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Evaluation of African Varieties of wheat crop under Modern Cultivation Conditions and different seed rates in North African

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Abstract

The present investigation was conducted at El-Mattana Agricultural Research Station Luxor Governorate, Agricultural Research Centre in Giza Egypt. The study aimed to evaluate the effect of three sowing methods (Broadcasting, Drilling and Hills on beds method) and three seeding rates (30, 45 and 60 kg grains/fed) on the yield and its components for three bread wheat varieties (Sakha95, Sids14 and Misr 3) (*Tritium aestivum* L.).The results showed that the drilling method was better for cultivating wheat varieties by increasing No. of spikes/m^2, 1000 grain weight (g), grains weight/spike (g), grain yield/fed and biological yield in the first season, the No. of grains/spike and harvest index in the second season than the broadcasting and hilling methods while the drilling was equal to the hill in the straw yield in the two seasons. The highest number of spikes/m^2 was obtained from 60 and 45 kg/fed in the first and second seasons, respectively, and the highest number of grains /spike was at a seed rate of 30 kg/fed in the first season ,while the highest weight was given for 1000 grains, grain yield, straw yield, biological yield for a seed rate of 45 kg/fed in the first season, the highest grains weight /spike for a seed rate of 45 kg/fed in the two seasons, and the harvest index for a seed rate of 45 and 30 kg/fed in the first and second seasons, respectively. Among the varieties tested, Misr 3 exhibited the highest No. of spikes/m^2, 1000 grain weight, grain yield, straw yield and biological yield in the two seasons and grains weight /spike in second season than cultivar Sakha 95 and sids 14, wherever, the highest number of grains /spikes was cultivar Sakha 95 in the first season. The first-order interactions were significant or highly significant for most of the traits in the first season, while the second-order interaction was significant or highly significant for most of the traits in the two seasons. The interaction of the drill sowing method with a seed rate of 45 kg/fed with Misr 3 cultivar resulted in the maximum grain yield / fed in both seasons, while the interactions of the hills and broadcast method with a seed rate of 30 and 60 kg/fed with Sakha 95 cultivar yielded the minimum grain yield in the two seasons, respectively.

Key words*: *sowing methods, seeding rates, grain yield, and wheat varieties.

Introduction

Wheat is considered the most important productive cereal crop in the World. Wheat is a staple food in many countries, including Egypt. It is primarily used in the production of bread, also used in various other food industries in Egypt, such as pasta from durum wheat, pastries, and other wheat-based products.

The area cultivated with wheat in the world is 525.4 million feddans, while the area in Africa is 22.9 million feddans and in Egypt 3.4 million feddans. The world's production of wheat is 770.8 million tons, while Africa's production is 29.2 million tons, and Egypt's production is 9.3 million tons. The average production of a feddan of wheat in the world is 9.7 ardebs/fed, while in Africa is 8.5 ardebs/feddan, while of Egypt is 18.28 ardebs/feddan (FAO, 2021).

Sowing methods plays an essential role in the placing of grain at appropriate depth, which affects plant growth and In Egypt, wheat is grown by broadcasting in a large area, and this method does not only require a higher seeding rate but give lower plant density, whereas drilling and raised bed planting methods are recommended for the reason of their standard seed distribution and high plant density **Soomro *et al*., (2009). El-Lattief, E. A. A. (2011**), **Genedy (2014), El-Hag (2015) and Tadesse *et al*., (2017)** showed that the planting techniques had significant effects on all growth metrics, including days to maturity, plant height, flag leaf area, 1000-grain weight, No. of grains/spike, grain yields, and harvest index. The findings indicated that bed planting techniques improved all characteristics except (plant height and 1000-grain weight). **Hashimi *et al*., (2021)** The results of two sites data showed that wheat planting increase grain yield by 21%, 1000 grain weight 30.5%, biological yield 29%, grain weight per spike 24.1%, the No. of grain per spike 17.6%, spike length 20.8%, the total No. of tillers 10.8% and plant height 14.2% under Raised Bed.

