



## Research Article

# Effect of Different Seed Sizes and Seed Rates on the Growth and Productivity of Wheat Grown Under Semi-Arid Conditions

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**Abstract** | Optimum seeding density and seed size are imperious agronomic practices for improving wheat productivity. Therefore, this field study assessed the impact of diverse seeding rates and seed sizes on performance of wheat. The study was comprised of various seeding rates 100, 125 and 150 kg ha<sup>-1</sup> and different seed sizes i.e., bold seed (more than 2.7 mm), medium seed (less than 2.7 mm) and small seed (less than 2.3 mm). The various seed sizes and rates significantly affected performance of wheat crop. For seed sizes maximum LAI, CGR, plant height (94.32 cm) productive tillers (PT) (364 m<sup>-2</sup>), thousand grain weight (TGW) (42.67 g), biological yield (BY) (10.61 t ha<sup>-1</sup>), grain yield (GY) (4.49 t ha<sup>-1</sup>) and harvest index (HI) (41.94%) was obtained with 150 kg ha<sup>-1</sup> seeding rate and lowest LAI, CGR, height (88.65 cm) PT (283.11 m<sup>-2</sup>), TGW (38.30 g), BY (9.57 t ha<sup>-1</sup>), GY (3.66 t ha<sup>-1</sup>) and HI (38.66) was noted in seed rate of 100 kg ha<sup>-1</sup>. In case of seed size maximum LAI, CGR, plant height (99.67 cm), PT (348 m<sup>-2</sup>), TGW (42.67 g), BY (10.68 t ha<sup>-1</sup>), GY (4.53 t ha<sup>-1</sup>) and HI (42.68%) was recorded with bold seed (more than 2.7 mm) LAI, CGR, plant height (88.09 cm) PT (294 m<sup>-2</sup>), TGW (36.29 g), BY (9.62 t ha<sup>-1</sup>), GY (3.61 t ha<sup>-1</sup>) and HI (36.92%) was recorded with small seed size (less than 2.3 mm). In conclusion, 150 kg ha<sup>-1</sup> of seed rate and bold seed size can be used under Faisalabad conditions to get the maximum wheat production.

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## Introduction

Wheat is an imperative staple food crop cultivated across the globe owing to its higher nutritional value. The grain wheat crop comprises 68% carbohydrate, 15.4% protein, 12.2% dietary fiber and 1.9% fat which makes him an imperative food crop for

humans (Anjum *et al.*, 2005; Chattha *et al.*, 2017a, b, 2018; Hassan *et al.*, 2019a, 2021). In Pakistan is also a largely consumed food crop and it is planted on 8825 hectares and it is producing 24.94 million tons yield to combat food needs in Pakistan (GoP, 2020). However, wheat productivity in our country is quite lower as compared developed nations (FAOSTAT, 2016).

There is a big gap among potential and actual yields of wheat crop and this large gap is due to a lack of knowledge about agronomic management and certain factors including late sowing of wheat, non-availability of high-quality certified seeds, poor plant geometry, poor fertilization, improper irrigation technique and high weeds infestation, seed rate and seed size (Sattar *et al.*, 2010; Zain *et al.*, 2017; Hassan *et al.*, 2020a, b; Muhsin *et al.*, 2021; Aslam *et al.*, 2021).

Seed size plays an imperious role in plants growth and final production (Sarker *et al.*, 2007). Many authors reported seed size has substantiated impacts on wheat growth and production (Valério *et al.*, 2009; Muhsin *et al.*, 2021). The seeds with large sizes are considered to have more vigor, germination potential and ability to perform well under wide range of conditions as compared to smaller seeds (Shahwani *et al.*, 2014). Bold seeds also produced the plants with better root growth and leaf area (Aparicio *et al.*, 2002) which in turn increased the overall wheat productivity (Stougaard and Xue, 2005). Contrarily, seeds with small size have poor vigor and poor germination potential which therefore give lower yield (Muhsin *et al.*, 2021). Therefore, seed size can be a viable option to enhance wheat production s (Mustafa *et al.*, 2018).

