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ORIGINAL ARTICLE

Effect of Different Sowing Methods on The Growth and Yield of Wheat (*Triticum aestivum L.*)

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ABSTRACT

Background: An appropriate choice of a planting method is very vital for the fixation of seeds on their position to grow and develop well without any obstacles. In Pakistan, drilling and broadcast sowing methods are largely applied, but the most usable method is broadcast on a large land area. However, drilling method is better than broadcast method for many reasons as crop cultivation is greatly impacted by the seed rate. Drilling method needs lower seed rate and still gives good plant population.

Objectives: The aim of this work was to conduct the assessment of different sowing methods to observe their effects on the growth and yield of wheat to highlight the best method that can be utilized for the improvement and development of agriculture in the future.

Methodology: This research work was carried out on the field of Agronomy Section, ARI, Tandojam Sindh, Pakistan (GPS coordinates 25° 25' 35.58" N and 68° 31' 29.568" E) for assessing the effect of different sowing methods on wheat yield and other traits during 2017-2018. The research was carried out using three replications in Split Plot Design with treatments in which Factor A consisted of sowing methods and Factor B comprised of varieties.

Results: The collected data on parameters indicated that maximum tillers (385m^{-2}), spike length (14cm), spikelets spike-1 (21), grains spike-1 (58), seed index (77g), biological yield (11822$kg.ha^{-1}$) and grain yield (7751$kg.ha^{-1}$) were recorded in Triple Dwarf (TD-1) wheat variety of Sindh. However, the maximum plant height (87cm) was recorded in Sindhu. In case of drilling sowing methods, maximum tillers, plant height, spike length, spikelets spike-1, grains spike-1, seed index, biological yield and grain yield were found to be of 340m^{-2}, 92cm, 13cm, 18, 48, 63g, 10132$kg.ha^{-1}$ and 6691$kg.ha^{-1}$, respectively. However, low values for all these parameters were recorded under the broadcast method.

Conclusion: It was concluded from present findings that TD-1 x drilling sowing method remained the most suitable interaction for getting more yield of wheat than other varieties and sowing methods.

Keywords	*Address of Correspondence	Article info.
Broadcasting method, Drilling, Growth, Sowing method, Wheat, Yield.	*jaykumar3030@gmail.com; mschang@sau.edu.pk*	*Received: July 06, 2021 Accepted: March 24, 2022*

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INTRODUCTION

Wheat is the world's most vital cereal without which no one can live. According to an estimates, 36% of the world's population consumes wheat. To be used as a staple food, the crop is grown in more than 40 nations on the planet[1].

In comparison with other higher grain producing countries, Pakistan is far behind in average yield competition. Out of the total area under cultivation, 37% is occupied by this crop and it shares 70% in the Rabi crops in Pakistan[2]. Wheat demand is mostly fulfilled by Punjab and Sindh in Pakistan, with Punjab ranking as the first in wheat production, followed by Sindh.

Crop management factors such as sowing methods, seed rate, and genotypes, all have an impact[3, 4]. Low production is caused by a wide range of reasons such as soil fertility, proper irrigation, resistance to weeds and sowing methods. Choice of planting method is vital for fixation of seeds in their position to germinate for better growth and development in the future without any obstacles. According to the Pakistan Bureau of Statistics, the most widely eaten crop in Pakistan is wheat, which is produced in 25979.4 million tons over an area of 9199.3 million hectares[5].

Seed rate is the only factor which governs planting density by affecting crop growth, nutrient uptake, tillering capacity and finally grain yield, through plant-to-plant competition. Many researchers advocate drilling plantation as the seeds are phenotypically similar and can reach appropriate depths owing to this method[6, 7].

In the modern world of science, new techniques have been developed to increase the yield per unit area by sowing the wheat seed after utilizing different approaches such as bed planting introduced by Turkey. Further parameters include proper germination-free from the attack of weeds, and other biotic/abiotic constraints recommended for good wheat cultivation. CIMMYT (Internacional de Mejoramiento de Maíz y Trigo) in Mexico also used this bed method for the cultivation of maize and wheat and gave good results. After these experiments, many benefits have been notified regarding wheat cultivation on beds. Developed countries put this method into practice and have greatly succeeded in wheat production[8].

