

## Influence of Different Seed Rates on the Growth and Yield Characteristics of Wheat Crop (*Triticum aestivum* L.): Case Study of Takhar Province, Afghanistan

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### Abstract

The purpose of this study was to determine the effect of seed rate on the growth and yield attributes of the wheat crop (*Triticum aestivum* L.) variety Mazar-99 under the agro-climatic conditions of Takhar province, Afghanistan. The experiment was implemented at the research farm of Agriculture Faculty of Takhar University in winter seasons of 2018-2019 with the specific objective of finding out the effect of five seeding rates as the treatment on growth and yield parameters of Mazar-99 variety of wheat. Randomized Complete Block Design (RCBD) was selected as an experiment design with 4 replications and 5 seeding rates viz. 80, 100, 120, 140 and 160 kg/ha made up treatments. Data on growth and yield parameters were collected and analyzed using Analysis of Variance (ANOVA) for Randomized Complete Block Design (RCBD). The result obtained from the current study reveal that all growth and yield characters were remarkably affected by seeding rate and seed rate of 100 kg per hectare of wheat variety Mazar-99 performed better with respect to different growth and yield parameters such as spike length, number of tillers, number of spike at each plant, leaf area, a total of spikelets per spike and stem girth, grain number/spike, the weight of spike, the weight of grain per spike, grain crop yield, straw crop weight, 1000-grain weight, and biological yield. Whereas 80 and 120 kg/ha were the second-best seeding rates after the 100 kg/ha. However, 160 kg/ha seed rate showed only superiority in plant height, but 140 kg/ha did not show any special superiority in any growth and yield characteristic evaluated in Takhar agro-climatic condition. Thus, a seeding rate of 100 kg per hectare could be recommended to the farmers for better wheat production in Takhar agro-climatic situation in North-Eastern Afghanistan.

### Keywords

Growth; Yield; Mazar-99; Seeding rate; Takhar; Wheat

## Introduction

Wheat (*Triticum aestivum* L.) is one of the conspicuous cereal crops in the world, belonging to the family of Poaceae (Gramineae). This crop originated from the South-Eastern part of Turkey (Ibukun and Moyin, 2018; Ullah *et al.*, 2018). It is an enormous source of nutrition for mankind and livestock (Ullah *et al.*, 2018). It is one of the main crops in the temperate countries. It has nutritive fiber components beneficial to the human diet (Sherry, 2009). Further, wheat is a staple food stuff used to make flour for steamed breads, leavened, flat, cookies, biscuits, breakfast cereal, cake, pasta, fermented alcoholic beverages (beer), noodles, and bio-fuel (Ibukun and Moyin, 2018), used by 7.592 billion individuals residing in 43 countries of the world. It contributes 30 percent to whole grain demand of the world and stand at the top among the cereal crops. It contributes about 20 percent of the aggregate food calories to the mankind (Ullah *et al.*, 2018). Globally, wheat production in 2012 was nearly 671 million tons in 215 million ha land area (FAOSTAT, 2014). Rapid population expansion increases wheat requirements in Afghanistan, where annual wheat production is 5 million metric tons grown approximately in 2.55 million ha area. Afghanistan's average wheat yield (1.7-1.9 tons/ha) is lower than the global average (3.4 tons/ha) (MAIL, 2020). The agro-climatic situation in Afghanistan is very much suitable for wheat production. But various issues are involved in the low production of this crop, such as edaphic properties, climatic situations, lack of technological knowledge, shortage of water supply for irrigation, and improper usage of fertilizer doses (Ullah *et al.*, 2018).

