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Evaluation of Different Seed Rates of Six Bread Wheat Cultivars Based upon Yield and Yield Traits

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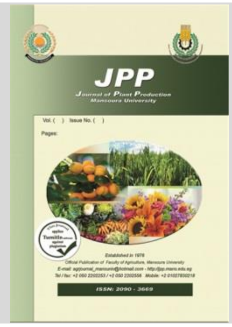

ABSTRACT

The present study was carried out to ascertain, the optimal seeding rate of 40, 50, and 60 kg/fed for six promising bread wheat cultivars: Giza 171, Misr 3, Misr 4, Sakha 95, Nubaria 2, and Sids 14 based on yield-contributing traits. The research investigation was carried out at El-Gemmeiza Agricultural Research Station, Agricultural Research Center, Egypt, during seasons, of 2021/22, and 2022/23. The results showed that the highest grain yield was produced by the Misr 4, which outperformed Sakha 95, Misr 3, Giza 171, Sids 14 and Nubaria 2. The best seeding rate was 50 kg/fed. Regarding the interaction, the seed rate 50 kg/fed under Misr 4 cultivar produced the highest grain yield. However, Sakha 95 yielded the highest grain yield at the lowest seeding rates (40 kg/fed).

***Keywords*: Bread Wheat, Seeding Rates, Yield.**

INTRODUCTION

Wheat has a higher nutritional value than other staple crops, so it is widely cultivated. The grain wheat crop is an essential food crop for humans because it contains 68% carbohydrates, 15.4% protein, 12.2% dietary fiber, and 1.9% fat (Hassan *et al.,* 2021). Approximately 8.9 million tons of wheat were produced in Egypt during the most recent growing season, 2020–2021, with an estimated 1.4 million hectares under cultivation (FAO, 2020).

Potential and actual wheat crop yields differ significantly, and this difference is mostly caused by agronomic management ignorance as well as a few other factors like seed size and rate (Muhsin *et al.,* 2021). One crucial element that impacts a plant's capacity to absorb natural resources is its seeding density. Wheat production is impacted by an optimal plant population, which can be attained with the right seed rate (Zecevic *et al.,* 2014). Regardless of the cultivar type, farmers typically use a standard seed rate of 120 kg/ha (Islam *et al.,* 2004).

In addition, they use more seed than is advised for a given cultivar because they anticipate a high yield, even though doing so raises their input costs. Nevertheless, this results in a significant drop in final production (Naseri *et al.,* 2012). In order to increase bread wheat yield, the goal of this study was to ascertain the optimal seeding rate of 40, 50, and 60 kg/fed for six promising cultivars of bread wheat: Giza 171, Misr 3, Misr 4, Sakha 95, Nubaria 2, and Sids 14.

MATERIALS AND METHODS

Using the bed planting method, the current study was conducted at El-Gemmeiza Agricultural Research Station, Tanta District, Gharbiya Governorate, Egypt, in the years 2021–2022 and 2022–2023. Four replications and a split plot design were used to set up the experiment. The main plots were assigned wheat cultivars, and the sub-plots were assigned seeding rates. Three seeding rates (40, 50, and 60 kg Fed^{-1}) and six Egyptian bread wheat cultivars (Giza 171, Misr 3, Misr 4, Sakha 95, Nubaria 2, and Sids 14) were used in the experiment. 4.8 m2 was the area of the experimental plot (6 rows, 20 cm between rows, and 4 m in length). The Wheat Research Department of the Field Crops Research Institute, Agricultural Research Center, ARC, provided the source and pedigree of the wheat cultivars under study in Table 1

Table 1. Wheat cultivars, origin, and its pedigree.