Apart from sowing methods, sowing time, and sowing of different desirable and high yielding cultivars are also of great importance because they also contribute significantly to better cultivation of the wheat crop. In some regions, crops are early sown while in others, they are sown late, but the most suitable time is early sowing especially for good cultivation of wheat crop. Due to early sowing, uniform seedling emergence with vigorous growth and development take place. Poudel *et al*. suggested that crop production and productivity must be augmented to feed the expected population of 9.1 billion up to 2050. Henceforth, the research was planned to analyze the effects of a wide range of seed sowing methods on the growth and yield of wheat so that the best method can be utilized for the improvement and development of agriculture in the future.

MATERIALS AND METHODS

Experimental Site

This research work was carried out on the field of Agronomy Section, ARI, Tandojam Sindh, Pakistan (GPS coordinates 25° 25' 35.58" N and 68° 31' 29.568" E) for assessing the effect of different sowing methods on wheat yield and other traits during 2017-2018. The bulk density ranged from 1.30 to 1.37g.cm^{-3} in the soil profile. The available water holding capacity of the soil was 85.2mm to 60cm^{-1}. The water quality classification was determined as C2S1 according to the USA Salinity Laboratory Graph System (EC=0.625dsm^{-1}, SAR=0.61).

Experimental Design

Factorial split plot design was practiced with three replications. The details of treatments and factors are as follows:

Treatments = (Two factors A and B)

Factor A: Sowing methods (02)

M1 = Drilling

M2 = Broadcasting

Factor B: Varieties (03)

V_1 = TD-1

V_2 = Imdad-2005

V_3 = Sindhu

Land Preparation

The land was prepared by applying two dry ploughs. After the soaking dose, when the soil reached correct wetness level, two cultivator ploughs were applied to the seedbed thoroughly. Three different kinds of chemical fertilizers were applied including Urea, Diammonium Phosphate (DAP) and Sulphate of Potash (SOP) for the requirement of NPK (Nitrogen, Phosphorus, Potassium) (120:75:56kg.h^{-1}) in which Diammonium phosphate (DAP) and Sulphate of Potash (SOP) and one fourth of urea were

applied as basel dose at the time of sowing with seed cum fertilizer drill. The remaining dose of nitrogen was applied in three splits, first at the seedling or emergence stage, second at tillering, and third at the dough stage of wheat crop for proper growth and development. Cultural practices were also applied for different purposes like freeing the crop from weed and insect attack. To capture agronomic observations, five plants were chosen at random and labeled from each plot. Manual calculation of values was done for the number of tillers, spikelets grains, and plant height (by ruler), however, the digital calculation of electric balance was used for seed index, biological yield, and grain yield.

Formula for Biological yield (kg.ha^{-1})

$$BY\ (kg.ha^{-1}) = \frac{BY\ (plot^{-1})}{Plot\ size\ (m^{-1})}\ x\ 10{,}000$$

Formula for Grain yield (kg.ha^{-1})

$$GY\ (kg.ha^{-1}) = \frac{GY\ (plot^{-1})}{Plot\ size\ (m^{-1})}\ x\ 10{,}000$$

Statistical Analysis

ANOVA and the least significant difference test was applied according to the methods developed by Torrie *et al*., 1980[8] to compare treatments superiority.

RESULTS AND DISCUSSION

Tillers (m^{-2})

Hexaploid ranks globally as a highly important staple food consumed all over the world at a time. Results showed variable and desirable differences of wheat genotypes for tillers (m^{-2}) at probability level P < 0.05 under two different seed sowing methods (Table **1**). The results of different wheat varieties indicated that the maximum tillers (385m^{-2}) were recorded by TD-1 variety, followed by Imdad-2005 (336m^{-2}), respectively, while the minimum tillers (280m^{-2}) were observed in the Sindhu variety. For sowing methods, maximum tillers (340m^{-2}) were seen for the drilling sowing method and minimum tillers (327m^{-2}) were noted in the broadcasting sowing method. Nevertheless, the highest and the lowest values for this attribute (394m^{-2} and 275m^{-2}) were articulated by variety x sowing methods under the interaction of TD-1 x drilling-sowing method, and Sindhu x broadcasting sowing method (Table **1**)[9]. Sikander *et al.,* 2003 demonstrated the same effects of sowing methods for wheat cultivars in his experiment. It was stated by Sikander *et al*., 2003[10] that plant growth is affected by proper and improper method of seed sowing. They further noted that the highest plant emergence was observed in the drilling method. Flat and bed sowing methods for wheat were also tested by Mehmood *et al*., 2013[11] and it was concluded that triple-row bed-sowing method was the most suitable for proper seed setting. It was concluded by Bakhsh *et al*., 2020[12] that the drilling method was more effective for high production of tillers which resulted in more grain yield per plant.

