in both seasons. Where,

C_1 cultivar surpassed other studied cultivar and resulted in the highest No. of grains spike^{-1} in the first and second sowing dates in both seasons. While, C_2 cultivar recorded the highest No. of grains spike^{-1} in the third sowing date in both seasons. These results might be related to genetic factors and genetic makeup of the wheat studied cultivars. These results are in conformity with those reported by El-Sayed *et al.* (2018) and Gomaa *et al.* (2018).

Increasing seeding rates from 30 to 50 and 70 kg grains fed^{-1} associated with significant decrease in No. of grains spike^{-1} under three studied sowing dates in the first growing season, while these increases did not significant under three studied sowing dates in the second growing season (Table 5). The highest No. of grains spike^{-1} produced from sowing with the lowest seeding rate (30 kg grains fed^{-1}) under three studied sowing dates in both seasons. However, the lowest No. of grains spike^{-1} were obtained from sowing with the highest seeding rate (70 kg grains fed^{-1}) under three studied sowing dates in both seasons. The increase in No. of grains spike^{-1} due to decreasing seeding rate might be ascribed to the same reasons that mentioned and discussed in spike length. Comparable results were stated by Iqbal *et al.* (2020) and Matsuyama and Ookawa (2020).

Data in Table 5 show that studied nitrogen fertilizer levels (50, 75 and 100 kg N fed^{-1}) had a significant effect on No. of grains spike^{-1} under three studied sowing dates in both seasons. It was observed that application of 100 kg N fed^{-1} resulted in the highest No. of grains spike^{-1} under three studied sowing dates in both seasons. In contrast, the lowest No. of grains spike^{-1} were resulted from application of 50 kg N fed^{-1} under three studied sowing dates in both seasons. Such increase in No. of grains spike^{-1} as a result of increasing nitrogen fertilizer levels may be imputed to its effective role in enhancement spike length, No. of spikelets spike^{-1} and nutritive status of wheat plant in addition increasing flowers fertility. Parallel results were obtained by Yang *et al.* (2019) and Seadh *et al.* (2020).

TABLE 5: Mean squares and mean performance of No. of grains spike^{-1} as affected by cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons.

Studied factors	No. of grains spike^{-1}					
	2021/2022 season			2022/2023 season		
	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)
Cultivars (C):						
Sakha 95 (C_1)	67.25a	68.22a	61.58b	66.49a	67.24a	60.32b
Misr-3 (C_2)	64.92b	66.43b	63.92a	64.14b	66.09b	62.14a
Seeding rates (SR):						
Mean square	13.28*	13.28*	33.53**	5.16	5.16	1.7
30 kg fed^{-1} (SR_1)	66.83a	67.85a	63.85a	65.72a	67.6a	61.45a
50 kg fed^{-1} (SR_2)	66.09b	67.50a	62.90b	65.43a	66.27b	61.30a
70 kg fed^{-1} (SR_3)	65.34c	66.63b	61.50c	64.81a	66.14b	60.93a
Nitrogen fertilizer levels (N): :						
Mean square	68.23**	43.97**	24.9**	82.92**	18.11**	6.37*
50 kg N fed^{-1} (N_1)	64.58c	66.06c	61.60b	63.97b	66.03b	60.75b
75 kg N fed^{-1} (N_2)	65.78b	67.16b	63.10a	64.54b	66.32b	61.17ab
100 kg N fed^{-1} (N_3)	67.90a	68.75a	63.54a	67.44a	67.66a	61.77a
Interactions MS:						
C × SR	2.34	11.21**	0.40	10.16*	0.31	1.00
C × N	4.12	12.79**	1.80	9.69*	3.34	4.63
SR × N	2.50	0.81	5.52*	3.32	1.16	0.54
C × SR × N	10.69**	0.95	10.16**	20.29**	0.51	1.92
CV	1.81	2.14	2.17	2.34	2.29	2.09

With respect to the interactions, the interaction between C × SR and C × N in 25th November sowing date in the first season and in 25th October sowing date in the second season, the interaction between SR × N in 25th December sowing date in the first season and the interaction between C × SR × N in 25th December sowing date in both seasons and in 25th December sowing date in the first season had a significant effect on No. of grains spike^{-1}, vice versa with regard to other interactions (Table 5).