To obtain the maximum yield, the application of optimal and suitable seed rates is essential (Ayoub *et al.*, 1994). To obtain maximum yield per unit area, it is required to use high quality seeds and better agronomical practices such as suitable seed rate, on-time sowing, irrigation, use of fertilizers, weeds control, water management, and on-time harvesting. Preferable wheat grain crop with higher quality desires an accurate seeding rate for different cultivars. Increasing in seeding amount might only boost production charge without any increase in grain yield (Rafique *et al.*, 2010). Afghanistan is a country with very limited cultivable field, there is an urgent need to enhance the final grain yield of wheat crop per unit area to meet the increasing food demand. There is further requirement to extend the area for wheat products. Seeding rate plays an indispensable role for ideal plant densities, which is required for an improved seed crop. It affects the crop and grain quality of wheat (Singh and Singh, 1987). Increased seeding rate causes the number of grains per spike decreased, but the number of spikes per m<sup>2</sup> and grain yield increased (Carr, Horsley and Poland, 2003; Loveras *et al.*, 2004; Ozturk, Caglar and Bulut, 2006). From the other point of view, low seeding amount might severely decrease the final yield (Ottesen, Mergoum and Ransom, 2007). The seed amount influences the lodging resistance of wheat crop and the final yield (Iwabuchi, Ogata and Hamachi, 2000), because the lodging degree increased as crop yield increased, lodging frequently happened in crops with a high seeding rate. Seed rate affected in wheat (Geleta *et al.*, 2002), as the basal internode being longer in dense plants, resulting in more lodging degree than in sparse plants (Fukushima, Kusuda and Furuhashi, 2004). Optimal seeding rate is deliberated key management elements for an effective yield of wheat (Arif *et al.*, 2019), because it is under the farmer's control in most cropping systems and it is important in wheat production (Ozturk, Caglar and Bulut, 2006; Arif *et al.*, 2019). Ideal plant density varies greatly between areas, soil properties, varieties, climatic conditions, and sowing time. If optimum seeding rates exceed, final yield decreases often happen. Earlier, many studies showed that seeding rates significantly influence spike number and biological yield achieved stands (Ozturk, Caglar and Bulut, 2006). High amounts of seed compensate for reduced plant tiller improvement and stimulate more central stem spikes, which can be satisfactory, particularly for variety, incline to produce fewer tillers (Arif *et al.*, 2019). However, no seeding rate has been identified as best adapted or most suitable for Takhar agro-climatic region, North-Eastern Afghanistan. Hence, the current study focuses on identifying the best adapted or the most suitable seeding rate with the most effective performance for increased yield in Takhat agro-climatic region. This is to be recommended to farmers for enhanced wheat production in Takhar agro-climatic region, North-Eastern Afghanistan, to meet the local and national population yearly wheat requirements.

## Material and Methods

To estimate influences of different seeding rates on wheat growth and yield characteristics of wheat (*Triticum aestivum* L.), an experiment was carried for one growing season from 1<sup>st</sup> of December 2018 to 1<sup>st</sup> of June 2019 in the research farm of Agriculture Faculty of Takhar State University, Taluqan, Afghanistan. Taluqan is located in the Northeast part of the country at 36.73° 19" N and 68° 65.4"E, with a mean altitude of 800 m. The climate of Taluqan is considered to be a cold semi-arid climate and rain deficient, with an annual mean temperature of 15.4°C and 256.30 mm precipitation (Figure 1). The experiment design was Randomized Complete Block Design (RCBD) with four replications, and five seed amounts of 80, 100, 120, 140, and 160 kg/ha sown as treatments. The experimental field size of 142 m<sup>2</sup> was marked using a measuring tape, rope, and wood peg. Soil samples were randomly collected from the experimental field from 30 cm depth and thoroughly mixed to make a composite soil sample. The composite soil sample was analyzed for soil physico-chemical properties (Table 1).

Table 1: Chemical and mechanical analyses of the experimental field soil (winter season of 2018-2019)

<i>Mechanical analysis</i>		<i>Chemical analysis</i>	
Sand %	89.9	Organic matter %	0.29
Silt %	4.3	EC mmhos/ cm <sup>3</sup>	0.3
Clay %	4.5	pH	6.5
CaCO <sub>3</sub>	1.3	Soluble N ppm	6.9
Soil texture	Sandy	Available P ppm	2.7
		Exchange K ppm	16.7