Table 1. Tillers (m^{-2}) of Wheat Genotypes under Different Sowing Methods.

Varieties	Sowing Methods		Mean for Varieties
	Drilling	Broadcasting	
TD-1	394	375	385 A
Imdad-2005	342	331	336 B
Sindhu	284	275	280 C
Mean for Methods	340 A	327 B	-
	Varieties	**Sowing Method**	**Varieties x Sowing Method**
S.E ±	3.3015	2.6957	4.6690
L.S.D $_{0.05\%}$	7.3562	6.0063	10.403

Table 2. Plant Height (cm) of Wheat Genotypes under Different Sowing Methods.

Varieties	Sowing Method		Means of Varieties
	Drilling	Broadcasting	
TD-1	76	67	78 C
Imdad-2005	88	79	84 B
Sindhu	98	90	87 A
Mean for Methods	92 A	74 B	-
	Varieties	**Sowing Method**	**Varieties x Sowing Method**
S.E ±	1.2168	0.9935	1.7208
L.S.D $_{0.05\%}$	2.7111	2.2136	3.8341

Table 3. Spike Length (cm) of Wheat Genotypes under Different Sowing Methods.

Varieties	Sowing Methods		Means of Varieties
	Drilling	Broadcasting	
TD-1	16	12	14.A
Imdad-2005	13	10	11 B
Sindhu	10	9	10 C
Mean for Methods	13 A	10 B	-
	Varieties	**Sowing Method**	**Varieties x Sowing Method**
S.E ±	0.6824	0.5572	0.9651
L.S.D $_{0.05\%}$	1.5205	1.2415	2.1503

Plant Height (cm)

Yield development and efficiency may contrast under various planting strategies and planting densities. The consequences of various wheat cultivars showed that the maximum plant height (87cm) was recorded for Sindhu, followed by Imdad-2005 (84cm) whereas, the minimum plant height (78cm) was verified in TD-1. In case of sowing methods, the longest and shortest plants (92cm and 74cm) were found at the drilling and broadcasting method. On the basis of interaction between varieties x sowing methods, long and short plants (98cm and 67cm) were identified in the interaction of Sindhu x drilling sowing and TD-1 x broadcasting sowing method[13] (Table **2**). Dagash *et al*., 2014 likewise determined the impact of plant height in drilling practice when contrasted with broadcast approach. These outcomes were in agreement with Dagash *et al*., 2014[14]. It was also reported by Twizerimana *et al*., 2020[15] that for more grain yield, it is very important to use different kinds of sowing methods so that the high yield values can be identified. The drilling method is advantageous, although it has low population but it produces high production. Therefore, Özberk *et al*., 2009[16], and Tapley *et al*., 2013[17] suggested that low plant population is only created by less seed rate, which reduced the competition between plant-to-plant for survival resources.

Spike Length (cm)

Awoke *et al*., 2017[18] and Kiliç *et al*., 2010[18, 19] reported that crop growth and development are considerably affected by the planting method due to the seed's placement in their depth. The results of different wheat varieties indicated that TD-1 had the longest spikes (14cm), followed by Imdad-2005 (11cm), with Sindhu having the shortest spikes (10cm). In sowing methods, the maximum and minimum spike length (13cm and 10cm) were detected in the drilling and broadcasting sowing method. Nevertheless, the collaboration revealed that the longest and shortest spikes (16cm and 9cm) were measured for TD-1 x drilling sowing and Sindhu x broadcasting sowing method (Table **3**). Our findings matched those of Attaullah *et al*., 2007[20], who conducted an experiment with wheat to determine the

effects of various planting approaches on various agronomic characteristics. Our findings differed from those of Meleha *et al*., 2020[21], as the broadcasting approach for seed planting performed better than the other methods. Belete *et al*., 2018[22] applied different planting methods, which gave good results for most of the traits, but broadcast methods became valuable in their study. For this support, according to Zohaib *et al.,* 2019[23,] and Muhammad *et al.,* 2009[24], sowing methods impact various varieties of the same species in different ways, with some types responding better to drilling and others to broadcasting.

