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INFLUENCE OF SEED SIZE ON GERMINABILITY AND GRAIN YIELD OF WHEAT (Triticum Aestivum *L.*) VARIETIES

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Abstract

A field study was carried out at the experimental fields of Agronomy Section, Agriculture Research Institute, Tandojam during Rabi, 2012-13, to investigate the influence of seed size on germ inability and grain yield of wheat varieties. The effect of two seed sizes (Small and Large) was examined against two commercial wheat varieties (Abadgar-93 and Mehran-89) in a three replicated Randomized Complete Block Design. The results revealed that the effect of seed size on seed germination (%), plant height (cm), number of tillers plant-1, spike length (cm), number of grains spike-1, seed index (1000 grains weight, g) and grain yield (kg ha-1) was significant ($P<0.05$), while non-significant ($P>0.05$) on biological yield (kg ha-1); while the effect of varieties was significant ($P<0.05$) on plant height (cm), spike length (cm), number of grains spike-1, seed index (1000 grains weight, g), biological yield (kg ha-1) and grain yield (kg ha-1) and non-significant ($P>0.05$) on seed germination (%) and number of tillers plant-1. However, the interactive effect of variety x seed size was significant ($P<0.05$) for seed index (1000 grains weight, g) and grain yield (kg ha-1) and non-significant ($P>0.05$) for seed germination (%), plant height (cm), number of tillers plant-1, spike length (cm), number of grains spike-1 and biological yield (kg ha-1). Wheat variety Mehran-89 showed superior agronomic performance over Abadgar-93 with 93.71 (%) germination, 96.75 (cm) plant height, 6.03 tillers plant-1, 11.07 (cm) spike length, 41.96 grains spike-1, 42.99 (g) seed index, 10434 kg ha-1 biological yield and 4956 (kg ha-1) grain yield. The crop sown with large size seeds showed remarkably better agronomic performance with 95.29 (%) germination, 96.61 (cm) plant height, 6.40 tillers plant-1, 11.44 (cm) spike length, 42.65 grains spike-1, 42.80 (g) seed index, 10241 (kg ha-1) biological yield and 4857.10 (kg ha-1) grain yield. It was concluded that sowing wheat with large size seeds was remarkably beneficial with most promising agronomic performance (4857.10 kg ha-1 grain yield) as compared to small size seeds (4400.70 kg ha-1 grain yield). The interactive effect of Mehran x large size seed surpassed rest of the interactions with maximum grain yield of 5260 (kg ha-1).

Keywords: Wheat, Influence, Seed size, Germinablity and Grain yield.