Seeding density is another imperative factor that determines the plant's ability to acquire natural resources. Optimum plant population affects the wheat production, and it can be achieved using appropriate seed rate (Chaudhry and Hussain, 2001; Zecevic *et al.*, 2014). It is most common practice that the farmer uses a standard seed rate (120 kg ha<sup>-1</sup>) irrespective to the cultivar type (Islam *et al.*, 2004). Furthermore, by expecting high yield, irrespective to the recommended seed rate for particular cultivar, they use more seed rate to lower weed pressure in their field that increases their input cost, however, increasing the seed caused substantial reduction in final production (Naseri *et al.*, 2012). Thus, we hypothesize that seed size could have a significant impact on wheat productivity under Faisalabad climatic conditions. Therefore, current research was executed to verify the optimum seed rate along with different seed size to improve wheat productivity grown in semi-arid conditions.

## Materials and Methods

### Experimental site

The current research experiment was conducted

during 2018-19 and study area has semiarid and humid climatic conditions during summer and dry conditions during the winter and further climatic conditions are presented in Table 1. The samples depth of 0-30 cm from various parts of the field was taken to determine the different soil properties (Homer and Pratt, 1961). The soil was recognized as sandy loam with pH of 8.5, EC 0.42 dS m<sup>-1</sup>, organic matter 0.72%, total 0.080% nitrogen, and available phosphorus and potassium 14 and 173 ppm, respectively.

### Experimental details

The research trail was carried out using RCBD with factorial arrangement. The study was comprised of three seed rates: SR<sub>1</sub> = 100 kg ha<sup>-1</sup>, SR<sub>2</sub> = 125 kg ha<sup>-1</sup>, SR<sub>3</sub> = 150 kg ha<sup>-1</sup> and three sees sizes: sizes: SS<sub>1</sub> = bold (> 2.7mm), SS<sub>2</sub> = medium (2.7mm), SS<sub>3</sub> = small (<2.3mm).

### Seed collection and grading

Three different sized seeds (bold, medium, small) were divided using two separate sieves. The first seed passes through a sieve of 2.7 mm, the remaining seeds in a sieve are bold seeds, then the seeds that move again through the first sieve of 2.3 mm, the seeds remain above the second filter are the middle seeds, and that seed passes through the second filter is a small seed.

### Crop husbandry

The soil was cultivated two times and planking was done for final sowing. The crop was planted on November 20, 2018 using hand drill with maintaining row spacing 22.5 cm. Fertilizer sources ammonium nitrate (33% N), triple-super phosphate (TSP) (46% P) and sulfate of potash (50% K) was used to supply the suggested amount of NPK 100:75:50 kg ha<sup>-1</sup>. Fiver number of irrigations including soaking irrigation (4-acre inch), and other 4 irrigations of 3-acre inch of each were supplied before the maturity stage of the crop.

### Data collection

The experimental plots were regularly visited and number of seeds emerged on each day were manually counted and time to 50% emergence (T50) and mean emergence time (MET) were measured by standard methods of Farooq *et al.* (2005). The wheat plants were harvested from unit area and leaves were separated from stem and leaves sub-sample (5 g) was taken and leaf area was determined and LAI was measured by methods of Watson (1947). Similarly, harvested samples were oven dried (70°C) until constant weight

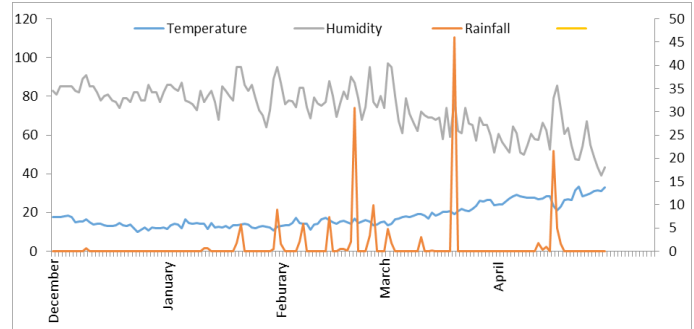
and CGR was measured by methods of [Hunt \(1978\)](#). We marked ten plants in each plot their heights were taken and averaged. Similarly, productive as well as non productive were counted from a unit area (1 m<sup>2</sup>). Moreover, ten spikes harvested and spikelet/spike and grains/spike were counted. Lastly, plots were harvested and weighed to determine biological yield and later on threshed to determine to grain yield.