Genotypes	Pedigree	Origin
Giza 171	SAKHA93/GEMMEIZA9	Egypt
Misr 3	ROHF 07*2/KIRITI	Egypt
Misr 4	NS732/HER/3/PRL/SARA//TSI/VEE 5/6/FRET 2/5/WHEAR/SOKOLL	Egypt
Sakha 95	PASTOR//SITE/MO/3/CHEN/AEGILOPS/SQUARROSA(TAUS)//BCN/4/WBLL1	Egypt
Nubaria 2	FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ*2/5/BOW/URES//2*WEAVER/3/CROC_1/AE.SQUARROS A (213)//PGO/CGSS05B00144T-099TOPY-099M-099NJ-099NJ-7WGY-0B-5Y-0B-0NUB	Egypt
Sids 14	BOW"S"/VEE"S"//BOW"S"/TSI/3/BANI SUEF 1	Egypt

The experimental field was prepared in accordance with the Ministry of Agriculture's and reclaimed land's recommendations. Fertilizer containing both nitrogen and phosphorus was applied as advised. The other wheat-growing practices were used. The analyses of the experimental soil before the 2021–2022 and 2022–2023 wheat sowing seasons are shown in Table 2. The meteorological data of the experimental site during both seasons is shown in Table 3.

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Table 2. The experimental site's physical and chemical characteristics before 2021/2022 and 2022/2023 wheat sowing seasons

Soil properties	2021/2022	2022/2023
	Mechanical analysis	
Clay %	49.89	50.85
Silt %	29.91	30.05
Sand %	8.55	7.90
Organic mater	1.70	1.63
Textural class	Clay	Clay
	Chemical analysis	
Available N (ppm)	43.45	41.65
Available P (ppm)	6.01	4.69
Available K (ppm)	389	420
pH	8.11	8.05

Table 3. Meteorological data of experimental site during both growing wheat seasons.

Month	Max. Temperature		Min. Temperature		Max Relative Humidity		Rainfall (mm/day)		Wind Speed	
	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023
November	28.64	24.84	16.47	15.36	66.14	60.51	1.39	0.089	9.83	8.33
December	20.29	24.18	10.86	13.03	71.63	67.23	0.72	0.41	7.93	6.38
January	17.60	22.02	6.96	13.60	71.22	70.09	1.68	1.29	5.81	6.01
February	19.90	20.85	7.97	8.65	70.13	68.25	0.45	0.35	6.20	5.99
Mars	20.78	23.45	8.18	9.45	65.32	61.99	1.03	0.86	5.96	6.45
April	30.80	29.43	13.17	9.91	57.24	58.95	0.00	0.01	7.44	7.65
May	34.10	35.21	16.77	16.98	50.77	49.58	0.00	0.00	8.41	9.05

*** Source: Water Requirement and Field irrigation Res., Dept**

The examined yield traits

Throughout the experiment seasons, the following data were recorded: heading (days), maturity (days), plant height (cm), no. of spikes/m^2, No. of grains/spike, 1000-kernel weight (gm), grain yield (ardab/fed).

Statistical analysis

A randomized complete block design (RCBD) with split plot arrangements and four replications was used to statistically analyze all the data. The least significant differences (LSD) at $p \leq 0.05$ were used to compare the means. Utilizing the analysis of variance technique (ANOVA) along with the CoHort/CoStat software, Version 6.311, statistical analysis was carried out.

RESULTS AND DISCUSSION

Impact of wheat cultivars

It was evident from the results shown in Tables 4 and 5 that wheat cultivars significantly influenced yield traits. Out of six wheat cultivars, Nubaria 2 outperformed Giza 171, Misr 3, Misr 4, Sakha 95, and Sids 14 in terms of days to heading (101.25 and 102.58 days), days to maturity (161.58 and 162.92 days), and plant height (116.91 and 117.34 cm) in both seasons, respectively.

Furthermore, Misr 4 wheat cultivar outperformed Sakha 95, Misr 3, Giza 171, Sids 14, and Nubaria 2 in terms of spikes No./m^2 (521.67 and 522.00), and No. of kernel /spike (69.42 and 65.33) in the two seasons, respectively. In addition, the wheat cultivar Misr 4 yielded the highest 1000-kernel weights of 58.63 and 56.96g, while the wheat cultivar Nubaria 2 produced the lowest weights of 53.49 and 49.94g. The genetic differences between the cultivars were cited as the cause of the variations in plant height; these conclusions are consistent with Khaliq *et al.* (1999).

In addition, Nubaria 2 had the lowest grain yield of all wheat cultivars, with 25.13 and 25.53 ardab/fed, whereas Misr 4 had the highest grain yield (29.92 and 29.54 ardab/fed) in the two seasons, respectively. The outcomes were supported by Ahloowalia and Maluszynskis (2001), who stated that cultivars with high yield potential are essential for raising yield during the ideal growing season.