1. Introduction

Wheat (Tritium aestivum L.) is the most important crop and among the major three cereal crops that provides 20 percent of the total energy requirement in human food (Shewry, 2009). Being a staple food in Pakistan, wheat is major source of food grain and high adaptation of this plant as well as its diverse consumptions in the human nutrition lead to present as the most important cereal in the world, especially in developing countries (Farzi and Bigloo, 2010). It is used to make flour for leavened, flat and steamed breads and most of the baked foods; for fermentation to make beer and alcohol (Tsenov et al., 2008). In Pakistan, wheat is averagely used for about 60 percent of daily diet of common man with average per capita consumption of 125 kg (Khan and Habib, 2003). Wheat is the essential diet of population and occupies a central position in agricultural policies of the government. The government announced wheat support price Rs. 1200/- per 40 kg which created interest among wheat growers. The latest Pakistan Economic Survey 2012-13 (GOP, 2013), the contribution of wheat to value addition in agriculture is 10.1; while it contributes to GDP is 2.2 percent. The area under wheat cultivation increased to 8693 thousand hectares in 2012-13 from 8650 thousand hectares showing an increase of 0.5 percent over preceding year area under wheat. The production of wheat stood at 24.2 million tons during 2012-13 against the target of 25.5 million tons showing 5.1 percent decrease while an increase of 3.2 percent over the last year production of 23.5 million tons. The yield per hectare in 2012-13 remained 2787 kg showing a positive growth of 2.7 percent as compared to negative 4.2 percent growth last year. Seed germination is one of the most important phase effecting yield and quality in crop production (Almansouri et al., 2001). Further, the interaction between seedbed environment and seed quality plays an important role in crop establishment (Khajeh-Hosseini et al., 2003). In modern agriculture, seed is a vehicle to deliver almost all agriculture-based technological innovations to farmers so that they can exploit the genetic potential of new varieties. The availability, access and use of seed of adaptable modern varieties is, therefore, determinant to the efficiency and productivity of other. packages (irrigation, fertilizers, pesticides) in increasing crop production to enhance food security and alleviating rural poverty in developing countries (Van Gastel et al., 2002).Seed quality is very important to optimum growth and yield production in farm which influenced by many factors such as genetic characteristics, viability, germination percent, vigor, moisture content, storage conditions, survival ability and seed health, but their most important is germination percent and vigor (Akbari et al., 2004). Generally, factors such as genetic structure, environment and parental nutrition, maturity stage in harvest time, mechanical damages, seed storages, age and aging and pathogens, affect seed germination and vigor. One of the important criteria in seed vigor is the amount of dry matter or the seed weight. Germination and seedling emergence requires a lot of energy that prepared through the oxidation of seed storages. Seed should be has adequate food supply for seedling growing because seedling until enough growth, is dependent to seed. Thousand grain weights is one of important scales in seed quality. It depends to embryo size and seed storages for germination and emergence. High thousand seeds weight will increase germination percent, seedling emergence, till erring, density, spike and yield (Cordazzo, 2002). Thus seed weight or thousand grain weight has a large effect on seed germination, seed vigor, seedling establishment and yield production. Nedeva and Nicolova (1999) reported that after flowering and during grain filling period of wheat, decreased the moisture percent and increased the dry matter percent (dry grain weight) and germination percent. Gorge and Ray (2004) showed that with increasing in hundred grains weight increased the germination percent, for example with increasing in hundred grains weight from 0.08g to 0.1g, the germination percent increased from 34 percent to 80 percent. Khan (2003) documented that with increasing in seed weight of Artocarpos heterophyllus L., from 4-6g to 12-14g, the germination percent increased from about 15 percent to about 85 percent showing a positive and significant correlation between seed weight and seed germination percent.

Seed size is an important physical indicator of seed related to yield, market grade factors and harvest efficiency (Kawade et al., 1987). A wide array of different effects of seed size has been reported for seed germination, emergence and related agronomical aspects in many crop species (Willenborg et al., 2005). However, these results varied widely between species. With increased seed size higher germination and emergence were determined. In wheat, seed size is positively correlated with seed vigor: larger seeds tend to produce more vigorous seedlings. In wheat, seed size not only influence emergence and establishment but also affected yield components and ultimately grain yield. Larger seeds of spring wheat produced higher yields than smaller seeds under late-sown conditions, but not under optimum management conditions. Similarly, Rukavina et al. (2002) found that low-vigor spring wheat seed produced lower crop stand and lower grain yields. In view of the above facts, the study was carried out to investigate the influence of seed size on germ inability and grain yield of wheat varieties.

1.1 Material and Methods

The study was carried out at the experimental fields of Agronomy Section, Agriculture Research Institute, Tandojam during Rabi, and 2012-13 in a three replicated Randomized Complete Block Design with factorial arrangements having net plot size of 3.15 × 5m (15.75m2). The sowing of both wheat varieties were done on the same dates with the help of single row hand drill. The nitrogen fertilizer was applied @ 168 kg ha-1 and phosphorus @ 84 kg ha-1.

Cultural practice

The recommended dose of NP fertilizers was applied; where all P (in the form of single super phosphate) and 1/3rd of N (in the form of Urea) were applied at the time of sowing and remaining N was applied in two equal splits at first irrigation and at 2nd irrigation, respectively. The irrigations were applied according to the crop requirement and the weeding was performed by using weedicides. For recording observations on various agronomical traits, five plants in each plot were selected at random and labeled. After completion of observations on growth parameters, and when the crop reached its physiological maturity, the labeled plants were harvested manually and tied in small bundles, and were shifted to threshing yard. Threshing was performed manually; the grains were collected carefully to count and record.