**Statistical analysis**

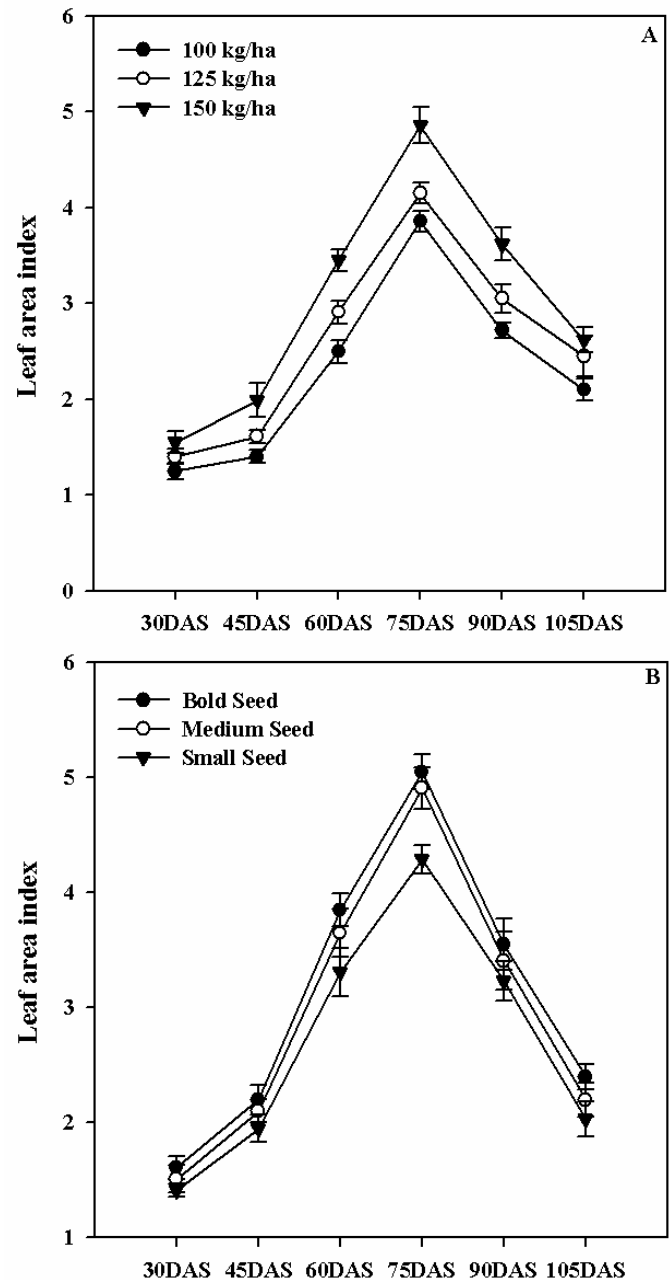
The date of diverse traits was analyzed with Fisher’s analysis of variance procedure and LSD test at 5% was used to determine significant differences amid means ([Steel et al., 1997](#)).

**Results and Discussion**

The results indicated that seed size has significant impact on the time to 50% emergence (Days) and mean emergence time (MET) (Days) whereas the seed rate and their interaction had non-significant impact on these traits ([Table 1](#)). The bold seeds took the least number of days to complete 50% emergence (8.18 days) and MET (10.79 days) t followed by medium sized seeds whereas, the small seeds took maximum time to complete the 50% emergence (10.74 days) and MET (12.90 days) ([Table 1](#)). The results indicated that different seed size classes and seeds rates had significant growth traits ([Figures 2 and 3](#)). Bold seeds produced maximum LAI and CGR followed by medium seeds whereas lowest LAI and CGR was noted with use of small seeds ([Figures 2 and 3](#)). In case of seeds rates the application of 150 kg ha<sup>-1</sup> seed resulted in maximum LAI and CGR followed closely with 150 kg ha<sup>-1</sup> and lowest LAI and CGR was noted 150 150 kg ha<sup>-1</sup> seed rate ([Figures 2 and 3](#)). LAI and CGR was noted maximum at 75 days after sowing (DAS), after that LAI and CGR both showed the reduction and reached to minimum values at 105 DAS ([Figures 2 and 3](#)). The bold seeds have more vigor which ensured the better stand establishment with production of more leaves with better length and width. Therefore, leaves with better length and width have more leaf area and subsequently LAI. Similarly, the better leaf area ensures the better light harvesting which resulted in production of more assimilates and subsequent CGR ([Muhsin et al., 2021](#); [Aslam et al., 2021](#)). The current results also coincide with the outcomes of [Aslam et al. \(2003\)](#) and [Sattar et al. \(2010\)](#) they noted that use of 150 kg/ha seed rate provided the greatest value of leaf area index and CGR.



