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RESEARCH ARTICLE

Comparison between wheat conventional planting methods and raised beds method using three seeding rates under Upper Egypt conditions.

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Abstract

Wheat grain yield can be improved by using appropriate planting method with a balanced seeding rate. The experiment was conducted during the two successive growing seasons, i.e. 2019/2020 and 2020/2021 at Almatana Agricultural Research Station, Agricultural Research Center, Egypt. The experiment was grown in a split plot arrangement in randomized complete block design with three replications, where the main plots were allocated to planting methods and seeding rates were represented in the split plots. The objective was to study the impact of three planting methods, i.e., broadcasting, drilling (conventional) and raised beds using three seeding rates, i.e., 35, 45 and 60 kg fed^{-1} (fed^{-1} = 4200 m^2) on yield and yield components of wheat cultivar Misr3. Results showed that grain yield and its components traits were significantly affected by different planting methods and seeding rates. Concerning to the interaction between planting methods and seeding rates it was significantly affected number of kernels/$spike^{-1}$ and grain yield (ardab/fed^{-1}). Raised Beds method produced the maximum grain yield (21.98 ardab/fed^{-1}) compared to the conventional methods; drilling method (16.41 ardab/fed^{-1}) and broadcasting method (14.28 ardab/fed^{-1}). Regarding to the seeding rates results found that 60 kg/fed^{-1} was the best seeding rate for conventional planting methods, while 45 kg/fed^{-1} seeding rate was the best for raised bed planting method.

Keywords: Bread wheat; raised beds; seeding rates.

1. Introduction

Wheat is the supreme grain crop perceived as a main food for the Egyptian citizens. Wheat local production could not face the consumption due to the increased inhabitants with a limited cultivated area in addition to the scarcity of water resources (El-Shaer *et al.*, 1997; Eid *et al.*, 1999). Thus, increasing the productivity of wheat is the principal mission owing to lack production. The most aspects that drive to rise grain yield are releasing new varieties with high yielding potential, sowing in favorable date and in proper method, as well as application of appropriate practices such as irrigation, fertilization, weed and pest control, and the ideal storage (Aglan *et al.*, 2002).

Wheat is one of the most worldwide cultivated grain crops that play an essential role in human food security (Hossain *et al.*, 2021). In Egypt wheat is grown between latitudes 25°N and 31°N. Most of the wheat area 65% situated in the Delta governorates, and there are small areas in each of Middle Egypt 18% and Upper Egypt 17% (Majeed *et al.*, 2015). Upper Egypt region situated in the southern part of the country; the region is characterized by high temperature. Wheat is the main staple crop in Egypt and regarded as a strategic product, which is considered a principal component in the Egyptian food.

Climate change is one of the overpowering environmental risks, including high temperature (El-Massah and Omran, 2014). Planting method

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plays an essential role in the placing of grain at appropriate depth, which finally affects plant growth (Sikander *et al.*, 2003). On the other hand, the inappropriate planting method could cause a reduction in grain yield owing to seeding rate. In Egypt, wheat is grown in 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). Raised beds method is one of the successful planting methods that enhancing water and fertilizer use efficiency and also decrease weed infestation and crop lodging (Hobbs and Morris., 2011). This study was conducted to determine the potential interactions between planting methods and seeding rate on grain yield and its components under Upper Egypt climate, aiming to produce higher grain yield.

2. Materials and methods

2.1. Experimental site and design

Field experiment was conducted in 2019/2020 and 2020/2021 growing seasons at Almatana agricultural Research Station, Agricultural Research Center, Luxor, Upper Egypt, latitude: 25°25'18"N, longitude: 32°32'06"E and 81 m above mean sea level (MSL).

The experiment was laid out as a split plot arrangement in randomized complete block design with three replications in a net plot size of 6x7 m = 42m^2, where the main plots were allocated to planting methods and seeding rates were represented in the split plots. The soil of the experimental site was clay loam in texture, slightly alkaline in reaction (pH 7.75).

2.2. Experiment treatments

Bread wheat cultivar Misr3 was sown on November 20th in both seasons. The treatments of the experiment were as following:

Planting method 1 (PM_1): (Broadcasting) in this method the seeds were hand broadcasted and then used harrowing to cover them.