Procedure for recording observations

1. **Seed germination (%)**Seed germination was recorded at the time of thinning after 20 days of sowing of crop on the basis of total number of seeds sown in particular area and total number of seeds emerged (seedling emergence) in percentage.
2. **Plant height (cm)** Plant height was recorded at maturity of the crop in randomly selected plants using measuring tape from bottom to tip of the spike in centimeters
3. **Number of tillers plant-1** Total tillers for randomly selected plants was counted at the time of maturity and averaged.
4. **Spike length (cm)** The length of all the spikes in randomly selected plants was measured in centimeters

with measuring tape and average will be worked out.

5. **Number of grains spike-1** The number of grains in each spike of the randomly selected plants was counted at the crop maturity and average was worked out.
6. **Seed index (1000 grains weight, g)** One thousand grains of each variety from each plot were collected at random and weighed to record the seed index.
7. **Biological yield (kg ha-1)** The all foliage and grains received from each plot was weighed and on the basis of biological yield plot-1¬, biological yield ha-1 was calculated in kilograms.
8. **Grain yield (kg ha-1)** The all grain received from each plot was weighed and on the basis of grain yield plot-1¬, grain yield ha-1 was calculated in kilograms.

Statistical analysis:

The data thus collected were subjected to statistical analysis using MSTAT-C. The LSD test was applied to compare treatments superiority, where necessary (Russel and Eisensmith, 1983).

RESULTS

1. Seed germination (%)

Seed germination is the growth of an embryonic plant contained within a seed, it results in the formation of the seedling and seed quality is determined by germination and purity analysis. The seed germination of wheat varieties Abadgar-93 and Mehran-89 as influenced by seed size is shown in Table-1 and its analysis of variance as Appendix-I. The statistical analysis suggested that germination percentage was significantly ($P<0.05$) influenced by the seed size, while the non-significant ($P>0.05$) differences in germination percentage were observed due to varieties and interaction between varieties seed size. The seed germination was relatively higher (93.71%) in case of wheat variety Mehran-89 as compared to variety Abadgar-93 (91.72%), but differences between these values were statistically non-significant; indicating similarity of these varieties for seed germination behaviour. The crop sown with bolder seeds (large size seeds) resulted in significantly higher seed germination of 95.29% as compared to the crop sown with small size seeds with 91.70% germination. This shows that bolder seeds represent the seed quality that resulted in more germinated seedlings as compared to those sown with relatively low quality seed (small size seed). The interaction studies showed that interaction between Mehran-89 × large size seeds resulted in highest seed germination of 95.74%; while the interaction between Mehran-89 × small size seeds resulted in minimum seed germination of 91.68 %. The results clearly suggested that seed germination is mainly influenced by the seed quality and urges that first choice of a wheat grower should be obtaining high quality seeds to achieve good crop stand.

Table 1. Seed germination (%) of wheat varieties as influenced by seed size

Seed size	Varieties		Mean
	Abadgar-93	Mehran-89	
S_1=Small size	91.72	91.68	91.70 b
S_2=Large size	94.84	95.74	95.29 a
Mean	93.28	93.71	-

Means followed by similar letters do not differ significantly at 0.05 probability level

	Seed size (S)	Varieties (V)	S x V
SE ±	0.2791	0.2791	0.3947
LSD 0.05	0.6829	-	-
LSD 0.01	1.0347	-	-
CV%	4.52		

2. Plant height (cm) Tallness in wheat plants is mostly associated with the genetic makeup of the parental material of varieties; but this trait is also influenced by the quality and quantity of inputs applied. The plant height of wheat varieties Abadgar-93 and Mehran-89 as affected by seed size is given in Table-2 and its analysis of variance as Appendix-II. The statistical analysis suggested that varieties and seed size had significant ($P<0.05$) influence on plant height, while their interactive effect was statistically non-significant ($P>0.05$). Wheat variety Mehran-89 grew significantly ($P<0.05$) taller than variety Abadgar-93 and average plant height of Mehran-89 was 96.75 cm against 93.16 cm plant height for Abadgar-93. This indicates that genetically, variety Mehran-89 is relatively superior than Abadgar-93. Similarly, wheat seedlings emerged from large size seeds resulted in taller plants (96.61 cm) as compared to those from small size seeds (93.30 cm). This suggests that the seedlings emerged from large size seeds resulted in healthier and tall growing plants as compared to those emerged from small size seeds. The interactive effect indicates that interaction between Mehran-89 × large size seeds resulted in maximum plant height of 98.32 cm. while the interaction between Abadgar-93 × small size seeds resulted in minimum plant height of 91.43 cm. The results indicated that quality of seed play most important role in producing healthy plants, and the crop sown with lower quality seeds could not produce potential growth and yields.

