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Field Performance of Three Wheat (*Triticum aestivum L.*) Cultivars in Various Seed Sizes

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Abstract: In order to evaluate the effect of seed size on emergence, yield and components yield of three bread wheat (*Triticum aestivum* L.) cultivars, an experiment was conducted at Seed and Plant Certification and Registration Research Institute (SPCRI), Karaj, Iran. The experimental factors included five seed sizes (2-2.2, 2.2-2.5, 2.5-2.8, 2.8-3 and >3 mm) and three wheat cultivars (Mahdavi, Pishtaz and Bahar). The experiment was carried out in a 3×5 factorial design (three cultivars, five different seed sizes) based on randomized complete blocks with three replicates. Seedling emergence percentage, green weight of 100 plants, dry weight of 100 plants, the number of spikes per area, number of seeds per spike, 1000- seeds weight and grain yield were measured. Seed size had a significant impact on all of measured traits with the exception of 1000- seeds weight. Results indicated that number of seeds per spike significantly decreased by increasing seed size. The other traits showed significant increase by increasing seed size. Cultivar had significant effect on 1000- seeds weight and number of spikes per area but other traits were similar among cultivars. This study 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.

Key words: Wheat · Seed size · Emergence · Seedling · Yield and yield components

INTRODUCTION

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 [1]. Out of growth stages of plants, the most important stage in seedling development is the germination phenomenon, which leads at normal conditions in the further development of plants to high yield and quality. This process starts with the absorption of water, continues with radicle emergence and terminates with successful crop production [2]. For seed to play a catalytic role, it should reach farmers in a good quality state, i.e. high genetic purity and identity, as well as high physical, physiological and health quality [1]. Seed size is an important physical indicator of seed quality that affects vegetative growth and is frequently related to yield, market grade factors and harvest efficiency [3].

A wide array of different effects of seed size has been reported for seed germination, emergence and related agronomical aspects in many crop species [4, 5, 6]. However, these results varied widely between species. With increased seed size higher germination and emergence were determined in pearl millet [4] and in triticale [5]. In wheat, seed size is positively correlated with seed vigor: larger seeds tend to produce more vigorous seedlings [7]. Baalbaki and Copeland [8] reported that 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 [9], but not under optimum management conditions [10]. Similarly, Khah *et al*. [11] found that low-vigor spring wheat seed produced lower

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yields only when it planted in low plant populations or when planting was later than normal. Hasstrup *et al*. [12] reported that wheat and barely yield would be decreased by increase of seed germination duration due to low seed vigor. Chastain *et al*. [13, 14] observed no consistent yield or grain quality advantages obtained from large winter wheat and barley seed. However, Mian and Nafziger [15] noticed seed size has little effect on emergence of soft red winter wheat.

MATERIALS AND METHODS

Seeds of wheat cultivars (Mahdavi, Pishtaz and Bahar) used in this study were obtained from a private seed production company in certified seed category. They were introduced in commercial production and all of them are cultivating in moderate origins of Iran. Seed samples of the three cultivars were sieved by slotted screens and placed into five groups of seed diameter size, 2-2.2, 2.2-2.5, 2.5-2.8, 2.8-3 and >3 mm.

The field trial was sown on 10 November 2008 at the experimental field of the Seed and Plant Certification and Registration Research Institute, Karaj, Iran. The experimental design was a two-factorial (three cultivars, five different seed diameter sizes) in a randomized complete block design with three replicates. Seedling emergence percentage, green weight of 100 plants, dry weight of 100 plants, number of spikes per area, number of seeds per spike, 1000- seeds weight and grain yield were measured. Sowing density was 400 seeds m^{-2} by planting 500 seeds on each row. Plots were 5 m long and 2 m wide, with eight rows 0.25 m apart. 30 days after planting, seedling emergence percentage was measured by counting emerged seedlings on 2 rows. In tillering stage, 100 plants on two rows were harvested. After measuring the samples, they were dried via oven at 75°C as long as 48 hours and dry weight of 100 plants were measured. At harvest, a 3 m^2 area was harvested from the center of each plot for grain yield. Also a 1 m^2 area was harvested for measuring the number of spikes per area, number of seeds per spike and 1000- seeds weight.

