The impact of different sowing methods on wheat (*Triticum aestivum* L.) growth and yield in Sindh Pakistan

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Abstract: In conducted 2023 on TD-1 wheat (*Triticum aestivum* L.) variety growth and yield was examined. The study three sowing methods: T1 = Drilling, T2 = Broadcasting and T3 = Ridges. Parameters were showcasing a plant height of 63.30 cm, 452.67 m-2 tillers, 10.13 cm spike length, 15.00 spikelets in accordance with spike, 35.33 grains for each one spike, 43.66 g seed index (1000-grain weight), 6218 kg ha-1 biological yield, and 4325 kg ha-1 grain yield. The ridge-sown crop displayed characteristics such as 63.20 cm plant height, 313.33 m-2 tillers, 8.23 cm spike length, 13.33 spikelets contained in each spike, 33.66 grains through to each spike, 34.66 g seed index (1000-grain weight), 5614 kg ha-1 biological yield, and 3922 kg ha-1 grain yield. In broadcasting method yielded a plant height of 65.87 cm, 320.67 m-2 tillers, 9.03 cm spike length, 13.33 spikelets on account of spike, 36.00 grains for spike, 41.33 g seed index (1000-grain weight), 6371 kg ha-1 biological yield, and 4141 kg ha-1 grain yield. In conclusion, the drilling method proved to be the most favorable, resulting in a greater yield of grains of 4325 kg ha-1 compared to broadcasting (4141 kg ha-1) and ridge sowing (3922 kg ha-1).

Keywords: wheat, sowing methods, drilling, broadcasting, ridges, TD-1, growth, yield.

1 INTRODUCTION

A vital cereal crop, wheat (*Triticum aestivum* L.) is expected to produce 2,601 million tonnes of cereal worldwide in 2018, according to the Food and Agriculture Organization (FAO). Although this amount is about 10 million tonnes more than the projection from the previous month, it is still 57 million tonnes (2.1%) less than the record level set in 2017. Wheat, belonging to the gramineae family, stands as a primary staple food crop worldwide. Its origins trace back to southwestern Asia, spreading across Asia, Europe, Africa, and the Americas. Wheat cultivation predominantly occurs in temperate regions, characterized by an annual rainfall ranging from 10 to 70 inches. Excessive rainfall coupled with high temperatures can be detrimental to wheat growth, as these conditions foster the development of diseases. Monthly variations in wheat output throughout the world are caused by a number of reasons. Currently, adjustments to wheat production in China and Canada have been higher, balancing revisions to wheat production in Australia and the EU that are downward. According to projections, global wheat output in 2018 is expected to be close to 728 million tonnes, a fall of 4.3% from 2017 levels.

Looking ahead to the next year, the planting of winter wheat in the Northern Hemisphere is underway. Plantings in the US, India, and the EU may rise in response to anticipated lucrative pricing. On the other hand, weather-related worries can affect sowing in several areas of Pakistan and China (F.A.O 2018). Wheat holds significant importance as a staple cereal crop in Pakistan, cultivated since prehistoric times. Evidence of its past cultivation comes from archaeological discoveries such as burnt wheat grains in the excavations of Moen-jo-Daro and Harapa, as well as the discovery of presumed wild wheat parents (*Aegilops squarosa* and *Triticum turgidum*) on the uplands of Baluchistan. With an average yield of 2500 kg/ha, over 8 million acres are used to raise wheat in Pakistan. Challenges in achieving optimal grain yield may stem from inappropriate planting methods, seed rates, and overall crop management.