Optimum seeding rate play an important role in achieving potential yield of bread wheat. **El-Lattief, E. A. A. (2011)**, **Said *et al*., (2012), Banisaeidi *et al*., (2014)** and **Tadesse *et al*., (2017),** results revealed that seeding rates significantly affected grain yield and 1000 grain weight (g). The lowest grain yield (3221 kg/ ha) was obtained from seeding rates of 100 kg /ha, but other yield components were not significantly impacted by seeding rates. Maximum 1000 grain weight (37.5 gm) was produced by seeding at a rate of 100 kg/ ha, whereas rates of 200 kg /ha produced rates and the lowest grain yield. **Naveed *et al*., (2014)** showed that effect of seeding rates on the yield and yield components of wheat, four seeding rates (100, 140, 180 and 220 kg/ ha) seeding rates had a significant effect on No. of tillers m^2 (287), No. of spike m^2 (281),biological yield (11690 kg /ha), fresh and dry forage yield (3961 and 832.6 kg/ ha) and grain yield (4741 kg /ha) by increasing seeding densities ,While he was heading date (122.5),No. of grains spike (58.9) and spike length (11.9cm) were higher in lower seed rate (100 kg /ha)**. DAA, E. H. (2016)** Results showed that lower seeding rates increased harvest index, flag leaf area, 1000-kernel weight, and the No. of kernels/spike. But increases of seeding rate increased plant height, No. of spikes/m2, grain and straw yields. **Intsar, H. H., and Wahid, S. A. (2017)** Revealed that the seeding rates had a significant impact on plant height, biological yield, and straw production. **Mohiy and Salous (2022)** Applied three seeding rates in wheat (35, 45 and 60 kg fed) Results showed that different seeding rates had significant impacts on grain yield and its components. Where it was found that the best seeding rate for traditional planting methods was 60 kg/fed, while the best seeding rate for raised bed planting methods was 45 kg/fed

Wheat varieties are indeed important factors that can significantly affect the yield of wheat. In summary, optimizing sowing methods, selecting appropriate seeding rates, and using the best wheat varieties can collectively enhance yield potential and overall crop performance**. Safina *et al.*, (2021)** Applied three wheat cultivars on Grain yield and its components, found that all studied traits significantly affected among verities in both seasons' variety in the most of studied traits following (50% heading, plant height, and No. of tillers/m^2, biological yield and straw yield) in both seasons. **DAA, E. H. (2016), El-Seidy *et al.*, (2022) and Khodadoost *et al.*, (2022)** evaluated tow wheat cultivars, results revealed that, a significant difference was observed between cultivars in terms of yield components, but the grain yield was not significantly different.

First and second-order interactions are important factors in this study**. Soomro *et al.*, (2009) and El-Lattief, E. A. A. (2011)** indicated that all growth characters and yield parameters were significantly affected by the sowing methods and seed rates. The interaction of sowing methods and seed rates significantly affected on grain/spike indicating that the response of sowing methods to seeding rates could be differed, while other characters showed no significant interactions. Wheat sown by drilling method at the seed rate of (150 kg/ha) significantly increased the grain yield.

Hefny *et al.*, (2015) data revealed that sowing methods, the cultivars had significantly impact on the all studied characteristic; plant height (cm), spike length (cm), No. of spikes/m^2, 1000-grain weight (g), grain yield (ardab/fed.) and biological yield (ton/fed.) in both seasons.

Mehasen (2009) found that, The No. of tillers plant-1, days to 50% heading, flag leaf area, plant height, spike length, No. of spikes/m^2 and grain and straw yields /fed were all significantly impacted by the interaction between wheat genotypes and seeding rates. **Intsar, H. H., and Wahid, S. A. (2017) and Hussain *et al.*, (2018)** studied the impact of seed rates and wheat cultivars on the yield and growth of bread wheat. Wheat plant height, tillers / m^2 biological yield, and straw production were all significantly impacted by the interaction between wheat cultivars and seed rate**.**

El-Seidy *et al.*, (2022) studied the impact of sowing methods and seed rates and wheat cultivars on growth, yield and yield components. found that, the interaction between wheat cultivars and planting methods with seeding rates in the first and second seasons, except harvest index in the first season, had an impact on the No. of spikes/m^2, biological yield, grain yield, and straw production**.**

The specific objectives of the study were to evaluate the performance of wheat varieties under different sowing methods and seeding rates, and to evaluate different effects on vegetative traits, yield components, and grain yield in North Africa (Egypt).

Materials and Methods

The present investigation was conducted during the two successive growing seasons, i.e., 2020/2021 and 2021/2022 at El-Mattana Agricultural Research Station Luxor Governorate, Agricultural Research Centre in Giza Egypt. The study aimed to evaluate the effect of three sowing methods (Broadcasting on beds method, drilling on beds method and Hills on beds method) and three seeding rates (30 kg grains/fed, 45 kg grains/fed and 60 kg grains/fed) on the yield and its components for three bread wheat varieties (Sakha95, Sids14 and Misr 3) (*Tritium aestivum* L.).