Impact of Seeding Rates

Generally, grain yield and its constituent parts were significantly impacted by seeding rates. As shown in Table 4, there were notable variations among the three seeding rates. Early heading was scored by seeding rates of 60 kg/fed (99.50 & 101.25) and 50 kg/fed (99.75 & 101.29) in the two seasons, respectively. On the other hand, 40 kg/fed recorded the latest heading (100.79 & 102.08) in the two seasons, respectively. In addition, 60 kg/fed seeding rates scored early days to maturity (156.96) with no significant differences with the seeding rate 50 kg/fed (157.21). However, seeding rate of 40 kg/fed recorded the highest days to maturity in the first season (157.63). In contrast, there were no significant differences among seeding rates concerning this trait in the second season.

Regarding to plant height, there were no significant differences among seeding rate in both seasons, despite it appears to be relatively high with the seeding rate of 50 kg/fed. The Table 4 results showed that the number of spikes/m^2 increased gradually as the seeding rate increased. When compared to seeding rates of 50 kg/fed (484.17 and 495.38) and 60 kg/fed (499.50 and 503.00), 40 kg/fed developed a substantially lower number of spikes /m^2 (479.96 and 488.96) in the two seasons, respectively. These results are comparable with the work of Iqbal *et al.* (2010), who indicated that increasing seeding rates significantly increased fertile spikes and total spikes.

Table 4. Effect of seeding rates and wheat cultivars on heading, maturity, plant height, number of spikes/ m² during both growing seasons.

Parameters	Heading (days)		Maturity (days)		Plant height (cm)		No. of Spikes/m²	
Season	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023
			A. Cultivars					
Giza 171	99.08b	100.67b	151.58e	152.75e	114.62bc	116.03b	482.33b	483.75c
Misr 3	98.92b	100.50b	158.42c	160.08c	113.62bc	114.53c	488.58b	508.92b
Misr 4	100.67a	102.17a	160.25b	161.75b	115.90a	116.66ab	521.67a	522.00a
Sakha 95	99.00b	101.00b	158.42c	160.50c	113.57c	114.60c	511.67a	516.50ab
Nubaria 2	101.25a	102.58a	161.58a	162.92a	116.91a	117.34a	457.58c	462.25c
Sids 14	101.17a	102.33a	153.33d	154.83d	114.47bc	115.04c	465.42c	481.25c
F test	**	**	**	**	**	**	**	**
			B. Seeding rates (kg/fed)					
S40	100.79a	102.08a	157.63a	159.25a	114.99	115.96	479.96b	488.96c
S50	99.75b	101.29b	157.21ab	158.75b	115.01	115.75	484.17b	495.38b
S60	99.50b	101.25b	156.96b	158.42b	114.54	115.39	499.50a	503.00a
F test	**	*	*	ns	ns	ns	**	**
			C. Interaction					
A * B	ns	ns	ns	ns	*	*	**	**

The CoHort/CoStat software Version 6.31 indicates that distinct letters prove significant variations between treatments at p ≤ 0.05. Levels of significance at p ≤ 0.05 ns not significant, * significant, ** significant, and *significant.

The data in Table 5 indicated a significant difference in the number of kernels/ spikes among seeding rates. Significantly fewer kernels/ spikes occurred at a seeding rate of 60 kg/fed (62.50 and 59.88). On the other hand, 50 kg/fed seeding rate recorded the highest number of kernels/spike (66.71 and 63.25), while 40 kg/fed seeding rate recorded (64.29 and 60.83). Due to lower competition for all essential elements than when there were more plants per unit area, the number of kernels or spikes increased while the seed rate decreased. This was because the plant nutrients in the soil were sufficient for vegetative development and grain formation. These findings are consistent with those of Abd El-Rady *et al.* (2016), who reported that a higher seeding rate results in fewer kernels per spike.