Sindh province emerges as a significant contributor to wheat production in Pakistan, following Punjab, especially as most wheat cultivation in the region occurs after the cotton crop. Consequently, the delay in wheat sowing within the cotton-wheat cropping system significantly contributes to a notable reduction in yield. Traditional methods of wheat planting often result in suboptimal yields. Hobbs and Gupta (2014) investigated the feasibility of drilling on raised beds for wheat cultivation and its suitability in the cotton-wheat cropping system; their findings showed higher grain yields when compared to broadcast and flatbed seeding. Mascagni et al (2016) emphasized advantages of drilling on raised beds for growing wheat, include the ability to quadruple crop efficient soil moisture management (drought and irrigation), and flexibility to narrow row spacing. Carver (2015) examined the effects of various crop establishment techniques in winter wheat. Although the broadcasting approach showed the most efficient geographical systematic there wasn't any discernible correlation among the geographical configurations and the produce results that followed. In accordance with a field test carried out in Uttar Pradesh, India, Singh et al. (2015) found that strip drilling produced the highest growth with grain production (5.67 t ha-1) in wheat drilling with no tillage, traditional planting beds and sowing coming next. Krezel and Sobkowicz (2014) observed that seeding in rows produced higher yields than broadcast sowing. The Fertile Crescent, an area in Southern West Asia, is where cultivated wheat first appeared (Anonymous, 2015). Emmer wheat and wild einkorn were house-trained about 10,000 years ago in the Levant, Syria, and Turkey, contributing to the beginning of agriculture in the Fertile Crescent. However, in Czech Republic by using intercropping method, the study found that the mixture of two crops for cultivation result in more growth and yield of wheat (Quanqi et al., 2013; Zhang et al., 2017; Hossain et al., 2016; Mühlbachová et al., 2022). It is the earliest archaeological evidence of wheat cultivation. The planting technique is a major factoring ensuring that seeds are planted at the correct depth, which in turn affects crop development. The quantity of residue on the field, the planting date, the soil's moisture content at that particular moment, and the type of planting machine all have a role in choosing the best planting technique for wheat. The most effective ways to plant wheat, maize, and cotton are raised bed and bridge planting according to Wang *et al* (2004), and Ortega *et al* (2008), (Gursoy *et al*., 2011). Drill sowing emerges as a recommended method due to its ability to guarantee consistent seed dispersion at the desired depth, leading to enhance due to its guarantee consistent dispersal of seeds at the desired depth, leading to enhanced germination and a consistent crop stand (Riffkin et al., 2003; Tariq et al., 2001). In Pakistan, broadcasting across a large region after rice and cotton harvest is necessary for subs tantial wheat planting.

In addition to requiring greater seed rates, broadcasting also reduces the number of plants. In contrast the drill sowing method is favored for its capacity to uniformly distribute seeds at the desired depth, typically resulting in increased germination rates and a more uniform stand. Recognizing the pivotal role of early crop establishment, especially in achieving optimal wheat production, this study was conceived to identify the most effective sowing methodology and seed value for maximizing wheat yield (Umed et al., 2009). The utilization of bed planting order has ingrained into cultivation practices for number of decades primarily associated with water management concerns.

Historically, raised-bed farming has helped high production irrigated systems become more effective at irrigation or has solved problems with surplus water in rainfed circumstances (Fahong et al., 2014). Farmers in irrigated regions have adopted an innovative approach during the past 20 years, wherein wheat is planted on top of beds in specified rows, with irrigation provided in furrows between the beds. This method is accepted by more than 95% of farmers of wheat and other crops, has significantly improved irrigation productivity. Abdelhadi *et al*., (2016) assert that seed drilling for bed planting might be taken into consideration a viable method for wheat production, contingent upon the availability of suitable seeding machines. Research has concentrated on water productivity, which is measured as crop yield per unit of agriculture water usage Aggarwal and Gosswami (2013) found that Bed-Planting, as opposite to saturate irrigation with water in traditional flat planting, boosted wheat yield and water productivity beneath soil that is sandy loam, with three rows of wheat planted in each bed, yielding 0.22 and 0.03 tonne ha-1, cm-1, respectively. Raised Bed planting combined with drilling seeding is one of the best ways to save cultivation expenses, boost water productivity, and maximize yield, according to Zang et al., (2017). The purpose of the recent research was to assess how different planting techniques affected the production and growth of wheat.

2 MATERIALS AND METHODS

The trial took place into the Agronomy Section of the Qaid-e-Awam Agriculture Research Institute in Larkano at Naudero during the Rabi season in 2016. The treatment details are outlined as follows:

Three replications of inadvertent Complete Block Design (RCBD) were applied as the experiential setup of the investigation. The net size of plot was specified as 5x3 m, covering an area of 15 m^2. The chosen variety for the experiment was TD-1. Three distinct sowing methods were implemented as treatments, denoted as T1 (Drilling), T2 (Broadcasting), and T3 (Ridges). In terms of cultural practices, the process of recording observations on various agronomical traits involved the random selection and labeling of five plants within each plot. The observations were then systematically recorded for analysis, encompassing a range of parameters.