**Figure 1:** Weather conditions during study period.



**Figure 2:** Effect of different rates (A) seed sizes (B) on LAI of wheat crop.

The bold seeds possess high nutritional constituents that help them to emerge more quickly ([Gholizadeh, 2012](#)) as compared to smaller seeds. Likewise, we found that in our study we also found that bold seeds

took less time for 50% emergence and mean emergence as compared to small and medium seeds. The current outcomes are in consistency with outcomes of Zareian *et al.* (2012) they noted that decrease in time to E<sub>50</sub> mean emergence by using bold seeds as compared to smaller seeds. The research study disclosed that plant height and spike length was significantly influenced by both different sized seeds and seed rate. Amid seed size, taller plants (99.67 cm) with longer spikes (11.37 cm) were recorded from bold seeds followed by medium sized seeds whereas, the least plant height and spike length was recorded from small seeded treatments (Table 1). As for seed rate, dense populated plot (using 150 kg ha<sup>-1</sup>) produced taller plants (94.32 cm) that was at par with 125 kg ha<sup>-1</sup>, contrary, the maximum spike length was noted using 125 kg ha<sup>-1</sup> seed rate that was same with 150 kg ha<sup>-1</sup> (Table 2). Amongst interaction, plants acquired highest plant height (102.47 cm) in the treatment of bold × 150 kg ha<sup>-1</sup> that was same with bold × 125 kg ha<sup>-1</sup> after that bold × 100 kg ha<sup>-1</sup> (Table 1).

Enlarged plant height and spike length was recorded from bold seeded wheat crop that might be due to early stand establishment to overcome weeds and better nutrient utilization (Keerio, 2013). Our research findings are confirmatory with Iqbal *et al.* (2021) who

also reported an increased in plant height from bold seeds due to better mineral usage in vegetative stages. Amid to spike length, our findings are observed closely related to research work reported by Akhter *et al.* (2017) they reported the maximum spike length with 125 kg ha<sup>-1</sup> seed rate and non-significant increase in spike length with further increase in seed rate.

The bold seeds produced maximum productive tillers (348.89 m<sup>2</sup>) and lowest non-productive tiller (8.56 m<sup>2</sup>) (Table 1). Conversely, least number of productive tillers (294.22 m<sup>2</sup>) and maximum un-productive tillers (11.53 m<sup>2</sup>) were recorded from small sized seeds (Table 1). Maximum productive tillers (364.00 m<sup>2</sup>) were obtained with 150 kg ha<sup>-1</sup> seeding rate after that 125 kg ha<sup>-1</sup> and the least productive tillers were recorded with using seed rate of 100 kg = kg ha<sup>-1</sup> (Table 1). Bold seeds produced highest productive tillers compared to medium and small seeds. Bold seeds make sure the optimum number of plants in field, consequently, lead to considerable increase in productive tillers. These findings are affirmed by Muhsin *et al.* (2021) they also noted that bolder seeds intercept light efficiently and produced more tillers. Moreover, applying more seed rate, the plant population/ area increased that augment the production of productive tillers (Sarker *et al.*, 2009; Akhter *et al.*, 2017).