The experimental design was a spilt-spilt plot design with three replications in both seasons. The main plot treatment was occupied by the three sowing methods, while the three seeding rates were assigned in the sub-plots and the three wheat varieties in the sub-sub plots. Sowing dates were 20th November in the two seasons. The harvesting area consists of two beds

with an area of 8.4 m^2 (2.8 m wide and 3 m long), each bed is 1 m wide and 3 m long, and the distance of the irrigation channels between the beds is 0.4 meters.

The phosphate fertilizer was applied at the rate of 15.5 kg p_2o_5/fed. The nitrogen fertilizer was divided into two splits: on being applied immediately before the first irrigation and the second was applied before the second irrigation. Nitrogen was added in the form of urea (163 kg/fed urea 46%N). Each crop was harvested during the first week of May 2021and 2022.

The experimental factors included the following:

A- Different sowing method :(M1-Drilling on beds method, M2-Broadcasting on beds method and M3-Hills on beds method).

B- Seeding rates :(30, 45and 60kg/fed).

C- Wheat Varieties :(Sakha 95, Sids 14 and Misr 3).

The data was recorded during the growing seasons and after harvest as follows:

1. Number of spikes/m^2: Number of fertile tillers/m^2 was calculated by counting all spikes per square meter.
2. Number of grains/spikes: was counted as the average number of grains collected per spike.
3. 1000-grain weight (g): A random sample of 1000-grains was taken from each plot, hand counted and weighted.
4. Grain weight /spike (g): Average number of grains of ten randomly chosen spikes and weighted.
5. Grain yield (ardab/fed): Recorded for the harvested area after threshing and then converted to ardab/fed (One ardab = 150 kg on the basic of 14.5% moisture content and one feddan = 4200 m^2.
6. Straw yield (ton/fed.): Determined as the difference between biological and grain yield of sub plot in terms of kg/plot and converted to ton/fed.
7. Biological yield (ton/fed.): was recorded for the harvested area and converted to ton/fed.
8. Harvest index (HI): was recorded as a ratio between grain yield to the total biological yield.
1. HI= (Grain yield / Biological yield) × 100.

Statistical analysis:

Data were subjected to the proper statistical analysis as the technique of analysis of variance (ANOVA) of split- split plot design as mentioned by **Gomez and Gomez (1984).** Treatment means were compared using the Least Significant Difference (LSD) test as outlined by **Waller and Duncan (1969)**.

3-Results and Discussion

A-Sowing methods:

Sowing methods had a significant or highly significant impact on No. of spikes/m^2, 1000 grain weight, grains weight/spike, grain yield and biological yield in the first season, the No. of grains/spike and harvest index in the second season and straw yield in the two seasons**,** as shown in Tables (1and 2).The drilling method was better for cultivating wheat varieties by increasing No. of spikes/m^2, 1000 grain weight, grains weight/spike, grain yield and biological yield in the first season, the No. of grains/spike and harvest index in the second season than the broadcasting and hilling methods while the drilling was equal to the hill in the straw yield in the two seasons.These results are in agreement with those obtained **by El-Lattief, E. A. A. (2011) Genedy (2014), El-Hag (2015), Tadesse *et al.*, (2017) and Hashimi *et al.*, (2021).** These results may be due to the good distribution of plants in the drill method. This distribution likely allowed for efficient uptake of nutrients and moisture by the plants, leading to higher yield and yield components.

Table (1): Effect of sowing methods, seeding rates and varieties on number of spikes/m^2, number of grains/spikes, 1000-grain weight (g.) and grain weight/spike (g) at harvest in 2020/2021 and 2021/2022 seasons.

Characters	Number of spikes/m^2		Number of grains/spikes		1000-Grain weight(g)		Grain weight /spike (g)	
Treatments	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22
A: Sowing methods								
Drilling	303	303	68	52.5	54.6	67.1	3.71	3.52
Broadcasting	299	297	69	51.0	48.4	68.6	3.31	3.50
Hills	294	300	67	52.4	51.6	65.9	3.41	3.45
F-test	*	n.s	n.s	**	**	n.s	**	n.s
LSD at 0.05	6	n.s	n.s	0.7	1.4	n.s	0.18	n.s
B: Seeding rates								
30 kg/fed	292	295	69	52.2	48.1	67.2	3.30	3.51
45 kg/fed	300	305	67	51.6	56.2	68.6	3.73	3.53
60 kg/fed	304	300	68	52.1	50.4	65.9	3.41	3.43
F-test	**	**	*	n.s	**	n.s	**	**
LSD at 0.05	7	5	1	n.s	2.9	n.s	0.19	0.08
C: Varieties								
Sakha-95	294	298	74	51.7	46.7	65.1	3.45	3.36
Sids-14	290	296	67	51.9	52.6	65.2	3.50	3.38
Misr-3	313	306	63	52.3	55.4	71.3	3.48	3.73
F-test	**	**	**	n.s	**	**	n.s	**
LSD at 0.05	3	3	1	n.s	1.8	1.6	n.s	0.76

*, **: significant at 0.05 and 0.01 levels of probability.