Field clearing was done using a cutlass. The soil was ploughed to fine tilts. The field was demarked into four blocks, each block containing four plots of 2 m x 2 m each, and was prepared using a hoe. 1 m rows were separated from adjacent blocks and 0.5 m alleys plots, respectively, and a line-to-line distance was maintained at 20 cm, while plant distance was not maintained. 220 kg/ha urea and 180 kg/ha di-ammonium phosphate (DAP) were used, all di-ammonium phosphate and 180 kg/ha urea was incorporated in the soil at the time of seedbed preparation, and all the remaining urea fertilizer was applied in the time of top-dressed phase. The wheat variety Mazar-99 was sown directly in the main field at the seed rates of 80, 100, 120, 140 and 160 kg/ha on the 1<sup>st</sup> of December 2018 through mechanical method using sowing drill at a depth of 4-5 cm. Before sowing, the seeds were treated with Benlate and Topsin M solution by following the standard recommendations to protect it from the soil-borne pathogens. To control the narrow and broad leaf weeds, regular mechanical weed control was done every week using a hoe.

Ten middle plants from each plot were selected randomly. Data were recorded for the different growth characteristics and yield contributing traits of the crop, such as plant height, spike length, tillers numbers of one plant, number of spikes per plant, flag leave area, number of spikelet per spike, stem girth, grain number/spike, weight of spike, weight of grain per spike, grain crop yield, straw crop weight, 1000 grain weight, harvest index and biological yield. The collected data for different growth and yield traits was analyzed through Analysis of Variance (ANOVA) for RCBD design using MSTAT-C software and LSD tests were applied at the 5% probability level to compare treatment means.

## Results and Discussion

### Plant height

Plant height is one of the key parameters representing wheat plant's vegetative growth reflecting the genetic variation and agro-technical effect. Plant height in the treatment sown at 80 kg seed per hectare was significantly shorter than that of 100, 120, 140, and 160 kg/ha seed rate (Table 2). The plant heights of 120,

140, and 160 kg/ha seed rates were statistically dissimilar at ( $P>0.05\%$ ) from each other's. The bending moment at the breaking of the undamaged internode was expressively more significant at lower seeding rates (Table 2). The lodging index was significantly lower than at high seed rates indicating that the lodging resistance improved as the seeding rate was reduced. High seed rates per capita influence on plant height, stimulate stem length and cause low spread of solar radiation into the canopy and tended to endorse lodging degree in wheat crop. The findings suggested that lodging resistance increased with decreasing seeding rate. The high number of seeds reduced the strength of the internode without leaf sheath covering, and affected the construction of the stem or cell wall constituents rather than the leaf covers (Table 2). Strength of internode and lodging resistance of stem rise as the seeding rate decreased in wheat crop. The crop height is mainly controlled by the genetic make-up of a variety and environmental factors. The enlargement of plant height was due to increased leaf area, resulting into the highest level of photosynthesis, more production of assimilates and plant dry matter due to uptake of other nutrients from the soil through synergistic effect, which increases the shoot length of plants or their genetic make-up. These outcomes were in line with those reported by Khaliq, Iqbal and Basra (1999), Hussain *et al.* (2001) and Soomro *et al.* (2009), which showed that wheat sowing at a vast seeding rate produced greater plant height and the shortest plant was recorded for the lowest seeding rate. However, these results did not coincide with the findings of Mohammad and Maqsuda (2017) who reported that seed rate increase resulted into a slight rise in the height of the plants, this could be because of environmental conditions and the genetic make-up of the cultivar used in both the studies.