Table 2. Plant height (cm) of wheat varieties as influenced by seed size

Seed size	Varieties		Mean
	Abadgar-93	Mehran-89	
S_1=Small size	91.43	95.18	93.30 b
S_2=Large size	94.89	98.32	96.61 a
Mean	93.16 b	96.75 a	

Means followed by similar letters do not differ significantly at 0.05 probability level

	Seed size (S)	Varieties (V)	S x V
SE ±	0.4894	0.4894	0.6921
LSD 0.05	1.1976	1.1976	-
LSD 0.01	1.8145	1.8145	-
CV%	4.89		

3. Number of tillers plant-1 Tillering pattern of wheat genotypes may vary according to their genetic makeup and per plant availability of space on average, but it is well recognized that increase in tillering influence the grain yield positively. The results on number of tillers plant-1 of wheat varieties Abadgar-93 and Mehran-89 as influenced by seed size is presented in Table-3 and its analysis of variance as Appendix-III. The analysis of variance demonstrated significant ($P<0.05$) effect of seed size on number of tillers plant-1, while the varieties and interaction between seed size and varieties did not show significant ($P>0.05$) effect on this trait. The number of tillers plant-1 was relatively higher (6.03) in variety Mehran-89 as compared to variety Abadgar-93 (5.96) and both of these varieties showed similar tillering pattern. However, wheat seedlings emerged from large size seeds resulted in more number of tillers (6.40) plant-1 as compared to those from small size seeds (5.60). This suggests that the bolder seeds produced healthier seedlings having higher tillering capacity as compared to the plants developed from smaller size seeds. The interactive effect showed that interaction between Abadgar-93 × large size seeds resulted in maximum number of tillers plant-1 (6.44), while the interaction between Abadgar-93 × small size seeds resulted in minimum number of tillers (5.49) plant-1. The overall results suggested that quality seed in wheat can influence the tillering pattern in positive direction.

Table 3. Number of tillers plant^{-1} of wheat varieties as influenced by seed size

Seed size	Varieties		Mean
	Abadgar-93	Mehran-89	
S_1=Small size	5.49	5.71	5.60 b
S_2=Large size	6.44	6.37	6.40 a
Mean	5.96	6.03	-

Means followed by similar letters do not differ significantly at 0.05 probability level

	Seed size (S)	Varieties (V)	S x V
SE ±	0.1530	0.1530	0.2164
LSD 0.05	0.3744	-	-
LSD 0.01	0.5673	-	-
CV%	4.42		

4. Spike length (cm) Spike length is a character of great significance that contributes to grain yield per unit area considerably. The spike length of wheat varieties Abadgar-93 and Mehran-89 as affected by seed size is presented in Table-4 and its analysis of variance as Appendix-IV. The statistical analysis indicated that the differences in the spike length due to seed size and varieties were statistically significant ($P<0.05$) and non-significant ($P>0.05$) due to seed size × varieties interaction. It is evident from the results that the spike length was markedly higher (11.07 cm) in variety Mehran-89 than variety Abadgar-93 (10.26 cm), and differences between these values were statistically significant; suggesting that Mehran-89 is genetically superior than Abadgar-93 for spike length character. The crop sown with bolder seeds (large size seeds) produced spikes of greater in length (11.44 cm) on average as compared to the crop sown with small size seeds with average spike length of 9.90 cm. This suggested that bolder seeds produced healthier seedlings and consequently greater spike length was achieved. The interactive effect showed that interaction between Mehran-89 × large size seeds resulted in maximum spike length of 12.00 cm, while the interaction between Abadgar-93 × small size seeds resulted in minimum spike length of 9.65 cm. The results of the present study regarding spike length urge that regardless the variety in use, adoption of quality seed is the only option to achieve quantitatively and qualitatively high crop performance.