B- Seeding rates:

Seeding rates had significantly or highly significant impact on No. of spikes/m^2, grains weight /spike and harvest index in the both seasons, No. of grains /spike in the first season, while the 1000 grains weight, grain yield, straw yield, and biological yield in the first season**,** as shown as in Tables (1 and 2). The highest number of spikes/m^2 was at a seed rate of 60 and 45 kg/fed in the first and second seasons, respectively and The high number of grains /spike was at a seed rate of 30 kg/fed in the first season ,while the highest weight was given for 1000 grains, grain yield, straw yield, biological yield for a seed rate of 45 kg/fed in the first season, the highest grains weight /spike for a seed rate of 45 kg/fed in the two seasons, and the harvest index for a seed rate of 45 and 30 kg/fed in the first and second seasons, respectively. These results are in agreement with **El-Lattief, E. A. A. (2011), Said *et al*., (2012), Banisaeidi *et al*., (2014), Naveed *et al*., (2014), DAA, E. H. (2016), Intsar, H. H., and Wahid, S. A. (2017), Tadesse *et al*., (2017) and Mohiy and Salous (2022).** The ideal seed rate is a key challenge to sustain wheat productivity under changing environments.

C- Wheat varieties:

Results in Tables (1and 2) showed that Varieties have had a significant or highly significant impact on No. of spikes/m^2, 1000 grain weight, grain yield, straw yield and biological yield in the two seasons and grains weight /spike in second season, No. of grains

/spike in the first season. Cultivar Misr 3 exhibited the highest No. of spikes/m^2, 1000 grain weight, grain yield, straw yield and biological yield in the two seasons and grains weight /spike in second season than varieties Sakha 95 and sids 14, but the high number of grains /spikes was cultivar Sakha 95 in the first season. These results are in harmony with those obtained by **DAA, E. H. (2016), El-Seidy *et al*., (2022), Safina *et al*., (2021) and Khodadoost *et al*., (2022).** It could be concluded that varietal differences among wheat varieties may be due to genetically make up and the variability among wheat varieties.

D- Interaction:

The first-order interactions (A*B, A*C and B*C) were significant for most of the traits in the first season, as shown as in Tables (3 to 8), while the second-order interaction (A*B*C) was significant for most of the traits in the two seasons, as shown as in Tables (9 and 10).

The interactions between sowing methods and seeding rates (A*B) was significant or highly significant concerning with No. of spikes/m^2, Grain weight/spike (g) 1000-grain weight (g), grain yield, straw yield and biological yield in the first season and harvest index in the second season as shown as in Tables (3 and 4). These results are in full agreement with those of **Soomro *et al*., (2009), El-Lattief (2011)**.

Table (2): Effect of sowing methods, seeding rates and varieties on grain yield (ardab/fed), straw yield (ton/fed), biological yield (ton/fed) and harvest index at harvest in 2020/21 and 2021/2022 seasons.

Characters	grain yield (ardab/fed)		straw yield (ton/fed)		biological yield (ton/fed)		harvest index	
Treatments	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22
A: Sowing methods								
Drilling	22.94	22.38	5.28	5.65	8.72	9.01	39.47	37.29
Broadcasting	21.15	21.50	4.95	5.58	8.12	8.80	39.03	36.69
Hills	21.22	21.38	5.03	6.07	8.21	9.27	38.76	34.66
F-test	**	n.s	*	*	*	n.s	n.s	**
LSD at 0.05	0.24	n.s	0.46	0.67	0.6	n.s	n.s	1.1
B: Seeding rates								
30 kg/fed	20.80	21.65	4.99	5.55	8.11	8.80	38.49	37.00
45 kg/fed	22.40	22.12	5.15	5.81	8.51	9.13	39.46	36.36
60 kg/fed	22.11	21.48	5.12	5.93	8.44	9.15	39.31	35.29
F-test	**	n.s	*	n.s	**	n.s	**	*
LSD at 0.05	0.22	n.s	0.2	n.s	0.42	n.s	0.87	0.70
C: Varieties								
Sakha-95	21.15	20.87	5.02	5.54	8.19	8.67	38.73	36.20
Sids-14	21.79	21.40	5.05	5.70	8.32	8.91	39.29	36.07
Misr-3	22.37	22.99	5.19	6.05	8.54	9.50	39.25	36.37
F-test	**	**	**	**	**	**	n.s	n.s
LSD at 0.05	0.15	0.13	0.16	0.29	0.26	0.35	n.s	n.s

*, **: significant at 0.05 and 0.01 levels of probability.