The following agronomical traits were systematically recorded for analysis.

1. Height of the plant (cm)

2. Tillers (m^{-2})

3. The length of the spike in centimeters

4. Each spike has spikelets.

5. Amount of grain per spike

6. Seed index (weight in grammes per 1000 grains)

7. Biomass yield (kg ha^{-1})

8. Yield of grains (kg ha^{-3})

These parameters were carefully observed and documented as part of the comprehensive evaluation of the experimental conditions and treatment effects.

Observation recording procedure

1. Plant Height (cm): A measuring tape was used to record height of plant at crop blooming. At unintentionally selected plant based on every replication of every treatment was measured from the bottom to the top, and the values were averaged in centimeters.

2. Tillers (m^{-1}): The tiller count per plant was recorded at the event of maturity. One plant from each replication of every treatment was chosen, and the tillers were counted and averaged.

3. Spike length (cm): Every replication of each treatment had its spike length quantified, and the results were averaged.

4. Spikelet per spike: At maturity, the quantity of spikelets in every plant spike chosen at random was tallied, and the counts were averaged.

5. Grains per spike: For each replication of each treatment, the total quantity of grains divided into five at random chosen spikes was totaled, and the counts were averaged.

6. Seed index (1000-Grains Weight, g): After the experimental crop was threshed, 1000 grains from each replication of every treatment were collected, and an electronic scale was used to weigh the grains in grammes.

7. Biological yield (kg ha^{-1}): The weight per square meter (m^{-2}) was used to calculate the biological yield at harvest and then computed to kilograms per hectare (ha^{-1}).

8. Grain yield (kg ha^{-1}): Every replication of every treatment's wheat crop was collected and threshed when it reached maturity. The formula used to compute the grain yield per plot (kg) was Grain yield per plot (kg) × 10,000 / Net plot size (m^{-2}).

9. Statistical analysis: MSTAT-C had been used to do statistical survey on the gathered data. When it was thought essential, the Russel and Eisemsmith (1983) recommended LSD analysis was used to compare better quality results.

3 RESULTS AND DISCUSSION

For the purpose to evaluate the impact of dissimilar seeding techniques on the growth and production of wheat, (*Triticum aestivum* L.), especially the TD-1 variety, research was carried out throughout the course of 2016. The three applied sowing methods were denoted as T1 (Drilling), T2 (Broadcasting), and T3 (Ridges). Recorded observations encompassed various parameters such as plant height (cm), the number of tillers per m^3, length of spike in centimeters, grains per spike (g), seed index (weight in grains per 1000, g) and grain yield (kg/ha^{-3}) for further examination. The detailed data for the mentioned parameters can be found in Tables 1-6, while the statistical analysis of variance is presented in Appendix I-VI.

T a b l e 1

Wheat plant height (cm) Influenced by different seeding methods

Treatments	R-I	R-II	R-III	Mean
T_1 = Drilling	61.2	65.2	63.5	63.30 AB
T_2 = Broadcasting	65.5	64.8	67.3	65.87 A
T_3 = Ridges	61.2	59.4	60.6	60.40 B

S.E.± 1.3547

LSD 0.05 3.7612

Plant height (cm)

Table 1 presents the results of the study on the plant height of the wheat variety TD-1 as a function of dissimilar planting techniques. Wheat plant height was shown to be significantly ($P<0.05$) impacted by sowing procedures, according to an analysis of variance (Appendix-I). The results indicated that wheat plants exhibited the tallest growth (65.87 cm) when sown using T2 = Broadcasting, followed by T1 = Drilling, which yielded a plant height of 63.30 cm. Conversely, Plant height was measured down to the lowest point, 60.40 cm with T3 = Ridges. The data highlighted broadcasting as the optimal method for achieving maximum plant height (cm) in wheat. The LSD test underscored the significance ($P<0.05$) of the observed differences in plant height across various sowing methods.