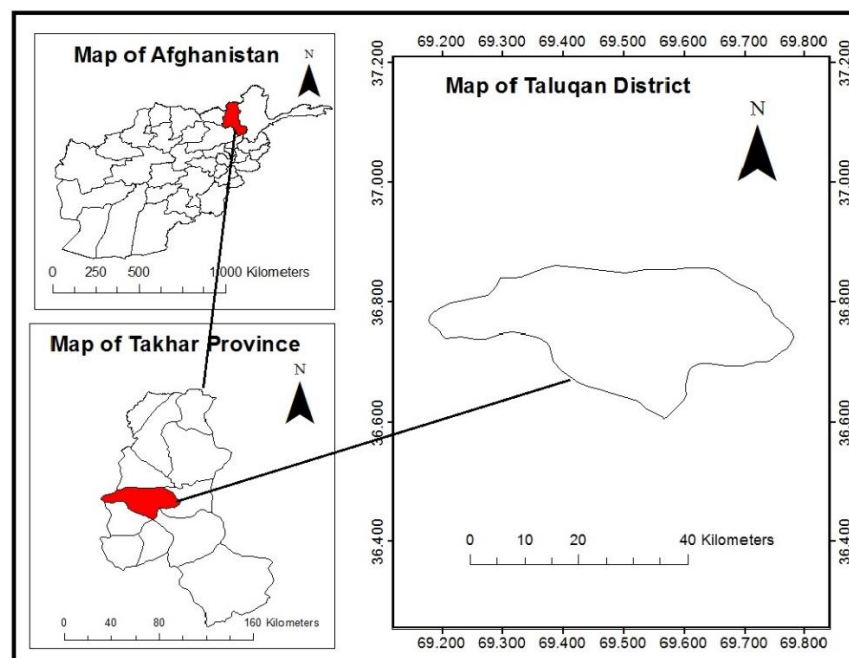


Figure 1: Map of the Study Area (Taluqan District, Takhar, Afghanistan)

### Spike length

The size of spike plays a fundamental role in wheat towards the grains spike and final yield (Mohammad *et al.*, 2019). In this field experiment, there was significant variation ( $P<0.05\%$ ) among the five seeding rates in response to seeding amounts. The mean values for this trait ranged from 6.8 cm to 9.75 cm (Table 2). The seeding rate of 100 kg/ha has recorded the highest mean value of 9.75 cm, and whereas, it was minimum (6.80 cm) for treatment 160 kg/ha. Overall, the seeding rate of 100 kg/ha had more spike length as compared to the rest of the four seeding rates: 80 kg (9.43 cm), 120 kg (8.43 cm), and 140 kg (7.43 cm). These results

are in harmony with the findings of Arif *et al.* (2019) who concluded that yield and growth were improved by applying appropriate quantities of seed rate.

### **Tillers number per plant**

Tillering is the main developmental phase that allows the plants to reimburse under low plant density or taking merit of good growing situations. The tillers appearance is closely harmonized with leaves on the main stem, though the variety and cultivation circumstances influence the number of tillers formed. The cost-effective yield of wheat is resolute by the number of tillers per plant. Tillers have the mean agronomic role as this may compensate the alteration of plants number in space, partly or entirely after crop formation and may allow crop from early frost and recover it easily (Hussain *et al.*, 2001; Soomro *et al.*, 2009). The observation recorded for the number of tillers per plant at different seeding rates showed significant difference ( $p < 0.05\%$ ) amongst all treatments in tillers number per plant where the use of 80 kg seed per hectare shaped a higher number of tillers (9.75) closely tracked by 100 kg/ha seed with 9.43 number of tillers. Rest of the three treatments did not show any superiority for this characteristic compared to above mentioned seed rates (Table 2). This may be due to the high plant population in the present study since the seeds were treated with fungicide, which led to competition among tillers and resulted in few tillers or spikes. Tillering phase is generally controlled by environmental factors and genetic traits of the variety. The result of this study was similar to the findings of Bodruzzaman *et al.* (2003) and Saifuzzaman *et al.* (2003).

### **Numbers of spike per plant**

The data recorded for the numbers of spikes per plant showed significant variation ( $p < 0.05\%$ ) among all treatments studied under this investigation. Among different seeding rates, the maximum numbers of spikes per plant (8.50 and 8.00) were recorded for seeding rates of 80 kg/ha and 100 kg/ha, respectively, which were statistically in line with other treatments (Table 2). The minimum number of spikes per plant (4.50) was noted in case of 160 kg/ha seeding rate. This study observed that more spikes in one plant were generated at the seed rate of 100 kg/ha and the lowest in case of the seeding rate of 160 kg/ha. The greater number of spikes per plants in 80 kg/ha seed rate was because of the less competition and appropriate seed placement in line. Whereas the plant competition causes fewer spikes per plant, a high density of plants per capita provides the conditions more prone to disease outbreak and stumpy osmotic pressure among the plant populations. The findings of this study are in line with many findings concluding that nutrient absorption is more due to reduced competition among the plant population having more number of tillers, enhanced vegetative growth, and increased number of spikes in a unit land area (Nourmohammadi, Siadat and Kashani, 2010; Talukdar *et al.*, 2004).