The interactions between sowing methods and varieties (A*C) were significant or highly significant concerning with No. of spikes/m^2 and No. of grains/spike in the both seasons while the interaction between sowing methods and varieties on Grain weight/spike, grain yield, straw yield, biological yield and harvest index was highly significant in the first season as shown in Tables (5 and 6), These results are in full agreement with those of **Hefny *et al*., (2015)**. The reason for these results can be attributed to the appropriate seeding method and cultivar creating optimal conditions and the lack of competition between plants.

The interaction between seeding rates and varieties (B*C) on straw yield and harvest index was significant or highly significant in the both seasons, While the interaction between varieties and seeding rates on No. of spikes/m^2, No. of grains/spikes**,** 1000-grain weight and Grain weight/spike was highly significant in the first seasons and biological yield was highly significant in the second season as shown as in Table (7 and 8). These results are in full agreement with those**. Mehasen (2009), Soomro *et al*., (2009), DAA, E. H. (2016), Intsar, H. H., and Wahid, S. A. (2017) and Hussain *et al*., (2018)** These

results may be due to the ability of the genotype to adapt to different rates of seeding and better productivity for the optimal rate of seeding.

Table (3): Effect of interaction between sowing methods and seeding rates (A*B) on Number of spikes/m^2 Number of grains/spikes, 1000-Grain weight (g) and Grain weight /spike (g) in two seasons.

Treatments		Number of spikes/m^2		Number of grains/spikes		1000-Grain weight(g)		Grain weight /spike (g)	
sowing methods	Seeding rates	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22
Drilling	30 kg/fed	297.94	299.17	68.89	52.24	51.9	67.5	3.57	3.52
	45 kg/fed	308.49	309.78	66.44	52.78	59.3	68.7	3.93	3.62
	60 kg/fed	303.43	299.68	69.33	52.51	52.6	65.1	3.62	3.42
Broadcasting	30 kg/fed	292.86	289.52	70.33	51.36	46.6	68.0	3.26	3.49
	45 kg/fed	303.02	303.71	68.33	49.62	53.7	71.3	3.64	3.53
	60 kg/fed	300.48	296.51	68.33	52.04	44.9	66.6	3.04	3.47
Hills	30 kg/fed	285.24	296.19	67.33	53.07	45.8	66.3	3.07	3.51
	45 kg/fed	288.42	300.95	65.56	52.51	55.5	65. 7	3.60	3.44
	60 kg/fed	308.05	303.08	67.22	51.68	53.6	65.9	3.56	3.40
F-test		**	n.s	n.s	n.s	*	n.s	*	n.s
LSD at 0.05		11.66	n.s	n.s	n.s	4.9	n.s	0.32	n.s

*, **: significant at 0.05 and 0.01 levels of probability.

Table (4): Effect of interaction between sowing methods and seeding rates (A*B) on grain yield straw yield, biological yield and harvest index in two seasons.

Treatments		grain yield (ardab/fed)		straw yield (ton/fed)		biological yield (ton/fed)		harvest index %	
sowing methods	Seeding rates	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22
Drilling	30 kg/fed	21.3	21.59	4.94	5.37	8.13	8.61	39.3	37.7
	45 kg/fed	23.9	22.83	5.42	5.78	9.01	9.20	39.8	37.2
	60 kg/fed	23.6	22.70	5.47	5.80	9.02	9.21	39.3	37.0
Broadcasting	30 kg/fed	20.9	21.85	4.94	5.70	8.08	8.98	38.3	36.6
	45 kg/fed	21.3	22.19	4.92	5.49	8.12	8.82	39.3	37.8
	60 kg/fed	21.3	20.46	4.99	5.54	8.18	8.61	39.0	35.6
Hills	30 kg/fed	20.2	21.51	5.08	5.59	8.12	8.82	37.4	36.7
	45 kg/fed	22.0	21.33	5.11	6.17	8.41	9.37	39.2	34.1
	60 kg/fed	21.4	21.28	4.89	6.44	8.11	9.63	39.6	33.2
F-test		*	n.s	**	n.s	**	n.s	n.s	**
LSD at 0.05		0.4	n.s	0.49	n.s	0.73	n.s	n.s	1.5

*, **: significant at 0.05 and 0.01 levels of probability.

Table (5): Effect of interaction between sowing methods and varieties (A*C) on Number of spikes/m^2 Number of grains/spikes, 1000-Grain weight (g) and Grain weight /spike (g) in two seasons.