**Table 1:** Effect of different size different seed sizes and seeds rates germination and yield traits of wheat crop.

Seed size (SS)	T50 (Days)	MET (Days)	PH (cm)	PT (m <sup>2</sup> )	NPT (m <sup>2</sup> )	SL (cm)
Bold	8.18C	10.79C	99.67A	348.89A	8.56C	11.37A
Medium	9.65B	12.19B	87.67B	339.56A	10.14B	9.60B
Small	10.74A	12.90A	88.09C	294.22B	11.53A	9.50B
LSD≤0.05P	0.46	0.65	2.21	15.13	0.34	0.32
<b>Seed rate (SR)</b>						
100 kg ha <sup>-1</sup>	9.35	12.01	88.65B	283.11C	9.83	9.64B
125 kg ha <sup>-1</sup>	9.56	11.99	92.44A	335.56B	10.07	10.52A
150 kg ha <sup>-1</sup>	9.67	11.89	94.32A	364.00A	10.31	10.31A
LSD≤0.05P	NS	NS	2.21	15.13	NS	0.32
<b>Interaction (SS×SR)</b>						
Bold × 100 kg ha <sup>-1</sup>	10.42	12.69	95.27b	298.00	8.47	10.70
Bold×125 kg ha <sup>-1</sup>	10.83	12.69	101.30a	365.33	8.51	11.83
Bold ×150 kg ha <sup>-1</sup>	10.97	13.13	102.47a	383.33	8.69	11.60
Medium×100 kg ha <sup>-1</sup>	9.55	12.58	87.30d	293.33	9.82	9.26
Medium ×125 kg ha <sup>-1</sup>	9.65	12.02	87.37d	350.00	10.17	9.73
Medium ×150 kg ha <sup>-1</sup>	9.77	11.98	88.37cd	375.33	10.43	9.50
Small× 100 kg ha <sup>-1</sup>	9.35	10.76	83.40e	258.00	11.22	8.96
Small ×125 kg ha <sup>-1</sup>	8.18	11.07	88.67cd	291.33	11.55	10.00
Small ×150 kg ha <sup>-1</sup>	8.27	10.56	92.13bc	333.33	11.81	9.83
LSD ≤ 0.05P	NS	NS	3.82	NS	NS	NS

T50: time to 50% emergence, MET: mean emergence time, PH: plant height, PT: productive tillers, NPT: non-productive tillers, SL: spike length, NS=non-significant; means with different letters differed at 0.05 P



**Table 2:** Effect of different size different seed sizes and seeds rates yield traits and yield of wheat crop.

Seed size	SLP	GPS	TGW (g)	GY (t ha <sup>-1</sup> )	BY (t ha <sup>-1</sup> )	HI (%)
Bold	18.13A	57.66A	42.67A	4.53A	10.68A	42.68A
Medium	16.67B	53.66B	39.34B	4.05B	9.82B	41.28A
Small	15.34C	43.66C	36.29C	3.61C	9.62B	36.92B
LSD $\leq$ 0.05P	NS	2.87	0.97	0.11	0.45	1.39
Seed rate						
100 kg ha <sup>-1</sup>	16.53	48.00C	38.30C	3.66	9.57B	38.66C
125 kg ha <sup>-1</sup>	16.92	55.11A	40.59A	4.03	9.94B	40.46B
150 kg ha <sup>-1</sup>	16.68	51.89B	39.43B	4.49	10.61A	41.94A
LSD $\leq$ 0.05P	0.32	2.87	0.97	0.11	0.45	1.39
Interaction (SS $\times$ SR)						
Bold $\times$ 100 kg ha <sup>-1</sup>	17.86	54.66	41.93	4.13	9.96	41.46
Bold $\times$ 125 kg ha <sup>-1</sup>	18.56	61.33	43.59	4.46	10.45	42.67
Bold $\times$ 150 kg ha <sup>-1</sup>	17.96	57.00	42.50	5.11	11.63	43.93
Medium $\times$ 100 kg ha <sup>-1</sup>	16.50	49.00	38.21	3.82	9.75	39.17
Medium $\times$ 125 kg ha <sup>-1</sup>	16.60	58.33	40.53	4.11	9.88	41.59
Medium $\times$ 150 kg ha <sup>-1</sup>	16.90	53.66	39.28	4.24	9.84	43.09
Small $\times$ 100 kg ha <sup>-1</sup>	15.23	40.33	34.77	3.15	8.99	35.04
Small $\times$ 125 kg ha <sup>-1</sup>	15.60	45.66	37.58	3.53	9.51	37.11
Small $\times$ 150 kg ha <sup>-1</sup>	15.20	45.00	36.52	4.01	10.38	38.63
LSD $\leq$ 0.05P	NS	NS	NS	0.19	NS	NS

SLP: spikelet's/spike, GPS: grains per spike, TGW: 1000 grain weight, GY: grain yield, BY: biological yield, HI: harvest index, NS=non-significant; means with different letters differed at 0.05 P.