Analysis of variance was carried out using SAS software. Treatment means were compared using Duncan's test at the 5% and 1% levels of significance and graph drawing was performed by means of Excel 2003 software. Data expressed as percentages were transformed prior to analysis of variance by using arc sin transformation.

RESULTS AND DISCUSSION

The main effects of seed size on seedling emergence percentage, green weight of 100 plants, dry weight of 100 plants, the number of spike per area, number of seed per spike, 1000- seeds weight and grain yield of three wheat cultivars are shown in Table 1.

Seedling Emergence Percentage: In this study, seed size had significant impact on seedling emergence percentage (Table 1).The lowest and highest seedling emergence percentage was occurred in smallest seed size (67.95%) and in 2.8-3 seed size (80.55%), respectively (Figure 1). Seedling emergence percentage was same among cultivars (Table 1). Spilde [16] noticed that seedling emergence in small, medium and large seed sizes in barley was 26, 25 and 28 plants ft^{-2} and in wheat was 35, 36 and 39 plants ft^{-2}, respectively. He reported that small kernels may germinate very well, but the seedling will be smaller and weaker. Emergence is less, seedling make slower early growth, tiller less, have less vigor and individual plants yield less from small seed than from plump seed.

Green Weight of 100 Plants and Dry Weight of 100 Plants: Seed size significantly affected green weight and dry weight of 100 plants (Table 1). Green weight of 100 plants increased as 45.9 % by increasing seed size (Figure 2). Smallest seed size produced 42.7 gram dry matter, whereas seeds with largest size produced 77.40 gram dry matter. Figure 3 shows that dry weight of 100 plants was increased by increasing seed size by 44.8%. Green weight of 100 plants from four groups of weight (40-44.9, 45-49.9, 50-54.9 and >60 ib bu^{-1}) by Helm and Spilde [17] was measured and results showed that green weight of 100 plants in these groups were 3.8, 4.6, 7.1 and 10.9 gram, respectively. Similar result was observed by Farhodi and Motamedi [18] in safflower who reported that for the control (no salt stress level), large seeds had a higher seedling fresh weight. Some researcher as Guberac *et al*. [19] and Mathur *et al*. [20] presented similar results. It was noticed that, seedling dry weight in larger seed sizes were related to more seed food storages in their endosperms.

Grain Yield and its Components: Results of variance analysis indicated significant influence of various seed sizes on grain yield and some of yield components (Table 1). Grain yield and number of spikes per area significantly increased by increasing seed size. Grain yield and spikes number of seeds with smallest size (2-2.2 mm)

Table 1: Analysis of variance of the traits under study in field.

		Mean of square							
Source of variance	df	Seedling emergence (%)	Green weight of 100 plants (g)	Dry weight of 100 plants (g)	Number of spike per area	Number of seed per spike	1000 -seeds weight	Grain yield (kg ha^{-1})
Block	2	0.0309	** 157839.200	** 4001.352	** 52000.380	9.4975	1.0428	573282.88
Cultivar (C)	2	0.0070	1588.393	40.759	** 222402.449	22.1262	** 380.1187	435868.63
Seed size (S)	4	0.0338 *	** 39912.34	** 1363.528	* 25018.055	** 42.8385	9.7340	1091026.60 *
Cultivar × seed size C× S	8	0.0021	3092.240	101.622	11242.610	20.6862	6.2636	461067.21
Error	28	0.0127	4323.0784	86.7130	8150.663	15.4477	7.1199	369349.17

* and **, significant at the 0.05 and 0.01 levels of probability, respectively.