T a b l e 2

Tillers m^{-2} of wheat as affected by various sowing methods

Treatments	R-I	R-II	R-III	Mean

T_1 = Drilling	460	446	452	452.67 A
T_2 = Broadcasting	350	300	312	320.67 B
T_3 = Ridges	300	330	310	313.33 B

S.E.± 16.609

LSD 0.05 46.113

Tillers m^{-2}

The outcomes related to the tillers count per square meter (m^{-2}) in wheat variety TD-1 under dissimilar sowing methods are exposed in Table-2, with the corresponding analysis of variance detailed in Appendix-II. The variance analysis revealed the significance ($P<0.05$) of the variety concerning the count of tillers. The results directed that the wheat variety exhibited a higher number of tillers per square meter (452.67 m^{-2}) when sown using T1 = Drilling, followed by T2 = Broadcasting (320.67 m^{-2}). Conversely, the less count of tillers (313.33 m^{-2}) was observed with T3 = Ridges. Broadcasting emerged as the optimal method for maximizing tiller density in wheat. The LSD test underscored the significant ($P<0.05$) differences in tillers per square meter among various sowing methods.

T a b l e 3

Effects of varying planting techniques on the length of the wheat spike (cm)

Treatments	R-I	R-II	R-III	Mean

T_1 = Drilling	10.2	9.3	10.9	10.13 A
T_2 = Broadcasting	9.8	9.4	7.9	9.03 B
T_3 = Ridges	8.1	8	8.6	8.23 B

S.E. ± 0.8183

LSD 0.05 2.2720

Spike length (cm)

The data relating the wheat variety's spike length (in centimeters) TD-1, impacted according to various sowing techniques, as shown in Table 3 with the accompanying analysis of differences supplied in Appendix-III. According to the data, A noteworthy variation ($P<0.05$) was seen among the spike length under different seeding techniques. The findings revealed that the highest spike length (10.13 cm) was reached when the crop was seeded using T1 = Drilling, followed by T2 = Broadcasting, resulting in an average spike length of (9.03 cm). In comparison, T3 = Ridges had the lowest spike length (8.23 cm). Broadcasting emerged as the optimal method for maximizing spike length in wheat. The LSD test confirmed the significance ($P<0.05$) of the observed differences in spike length among different sowing methods.

Table 4

The impact of different seeding techniques on wheat spikelets (spike-1).

Treatments	R-I	R-II	R-III	Mean

T_1 = Drilling	16	14	15	15.00 A
T_2 = Broadcasting	15	13	12	13.33 B
T_3 = Ridges	11	17	12	13.33 B

S.E.± 1.8257

LSD 0.05 5.0691

Spikelets spike^{-1}

Results for the amount in terms of spikelets per spike, (spike-1) for wheat variety TD-1, which were influenced by varying sowing techniques, are shown in Table-4 and the related assessment of variance is provided in Appendix-IV. A considerable (P<0.05) variation in the number of spikelets per spike-1 under different seeding techniques was found in the investigation. The findings showed that when the crop was seeded using T1 = Drilling, followed by T2 = Broadcasting, the largest amount in terms per spike-1 (15.00) was recorded, resulting in an average of spikelets spike-1 (13.33). Conversely, the minimum quantity of spikelets per spike-1 (13.33) was recorded under T3 = Ridges. Broadcasting emerged as a favorable sowing method for maximizing spikelets per spike-1 in wheat. The LSD test confirmed the significance (P<0.05) of the observed differences in spikelets per spike-1 among different sowing methods.

T a b l e 5

Wheat grains spike-1 as impacted by dissimilar planting techniques

Treatments	R-I	R-II	R-III	Mean
T_1 = Drilling	38	35	33	35.33 B
T_2 = Broadcasting	39	34	35	36.00 A
T_3 = Ridges	32	39	30	33.66 C

S.E.± 4.0552

LSD 0.05 11.259

Grains spike^{-1}

The outcomes of the analysis of variance concerning the grains per spike (spike-1) for the wheat variety TD-1, influenced by diverse sowing techniques, are delineated in Table-5 and Appendix-V. A substantial (P<0.05) variation in the number of grains per spike-1 was found for various seeding procedures according to the research. The findings indicated that the highest count of grains per spike-1, totaling 36.00, was documented when the crop was sown using T2 = Broadcasting, followed by T1 = Drilling, which resulted in an average grains per spike-1 (35.33). In contrast, T3 = Ridges yielded results demonstrated that the minimum quantity of grains per spike-1 specifically 33.66, was recorded. Broadcasting emerged as a suitable sowing method for maximizing grains per spike-1 in wheat. The significance (P<0.05) of the observed variations in grains per spike-1 across the various seeding techniques was confirmed by the LSD test.