Different seed size significantly affected the spikelets/spike whilst varying seed rate showed no significant impact on spikelets. The maximum spikelets/spike (18.13) was counted from bold seeds followed by medium sized seeds, and the small seeds remained at lowest position with minimum spikelet's (15.34) (Table 2). Our findings suggested that bold sized seeds completed early vegetative stage by emerging more quickly to assemble high assimilates and thus, more produced more spikelets/spike. The current outcomes are same with Gadisa (2019) and Neugschwandtner *et al.* (2019) they also noted the use bold seeds improved the productions of spikelet's in winter wheat. Various seeding rates and seed sizes had significant impact on the grains/spike and thousand grain weights was found significant (Table 2) More rains/spike (57.66) and TGW (42.67g) was noticed from bold seeded crop followed by medium sized seeds and the least grain numbers per spike (43.66) along with 1000 grain weight (36.29g) was recorded from small size seeds (Table 2). Amid seed rate, the use of 125 kg ha<sup>-1</sup> seed rate showed highest number of grains/spike (55.11) and TGW (40.59g) and lowest grains/spike (48) and 1000 grain weight (38.30g) was noted by

utilizing 100 kg ha<sup>-1</sup> seed rate (Table 2).

Bold seeds significantly increased grains/spike and 1000 grains weight that could be due to high food reserve present in bold seeds compared to other medium and small seeds, which enables the seedling to produce more productive tillers, lower the weed density to create more surface area to intercept photosynthetic active radiation (PAR) that resulted in increase in production of more grains with more weight (Iqbal *et al.*, 2021). Our observation showed that thousand grains weight was increased with use of optimum seed rate. The current outcomes are comparable with findings of Baloch *et al.* (2010) they also noted increase in TGW with use of optimum seed whereas 1000 seed weight decreased with increasing the seed rate (Laghari *et al.*, 2011; Akhter *et al.*, 2017). The maximum grain yield (4.53 t ha<sup>-1</sup>) produced by bold seeds followed by medium size seeds and the low grain yield (3.61 t ha<sup>-1</sup>) was recorded with small size (Table 2). Amongst seed rate, the use of high seed rate (150 kg ha<sup>-1</sup>) increases the grain yield up to 4.49 t ha<sup>-1</sup> followed by 125 kg ha<sup>-1</sup> seed rate (Table 2).