Table.4 Spike length (cm) of wheat varieties as influenced by seed size
Means followed by similar letters do not differ significantly at 0.05 probability level

Seed size	Varieties		Mean
	Abadgar-93	Mehran-89	
S_1=Small size	9.65	10.14	9.90 b
S_2=Large size	10.88	12.00	11.44 a
Mean	10.26 b	11.07 a	-

	Seed size (S)	Varieties (V)	S x V
SE ±	0.1585	0.1585	0.2241
LSD 0.05	0.3878	0.3878	-
LSD 0.01	0.5876	0.5876	-
CV%	2.57		

5. Number of grains spike-1 Grains spike-1 is considered to be the most important factor to influence grain weight plant-1 under normal tillering. The results in regards to number of grains spike-1 of wheat varieties Abadgar-93 and Mehran-89 as affected by seed size is shown in Table-5 and its analysis of variance as Appendix-V. The analysis of variance indicated that the effect of varieties and seed size on the number of grains spike-1 was significant (P<0.05), while varieties × seed size interaction did not influence the number of grains spike-1 significantly (P>0.05). The number of grains spike-1 was significantly higher (41.96) in variety Mehran-89 than variety Abadgar-93 having 37.98 grains spike-1, and Mehran-89 showed its superiority over Abadgar-93. Similarly, the wheat crop sown with large size seeds produced more number of grains (42.65) spike-1 as compared to the crop sown with small size seeds with 37.98 average number of grains spike-1. This indicates that wheat crop sown with bolder seeds resulted in more grains spike-1 because the spike length was improved. The studies further showed that interaction between Mehran-89 × large size seeds resulted in maximum number of grains spike-1 (45.05), while the interaction between Abadgar-93 × small size seeds resulted in minimum number of grains (35.72) plant-1. It is observed that the crop sown with high quality seed resulted a positive impact on all the growth and yield contributing traits and hence the number of grains spike-1 was also positively influenced.

Table 5. Number of grains spike^{-1} of wheat varieties as influenced by seed size

Seed size	Varieties		Mean
	Abadgar-93	Mehran-89	
S_1=Small size	35.72	38.86	37.29 b
S_2=Large size	40.24	45.05	42.65 a
Mean	37.98 b	41.96 a	

Means followed by similar letters do not differ significantly at 0.05 probability level

	Seed size (S)	Varieties (V)	S x V
SE ±	0.8355	0.8355	1.1816
LSD 0.05	2.0445	2.0445	-
LSD 0.01	3.0977	3.0977	-
CV%	3.62		

6. Seed index (1000 grains weight, g) Seed index is a quality parameter to assess the grain quality in wheat and this trait is generally influenced by genetic makeup of varieties and application of inputs to the crop. The seed index value of wheat varieties Abadgar-93 and Mehran-89 as influenced by seed size is given in Table-6 and its analysis of variance as Appendix-VI. The analysis of variance indicated that varieties and seed size had significant (P<0.05) influence on seed index, while their interactive effect was statistically non-significant (P>0.05). The seed index value of wheat variety Mehran-89 was significantly (P<0.05) higher (42.99 g) than variety Abadgar-93 (40.05 g), suggesting that the grains of Mehran-89 are bolder and heavier than those of variety Abadgar-93. Similarly, the plots sown with bolder seeds (large size) resulted in heavier grains with average seed index value of 42.80 g as compared to small size seeds, where the average seed index value was 40.24 g. The interactive effect showed that interaction of Mehran-89 × large size seeds resulted in maximum seed index of 43.58 g, while the interaction between Abadgar-93 × small size seeds resulted in minimum seed index of 38.08 g. The results argue that the increase in seed index value is proportional to quality of seed, and in case the farmers are conscious to consider this factor and use quality seed, the potential grain weight can be achieve

Table 6. Seed index (1000 grains weight, g) of wheat varieties as influenced by seed size

Seed size	Varieties		Mean
	Abadgar-93	Mehran-89	
S_1=Small size	38.08	42.39	40.24 b
S_2=Large size	42.02	43.58	42.80 a
Mean	40.05 b	42.99 a	-

Means followed by similar letters do not differ significantly at 0.05 probability level

	Seed size (S)	Varieties (V)	S x V
SE ±	0.4145	0.4145	0.5862
LSD 0.05	1.0145	1.0145	1.4345
LSD 0.01	1.5368	1.5368	2.1734
CV%	1.73		