Based on Table 5 results, 1000-kernel weight was decreased by increasing seeding rate. It is evident that the highest weights of 1000 kernels were produced at the seeding rate of 50 kg/fed seeding rate (57.36 & 56.82) in the two seasons, respectively. On the other hand, the lowest weights of 1000 kernels were produced at the seeding rate of 60 kg/fed (53.38 & 51.78) in both seasons, respectively. This could be because plants produced more total dry matter and seed index due to less competition and shading from one another. Additionally, these results concur with those of Chauhdary *et al.* (2015).

Our findings showed that there were notable variations between the three seeding rates concerning to the grain yield as shown in Table 5. The highest grain yield was scored under the seeding rate of 50 kg/fed (29.25 and 29.22 ardab/fed) in both seasons, with no significant differences with the seeding rate of 40 kg/fed (28. 24 and 28.53 ardab/fed) in the two seasons, respectively. On the other hand, the lowest grain yield (26.37 and 26.12 ardab/fed) was scored by the lowest seeding rate of 60 kg/fed, in both seasons, respectively. According to Abd El-Rady *et al.* (2016), low growth and fewer spikes per unit area could be the cause of the decrease in grain yield when utilizing a low seeding rate. These findings also support those of Sikander *et al.* (2003), who found that higher yields were obtained from lower seeding rates because of vigorous crop growth. These results are in accordance with that obtained by Akhter *et al.* (2017) and Shoaib *et al.* (2022)

Table 5. Effect of seeding rates and wheat cultivars on No. kernel/spike, 1000 kernel weight, and grain yield during both growing seasons.

Parameters	No. of Kernels/Spike		1000-kernel weight (g)		Grain yield (ardab/fed)	
Season	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023
			A. Cultivars			
Giza 171	63.25c	59.75c	53.77d	53.25b	27.28bc	27.96ab
Misr 3	66.58b	61.33bc	55.96c	55.81a	29.25ab	29.31a
Misr 4	69.42a	65.33a	58.63a	56.96a	29.92a	29.54a
Sakha 95	66.83ab	63.50ab	57.18b	56.38a	29.66a	29.31a
Nubaria 2	60.33d	58.92c	53.49d	49.94c	25.13c	25.53c
Sids 14	60.58cd	59.08c	53.53d	53.15b	26.48c	26.35bc
F test	**	*	**	**	*	**
			B. Seeding rates (kg/fed)			
S40	64.29b	60.83b	55.53b	54.15b	28.24a	28.53a
S50	66.71a	63.25a	57.36a	56.82a	29.25a	29.22a
S60	62.50c	59.88b	53.38c	51.78c	26.37b	26.12b
F test	**	*	**	**	**	**
			C. Interaction			
A * B	**	**	*	*	*	**

The CoHort/CoStat software Version 6.31 indicates that distinct letters prove significant variations between treatments at p ≤ 0.05. Levels of significance at p ≤ 0.05 ** significant, and ***significant.

Interactive Impact of cultivars and Seeding Rates

Our findings in Figure 1 demonstrated that, the maximum plant height (117.13 cm & 117.70 cm) and (116.43 cm & 116.05 cm) were detected for Misr 4 and Sakha 95, respectively in both seasons at the seeding rate of 50 kg/fed for the. On the other hand, Misr 3 wheat cultivar recorded the lowest plant height at the seeding rate of 60 kg/fed (112.95 cm & 113.38 cm). Our results were in line with studies by Akhter *et al.* (2017) and Shoaib *et al.* (2022), which found that the maximum plant height was achieved at the ideal seed rate. Variations in the genetic composition of wheat cultivars were identified as the cause of the variations in plant height (Khaliq *et al.*, 1999). Also, Naseem *et al.* (2002) reported similar findings, indicating that wheat exhibited a high degree of responsiveness to elevated seeding rates.

Data in figure 1 demonstrated a significant impact of the interaction between seeding rates and wheat cultivars for the number of spikes/ m^2. With the seeding rate of 60 kg/fed, Misr 4 produced the greatest number of spikes/m^2 (535.0 &533.25), in the two seasons, respectively. While Nubaria 2 used the seeding rate of 40 kg/fed recorded the lowest number of spikes/m^2 (446.0 & 446.0), in the two seasons, respectively. With respect to the seeding rates effect, number of spikes/m^2 in Sakha 95 wheat cultivar badly responded to the gradual increase of seeding rates in both study seasons. Hence, Sakha 95 wheat cultivar with the seeding rate of 40 kg/fed produced the greatest number of spikes/m^2 (517.5 & 526.0), in the two seasons, respectively. While it produced the lowest number of spikes/m^2 (507.0& 490.0) with the highest seeding rate of 60 kg/fed, in the two seasons, respectively (Figure 1).