Spikelets spike-1

Because of the cultivation of wheat in diversified conditions, spikelets spike-1 reacts variably with the practices of crop management. The findings of several wheat genotypes revealed that TD-1 and Sindhu had the highest and lowest number of spikelets spike-1 (21 and 12), respectively (Table **4**). In case of sowing methods, the maximum spikelets spike-1 (18) was expressed in the drilling-sowing method and minimum spikelets spike-1 (15) was observed with broadcasting-sowing method. Nonetheless, the highest and the lowest values for this character (23 and 11) were articulated by variety x sowing methods in TD-1 x drilling sowing method and Sindhu x broadcasting sowing method (Table **4**). As it has been discussed that drilling methods require low seed rate, which decreases plant population and brings about more spikelets on a single spike and high seed index, because plants show less competition between themselves for available resources. Comparable outcomes were likewise found by Chaudhary *et al*., 2015[25].

According Poudel *et al*., 2020[26], wheat yield and water productivity can be increased by sowing on beds with a managed seed rate. As per Meleha *et al*., 2020[27], there are a variety of causes for low wheat yield, including planting approaches. So, it is very important to apply a suitable sowing method which must be beneficial for the increase of yield. Inappropriate planting method owing to seed rate and crop management always gives low yield[28].

Table 4. Spikelets spike-1 of Wheat Genotypes under Different Sowing Methods.

Varieties	Sowing Methods		Means of Varieties
	Drilling	Broadcasting	
TD-1	23	19	21 A
Imdad-2005	16	15	15 B
Sindhu	14	11	12 C
Mean for Methods	18 A	15 B	-
	Varieties	**Sowing Method**	**Varieties x Sowing Method**
S.E ±	0.4240	0.3462	0.5996
L.S.D $_{0.05\%}$	0.9447	0.7714	1.3361

Table 5. Grains spike-1 of Wheat Genotypes under Different Sowing Methods.

Varieties	Sowing Methods		Means of Varieties
	Drilling	Broadcasting	
TD-1	62	55	58 A
Imdad-2005	47	43	45 B
Sindhu	39	35	37 C
Mean for Methods	48 A	45 B	-
	Varieties	**Sowing Method**	**Varieties x Sowing Method**
S.E ±	1.0971	0.8958	1.5515
L.S.D $_{0.05\%}$	2.4444	1.9959	3.4569

Grains spike-1

The application of drilling sowing method provides many advantages like double cropping, controlled soil moisture, and narrow row spacing. The findings of wheat varieties revealed that TD-1 seemed to have the highest number of grains spike-1 (58), followed by Imdad-2005 (45), and Sindhu could have the lowest number of grains spike-1 (37) (Table **5**). For sowing methods, the maximum grains spike-1 (48) was observed with the drilling-sowing method and minimum grains spike-1 (45) was counted with the broadcasting sowing method. TD-1 x drilling sowing method and Sindhu x broadcasting sowing method, however, produced the highest and lowest values for this trait (62 and 35) (Table **5**). Naresh *et al.,* 2013[29] succeeded in obtaining good results from their experiment under different sowing methods. Resource availability including sunlight capture, moisture and nutrient availability are enhanced by a proper seed sowing method, which leads to ultimately good root system for its initial growth and development from a seedling to a mature plant. For increasing the number of grains in a single spike, 30. Debebe *et al.,* 2016[30] recommended the drilling method and suggested that wheat production can also be increased by different sowing methods such as ridge sowing method, which included more seed rate. This method was very helpful to increase the grain yield and to improve the productivity of wheat bread.

Seed Index (1000 grain weight-g)

Unsuitable sowing methods lead to unproductive crops due to the lodging, disease and pest attack resulting in lower yield. The results of different wheat varieties indicated that the heaviest seeds (77g) were recorded in TD-1, followed by Imdad-2005 (60g) (Table **6**). Whereas the lightest seeds (45g) were weighed for Sindh. In case of sowing methods, the maximum seed index (63g) was observed with drilling sowing method and minimum seed index (59g) was weighed with the broadcasting sowing method (Table **6**). Though, the interaction between varieties x sowing methods confirmed that heaviest and lightest seeds (81g and 43g) were obtained by TD-1 x drilling sowing method and Sindhu x broadcasting sowing method, respectively. The drilling method led to more growth and grain yield in the experiment of Singh *et al.,* 2009[31]. Ehsanullah *et al.,* 2017[32] investigated crop performance using several seed sowing methods and came up with some impressive end results in favor of the drilling approach. It was suggested by different scientists to use the most appropriate seed sowing methods which play a vital role for the improvement of crop management and crop productivity.

Table 6. Seed Index (g) of Wheat Genotypes under Different Sowing Methods.