5. 1000 – grain weight (g):

As shown from data in Table 6, there were significant differences among studied cultivars (Sakha 95 "C_1" and Misr-3 "C_2") in 1000-grain weight in the first and second sowing dates (SD_1" and SD_2) in the first season. The highest values of 1000-grain weight were obtained from C_1 cultivar, which were 33.53 and 34.24 g in the first and the second seasons, respectively. The variation among wheat cultivars in 1000-grain weight may be due to the genetical variation among them. Comparable results were obtained by El-Sayed *et al.* (2018), Gomaa *et al.* (2018) and Hassanein *et al.* (2018).

Seeding rates of 30, 50 and 70 kg grains fed^{-1} insignificantly affected 1000-grain weight under three studied sowing dates in both seasons, except second and third sowing dates (25th November and 25th December) in the first season as shown from data in Table 6. Sowing wheat plants with the lowest seeding rate (30 kg grains fed^{-1}) resulted in the highest values of 1000-grain weight under three studied sowing dates in both seasons. These results may be due to the high competition between the adjacent plants at higher seeding rate for light, water and nutrients which led to decrease photosynthetic activities and produce less dry matter accumulated in different plant organs. These results are in well agreement with those obtained by Iqbal *et al.* (2020).

TABLE 6: Mean squares and mean performance of 1000 – grain weight as affected by cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons.

Studied factors	1000 – grain weight (g)					
	2021/2022 season			2022/2023 season		
	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)
Cultivars (C):						
Sakha 95 (C_1)	53.53a	54.24a	51.61a	52.48a	53.63a	50.72a
Misr-3 (C_2)	53.18b	53.44b	51.28a	51.92a	53.63a	50.56a
Seeding rates (SR):						
Mean square	2.31	2.31*	6.51**	0.69	0.69	0.06
30 kg fed^{-1} (SR_1)	53.67a	54.29a	51.96a	52.40a	53.87a	50.67a
50 kg fed^{-1} (SR_2)	53.35a	54.12a	51.46ab	52.11a	53.53a	50.67a
70 kg fed^{-1} (SR_3)	53.05a	53.11b	50.92b	52.09a	53.50a	50.58a
***Nitrogen fertilizer levels (N):*:**						
Mean square	5.12*	4.58	2.39	0.53	2.69*	0.68
50 kg N fed^{-1} (N_1)	52.86b	53.35a	51.08a	52.05a	53.33b	50.46a
75 kg N fed^{-1} (N_2)	53.44ab	54.01a	51.58a	52.21a	53.58ab	50.67a
100 kg N fed^{-1} (N_3)	53.77a	54.17a	51.67a	52.34a	53.99a	50.79a
Interactions MS:						
C × SR	2.61	0.69	4.54*	0.66	2.05	1.17
C × N	0.24	0.89	3.17	1.44	0.65	0.38
SR × N	0.35	0.26	0.31	0.09	0.62	0.97
C × SR × N	0.52	2.69	1.46	1.43	2.39	0.29
CV	4.09	3.97	3.23	4.30	3.11	3.09

Data listed in Table 6 show that nitrogen fertilizer levels markedly affected 1000-grain weight in the first sowing date (25th October "SD_1") in the first season and in the second sowing date (25th November "SD_2") in the second season. Application of 100 kg N fed^{-1} produced the highest values of 1000-grain weight under three studied sowing dates in both seasons. In contrast, the lowest values of 1000-grain weight under three studied sowing dates were resulted from application of 50 kg N fed^{-1} in both seasons. These increases in 1000 – grain weight due to increasing nitrogen fertilizer levels may be ascribed to its role in activating cells division, size, elongation, also metabolic and photosynthesis processes, and consequently increased grains weight. These results are in line with those reported by Seadh *et al.* (2020).

With concern to the interactions, the interactions among studied factors were insignificant under three studied sowing dates in both seasons, with exception the interaction between C × SR in 25th December in the first season only (Table 6).