### **Flag leaf area**

The mean of collected data related to leaf area revealed significant variability ( $p < 0.05\%$ ) of different seed quantities among all the five seeding rates studied for vegetative characteristics of flag leaf area. The mean value for this character varied from 38.50 cm<sup>2</sup> to 74.50 cm<sup>2</sup> (Table 2). The highest flag leaf area was found in the population grown from seed rate of 100 kg/ha and 80 kg/ha (74.50 cm<sup>2</sup> and 38.50 cm<sup>2</sup>), respectively, followed by 120 kg/ha and 140 kg/ha. On the other hand, seeding rate of 160 kg/ha produced the lowest flag leaf area of 38.50 cm<sup>2</sup> (Table 2). Mohammad *et al.* (2019) obtained a lower leaf area with high seeding rate due high density of plant numbers per capita and growth competition. Supplementary increase in seed amount would not increase leaf area because the dense plant population will create intense competition between plants for light, moisture and nutrients (Ullah *et al.*, 2018; Prystupa, Slafer and Savin, 2004).

### **Number of spikelets per spike**

The data has shown significant variation ( $p < 0.05\%$ ) of seeding rate on spikelet number per spike. A higher mean number of spikelets per spike was observed in plants sown at a seeding rate of 100 kg/ha (16.50 spikelets per spike) followed by 80 kg/ha (14.00 spikelets per spike), 120 kg/ha (14.50 spikelets per spike), which were statistically at par with each other. While the lowest spikelet per spike was recorded in plants

sown at the seeding rate of 160 kg/ha (11.75 spikelets per spike), it was the same with 140 kg/ha (Table 2). The result reveals the lowest spikelets in seeding rate of 160 kg/ha causing more plant competition due to improper seed placement. Seed rate has a major influence on the vegetative growth of the plant. At the same time, at reproductive stage, its role is less considerable which is why different levels of seeding rate did not affect the number of spikelets per spike significantly. These results contradict the findings of several other research done by Ullah *et al.* (2018), Dalirie, Sharifi and Farzaneh (2014), Talukdar *et al.* (2004) and Nourmohammadi, Siadat and Kashani (2010).

### Stem girth

The results indicate that there was significant variability ( $p < 0.05\%$ ) in stem girth the plants sown at the five seeding rates. The mean value for this character laid from 3.60 cm to 0.96 cm. The highest girth with a mean value of (3.60 cm) was recorded in seed rate of 80 kg/ha, which was statistically different from the stem girths recorded with seed rates of 100, 120, 140 and 160 kg/hectare. The seed rate of 160 kg per hectare had minimum stem girth with the mean value of (0.96 cm), which was statistically in harmony with 140 kg/ha. On the other hand, 100 kg/ha seed rate had the second highest mean value of 2.80 cm but was statistically different with a seeding rate of 80 kg/hectare (Table 2). Generally, the more vigorous is the stem the higher is the yield in wheat. Earlier similar outcomes were reported by Ullah *et al.* (2018), Dalirie, Sharifi and Farzaneh (2014) and Talukdar *et al.* (2004).

Table 2: Effect of various seeding rates on some vegetative characteristics of wheat (*Triticum aestivum* L.)

Treatment [Seed rate kg/ha]	Plant height (cm)	Spike length (cm)	No. of tillers/plant	No. of spikes/plant	Flag leaf area (cm <sup>2</sup> )	No. Spikelets/spike	Stem girth (cm)
80	85.75 b	9.43 ab	9.25 a	8.00 a	69.75 a	14.00 b	3.60 a
100	94.75 ab	9.75 a	9.50 a	8.50 a	74.50 a	16.50 a	2.80
120	99.75 a	8.43 bc	8.00 ab	6.75 ab	58.75 ab	14.50 b	2.70
140	104.50 a	7.43 cd	6.50 b	5.75 bc	49.25 bc	12.25 c	1.80
160	100.75 a	6.80 d	6.00 b	4.50 c	38.50 c	11.75 c	0.96
F test	*	**	*	**	**	**	**
SEM $\pm$	3.48	0.33	0.68	0.60	5.57	0.55	0.27
CV (%)	7.12	7.94	17.33	17.92	19.16	7.91	9.95

Note: \* = (Critical variation); SEM = Standard Error Mean; CV= Coefficient of Variation; Mean values of each parameter within each column with a similar alphabet are not significantly difference at ( $p > 0.05\%$ ).