Table 2: Comparison of mean spikes number per area and 1000- seeds weight of wheat cultivars

Cultivars	Spikes number per area ± SD	1000- seeds weight (g) ± SD
Mahdavi	529.57±90.03 [c]	39.15±2.97 [a]
Pishtaz	773.07±109.06 [a]	34.14±2.79 [b]
Bahar	654.26±96.66 [b]	29.08±2.01 [c]

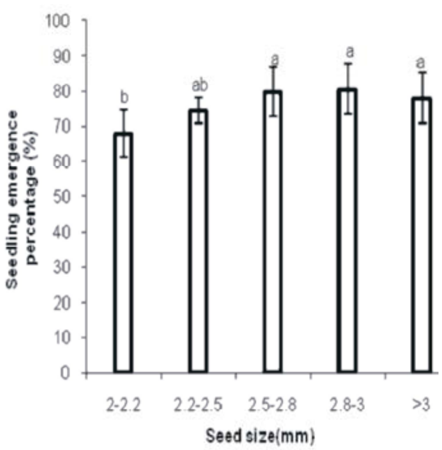

Fig. 1: Comparison of mean seedling emergence percentage in various seed sizes. The vertical bars represent standard deviation.

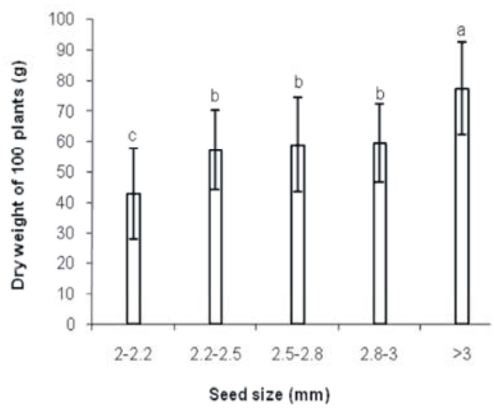

Fig. 3: Comparison of mean dry weight of 100 plants in various seed sizes.The vertical bars represent standard deviation.

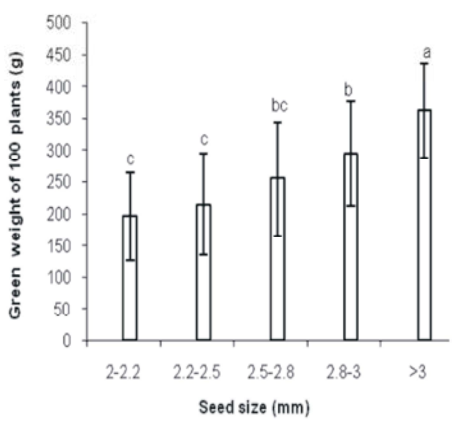

Fig. 2: Comparison of mean green weight of 100 plants in various seed sizes.The vertical bars represent standard deviation.

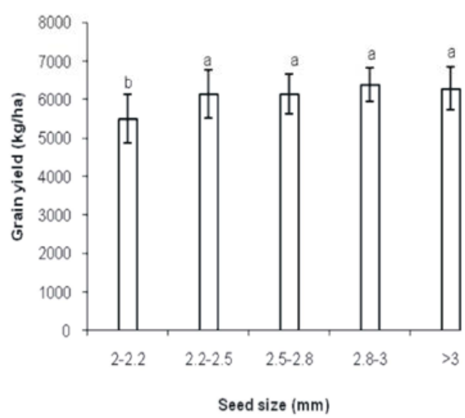

Fig. 4: Comparison of mean grain yield in various seed sizes.The vertical bars represent standard deviation.

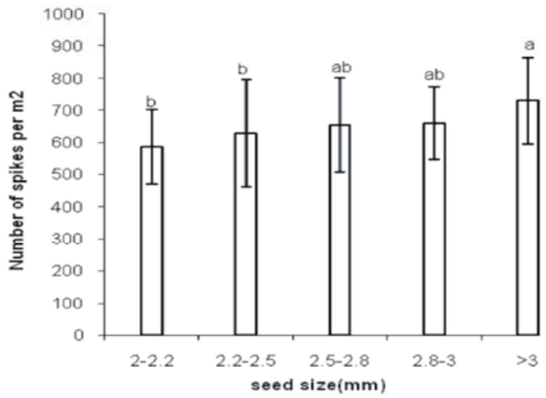

Fig. 5: Comparison of mean number spikes per area in various seed sizes.The vertical bars represent standard deviation.