Planting method 2 (PM_2): (Drilling) in this method seeds were sown by seed drill with 15 cm between rows.

Planting method 3 (PM_3): (Raised Beds) hilling bed planting on 120 cm (center-to-center of furrows) wide with six rows bed^{-1} with 15 cm between rows and 10 cm between hills and the height of beds was 40 cm. Raised beds were made manually following the conventional land preparation.

Three seeding rates were evaluated as following:

Seeding rate 1 (SR_1): 35 kg/fed^{-1}

Seeding rate 2 (SR_2): 45 kg/fed^{-1}

Seeding rate 3 (SR_3): 60 kg/fed^{-1}

The studied agronomic characters were number of spikes/m^{-2} (S/m^2), number of kernels/spike^{-1} (K/S), 1000-grain weight (1000-KW), g and Grain yield (GY) ardab/fed^{-1}. Data were subjected to analysis of variance (ANOVA). Combined analysis across the two growing seasons was performed when the assumption of errors homogeneity cannot be rejected (Levene, 1960).

3. Results and discussion

3.1. Combined analysis of variance

Mean squares for the combined analysis of variance of the collected data are presented in (Table 1). The results showed that seasons had a significant effect on all the studied characters except number of kernels/spike^{-1}. Meanwhile, planting methods mean squares had a significant effect on all the studied characters. In addition, seeding rates were highly significant for all the studied characters. The interaction between seasons and planting methods showed significant differences only for number of spikes/m^{-2}.

On the other side planting methods and seeding rates interaction was significantly affected number of kernels/spike^{-1} and grain yield. Significant difference was recorded between seasons, planting methods and seeding rates interaction for number of kernels/spike^{-1}.

Table 1. Combined analysis of variance for the studied characters as affected by planting methods and seeding rates of the two growing seasons (2019/2020 and 2020/2021).

S.O.V	d.f	M.S			
		S/m^2	K/S	1000-KW	GY
Season (S)	1	10416.7**	98.69	126.90*	41.52*
Error	4	3140.1	65.35	29.13	23.23
Planting Method (PM)	2	27943.6*	296.52*	320.30*	284.59**
S x PM	2	226.9*	6.741	8.863	0.423
Error	8	3841.9	51.69	47.88	14.841
Seeding Rate (SR)	2	77716.5**	392.13**	108.06**	205.40**
S x SR	2	144.7	5.13	2.618	0.462
PM x SR	4	726.5	98.24*	4.118	22.981*
S x PM x SR	4	130.9	1.852*	1.153	0.224
Error	24	892.6	31.40	15.66	4.662

* and ** Significant and highly significant at 0.05 and 0.01 levels of probability, respectively.

3.2. Impact of planting methods

Concerning to the planting methods results reported in (Table 2). Significant effects among planting methods were detected for yield and yield components.

The Highest number of spikes/m^{-2} was produced by raised beds method (390.7) which was followed by drilling method (347.9), while the lowest number of spikes/m^{-2} was produced by broadcasting method (325.3). The best number of spikes per unit area produced from raised beds methods compared to the broadcasting method could have been due to better micro environment for wheat on beds, the cultivation at perfect and regular depth, commensurate distribution of seed and suitable amount of irrigation water as compared to conventional planting method (broadcasting). These results are in consent with those informed by Tanveer *et al*. (2003), Yuksel (2009), Chauhdary *et al*. (2015) and Shailendra *et al*. (2021), who concluded that raised bed sowing yielded higher number of spikes when compared to flat sowing methods (broadcasting and drilling methods).Significant effects between raised beds and broadcasting methods, were detected for number of kernels/spike^{-1}, and non-significant effect between raised beds and drilling planting methods. Raised beds method gave the highest number of kernels spike^{-1} (48.94), while broadcasting method had the lowest one (40.98). The possible reasons could be due to higher water and nutrient use efficiency resulting in best root development in raised beds compare to conventional methods. These results are backed by Tripathi *et al*. (2002), Alam *et al*. (2007) and Ozberk *et al*. (2009). They reported that bed sowing, showed significantly improved number of kernels/spike than conventional sowing methods.