7. Biological yield (kg ha-1) The biological yield refers to the total dry matter accumulation of a plant system and biological yield is also referred to as gross yield that is the yield obtained before any losses occur during and after harvest. The results pertaining to biological yield ha-1 of wheat varieties Abadgar-93 and Mehran-89 as influenced by seed size are presented in Table-7 and its analysis of variance as Appendix-VII. The analysis of variance suggested that the biological yield of wheat was significantly ($P<0.05$) affected by varieties, while the effect of seed size and interaction of varieties × seed size was non-significantly ($P>0.05$) statistically. It is apparent from the results that the biological yield was significantly higher (10434 kg ha-1) in variety Mehran-89 as compared to variety Abadgar-93 having average biological yield of 9720 kg ha-1. Variety Mehran-89 displayed its relative superiority over Abadgar-93. Similarly, the wheat crop sown with large size seeds produced higher biological yield of 10241 kg ha-1 as compared to the crop sown with small size seeds having average biological yield of 9913 kg ha-1. This showed that wheat crop sown with quality seed resulted in higher biological yield ha-1 which was mainly contributed by increased plant height, number of tillers plant-1, spike length, grains plant-1 and seed index value. The interaction Mehran-89 × large size seeds resulted in maximum biological yield ha-1 (10691 kg); while the interaction Abadgar-93 × small size seeds resulted in minimum biological yield (9648 kg) ha-1. The results clearly showed that although the effect of seed size on biological yield was not considerable, but the varieties showed significant difference in the respective biological yield and this might be associated with the genetic makeup of their parental material.

Table 7. Biological yield (kg ha^{-1}) of wheat varieties as influenced by seed size

Seed size	Varieties		Mean
	Abadgar-93	Mehran-89	
S_1=Small size	9648.00	10178.00	9913.00
S_2=Large size	9791.00	10691.00	10241.00
Mean	9720.00 b	10434.00 a	-

Means followed by similar letters do not differ significantly at 0.05 probability level

	Seed size (S)	Varieties (V)	S x V
SE ±	170.86	170.86	241.63
LSD 0.05	-	418.43	-
LSD 0.01	-	633.43	-
CV%	2.94		

8. Grain yield (kg ha-1) Wheat grain yield is the product of heads, accumulated by grains head-1, grain weight per unit area and using these parameters grain yield potential can be assessed. The results pertaining to grain yield ha-1 of wheat varieties Abadgar-93 and Mehran-89 as influenced by seed size are presented in Table-8 and its analysis of variance as Appendix-VIII. The analysis of variance indicated that the grain yield was significantly ($P<0.05$) affected by varieties, seed size as well as by the interaction of varieties × seed size was. The highest grain yield of 4956 kg ha-1 was achieved from variety Mehran-89, while the lowest grain yield of 4301.80 kg ha-1 was obtained in variety Abadgar-93. This indicates that Mehran-89 is genetically superior in grain yield than Abadgar-93. Similarly, the wheat crop sown with large size seeds produced higher grain yield of 4857.10 kg ha-1 as compared to 4400.70 kg ha-1 in plots sown with small size seeds. This showed that wheat crop sown with bolder seeds resulted in higher grain yield ha-1 which was mainly contributed by increased plant height, number of tillers plant-1, spike length, grains plant-1 and seed index value. The interaction Mehran-89 × large size seeds resulted in maximum grain yield ha-1 (5260 kg); while the interaction Abadgar-93 × small size seeds resulted in minimum grain yield (4149.40 kg ha-1). The results showed that quality seed is essential for achieving higher grain yield regardless the crop varieties, because the crop sown with low quality seed produces lower germination, and relatively weaker in agronomic performance.

Table 8. Grain yield (kg ha^{-1}) of wheat varieties as influenced by seed size

Seed size	Varieties		Mean
	Abadgar-93	Mehran-89	
S_1=Small size	4149.40	4652.10	4400.70 b
S_2=Large size	4454.20	5260.00	4857.10 a
Mean	4301.80 b	4956.00 a	-

Means followed by similar letters do not differ significantly at 0.05 probability level

	Seed size (S)	Varieties (V)	S x V
SE ±	53.653	53.653	75.877
LSD 0.05	131.28	131.28	185.66
LSD 0.01	198.91	198.91	-
CV%	2.01		