### Grains per spike

High mean number of grain numbers per spike was achieved in plants sown at a 100 kg/hectare seeding rate. The present study reveals that there was significant variation at ( $p < 0.05\%$ ) amongst all five seeding rates. The average number of grains per spike ranged from 30.70 to 42.25 (Table 3). The treatment 80 kg/ha had highest number of grains per spike (42.25), which was statistically at par with 100 kg/ha (421.75 grains per spike). It was minimum (30.75 grains per spike) in plants sown at seeding rate of 160 kg/ha. Overall, 80 kg/ha had a greater number of grains per spike, as compared to the rest of the four seeding rates followed by 100 kg (41.75 grains per spike), 120 kg/ha (35.50 grains per spike), 140 and 160 kg/ha (30.75 grains per spike). Proper seed rate promotes the beginning of spikelets that resulted in high number of seeds per spike, but further seed rate of 120 kg/ha reduced the number of grains due to improper vegetative development of wheat crop as witnessed in case of plant elevation. The result of this study is in line with the findings of Talukdar *et al.* (2004), Allam (2005), El-Hag (2006) and Ramadan and Awaad (2008). Application of optimum seeding rate decreased the deterioration chance in the spikes; otherwise, in the situation of seed worsening, final seed yield is reduced.

### Weight of spike

Due to variation in seeding rate, the weight of spike was significantly different ( $p < 0.05\%$ ) in the present study. The maximum weight of spike was found in 80 kg/ha (1.89 g) seed rate, statistically identical to 100 kg/ha (1.70 g) (Table 3). While the minimum weight of spike (1.23 g) was recorded from 160 kg/ha. Likewise, 100 kg/ha seeding rate had the second-highest average value of 1.70 g but was statistically at par with 80 kg/ha (1.89 g). However, there was non-significant alteration ( $p > 0.05\%$ ) between 120 kg/ha (1.37 g), 140 kg/ha (1.25 g) and 160 kg/ha (1.23 g) seeding rates applied in this study. The mean values for different seeding rates revealed that treatments 80 kg/ha and 100 kg/ha were optimal for agro-ecological situation in Taluqan. The present study indicates that the seeding rate has an important role in the growth and improvement of spike and its final weight. A similar response of seeding rate on the weight of spike has also been reported by Talukdar *et al.* (2004) and Ramadan and Awaad (2008).

### Weight of grain per spike

The present study reveals that the weight of grains per spike was also significantly affected by the seeding rate per hectare ( $p < 0.05\%$ ). Maximum weight of grains per spike (1.43 g) was noted from 100 kg/ha seeding rate that was also statistically in harmony with 120 kg/ha seeding rate (Table 3). While minimum was observed in 160 kg/ha treatment (0.93 g), it was statistically at par with 80 kg/ha and 140 kg/ha seed rates. Grain number, the weight of spike and spike length have a positive role in the weight of grains per spike, and the optimal seeding rate for the Takhar agroclimatic situations is 100 or 120 kg/ha. These findings are pretty in line with the findings of Ali *et al.* (2004), Soomro *et al.* (2009), Baloch *et al.* (2010) and Kiliç and Gürsoy (2010). Seed rate applied in optimum dose has a crucial role on the grain number, the weight of spike and spike length and weight of grains per spike.

### Grain yield

The results of this study showed that, there was a statistically significant increase in wheat crop yield with decreasing seeding rate. Maximum grain yield (4.94 kg/ha) was obtained from 100 kg/ha seeding rate, and it was statistically superior with the rest of the seeding rates adopted in this study. The second-high mean value of crop grain yield was observed in 80 kg/ha (3.96 kg/ha) seed rate. Statistically, it was at par with 120 kg/ha seed rate (3.94 kg/ha). The minimum crop grain yield (3.03 kg/ha) was recorded from the seed amounts of 160 kg/ha, and statistically, it was in harmony with seed rate of 140 kg/ha (Table 3). The mean value of grain yield gradually improved with decreasing seed rates. The findings showed that the cumulative consequence of yield influencing traits, such as effective spikelets/spike, tillers number/plant, 1000-grain weight and grains/spike, had a positive influence on increased grain yield achieved from 100 kg/ha seed rate. In the case of higher seed rate, the growth and vegetative improvement of plants were reduced due to competition and unequal uptake of essential nutrients, which caused poor performance of crop yield traits and finally reduced the grain yield. These findings are in accordance with the results of Talukdar *et al.* (2004), Ramadan and Awaad (2008), and Nourmohammadi, Siadat and Kashani (2010).