Treatments		Number of spikes/m^2		Number of grains/spikes		10000-Grain weight(g)		Grain weight /spike (g)	
sowing methods	Varieties	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22
Drilling	Sakha-95	300	299	72.56	51.22	51.58	65.11	3.73	3.33
	Sids-14	292	303	68.44	52.91	53.98	65.13	3.69	3.44
	Misr-3	317	307	63.67	53.40	58.23	71.00	3.70	3.79
Broadcasting	Sakha-95	295	292	75.11	51.36	42.05	65.80	3.16	3.38
	Sids-14	287	294	68.56	49.93	49.96	67.90	3.41	3.38
	Misr-3	315	303	63.33	51.74	53.20	72.21	3.38	3.73
Hills	Sakha-95	286	304	74.78	52.58	46.39	64.34	3.47	3.38
	Sids-14	290	290	64.11	52.88	53.77	62.65	3.40	3.31
	Misr-3	306	307	61.22	51.80	54.71	70.81	3.36	3.67
F-test		**	**	**	**	n.s	n.s	*	n.s
LSD at 0.05		5	5	1.89	1.12	n.s	n.s	0.18	n.s

*, **: significant at 0.05 and 0.01 levels of probability.

*, **: significant at 0.05 and 0.01 levels of probability.

Table (6): Effect of interaction between sowing methods and varieties (A*C) on grain yield straw yield, biological yield and harvest index in two seasons.

Treatments		**grain yield (ardab/fed)**		**straw yield (ton/fed)**		**biological yield (ton/fed)**		**harvest index** %	
sowing methods	**Varieties**	**Season 2020/21**	**Season 2021/22**	**Season 2020/21**	**Season 2021/22**	**Season 2020/21**	**Season 2021/22**	**Season 2020/21**	**Season 2021/22**
Drilling	Sakha-95	21.89	21.35	5.09	5.43	8.37	8.63	39.25	37.24
	Sids-14	22.26	21.92	5.12	5.65	8.46	8.93	39.50	36.82
	Misr-3	24.67	23.86	5.63	5.88	9.33	9.46	39.66	37.83
Broadcasting	Sakha-95	20.22	20.76	4.85	5.36	7.88	8.47	38.46	36.79
	Sids-14	21.48	21.20	5.08	5.56	8.31	8.74	38.79	36.41
	Misr-3	21.74	22.54	4.92	5.81	8.18	9.19	39.84	36.86
Hills	Sakha-95	21.33	20.48	5.12	5.84	8.32	8.92	38.47	34.59
	Sids-14	21.63	21.09	4.96	5.89	8.20	9.06	39.57	34.98
	Misr-3	20.70	22.56	5.02	6.46	8.12	9.84	38.24	34.43
F-test		**	**n.s**	**	**n.s**	**	**n.s**	*	**n.s**
LSD at 0.05		**0.27**	**n.s**	**0.28**	**n.s**	**0.46**	**n.s**	**0.98**	**n.s**

*, **: significant at 0.05 and 0.01 levels of probability.

The interaction between sowing methods, seeding rates and varieties (A*B*C) on No. of spikes/m^2, No. of grains/spike**,** 1000-grain weight, grain yield and straw yield was significant or highly significant in both seasons, grain weight/spike, Grain weight/spike and harvest index was highly significant in the first season, while biological yield was highly significant in the second season**,** as shown as in Table (9and 10). These results in accordance with those obtained by**. El-Seidy *et al.*, (2022).** Thus, the choice of sowing method, seeding rate and cultivar can significantly affect the production rates for all productive traits in agricultural practices.

Table (7): Effect of interaction between seeding rates and varieties (B*C) on Number of spikes/m^2 Number of grains/spikes, 10000-Grain weight (g) and Grain weight /spike (g) in two seasons.

Treatments		Number of spikes/m^2		Number of grains/spikes		1000-Grain weight(g)		Grain weight /spike (g)	
Seeding rates	Varieties	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22
30 kg/fed	Sakha-95	283.18	293.65	73.00	52.20	46.69	64.41	3.40	3.36
	Sids-14	285.08	290.60	71.67	52.56	45.92	65.14	3.29	3.42
	Misr-3	307.78	300.63	61.89	51.92	51.69	72.17	3.20	3.74
45 kg/fed	Sakha-95	294.60	304.44	72.89	51.38	50.53	66.63	3.68	3.42
	Sids-14	292.44	299.63	63.44	51.29	58.15	67.14	3.68	3.42
	Misr-3	312.87	310.38	64.00	52.24	59.78	71.89	3.82	3.76
60 kg/fed	Sakha-95	303.16	297.14	76.56	51.58	42.80	64.20	3.28	3.31
	Sids-14	291.57	296.51	66.00	51.88	53.64	63.40	3.53	3.29
	Misr-3	317.23	305.62	62.33	52.78	54.68	69.96	3.41	3.69
F-test		**	n.s	**	n.s	**	n.s	**	n.s
LSD at 0.05		5.26	n.s	1.89	n.s	3.04	n.s	0.18	n.s

*, **: significant at 0.05 and 0.01 levels of probability.