T a b l e 6

Wheat seed index, or 1000-grain weight in grammes, as influenced by different seeding techniques.

Treatments	R-I	R-II	R-III	Mean
T_1 = Drilling	45	46	40	43.66 A
T_2 = Broadcasting	34	37	33	41.33 B
T_3 = Ridges	42	45	37	34.66 C

S.E.± 3.7786

LSD 0.05 10.491

Seed index (weight, in grammes, of 1000 grains)

Results for the wheat variety TD-1's seed index, denoted as the 1000-grain weight in grams, as a function of Diverse sowing techniques are presented in Table-6, and the corresponding analysis of variance is provided in appendix-vi. A substantial difference ($P<0.05$) in the seed index was found under different seeding procedures according to the research. The findings indicated that when the wheat crop was seeded using T1 = Drilling, the largest seed index (43.66 g) was recorded. This was followed by T2 = Broadcasting, which produced an average seed index (41.33 g). Conversely the lowest seed index, amounting to 34.66 g, was documented for T3 = Ridges. Broadcasting was identified as the optimal sowing method for achieving the maximum seed index, represented by the 1000-grain weight in grams, was observed in wheat. The LSD test confirmed the significance ($P<0.05$) of the observed differences in seed index among different sowing methods.

T a b l e 7

Wheat's biological yield (kg ha-1) as influenced by different planting techniques

Treatments	R-I	R-II	R-III	Mean
T_1 = Drilling	6256	6215	6183	6218 B
T_2 = Broadcasting	5690	5592	5560	6371 A
T_3 = Ridges	6695	6730	5688	5614 C

S.E.± 262.17

LSD 0.05 727.91

Biological yield, measured in kilograms per hectare (kg ha-1)

The biological output (kg ha-1) of the wheat variety TD-1 is affected by several planting methods is displayed in Table 7. The relevant variance analysis is provided in Appendix VII. The study discovered a notable distinction ($P<0.05$) into the seeding techniques. The results shown that the highest biological production (6371 kg ha^{-1}) was seen at the time when wheat crop was planted with T2 = Broadcasting. T1 = Drilling came next, with an average biological output of 6218 kg ha^{-1}. In comparison, T3 = Ridges yielded the lowest biological production (5614 kg ha^{-1}). Drilling has been shown to be an effective way to plant wheat that maximizes biological production. The observed variations in biological yield between the various planting techniques were confirmed according to statistics noteworthy ($P<0.05$) by the LSD test.

T a b l e 8

Effects of different planting techniques on wheat grain yield (kg ha-1)

Treatments	R-I	R-II	R-III	Mean
T_1 = Drilling	4110	4195	4120	4325 A
T_2 = Broadcasting	4360	4291	4325	4141 B
T_3 = Ridges	3840	3925	4002	3922 C

S.E.± 52.388

LSD 0.05 145.45

Grain yield, expression in kilograms per hectare (kg ha-1).

Table-8 displays the outcomes of the analysis of variance conducted on the grain yield (kg ha^{-1}) for the specified wheat variety. TD-1 as impacted by various planting techniques. Appendix-VIII has the relevant data. A significant distinction ($P < 0.05$) in grain yield (kg ha^{-1}) was found between the two sowing strategies according to the research. The findings showed that when the wheat crop was seeded using T1 = Drilling, followed by T2 = Broadcasting, the greatest grain yield (4325 kg ha^{-1}) was found, yielding an average grain yield of 4141 kg ha^{-1}. However, T3 = Ridges yielded the lowest yield of grains 3922 kg ha^{-1}. Drilling was identified as the optimal sowing method for maximizing grain yield in wheat. The LSD test affirmed the significance, ($P<0.05$) of the observed differences in grain yield among different sowing methods. Several crop management techniques can affect the growth and productivity of wheat (*Triticum aestivum* L.), especially in a range of environmental circumstances (Ali et al., 2014). Traditional planting methods have, in many cases, given way to modernized approaches, which have been substantiated through research (Hobbs and Gupta, 2014). The utilization of drilling as a method for wheat sowing holds the advantage of supporting duplex cropping and presents remarkable benefits in managing soil humidity, both in terms of drainage and irrigation. Moreover, drilling is conducive to narrow row spacing, distinguishing it from other sowing methods (Mascagni et al., 2013). Given these considerations, the current investigation was conducted to look into the effects of different sowing methods regarding wheat output and growth. However, soil and climatic factors affect the growth and yield on the wheat production (Kim 2023).