### Straw weight per plot

The mean value for total straw weight (kg/ha) showed significant variation ( $p < 0.05\%$ ). The average mean value for this parameter ranged from 6.15 kg/ha to 3.15 kg/ha. The maximum straw weight was verified for 100 kg/ha seed rate, which was statistically at par with 120 kg/ha, while the minimum plant material weight was noted for seeding rate of 160 kg/ha. The second highest mean value of straw weight was observed on treatment with 80 kg/ha seed rate (5.65 kg/ha), and was statistically in the same line with a seeding rate of 140 kg/ha (Table 3). It is observed that proper seed rate has improved plant vigor and yield. It boosts nutrient accessibility, suitable sun light penetration for plant photosynthesis process, and a good soil environment for nutrient uptake for soil and water efficiency, all necessary for crop vigor and final crop yield. The total straw weight has increased in plants sown at seeding rate of 120 kg/ha (6.00 kg/ha) followed by 100 kg/ha. These results coincide with the findings of Bodruzzaman *et al.* (2003), Saifuzzaman *et al.* (2003), while

Talukdar *et al.* (2004), reported significant variability in straw weight per plot that could be ascribed to different seed rates affecting plant vitality and yield.

### 1000-grain weight

Documented results reveal that there was significant variation ( $p < 0.05\%$ ) in 1000-grain weights at the five seeding rates, the mean value for which ranged from 30.25 g to 33.75 g (Table 3). The highest weight of 1000-grain with a mean value of (33.75 g) was noted in 100 kg/ha seed rate, which statistically was similar to 120 kg/ha (33.00 g). Seeding rate of 160 kg/ha had a minimum weight of 1000 grain with the mean value of (30.25 g), which was statistically identical to 140 kg and 80 kg/ha. This result showed the optimal seeding rate for this trait in Takhar agro-climatic situation was 100 kg and 120 kg per hectare. The proper seeding rate has a crucial role and is responsible for the quality of grain and their weight. The present study's results resemble those reported by Bodruzzaman *et al.* (2003), Ramadan and Awaad (2008) and Hag (2006), who concluded that a higher seed rate significantly decreased 1000-grain weight.

### Biological yield

The mean value recorded for biological yield showed a vital difference ( $p < 0.05\%$ ) among the seeding rates under study. The data for biological yield depicted a linear upward rise with the decrease in seeding rates (Table 3). Different seeding rates in wheat showed variability in biological yield significantly. Maximum biological yield (11.46 kg/ha) was harvested from 100 kg per hectare seed rate. In comparison, minimum yield (9.03 kg/ha) was recorded from the treatment with seed rate of 160 kg per hectare, which was statistically identical to the 80 kg, 120 kg, 140 kg, and 160 kg per hectare seed rates. The result showed that the biological yield progressively improved with the decreasing levels of seeding rates. The mean value for this parameter indicated that the cumulative influence of yield contributing characteristics, such as adequate number of tillers per plant, number of grains/spike, spikelets/spike and 1000 grains weight, had effective influence on higher grains yield obtained from 100 kg per hectare seeding rate. In the case of high seed rate, the growth and enlargement of plants were exposed due to competition of uptake of vital constituents and sunlight. It has caused poor yield characteristics and eventually culminated in the most negligible biological yield. Earlier, similar results for biological yield was reported by Talukdar *et al.* (2004), Allam (2005), and Hag (2006). Seeding rate had an influential role in various biochemical and physiological processes resulting in higher dry matter in cereal crops and more grain yield production.

Table 3: Influence of different seed amounts on some yield characteristic of wheat crop (*Triticum aestivum* L.)