6. Biological yield (t fed^{-1}): Wheat cultivars under in this (Sakha 95 "C_1" and Misr-3 "C_2") were significantly differed in biological yield fed^{-1} in the first sowing date in both seasons, but these differences in the second and third sowing dates in both seasons were insignificant as shown in (Table 7). C_1 cultivar surpassed other studied cultivars and resulted in the highest values of biological yield fed^{-1} in the first sowing date in both seasons. While, C_2 cultivar recorded the highest values of biological yield fed^{-1} in the second and third sowing dates in both seasons. These results might be related to genetic factors and genetic makeup of the wheat studied cultivars. These results are in agreement with those reported by Hassanein *et al.* (2018).

Corresponding results listed in Table 7 which revealed that there was insignificant effect on biological yield fed^{-1} due to studied seeding rates (30, 50 and 70 kg grains fed^{-1}) under three studied sowing dates in both seasons, except the first sowing date (25th October) and the third sowing date (25th December) in the first season. The highest values of biological yield fed^{-1} were recorded due to sow with the highest seeding rate (70 kg grains fed^{-1}) under three studied sowing dates in both seasons. On opposition to, the lowest values were produced from sowing with the lowest seeding rate (30 kg grains fed^{-1}) under three studied sowing dates in both seasons. This increase in biological yield fed^{-1} due to decreasing seeding rate might have been due to the increase in No. of plants at harvest and high soil fertility.

Concerning the effect of nitrogen fertilizer levels on biological yield fed^{-1} of wheat, the results indicated that biological yield fed^{-1} was significantly affected by nitrogen fertilizer levels (50, 75 and 100 kg N fed^{-1}) under three studied sowing dates in both seasons, except the second sowing date (25th November "SD_2") in both seasons (Table 7). Application of 100 kg N fed^{-1} resulted in the highest values of biological yield fed^{-1}, while application of 50 kg N fed^{-1} resulted in the lowest values of biological yield fed^{-1} of wheat under three studied sowing dates in both seasons. The increase in biological yield fed^{-1} as a result of increasing nitrogen fertilizer levels might be related to the role of nitrogen fertilizer in improving vegetative growth, plant height and stem diameter accordingly increasing biological yield per unit area.

TABLE 7: Mean squares and mean performance of biological yield fed^{-1} as affected by cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons.

Studied factors	Biological yield (t fed^{-1})					
	2021/2022 season			2022/2023 season		
	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)
Cultivars (C):						
Sakha 95 (C_1)	12.81a	14.29a	13.33a	12.70a	14.20a	13.24a
Misr-3 (C_2)	12.37b	14.49a	13.41a	11.94b	14.47a	13.27a
Seeding rates (SR):						
Mean square	1.53*	1.53	1.34*	0.78	0.78	1.66
30 kg fed^{-1} (SR_1)	12.37b	14.24a	13.11b	12.16a	14.11a	13.05a
50 kg fed^{-1} (SR_2)	12.53ab	14.28a	13.41ab	12.29a	14.26a	13.15a
70 kg fed^{-1} (SR_3)	12.86a	14.65a	13.58a	12.52a	14.62a	13.55a
Nitrogen fertilizer levels (N):						
Mean square	6.11**	0.64	2.48*	10.52**	0.65	2.63*
50 kg N fed^{-1} (N_1)	12.14b	14.21a	13.14b	11.70b	14.14a	12.99b
75 kg N fed^{-1} (N_2)	12.50b	14.52a	13.23b	12.24b	14.41a	13.14b
100 kg N fed^{-1} (N_3)	13.13a	14.44a	13.74a	13.02a	14.45a	13.62a
Interactions MS:						
C × SR	4.44**	0.27	0.02	5.19**	0.2	0.11
C × N	0.08	1.46	0.43	0.57	1.4	0.6
SR × N	1.67*	0.02	0.6	1.49	0.16	0.64
C × SR × N	0.9	0.88	0.26	1.18	1.27	0.34
CV	6.26	6.79	5.62	7.60	7.22	6.28

The authors thank the members of the plant virus Biological yield fed^{-1} was insignificantly affected by various interactions among studied factors *i.e.* cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates in both seasons, except the interaction between C × SR in the first sowing date (25th October) in the two growing seasons and the interaction between C × N in the first sowing date in the first season (Table 7).