The wheat variety sown through broadcasting exhibited notably superior performance across various parameters, including a plant height of 65.87 cm, 320.67 m^{-2} tillers, 9.03 cm spike length, 13.33 number of spikelets present on each individual spike, 36.00 quantity of grains found on each spike of a plant., a 1,000-grain weight of the seed index of 41.33 g, a biological production of 6371 kg ha^{-1}, and a grain output of 4141 kg ha^{-1}. In contrast, the crop sown using ridges resulted in a plant height of 60.40 cm, 313.33 m^{-2} tillers, 8.23 cm length of spike, 13.33 spikelets on each spike, 33.66 grains/ spike, a seed index of 34.66 g, a biological harvest of 5614 kg ha^{-1}, and a grain out turn of 3922 kg ha^{-1}. The drilling method yielded intermediate results, with a plant height of 63.30 cm, 452.67 m^{-2} tillers, 10. 13 cm spike extent length, 15.00 spikelets per spike, 35. 33 grains by means of spike, a seed index of 43.66 g, a biological yield of 6218 kg ha^{-1}, and a grain turnout of 4325 kg ha^{-1}. The study concludes that drilling reduced grain yield by 4325 kg ha^{-1} compared to broadcasting (4141 kg ha^{-1}) and ridges (3922 kg ha^{-1}). These findings align with Ashrafi et al. (2018), who emphasized the significant impact of sowing methods on wheat yields, favoring drilling over conventional methods. Soomro et al. (2012) reported similar outcomes, demonstrating the effects of sowing procedures on various growth & yield parameters. Nasrullah et al. (2017) highlighted the positive effect of drilling and raised bed planting on wheat yield, emphasizing the importance of tiller and spike parameters.

Studies by Hobbs and Gupta (2014), Singh et al., (2015), and Hossain et al., (2016) further support the significance of sowing methods and Hossain et al., in influencing wheat crop trait and yields. These findings collectively underscore the importance of careful consideration and selection of sowing methods for optimizing wheat cultivation outcomes in varied environmental conditions. Quanqi et al. (2015) also observed higher grain yield with drilling, recommending it for wheat cultivation.

4 CONCLUSIONS

This study investigated the effects of different sowing methods on growth & yield of wheat (*Triticum aestivum* L.) variety TD-1. The treatments included three sowing methods T1 = Drilling, T2 = Broadcasting and T3 = Ridges. The observations were recorded on plant height (cm), tillers m-2, spike length (cm), grains spike-1 (g), seed index (1000-grain weight, g) and grain yield (kg ha-1). The findings of the study are summarized as follows: The wheat variety sown by broadcasting showed remarkably superior performance with 65.87 cm plant height, 320.67 m-2 tillers, 9.03 cm spike length, 13.33 spiklets spike-1, 36.00 grains spike-1, 41.33 g seed index (1000-grain weight), 6371 kg ha-1 biological yield and 4141 kg ha-1 grain yield.

The crop ridges resulted 60.40 cm plant height, 313.33 m-2 tillers, 8.23 cm spike length, 13.33 spiklets spike-1, 33.66 grains spike-1, 34.66 g seed index (1000-grain weight), 5614 kg ha-1 biological yield and 3922 kg ha-1 grain yield. On the other drilling method remained with 63.30 cm plant height, 452.67 m-2 tillers, 10.13 cm spike length, 15.00 spiklets spike-1, 35.33 grains spike-1, 43.66 g seed index (1000-grain weight), 6218 kg ha-1 biological yield and 4325 kg ha-1 grain yield. It is concluded that the crop sown by drilling reduced more grain yield of 4325 kg ha-1 as compared to broadcasting 4141 kg ha-1 and ridges (3922 kg ha-1).

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