Regarding the impact of interaction on kernels no./spike, the findings showed that with the seeding rate of 50 kg/fed, Misr 4 recorded the highest values of kernels no./spike (71.50 and 72.75), followed by Sakha 95 (68.5 & 69.25) and 68.0 & 67.75 for Giza 171. On the other hand, at seeding rates of 60 kg/fed, Nubaria 2 recorded the lowest values of kernels no./spike (58.00 & 51.50) in the two seasons, respectively.

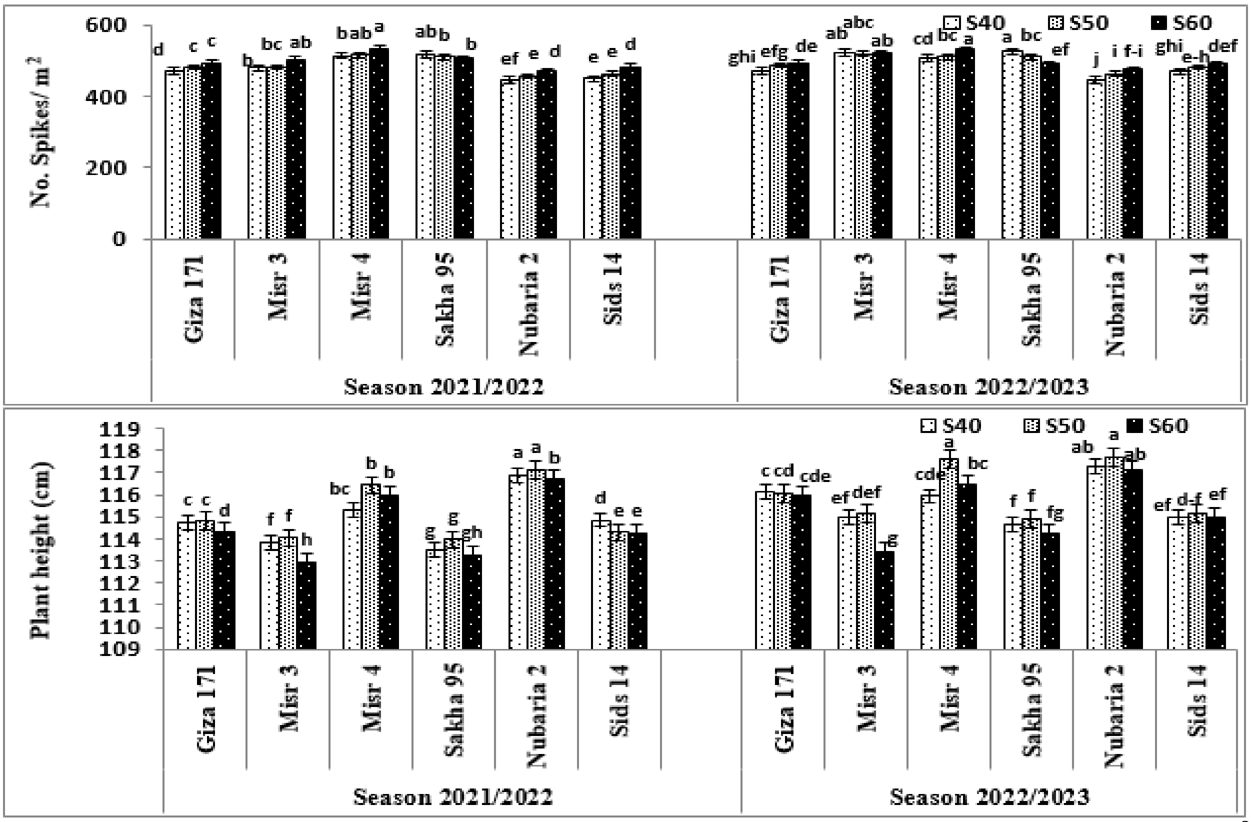

Figure 1. Effect of di-interaction between seeding rates and wheat cultivars on plant height and number of spikes/ m^2 during both growing seasons. The CoHort/CoStat software Version 6.31 indicates that different letters indicate significant differences between treatments at $p \leq 0.05$. The standard error of the mean (n=4) is shown by vertical bars.