Table (8): Effect of interaction between seeding rates and varieties (B*C) on grain yield straw yield, biological yield and harvest index in two seasons.

Treatments		grain yield (ardab/fed)		straw yield (ton/fed)		biological yield (ton/fed)		harvest index %	
Seeding rates	Varieties	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22
30 kg/fed	Sakha-95	19.93	20.92	5.01	5.08	8.00	8.22	37.42	38.21
	Sids-14	21.15	21.27	4.89	5.50	8.06	8.69	39.37	36.72
	Misr-3	21.33	22.76	5.07	6.07	8.27	9.49	38.69	36.05
45 kg/fed	Sakha-95	21.85	21.17	4.93	5.78	8.21	8.96	39.89	35.50
	Sids-14	22.22	21.63	5.14	5.82	8.47	9.07	39.34	35.82
	Misr-3	23.11	23.56	5.38	5.83	8.85	9.37	39.15	37.77
60 kg/fed	Sakha-95	21.67	20.50	5.11	5.76	8.36	8.84	38.87	34.89
	Sids-14	22.00	21.30	5.13	5.77	8.43	8.97	39.14	35.66
	Misr-3	22.67	22.64	5.12	6.24	8.52	9.64	39.91	35.31
F-test		n.s	n.s	**	**	n.s	**	**	**
LSD at 0.05		n.s	n.s	0.28	0.5	n.s	0.62	0.98	1.09

*, **: significant at 0.05 and 0.01 levels of probability.

Conclusion:

With regard to this study, it is preferable to use the sowing method by drill with a seed rate of 45 kg / feddan with the cultivar Misr 3, as it was the best treatment for wheat cultivation and increasing grain yield under these conditions.

Table (9): Effect of interaction among sowing methods, seeding rates and varieties (A*B*C) on Number of spikes/m2 Number of grains/spikes, 1000-Grain weight and Grain weight /spike in two seasons.

Treatments			Number of spikes/m^2		Number of grains/spikes		1000-Grain weight(g)		Grain weight /spike (g)	
sowing methods	Seeding rates	Varieties	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22
Drilling	30 kg/fed	Sakha-95	293.33	298.10	70.00	50.93	49.02	65.52	3.43	3.33
		Sids-14	285.71	298.47	72.33	53.00	51.61	65.44	3.73	3.47
		Misr-3	314.77	300.95	64.33	52.80	54.95	71.40	3.53	3.77
	45 kg/fed	Sakha-95	304.76	308.57	71.00	51.47	59.61	67.42	4.23	3.47
		Sids-14	302.10	308.40	65.67	53.13	54.86	66.59	3.60	3.53
		Misr-3	318.60	312.38	62.67	53.73	63.44	71.97	3.97	3.87
	60 kg/fed	Sakha-95	302.86	291.43	76.67	51.27	46.10	62.39	3.53	3.20
		Sids-14	289.51	300.95	67.33	52.60	55.46	63.36	3.73	3.33
		Misr-3	317.92	306.67	64.00	53.67	56.29	69.63	3.60	3.73
Broadcasting	30 kg/fed	Sakha-95	280.00	280.00	76.00	51.60	44.45	65.98	3.37	3.40
		Sids-14	287.62	291.43	71.67	51.33	44.76	64.97	3.20	3.33
		Misr-3	310.95	297.14	63.33	51.15	50.61	73.02	3.20	3.73
	45 kg/fed	Sakha-95	299.05	301.90	73.00	51.13	42.87	66.46	3.13	3.40
		Sids-14	293.33	299.05	66.33	46.67	57.82	74.39	3.83	3.47
		Misr-3	316.67	310.19	65.67	51.07	60.40	73.13	3.97	3.73
	60 kg/fed	Sakha-95	304.76	295.24	76.33	51.33	38.84	64.95	2.97	3.33
		Sids-14	280.00	291.43	67.67	51.80	47.31	64.35	3.20	3.33
		Misr-3	316.67	302.86	61.00	53.00	48.61	70.48	2.97	3.73
Hills	30 kg/fed	Sakha-95	276.20	302.86	73.00	54.07	46.59	61.73	3.40	3.33
		Sids-14	281.90	281.90	71.00	53.33	41.39	65.00	2.93	3.47
		Misr-3	297.62	303.81	58.00	51.80	49.50	72.08	2.87	3.73
	45 kg/fed	Sakha-95	280.00	302.86	74.67	51.53	49.12	66.01	3.67	3.40
		Sids-14	281.90	291.43	58.33	54.07	61.77	60.44	3.60	3.27
		Misr-3	303.35	308.57	63.67	51.93	55.49	70.57	3.53	3.67
	60 kg/fed	Sakha-95	301.86	304.76	76.67	52.13	43.46	65.27	3.33	3.40
		Sids-14	305.19	297.14	63.00	51.23	58.16	62.50	3.67	3.20
		Misr-3	317.10	307.35	62.00	51.67	59.13	69.77	3.67	3.60
F-test			*	*	**	**	**	*	**	n.s
LSD at 0.05			9.12	8.15	3.27	1.94	5.27	4.83	0.31	n.s