Data in (Table 2) indicated insignificant effect between raised beds and drilling planting methods on 1000-kernel weight. Raised beds method had the highest 1000-kernel weight (49.68 g) which was followed by drilling method (45.19 g), while the broadcasting method had the lowest value (41.25 g). The heavier grains which obtained from raised beds may be owing to the best sunlight access in the canopy to the lower leaves, which gave more ability for grain filling, under raised beds sowing, while the lighter grains which produced under broadcasting method may be due to poor growth. These results are in line with those of Dawelbeit and Babiker (1997) and Tanveer *et al*. (2003).

Table 2. Mean comparisons of the studied characters affected by planting methods across all two growing seasons (2019/2020 and 2020/2021).

Planting method (PM)		Mean			
		S/m^2	K/S	1000-KW (g)	GY (ardab/fed^{-1})
Broadcasting	(PM_1)	325.3	40.98	41.25	14.278
Drilling	(PM_2)	347.9	44.61	45.19	16.411
Raised Beds	(PM_3)	390.7	48.94	49.68	21.979
LSD 0.05		37.6	5.53	5.32	2.961

Regarding to planting methods, there was a highly significant differences in grain yield between raised beds and broadcasting planting methods, and non-significant differences between broadcasting and drilling methods. Maximum grain yield 21.98 ardab/fed^{-1} was produced by raised beds method, while drilling method produced 16.41 ardab/fed^{-1} and the minimum grain yield was produced by broadcasting method 14.28 ardab/fed^{-1}. Superior grain yield in raised beds method might be owing to increase number of spikes per unit area and number of grains per spike (Table 2) in this planting method as compared to other conventional methods. These results are supported by Ahmad and Mahmood (2005), Yuksel (2009) and Chauhdary *et al*. (2015), who mentioned that wheat cultivated on beds gave higher yield than flat cultivated wheat.

3.3. Impact of seeding rates

Seeding rates had significant effects on grin yield and its components. Results in (Table 3) indicated significant differences between the three seeding rates. It is apparent from the results that there was linear increase in number of spikes/m^{-2} with increasing seeding rate. Between seeding rates, 35 kg/fed^{-1} produced significantly lower number of tillers (289.9) than that under seeding rates of 45 kg/fed^{-1} and 60 kg/fed^{-1} which produced (364.4 and 409.5) number of spikes/m^{-2}, respectively. These results are comparable with the work of Yuksel (2009) and Iqbal *et al*. (2010) who indicated that increasing seeding rate significantly increased the fertile spikes and total spikes.

Number of kernels/spike significantly differed between seeding rates. The second seeding rate (SR2) of 45 kg/fed^{-1} significantly yielded more number of kernel/spike 49.94. The third seeding rate (SR3) of 60 kg/fed^{-1} produced 43.87 kernel/spike, while the first (SR1) of 35 kg/fed^{-1} recorded the lowest number of kernels/spike 40.72. The increasing in number of kernels/spike^{-1} with the reduction in seed rate owing to the plant nutrients available in the soil were enough for the vegetative development and grain formation due to less competition for all important elements as compared to the higher number of plants per unit area. These results are in harmony with Abd El-Rady *et al*. (2016) and Abd El-Lattief (2011), who mentioned that by increasing seeding rate, the number of kernels/spike is reduced.

Looking at the results in (Table 3), it is clear that the heaviest 1000-kernel was observed for the plants which sown at seeding rate of 35 kg/fed^{-1} 48.05 g, while the lightest weight of 1000-kernel 43.25 g had the highest seeding rate of 60 kg/fed^{-1} and the second seeding rate of 45 kg/fed^{-1} produced 44.82 g for 1000-kernel. The results clearly showed that 1000-kernel weight was decreased by increasing seeding rate. That might be owing to the decrease in competition and shading between plants, which increased the production of total dry matter and therefor seed index. These findings are also in agreement with the results obtained by Chauhdary *et al*. (2015) and Soomro *et al*. (2009).

Table 3. Mean comparisons of the studied characters affected by seeding rates across all two growing seasons (2019/2020 and 2020/2021).