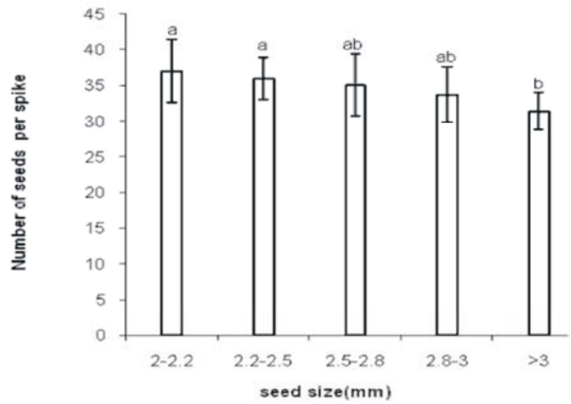

Fig. 6: Comparison of mean number seeds per spike in various seed sizes.The vertical bars represent standard deviation.

was significantly lower than other seed sizes and this reduction were 892.8 kg ha^{-1} (by 16.9%) and 144.49 (by 19.7 %), respectively (Figure 4, 5). whereas the number of seeds per spike significantly reduced by increasing seed size and this trait with smallest size was significantly higher than other seed sizes and this increase was by 15.1 % (Figure 6). Similar results were recorded by Stougaard and Xue [21] who reported that use of larger seed sizes improved grain yields by 18% and the use of small seeds reduced yield by 16% in wheat. In other crops, Tuba Bicer [22] in chickpea and lentil found that plants from large seeds yielded 6% more than medium seeds and 10% more than mixed seeds. Spilde [16] indicated that yield in small, medium and large seed sizes in barley was 82, 85 and 87 bu acres^{-1} and in wheat was 44, 45 and 48 bu acres^{-1}, respectively. He reported that reduced yield associated with reduced spike density is likely indicative of less tillering capacity. Rukavina *et al*. [3] in barley, informed that grain yield significantly declined by 9.8% from large seed compared to very small seed. In this study, from large seed to very small seed, spikes per m^2 and number of tillers decreased by 9.2 and 21.6 %, respectively. They resulted significant differences in spike production, specially kernel number and mass per spike were the most reliable indicators of grain yield reduction affected by small seed in spring barley. These results showed that difference in yield components especially the number of tillers and number of spikes per area in different seed sizes could be effective on grain yield. In this study, smallest seed size had lowest emergence. Therefore, it is assumed that plants grown from small seed had less fertile tillers than those grown from large seed.whereby, grain yield decreased in smallest seed size.

Significant impact of wheat cultivars on seeds number per spike and 1000- seeds weight were observed (Table 1). Mahdavi cultivar produced the highest 1000-seeds weight (39.15 g) and Pishtaz cultivar produced the highest spikes per m^2 (773.07) compared to the other cultivars (Table 2). Similar result was recorded by Rukavina *et al* [3], who noted that there were significant differences in spike density, spike production and thousand kernel mass among three barely cultivars. It may be concluded that, difference among cultivars for these traits was due to their various genetic potential and increase in a component was compensated by decrease in other component, whereby yield was same among cultivars.

CONCLUSION

Assessment of treatments in this study showed seed size had significant impact on seedling emergence, in this way the best category of seed size was related to >2.2-2.5 size, whereas emergence percentage of seeds with 2-2.2 size was significantly less than compared to other sizes. Furthermore, grain yield of seeds with smallest seed size was significantly less than compared to other sizes. Although, cultivars were different for some components, but grain yield was same among them.

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