*, **: significant at 0.05 and 0.01 levels of probability.

Table (10): Effect of interaction among sowing methods, seeding rates and varieties (A*B*C) on grain yield straw yield, biological yield and harvest index in two seasons.

Treatments			grain yield (ardab/fed)		straw yield (ton/fed)		biological yield (ton/fed)		harvest index %	
sowing methods	Seeding rates	Varieties	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22	Season 2020/21	Season 2021/22
Drilling	30 kg/fed	Sakha-95	20.89	20.89	4.68	4.88	7.82	8.02	40.10	39.06
		Sids-14	20.78	21.44	4.93	5.62	8.05	8.83	38.77	36.42
		Misr-3	22.22	22.44	5.20	5.62	8.53	8.98	39.05	37.51
	45 kg/fed	Sakha-95	22.78	21.39	5.15	5.84	8.57	9.05	39.88	35.44
		Sids-14	22.78	21.56	5.17	5.55	8.58	8.78	39.84	36.86
		Misr-3	26.11	25.56	5.95	5.93	9.87	9.77	39.73	39.25
	60 kg/fed	Sakha-95	22.00	21.78	5.43	5.55	8.73	8.82	37.78	37.21
		Sids-14	23.22	22.76	5.25	5.77	8.73	9.18	39.89	37.17
		Misr-3	25.67	23.58	5.73	6.08	9.58	9.62	40.21	36.73
Broadcasting	30 kg/fed	Sakha-95	20.00	21.38	4.88	5.33	7.88	8.53	38.02	37.73
		Sids-14	21.44	21.22	4.92	5.48	8.13	8.67	39.55	36.79
		Misr-3	21.22	22.96	5.03	6.29	8.22	9.73	38.72	35.38
	45 kg/fed	Sakha-95	20.22	21.58	4.80	5.33	7.83	8.57	38.71	37.75
		Sids-14	21.56	22.44	5.10	5.82	8.33	9.18	38.79	36.66
		Misr-3	22.11	22.56	4.87	5.32	8.18	8.70	40.52	38.94
	60 kg/fed	Sakha-95	20.44	19.33	4.87	5.42	7.93	8.32	38.65	34.87
		Sids-14	21.44	19.93	5.23	5.38	8.45	8.37	38.03	35.79
		Misr-3	21.89	22.11	4.87	5.83	8.15	9.15	40.29	36.26
Hills	30 kg/fed	Sakha-95	18.89	20.50	5.47	5.04	8.30	8.12	34.14	37.84
		Sids-14	21.22	21.16	4.82	5.41	8.00	8.58	39.79	36.97
		Misr-3	20.56	22.89	4.97	6.32	8.05	9.75	38.29	35.26
	45 kg/fed	Sakha-95	22.56	20.54	4.85	6.17	8.23	9.25	41.09	33.32
		Sids-14	22.33	20.89	5.15	6.10	8.50	9.23	39.40	33.93
		Misr-3	21.11	22.56	5.33	6.25	8.50	9.63	37.21	35.11
	60 kg/fed	Sakha-95	22.56	20.40	5.03	6.32	8.42	9.38	40.20	32.60
		Sids-14	21.33	21.22	4.90	6.17	8.10	9.35	39.51	34.03
		Misr-3	20.44	22.22	4.75	6.82	7.82	10.15	39.23	32.92
F-test			*	*	**	*	n.s	**	**	n.s
LSD at 0.05			0.46	0.4	0.5	0.87	n.s	1.07	1.7	n.s

*, **: significant at 0.05 and 0.01 levels of probability.

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