Varieties	Sowing Methods		Mean for Varieties
	Drilling	Broadcasting	
TD-1	81	73	77 A
Imdad-2005	65	56	60 B
Sindhu	47	43	45 C
Mean for Methods	63 A	59 B	-
	Varieties	**Sowing Method**	**Varieties x Sowing Method**
S.E ±	1.2622	1.0306	1.7850
L.S.D $_{0.05\%}$	2.8124	2.2963	3.9773

Table 7. Biological Yield (kg.ha^{-1}) of Wheat Genotypes under Different Sowing Methods.

Varieties	Sowing Method		Means of Varieties
	Drilling	Broadcasting	
TD-1	12477	11166	11822 A
Imdad-2005	9392	8996	9194 B
Sindhu	8527	7767	8147 C
Mean for Methods	10132 A	9310 B	-
	Varieties	**Sowing Method**	**Varieties x Sowing Method**
S.E ±	215.19	175.70	304.33
L.S.D $_{0.05\%}$	479.48	391.49	678.08

Table 8. Grain Yield (kg.ha^{-1}) of Wheat Genotypes under Different Sowing Methods.

Varieties	Sowing Methods		Means of Varieties
	Drilling	Broadcasting	
TD-1	8283	7219	7751 A
Imdad-2005	6363	6303	6333 B
Sindhu	5426	4482	4954 C
Mean for Methods	6691 A	6001 B	-
	Varieties	**Sowing Method**	**Varieties x Sowing Method**
S.E ±	98.810	121.02	171.14
L.S.D $_{0.05\%}$	220.16	269.64	381.33

Biological Yield (kg.ha^{-1})

According to the findings of some wheat varieties, TD-1 have had the highest biological yield (11822kg.ha^{-1}), followed by Imdad-2005 (9194kg.ha^{-1}). Sindhu, on the other hand, had the lowest biological yield (8147kg.ha^{-1}). Under sowing methods, the maximum and minimum biological yield (10132kg.ha^{-1} and 9310kg.ha^{-1}) was observed with drilling method and broadcasting method. Yet, the highest and the lowest values for these characters (12477kg.ha^{-1} and 7767kg.ha^{-1}) were demonstrated by TD-1 x drilling sowing method and Sindhu x broadcasting sowing method (Table **7**). A suitable sowing method not only improves utilization of solar energy through the space between plant to plant, but also sets up a proper position of the crop in the soil[33, 34]. These results were in conformity with Krezel *et al.,* 2013[35] in favor of the drilling method. In the sowing method experiment, Ali *et al.,* 2014[36] discovered the same findings. Umed *et al.,* 2009[37] additionally announced the exhibition of bread wheat assortments under various line separations including drilling technique. Low yield due to broadcast method was also presented by Hayat *et al.,* 2017[38].

Grain Yield (kg.ha^{-1})

The TD-1 and Imdad-2005 genotypes generated the best grain production in terms of wheat genotype efficiency (7751 and 6333). Sindhu had the lowest grain yield (4954kg.ha^{-1}). In case of sowing methods, the drilling method (6691kg.ha^{-1}) produced more grain yield than the broadcast planting method (6001kg.ha^{-1}). However, the interaction between varieties x sowing methods articulated that maximum and minimum grain yield (8283kg.ha^{-1} and 4482kg.ha^{-1}) were observed under the variety TD-1 x drilling sowing method and Sindhu x broadcasting sowing method (Table **8**). Hossain *et al*., 2011[39] also found some good outcomes from their research work and concluded while experimenting with the genotypes of wheat. Increase in the yield was also supported by Harishankar *et al*., 2017[40] and Iqbal *et al*., 2020[41], informing about the parameters contributing to the rise in yield. The use of various crop sowing methods also aids in the crop yield and in conserving water by optimizing tillering capability, soil moisture content, and nutrient availability[42]. Drilling

methods were shown to be beneficial for cultural practices in crops and agricultural development by Kabesh *et al.,* 2009[43].

CONCLUSION

According to the data, wheat growth and yield were positively influenced by cultivars and planting methods. Variety TD-1 and drilling sowing method were likewise shown to have performed best in both the growth and yield metrics. The current data articulated that the variety of TD-1 x drilling sowing method is a good combination for generating the most wheat yield from other varieties and sowing methods. Finally, it was recommended that the drilling method was very good in showing better results and it would be very beneficial for farmers in the upcoming years.

CONFLICTS OF INTEREST

All authors have no conflict of interest.

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LIST OF ABBREVIATIONS

BY	Biological Yield
DAP	Diammonium Phosphate
GY	Grain Yield
NPK	Nitrogen, Phosphorus, Potassium
SOP	Sulphate of Potash
TD	Triple Dwarf

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