As shown in figure 2, the 1000-kernel weight was greatly affected by the interaction between wheat cultivars and seeding rates. Misr 4 produced the maximum 1000-kernel weight of (60.43g & 60.21g) at a seeding rate of 50 kg/fed, in the two seasons, respectively. Conversely, Nubaria 2 recorded the lowest 1000-kernel weights of 52.11 and 47.89 at a seeding rate of 60 kg/fed, in the two seasons, respectively.

According to our findings in figure 2, the 1000-kernel weight increased with increasing the seeding rates from 40 to 50 kg/fed. On the other hand, 1000-kernel weight decreased with increasing the seeding rates from 50 to 60 kg/fed. The present results are similar to those of Laghari *et al.* (2011) and Akhter *et al.* (2017), who observed a decrease in grain weight as the seed rate increased.

The results in Figure 2 showed that the grain yield of wheat was significantly impacted by the interaction between seeding rates and cultivars. Our data showed that using 50 kg/fed seeding rates produced the highest grain yields for all wheat cultivars except for Sakha 95 with order Misr 4 > Misr 3 > Giza 171 > Sids 14 > Nubaria 2 in the two seasons, respectively. Conversely, Sakha 95 with the rate of 40 kg/fed yielded the highest grain yields (30.98 and 32.07 ardab/fed) in the two seasons, respectively. The present results are similar to those of Baloch *et al.* (2010), who observed that using the best seed led to an increase in grain weight.