7. Grain yield (ardab fed^{-1}):

The results in Table 8 indicate that grain yield fed^{-1} of wheat significantly differed due to various studied cultivars (Sakha 95 "C_1" and Misr-3 "C_2") in the first sowing date in both seasons, but these differences in the second and third sowing dates in both seasons were insignificant. Where, C_1 cultivar surpassed other studied cultivar and resulted in the highest values of grain yield fed^{-1} under three studied sowing dates in both seasons. While, C_2 cultivar recorded the lowest values of grain yield fed^{-1} under three studied sowing dates in both seasons. These findings might be attributed to the differences in their genetical constitution and genetic factors makeup. These results are in conformity with those reported by Baqir and Al-Naqeeb (2018), Sayed *et al.* (2018), Gomaa *et al.* (2018), Hassanein *et al.* (2018) and Khan *et al.* (2019).

Increasing seeding rates from 30 to 50 and 70 kg grains fed^{-1} associated with significant increase in grain yield fed^{-1} under three studied sowing dates (Table 8). The highest values of grain yield fed^{-1} produced from sowing with the highest seeding rate (70 kg grains fed^{-1}) under three studied sowing dates in both seasons. However, the lowest values of grain yield fed^{-1} were obtained from sowing with the lowest seeding rate (30 kg grains fed^{-1}) under three studied sowing dates in both seasons. The increase in grain per individual wheat plant due to the decrease in seeding rate may be due to the low competition among the adjacent plants, which led to increase the amount of solar radiations intercepted by plants, as well as higher aeration and light distribution among plants, which led to increase the photosynthetic activities and dry matter accumulation per plant. But at the same time, wheat grain yield fed^{-1} increased when sowing wheat with the highest seeding rate may be due to the increase in the No. of plants holder spikes per unit area. These results are in agreement with those obtained by Ahmad *et al.* (2018), Yang *et al.* (2019), Iqbal *et al.* (2020), Matsuyama and Ookawa (2020), Twizerimana *et al.* (2020) and Ghazanfar *et al.* (2023).

Data in Table 8 show that studied nitrogen fertilizer levels (50, 75 and 100 kg N fed^{-1}) had a significant effect on grain yield fed^{-1} under three studied sowing dates in both seasons, except in the third sowing dates (sowing on 25th December) in the two growing seasons. It was observed that increasing nitrogen levels up to 100 kg N fed^{-1} resulted in the highest values of grain yield fed^{-1} under three studied sowing dates in both seasons. In contrast, the lowest values of grain yield fed^{-1} were resulted from application of 50 kg N fed^{-1} under three studied sowing dates in both seasons. The increase in grain yield due to increasing nitrogen fertilizer levels up to 100 kg N fed^{-1} can be easily ascribed to the nitrogen which consider as one of the major elements for plant nutrition and it increases the vegetative cover for plant and forms strong plants with long spikes. In addition, the low soil content of available nitrogen (Table 1) which compensated with application of nitrogen fertilization. Moreover, nitrogen encourages plant to uptake other elements activating, consequently enhancing growth measurements and all yield components and grain yield per unit area. These results are in good accordance with those of Liu *et al.* (2019), Yang *et al.* (2019) and Seadh *et al.* (2020).

TABLE 8: Mean squares and mean performance of grain yield fed^{-1} as affected by cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons.