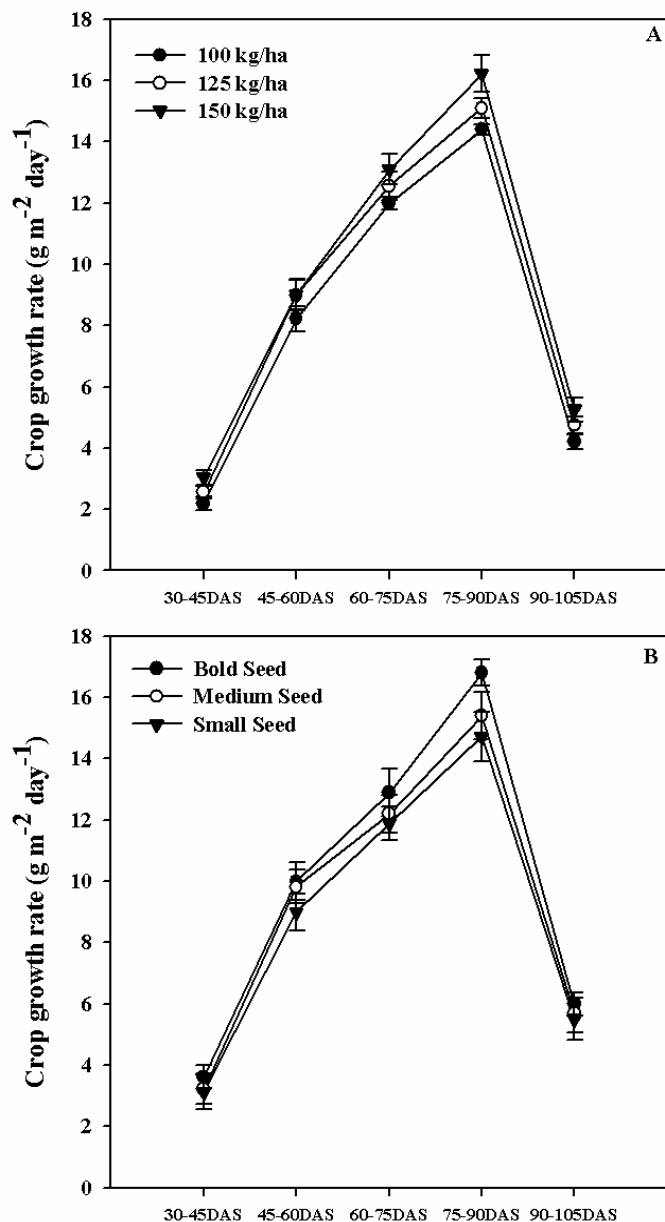


Figure 3: Effect of different rates (A) seed sizes (B) on CGR of wheat crop.

The maximum yield in bolder seeds might be due to higher LAI which ensure the better assimilates production and thus improved the tillers production, spikes, grains/spike and grain weight all of these contributed to significant increase in grain yield (Shahwani *et al.*, 2014; Gadisa, 2019; Tenikecier and Genctan, 2020). The maximum biomass production (10.68 t ha<sup>-1</sup>) was noted from bold seeds followed by medium size a seed (Table 2). In case of diverse seeding rates maximum biological yield (10.61 t ha<sup>-1</sup>) was attained when high seed rate (150 ha<sup>-1</sup>) was used followed by 125 and 100 kg ha<sup>-1</sup> seed rates that were observed statistically similar for each treatment (Table 2). The remarkable increase in biological yield was noted from the crop sown with bold size seeds which is supported by the findings reported by

Keerio (2013) they also stated bold seeds ensured the better LAI, assimilates production and which in turn increased the biomass production. Highest biological yield was obtained with increasing seeding rate that can be due to more productive tillers and subsequently increased biological yield (Akhter *et al.*, 2017).

Different seed rates applying in a combination to varying seed size significantly affected the harvest index (HI) of the crop. The highest HI (42.68%) was noted from the crop sown with bold seeds and observed similar to the crop sown with medium seeds that was followed by small seeds (Table 2). In addition, the use of high seed rate (150 kg ha<sup>-1</sup>) ensured maximum HI (41.94%) lowest harvest index (38.66%) was obtained from the use of least seed rate (100 kg ha<sup>-1</sup>) (Table 2). The HI is product of grain and biological yield therefore, maximum HI in bold seeds with use of seed rate at 150 kg ha<sup>-1</sup> was due to maximum grain and biological yields.

### Conclusions and Recommendations

The results showed that bold seeds markedly improved final production owing to vigorous germination and increase in yield contributing traits. Moreover, application of seed rate at the 150 kg ha<sup>-1</sup> remained the top performer in improving yield and yield associated traits. Therefore, use of bold seeds and application of 150 kg ha<sup>-1</sup> seed rate can significantly improve the wheat growth and productivity.

### Novelty Statement

Limited information is available about the effect of seed sizes on the growth and yield of wheat crop. Therefore, this study was conducted to verify the effect of different seed sizes along with different seed rates on productivity of wheat crop.

### Autor's Contribution

**Muhammad Shoaib:** Conducted the experiment.  
**Imran Khan and Muhammad Umer Chattha:** Supervised.  
**Muhammad Nawaz, Muhammad Ilyas, Muhammad Shafique, Muhammad Talha Aslam, Muhammad Sultan Ali Bazmi, Muhammad Arshid, Ghulam Ahmad, Muhammad Irfan and Muhammad Umair Hassan:** Reviewed and edited the manuscript.

The authors have declared no conflict of interest.

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