Treatment [Seed rate kg/ha]	Grain No. per spike	Wt. of spike (g)	Wt. of grain (g/spike)	Grain crop yield (kg/ha)	Straw crop (kg/ha)	1000 grain weight (g)	Biological yield (kg/ha)	Harvest index
80	42.25 a	1.89 a	1.11 b	3.96 b	5.15 b	31.25 b	9.46 b	39.51
100	41.75 a	1.70 ab	1.43 a	4.94 a	5.65 a	33.75 a	11.46 b	41.27
120	35.50 b	1.37 bc	1.38 a	3.94 b	6.15 a	33.00 a	9.59 b	39.17
140	35.25 b	1.25 c	1.10 b	3.22 c	4.98 b	31.25 b	8.37 b	35.60
160	30.75 b	1.23 c	0.93 b	3.03 c	3.15 c	30.25 b	8.03 b	34.87
F test	**	*	**	**	**	**	**	NS
SEM±	1.94	0.13	0.07	0.21	0.45	0.40	0.53	1.74
CV (%)	10.43	17.93	10.95	10.95	15.3	2.49	11.20	9.13

Note: \* = (Critical dissimilarity); SEM = Standard Error Mean; CV = Co-efficient of Variation. Mean values of each parameter within each column with the similar alphabet are not significantly difference at ( $p > 0.05\%$ ).



### Harvest index

The harvest index shows the functional ability of plants to convert photosynthesis to final grain yield. Due to the application of different seeding rates, the mean values recorded for harvest index (Table 3) were non-significant ( $P>0.05\%$ ). However, higher harvest index (41.27%) was noted for the seeding rate of 100 kg per hectare with 80 kg/ha and 120 kg/ha seeding rates. Minimum harvest index (34.87%) was observed from 160 kg per hectare seed rate. Statistically at par with the rest, four seed rates were applied in this study. When harvest index is low, there is less translocation of nutrients and solar energy from the source to the sink, which results in less development of seeds and makes them of shriveled size. When harvest index is high, more assimilates were translocated from source to the grains, resulting in more assimilates being translocated from source to the grains, resulting in improved development and filling. Wheat crop harvest index is directly linked with the grain weight and plant dry matter, which in the long run depends upon the accessibility and absorption of nutrients from soil and sunlight penetration in the different parts of the plot. Hag (2006), Allam (2005) and Nourmohammadi, Siadat and Kashani (2010) reported that the harvest index varied significantly among the different seed rates, their results are against the finding of this study.

### Conclusions and Recommendation

The results acquired from the present experiment have revealed that the application of various seeding rates, namely, 80, 100, 120, 140 and 160 kg per hectare, significantly affected different growth and yield parameters of wheat crop. The results indicated that the seed rate of 100 kg per hectare of wheat variety Mazare-99 performed better with respect to different growth and yield parameters such as spike length, total tillers number, the quantity of spike per plant, flag leaf area, number of spikelets per spike, and stem girth, grain number/spike, weight of spike, the weight of grain per spike, grain crop yield, crop straw weight, biological yield, and 1000-grains weight. The seeding rates of 80 kg/ha and 120 kg/ha were the second-best seeding rates after the 100 kg/ha seed rate. However, 160 kg/ha seed rate showed only superiority in plant height, but the 140 kg/ha seeding rate of a wheat variety of Mazar-99 did not show any remarkable superiority in any growth and yield characteristic evaluated in Takhar agro-climatic situation. Thus, a 100 kg per hectare seeding rate could be recommended to the farmers for better wheat production in Takhar agro-climatic conditions in North-Eastern Afghanistan.

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## Authors' Declarations and Essential Ethical Compliances

### *Authors' Contributions (in accordance with ICMJE criteria for authorship)*

Contribution	Author 1	Author 2	Author 3
Conceived and designed the research or analysis	Yes	Yes	No
Collected the data	Yes	No	Yes
Contributed to data analysis & interpretation	Yes	Yes	No
Wrote the article/paper	Yes	Yes	Yes
Critical revision of the article/paper	Yes	Yes	Yes
Editing of the article/paper	No	Yes	Yes
Supervision	No	Yes	No
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