Studied factors	Grain yield (ardab fed^{-1})					
	2021/2022 season			2022/2023 season		
	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)
Cultivars (C):						
Sakha 95 (C_1)	29.6a	32.57a	30.7a	29.3a	32.11a	29.40a
Misr-3 (C_2)	27.4b	32.45a	29.9a	27.06b	31.34a	28.54a
Seeding rates (SR):						
Mean square	16.56*	16.56*	15.52*	11.82*	11.82*	13.66*
30 kg fed^{-1} (SR_1)	27.91b	31.14c	29.83b	26.87b	30.08b	28.48b
50 kg fed^{-1} (SR_2)	28.69a	32.35b	29.85b	28.05a	31.33b	28.49b
70 kg fed^{-1} (SR_3)	28.90a	34.03a	31.23a	28.13a	33.76a	29.79a
Nitrogen fertilizer levels (N)::						
Mean square	49.01**	18.51*	4.28	41.47**	29.27**	11.49
50 kg N fed^{-1} (N_1)	27.39b	31.62b	30.02a	26.59b	30.64b	28.30a
75 kg N fed^{-1} (N_2)	27.99b	32.53ab	30.10a	27.31b	31.69ab	28.79a
100 kg N fed^{-1} (N_3)	30.11a	33.37a	30.79a	29.14a	32.84a	29.67a
Interactions MS:						
C × SR	11.58*	12.01	6.19	14.72	5.19	0.26
C × N	1.23	1.14	0.62	1.17	1.32	6.53
SR × N	8.36	1.7	8.48	10.7	3.59	2.41
C × SR × N	1.16	5.91	1.01	2.54	8.26	1.66
CV	6.54	6.12	6.82	7.99	7.22	8.06

With respect to the interactions, the interaction between C × SR in 25th October sowing date in the first season had a significant effect on grain yield fed^{-1}, vice versa with regard to other interactions (Table 8).

8. Harvest index (HI):

As shown from data in Table 9, there were significant differences among studied cultivars (Sakha 95 "C_1" and Misr-3 "C_2") in harvest index (HI) in the first sowing date (25th October "SD_1") in the first season and in the three sowing dates in both seasons. The highest values of HI were obtained from C_1 cultivar, which were 34.72, 34.30, 34.64, 34.66, 34.07 and 33.39 in the three sowing dates in the first and the second seasons, respectively. The variation among wheat cultivars in HI may be due to the genetical variation among them. Comparable results were obtained by El-Sayed *et al.* (2018) and Gomaa *et al.* (2018).

Seeding rates of 30, 50 and 70 kg grains fed^{-1} insignificantly affected harvest index (HI) under three studied sowing dates in both seasons, except the second sowing date (25th November) in the two growing as shown from data in Table 9. Sowing wheat plants with the lowest seeding rate (30 kg grains fed^{-1}) resulted in the lowest values of HI under three studied sowing dates in both seasons. However, sowing wheat plants with the highest seeding rate (70 kg grains fed^{-1}) resulted in the highest values of HI under three studied sowing dates in both seasons. Such increase in HI as a result of increasing seeding rate might be due to the same reasons that mentioned and discussed formerly in increasing biological and grain yield fed^{-1}. These results are coincidence with those obtained by Ahmad *et al.* (2018).

TABLE 9: Mean squares and mean performance of harvest index (HI) as affected by cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons.

Studied factors	Harvest index (HI)					
	2021/2022 season			2022/2023 season		
	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)
Cultivars (C):						
Sakha 95 (C_1)	34.72a	34.30a	34.64a	34.66a	34.07a	33.39a
Misr-3 (C_2)	33.26b	33.77a	33.50a	32.86b	32.71b	32.15b
Seeding rates (SR):						
Mean square	2.45	12.45*	8.49	7.32	17.32*	1.73
30 kg fed^{-1} (SR_1)	33.73a	32.05c	33.43a	33.18a	31.03c	32.52a
50 kg fed^{-1} (SR_2)	33.89a	34.16b	34.17a	33.84a	33.38b	32.72a
70 kg fed^{-1} (SR_3)	34.34a	35.91a	34.61a	34.27a	35.75a	33.06a
Nitrogen fertilizer levels (N)::						
Mean square	3.24	11.15	3.09	2.29	21.42*	0.18
50 kg N fed^{-1} (N_1)	33.68a	33.48a	33.68a	33.58a	32.57b	32.69a
75 kg N fed^{-1} (N_2)	33.89a	33.84a	34.14a	33.58a	33.17ab	32.76a
100 kg N fed^{-1} (N_3)	34.39a	34.80a	34.39a	34.12a	34.42a	32.86a
Interactions MS:						
C × SR	2.73	8.21	9.3	3.47	3.08	0.04
C × N	1.37	16.45	2.23	8.02	13.65	0.94
SR × N	1.83	2.85	10.37	13.13	4.84	2.40
C × SR × N	5.65	6.80	2.62	3.59	9.00	2.42
CV	1.37	16.45	2.23	8.02	13.65	0.94