Seeding Rate (SR)	Mean			
	S/m^2	K/S	1000-KW (g)	GY (ardab/fed^{-1})
35 kg/fed^{-1} (SR_1)	289.9	40.72	48.05	14.06
45 kg/fed^{-1} (SR_2)	364.5	49.94	44.82	17.81
60 kg/fed^{-1} (SR_3)	409.5	43.87	43.25	20.80
LSD 0.05	20.6	3.86	2.72	1.485

Relating to grain yield data in (Table 3) results revealed that significant differences were obtained among the three seeding rates. The highest grain yield was 20.80 ardab/fed^{-1} using 60 kg/fed^{-1} (SR_3) followed by 17.81 ardab/fed^{-1} under seeding rate of 45 kg/fed^{-1} (SR_2), while the lowest seeding rate of 35 kg/fed^{-1} (SR_1) produced the minimum grain yield 14.06 ardab/fed^{-1}). Abd El-Lattief, (2011) and Abd El-Rady *et al*. (2016) mentioned that the reduction in grain yield using seeding rate of 35 kg fed^{-1} with broadcasting planting method may be due to poor growth and lower number of spikes per unit area.

3.4. Impact of planting methods and seeding rates interaction

The data in (Table 4) showed significant effect of the interaction between planting methods and seeding rates for number of kernels/spike^{-1} and grain yield, and insignificant effect of planting methods and seeding rates on number of spikes/m^{-2}. The highest number of spikes m^{-2} was observed with raised beds method using the seeding rate of 60 kg fed^{-1} (423.0). While the lowest number of spikes m^{-2} (257.0) was recorded under broadcasting method using the seeding rate of 35 kg fed^{-1}.

Table 4. Impact of planting method and seeding rates on grain yield characters of the two growing seasons (2019/2020 and 2020/2021).

Planting Methods (PM)	Seeding Rates (SR)	S/m^2	K/S	1000-KW (g)	GY (ardab/fed^{-1})
Broadcasting (PM_1)	35 kg/fed^{-1} (SR_1)	257.0	37.17	44.63	11.080
	45 kg/fed^{-1} (SR_2)	331.7	46.32	40.83	13.660
	60 kg/fed^{-1} (SR_3)	387.3	39.44	38.28	18.093
Drilling (PM_2)	35 kg/fed^{-1} (SR_1)	270.7	40.16	47.74	12.547
	45 kg/fed^{-1} (SR_2)	350.0	49.00	44.90	16.605
	60 kg/fed^{-1} (SR_3)	418.3	44.67	42.95	20.080
Raised Beds (PM_3)	35 kg/fed^{-1} (SR_1)	342.0	44.83	51.79	18.553
	45 kg/fed^{-1} (SR_2)	411.7	54.50	48.72	23.150
	60 kg/fed^{-1} (SR_3)	423.0	47.50	48.52	24.233
CV %		12.51	8.34	8.72	12.30
LSD 0.05 (PM x SR)		ns	6.677	ns	2.573

Concerning to the interaction effect on number of kernels/spike, results indicated that the raised beds planting method with the seeding rate of 45 kg fed^{-1} recorded the highest number of kernels/spike 54.50 followed by 49.00 kernels/spike for drilling planting method using 45 kg fed^{-1}, while broadcasting planting method with the seeding rate of 35 kg fed^{-1} produced the lowest number of kernels/spike (37.17).

The effect of the interaction between planting methods and seeding rates on 1000-kernel weight was insignificant. Maximum 1000-kernel weight 51.79 was produced by 35 kg/fed^{-1} seeding rate when planted under raised beds planting method.

On the other hand the minimum value of 1000-kernel weight 38.28 was observed by broadcasting planting methods with 35 kg/fed^{-1} seeding rate. The interaction between planting methods and seeding rates had significant effects on grain yield (ardab/fed^{-1}). Results in (Table 4) revealed that the highest grain yields 23.150 and 24.233 ardab/fed^{-1} were produced by raised beds planting method using 45 kg/fed^{-1} and 60 kg/fed^{-1} seeding rates, respectively. On the opposite side, broadcasting and drilling planting methods with the seeding rate of 35 kg/fed^{-1} recorded the lowest grain yields 11.080 and 12.547 ardab/fed^{-1}, respectively.

4. Conclusion

It is recommended that wheat need to be cultivated with the seeding rate of 45 kg/fed^{-1} by raised beds planting method to improve grain yield productivity under Upper Egypt conditions.

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This work carried out at department of wheat and followed all the department instructions.
Consent for Publication
Not applicable.
Conflicts of Interest
The authors declare no conflict of interest.

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