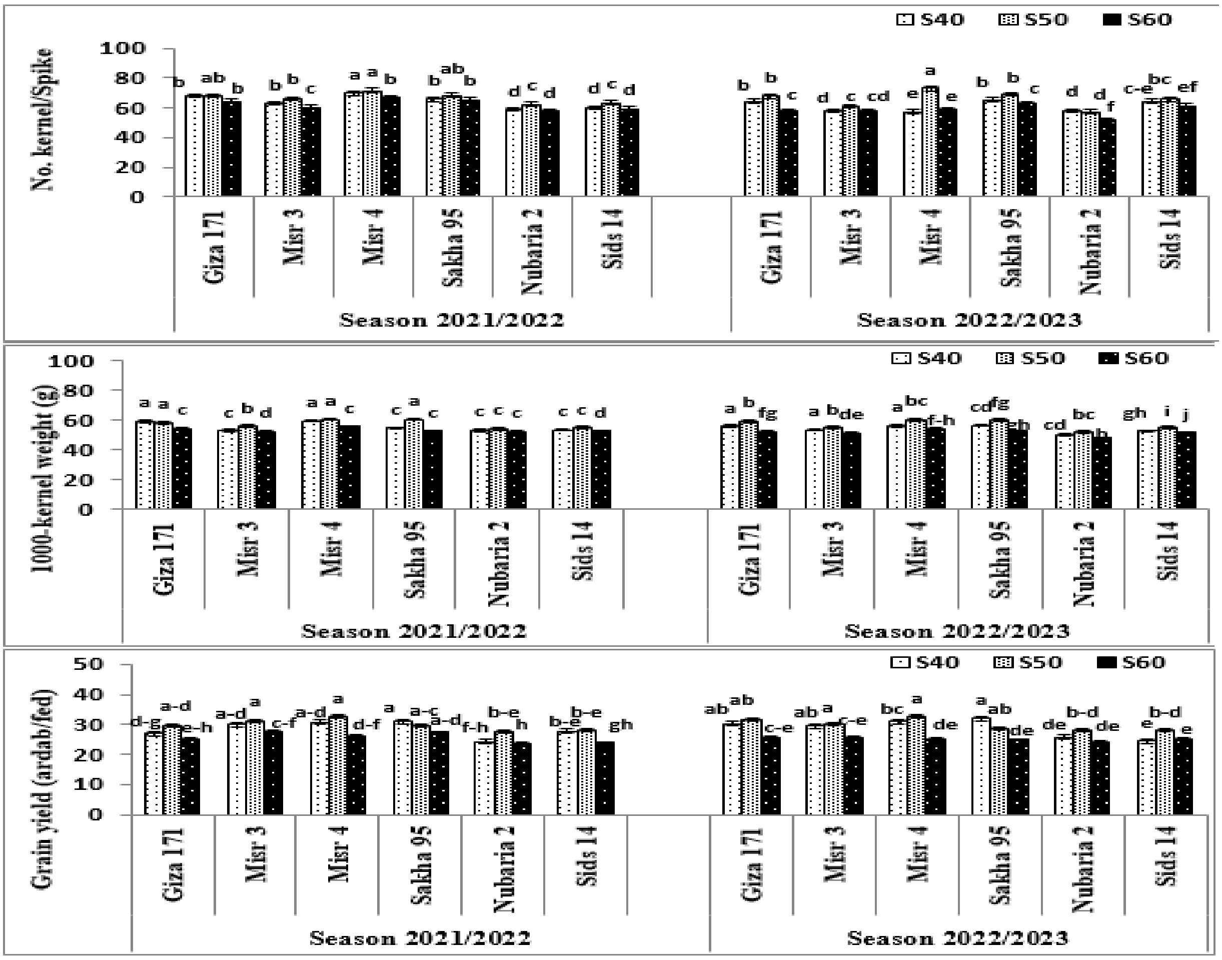

Figure 2. Effect of di-interaction between seeding rates and wheat cultivars on No. kernel/spike, 1000 kernel weight, and grain yield during both growing seasons. The CoHort/CoStat software Version 6.31 indicates that different letters indicate significant differences between treatments at p ≤ 0.05. The standard error of the mean (n=4) is shown by vertical bars.

CONCLUSION

It is concluded that wheat plants with a seeding rate of 50 kg/fed enhanced the greatest yield parameters and grain yield. On the basis of wheat cultivars, our results cleared that Misr 4 > Sakha 95 > Misr 3 > Giza 171 > Sids 14 > Nubaria 2 in grain yield. Moreover, the interactive impact of Misr 4, Misr 3, Giza 171, Sids 14, and Nubaria 2 versus 50 kg/fed seeding rate was noticed to be superior, while Sakha 95 was detected to be more efficient for achieving a higher grain yield versus 40 kg/fed.

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تقييم معدلات التقاوي المختلفة لستة أصناف من قمح الخبز على أساس المحصول وصفاته

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الملخص

معدلات التقاوي المثالية هي ممارسات زراعية حتمية لتحسين إنتاجية القمح. لذلك، تهدف هذه الدراسة إلى تحديد أفضل معدل تقاوي من الثلاث معدلات (40، 50، 60 كجم /فدان) لستة أصناف واعدة من قمح الخبز؛ جيزة 171، مصر 3، مصر 4، سخا 95، نوبارية 2، سدس 14 بناء على المحصول وصفاته. أجريت التجربة خلال موسمي 2022/2021 و 2023/2022 بمحطة البحوث الزراعية بالجميزة – مركز البحوث الزراعية – مصر. أوضحت النتائج تأثر المحصول ومكوناته معنوياً بمعدلات التقاوي المختلفة. ومن بين أصناف القمح، أنتج الصنف مصر 4 أقصى إنتاجية للحبوب مقارنة بسخا 95، مصر 3 ، جيزة 171 ، سدس 14 ، نوبارية 2. وفيما يتعلق بمعدلات التقاوي أظهرت النتائج أن معدل التقاوي 50 كجم/فدان هو أفضل معدل تقاوي. وبالنسبة للتفاعل بين معدلات التقاوي والأصناف، بلغ أقصى إنتاجية للحبوب 32.68 و32.07 أردب/فدان للصنف مصر 4 بمعدل تقاوي 50 كجم /فدان. بينما بلغ أقصى إنتاجية للصنف سخا 95 30.98 و 32.51 أردب/ فدان بأقل معدلات تقاوى 40 كجم معدل تقاوى/ فدان.