Data listed in Table 9 show that nitrogen fertilizer levels markedly affected harvest index (HI) in the second sowing date (25th November "SD_2") in the second season. Application of 100 kg N fed^{-1} produced the highest values of HI under three studied sowing dates in both seasons. In contrast, the lowest values of HI under three studied sowing dates were resulted from application of 50 kg N fed^{-1} in both seasons. Such increase in HI as a result of increasing nitrogen levels might be due to the same reasons that mentioned and discussed formerly in increasing biological and grain yield fed^{-1}.

With concern to the interactions, the interactions among studied factors on harvest index (HI) were insignificant under three studied sowing dates in both seasons (Table 9).

9. Crude protein percentage in grains (%):

Wheat cultivars under study (Sakha 95 "C_1" and Misr-3 "C_2") were significantly differed in crude protein percentage under three studied sowing dates in both seasons, except the second sowing date (25th November) in the second season as shown in Table 10. C_1 cultivar surpassed other studied cultivar and resulted in the highest values of crude protein percentage under three studied sowing dates in both seasons. While, C_2 cultivar recorded the lowest values of crude protein percentage under three studied sowing dates in both seasons. These results are in agreement with those reported by El-Sayed *et al.* (2018).

Corresponding results listed in Table 10 which revealed that there was significant effect on crude protein percentage due to studied seeding rates (30, 50 and 70 kg grains fed^{-1}) under three studied sowing dates in both seasons. The highest values of crude protein percentage were recorded due to sow with the lowest seeding rate (30 kg grains fed^{-1}) under three studied sowing dates in both seasons. On opposition to, the lowest values of crude protein percentage were produced from sowing with the highest seeding rate (70 kg grains fed^{-1}) under three studied sowing dates in both seasons. These results may be due to the high competition between the adjacent plants at higher seeding rate for light, water and nutrients which led to decrease photosynthetic activities and produce less dry matter accumulated in different plant organs and decreasing crude protein percentage in wheat grains.

TABLE 10: Mean squares and mean performance of crude protein percentage in wheat grains as affected by cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates during 2021/2022 and 2022/2023 seasons.

Studied factors	Crude protein (%)					
	2021/2022 season			2022/2023 season		
	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)	25th Oct. (SD_1)	25th Nov. (SD_2)	25th Dec. (SD_3)
Cultivars (C):						
Sakha 95 (C_1)	11.11a	12.19a	11.21a	11.63a	10.69a	11.89a
Misr-3 (C_2)	10.64b	11.00b	10.69b	11.11b	10.44a	10.91b
Seeding rates (SR):						
Mean square	2.68*	2.68*	9.42**	6.7**	6.7**	7.35**
30 kg fed^{-1} (SR_1)	11.26a	12.18a	11.65a	11.80a	11.18a	12.02a
50 kg fed^{-1} (SR_2)	10.71b	11.57b	10.75b	11.54a	10.36b	11.23b
70 kg fed^{-1} (SR_3)	10.66b	11.05c	10.45b	10.78b	10.17b	10.96b
Nitrogen fertilizer levels (N): :						
Mean square	1.28*	1.37*	8.03**	2.98**	2.43**	0.87
50 kg N fed^{-1} (N_1)	10.61b	11.39b	10.28b	11.03c	10.24b	11.23a
75 kg N fed^{-1} (N_2)	10.99ab	11.54ab	11.27a	11.37b	10.59ab	11.37a
100 kg N fed^{-1} (N_3)	11.03a	11.86a	11.30a	11.73a	10.88a	11.61a
Interactions MS:						
C × SR	2.62	2.79**	17.52**	10.18**	4.64**	2.8**
C × N	0.4	0.59	0.11	0.11	0.11	0.91
SR × N	2.86**	1.48*	10.59**	2.22**	7.99**	4.26**
C × SR × N	3.2**	3.44**	8.09**	3.13**	6.1**	4.45**
CV	0.79	0.89	0.94	0.93	0.87	0.87