DISCUSSION

The crop stand is mainly dependent of good germination of seed and germination is entirely dependent on the viability and quality of seed (Almansouri et al., 2001; Khajeh-Hosseini et al., 2003). In modern agriculture, seed is a vehicle to deliver almost all agriculture-based technological innovations to farmers so that they can exploit the genetic potential of new varieties (Van Gastel et al., 2002). For achieving optimum growth and yield production, the basic requirement of farming is to obtain quality seed (Akbari et al., 2004). Similarly, seed size is an indicator of seed related to yield, market grade factors and harvest efficiency (Kawade et al., 1987; Willenborg et al., 2005). It is important to define the optimal seeding rate of winter wheat breeds, due to the climate-change of habitats, not only from agro-technical factors, but also from economic point of view (Kristo et al., 2006). On the basis of above hypotheses, the study was carried out to investigate the influence of seed size on germinability and grain yield of wheat varieties. The findings of the present study showed that the effect of seed size on seed germination, plant height, number of tillers plant-1, spike length, number of grains spike-1, seed index and grain yield ha-1 was significant (P<0.05), while non-significant (P>0.05) on biological yield ha-1; while the effect of varieties was significant (P<0.05) on plant height, spike length, number of grains spike-1, seed index, biological yield ha-1 and grain yield ha-1 and non-significant (P>0.05) on seed germination and number of tillers plant-1. The crop sown with large size seeds showed remarkably better agronomic performance with 95.29% germination, 96.61 cm plant height, 6.40 tillers plant-1, 11.44 cm spike length, 42.65 grains spike-1, 42.80 g seed index (g), 10241 kg ha-1 biological yield and 4857.10 kg ha-1 grain yield. The sowing wheat with large size seeds was remarkably beneficial with most promising agronomic performance (4857.10 kg ha-1 grain yield) as compared to small size seeds (4400.70 kg ha-1 grain yield). The interactive effect of Mehran × large size seed surpassed rest of the interactions with maximum grain yield of 5260 kg ha-1. These results are further supported by Mian and Nafziger (1994) who found that seed size positively influenced the vegetation and seed yield in wheat; while Farmer (1997) concluded that the seeds of wheat cultivars differ in several respects including size, color and shape. Seed mass has a strong influence on seedling establishment, with heavier seeds often exhibiting more rapid emergence, larger initial seedling size, and/or a higher capacity for survival of environmental hazards. Al-Qasem et al. (2011) studied the effects of seed size on germination percentage of two wheat cultivars, Hourani-27 and F8 and concluded that accumulative germination percentage for large seeds was significantly higher than that for small seeds. Zareian et al. (2012) evaluated the effect of seed size on emergence, yield and components yield of three bread wheat cultivars and suggested that large seed sizes were superior compared to the other seed size and wheat cultivars had similar performance regarding to the variation in seed sizes. No significant interaction was observed for all traits studied in this experiment. Zareian et al. (2013) evaluated the effect of seed size on germination, emergence percentage and yield of three bread wheat cultivars and showed that seed size had no significant impact on germination percentage, but it changes seedling emergence and grain yield, in this way the best category of seed size was related to >2.2-2.5 size, whereas emergence percentage and yield of seeds with 2-2.2 size was significantly less than other sizes. Keerio (2013) assessed the influence of seed size on germinability and grain yield of wheat varieties and reported that the crop sown with large seed size resulted in 102.70 cm plant height, 5.91 tillers plant-1, 10.64 cm spike length, 40.00 grains spike-1, 43.31 g seed index, 10640 kg ha-1 biological yield, 5294.30 kg ha-1 grain yield and 50.13 percent harvest index; while wheat sown with medium size of seed and small size seed followed a simultaneous decrease in wheat production and concluded that large size seed resulted in maximum grain yield (5294.30 kg ha-1) and yield decreased considerably when sowing was done with medium size and small size seed. The above findings are fully in agreement with the results achieved from the present study regarding the effect of seed size on growth and grain yield traits of wheat. The minor differences might be associated with the variation in genotypic behavior and response to these treatments.

Conclusion

The results of the present study concluded that sowing wheat with large size seeds was remarkably beneficial with most promising agronomic performance (4857.10 kg ha-1 grain yield) as compared to small size seeds (4400.70 kg ha-1 grain yield). The interactive effect of Mehran × large size seed surpassed rest of the interactions with maximum grain yield of 5260 kg ha-1.

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