Concerning the effect of nitrogen fertilizer levels on crude protein percentage, the results indicated that crude protein percentage was significantly affected by nitrogen fertilizer levels (50, 75 and 100 kg N fed^{-1}) under three studied sowing dates in both seasons, except the third sowing date (25th December) in the second season (Table 10). Application of 100 kg N fed^{-1} resulted in the highest values of crude protein percentage, while application of 50 kg N fed^{-1} resulted in the lowest values of crude protein percentage under three studied sowing dates in both seasons. This increase in crude protein content in wheat grains due to increasing nitrogen fertilizer levels may be due to the role of nitrogen fertilizer in improving growth and dry matter accumulation as well as by the influence of nitrogen availability at critical stages of spike initiation and the development of plant metabolism, which leading to increase synthesis of amino acids and their incorporation into grain protein. These results are in good accordance with those of Ali *et al.* (2019).

Crude protein percentage was significantly affected by various interactions among studied factors *i.e.* cultivars, seeding rates and nitrogen fertilizer levels under the three studied sowing dates in both seasons, except the interaction between C × SR in the first sowing date in the first season and the interaction between C × N under the three studied sowing dates in both seasons (Table 10).

Conclusion

From the results of this study, it could be recommended that sowing wheat Sakha 95 cultivar on 25th November with 50 kg grains fed^{-1} and fertilizing with 100 kg N fed^{-1} obtained the highest productivity and grains quality under the environmental conditions of Qalin City, Kafrelsheikh Governorate, Egypt.

Consent for publication:
All authors declare their consent for publication.

Author contribution:
The manuscript was edited and revised by all authors.

Conflicts of Interest:
The author declares no conflict of interest.

Acknowledgments:
The authors thank the members of Department of Agronomy, Faculty of Agriculture, Tanta University, Egypt, Wheat Department, Field Crops Research Institute, Agricultural Research Center, Egypt and Department of Agronomy, Faculty of Agriculture, Cairo University, Egypt.

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استجابة إنتاجية وجودة حبوب بعض أصناف القمح لمعدلات التقاوى ومستويات التسميد النيتروجينى تحت مواعيد زراعة مختلفة

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أجريت تجربتان حقليتان بحقل خاص بمدينة قلين، محافظة كفر الشيخ، مصر خلال الموسمين الشتويين المتتاليين 2022/2021 و2023/2022 بهدف دراسة استجابة المحصول ومكوناته وجودة الحبوب لبعض أصناف القمح المصري الجديدة (سخا 95 ومصر 3) لمعدلات التقاوى (30، 50 و70 كجم تقاوى/فدان) ومستويات السماد النيتروجيني (50، 75 و100 كجم نيتروجين/فدان) خلال مواعيد زراعة مختلفة (25 أكتوبر، 25 نوفمبر و25 ديسمبر) تحت الظروف البيئية لمدينة قلين، محافظة كفر الشيخ، مصر. تم إجراء كل موعد للزراعة في تجربة منفصلة (ثلاث تجارب). نفذت كل تجربة لمواعيد الزراعة فى تصميم القطع المنشقة مرتين فى أربعة مكررات. وأوضحت النتائج المتحصل عليها أن مواعيد الزراعة وأصناف القمح ومعدلات التقاوى ومستويات السماد النيتروجيني أثرت معنوياً في عدد السنابل/م2، طول السنبلة، عدد السنيبلات/سنبلة، عدد الحبوب/سنبلة، وزن 1000 حبة، المحصول البيولوجى/فدان، محصول الحبوب/فدان، دليل الحصاد ونسبة البروتين الخام فى الحبوب في معظم الحالات. من النتائج المحصل عليها من هذه الدراسة يمكن التوصية بزراعة القمح صنف سخا 95 فى 25 نوفمبر بمعدل تقاوى 50 كجم تقاوى/فدان مع التسميد النيتروجينى بمعدل 100 كجم نيتروجين/فدان للحصول على أعلى إنتاجية وجودة الحبوب تحت الظروف البيئية لمدينة قلين، محافظة كفر الشيخ، مصر.