Effect of Seed Size on Some Germination Characteristics, Seedling Emergence Percentage and Yield of Three Wheat (Triticum aestivum L.) Cultivars in Laboratory and Field

A. Zareian, A. Hamidi, H. Sadeghi and M.R. Jazaeri

Abstract: The effect of seed size on germination, emergence percentage and yield of three bread wheat (Triticum aestivum L.) cultivars were evaluated in Seed and Plant Certification and Registration Research Institute (SPCRI), Karaj, Iran. The experiment factors included five seed sizes (2-2.2, 2.2-2.5, 2.5-2.8, 2.8-3 and >3 mm) of three wheat cultivars (Mahdavi, Pishtaz and Bahar). Seed size had significant impact on all measured traits in laboratory and field with the exception of germination percentage and harvest index. Results indicated that germination rate significantly decreased by increasing seed size. The other traits showed significant increase by increasing seed size. Mahdavi cultivar had significant effect on seedling dry weight and dry weight of 100 plants. Other traits were similar among cultivars. Significant interaction was observed for seedling dry weight and dry weight of 100 plants. Assessment of treatments in this study 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.

Key words: Wheat • Seed size • Germination • Emergence • Seedling • Yield

INTRODUCTION

As generally known, among producing factors, seed as the first consumer store, plays an important role in the transfer of genetic characters and improvement of qualitative and quantitative traits of production. One of the most important factors in maximizing crop yield is planting high quality seed. 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 [1].

The effect of seed size on germination and following seedling emergence have been investigated by many researchers in various crop species/ cultivar [2-5]. However, these results varied widely between species. Most investigators have reported a positive relationship between seedling vigor, improved stand establishment and higher productivity of cereal crops with plants originating from large seed compared to those grown from smaller seed. With increased seed size higher germination and emergence were determined in pearl millet [2] and in triticale [5], but besides higher germination percentage declined median germination time were determined in some forage plants [3]. In wheat, seed size not only influence emergence and establishment but also affected yield components and ultimately grain yield [6]. Effect of seed size (less than 1.95, 1.95-2.35 and more than 2.35 mm) on germination characteristics of six oat (Avena sativa L.) cultivars under water stress condition were showed that germination was increased with increasing seed size in oat cultivars [4]. Results of a study showed that higher vigor that occurred in larger seed is due to the larger food reserves in these seeds [7]. On the other hand, crop stand and grain yield of soft red winter wheat were similar regardless of seed size in no-tillage systems [8]. No consistent yield or grain quality advantages obtained from large winter wheat and barley seed [9, 10].

In the present paper, effects of different seed size on seed germination and field performance of wheat cultivars were investigated. This study has some advantages such
as indicating of seed growth potential, making competition among seed producers from the aspect of seed quality promotion, increasing of uniformity at emergence and decreasing the charges by using less seeds for planting.

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.

An experiment was carried out at seed analysis laboratory of the Seed and Plant Certification and Registration Research Institute, Karaj, Iran. The experimental design was a 3×5 factorial design based on randomized complete with three replicates. Seed germination and vigor values were determined according to standard germination test. Three replicate dishes, each with 100 seeds, were used for each treatment and seeds were allowed to germinate at 20°C on germination paper for eight days [11]. Number of germinated seeds was recorded eight days after planting as final germination percentage. A seed was considered germinated when the emerging root had elongated to 3 mm. Daily number germination was done for estimating germination rate [12].

\[
\text{Germination percentage} = \frac{\text{No. of seeds germinated}}{\text{Days of first count}}
\]

Mean of 10 seedlings dry weight was measured on the 8th day of the experiment by putting the seedlings in oven at 75°C as long as 48 hours.

The field trial was sown on 10 November 2008 at the experimental field of the Institute. 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, weight of 100 plants, grain yield, biological yield and harvest index were measured. Wheat rows were spaced 0.25 m apart with sowing density of 400 seeds m⁻². Each plot was 5 m long and 2 m wide, so that eight rows of each cultivar were sown in every plot. 30 days after planting, the seedling emergence percentage was measured by counting emerged seedlings on 2 rows. About 14 days after emergence, 100 plants on two rows were harvested and samples were dried via oven at 75°C as long as 48 hours and dry weight of 100 plants were measured.

At harvest, a 3 m² area was harvested from the center of each plot for grain yield and 1 m² area was harvested for measuring biological yield and harvest index.

Analysis of variance was carried out using MSTATC 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 germination percentage, germination rate, seedling dry weight, seedling emergence percentage, weight of 100 plants, grain yield, biological yield and harvest index of three wheat cultivars are shown in Table 1.

Germination Percentage: Germination percentage for both seed sizes and all cultivars was greater than 93% (range 93-96%) and there were no significant differences between seed size, among cultivars, or for their interaction (Table 1). In safflower, there was no significant difference between seed size on germination and for both seed sizes and all salinity treatments was greater than 90% (range 91-97%) [13]. Also in barley, germination was range 97.5%-98.5% in four groups of seed sizes and there was no significant difference between them [1]. These results are in agreement with our findings.

Seedling Dry Weight: Seed size, cultivar and their interaction significantly affected seedling dry weight (Table 1). The largest seed size produced the highest seedling dry weight. Seedling dry weight was increased from smallest size (0.0977 g) to largest size (0.1488 g) by 34.3% (Figure 1). In safflower, similar result was reported that for the control (no salt stress level), large seeds had a higher seedling fresh weight [13]. Similar results were reported by some researchers [14-16]. It was noticed that, seedling dry weight in larger seed sizes was related to more seed food storages in their endosperms. Each increase in seed size caused an increase in seedling dry weight and this increase was greater in Mahdavi cultivar. Bahar cultivar had different reaction from smallest size to next seed size compared to the other cultivars in this character (Figure 1). The difference between Mahdavi cultivar with other cultivars is probably because of its superior genetic potential in 1,000-kernel weight which shows more seed food storage. This result has been confirmed by Some researchers [4, 15].
Table 1: Analysis of variance of the traits under study (in laboratory and field)

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>Laboratory</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean of square</td>
<td></td>
</tr>
<tr>
<td>Germination rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seedling emergence (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry weight of 100 plants (g)</td>
<td>0.0309</td>
<td>0.5425 *</td>
</tr>
<tr>
<td>Grain yield (kg ha(^{-1}))</td>
<td>1.6507**</td>
<td>435868.63</td>
</tr>
<tr>
<td>Biological yield (kg ha(^{-1}))</td>
<td>1.3600 **</td>
<td>1091026.60 *</td>
</tr>
<tr>
<td>Harvest index (%)</td>
<td>10.07</td>
<td>14.4987</td>
</tr>
</tbody>
</table>

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

Table 2: Means comparison of some traits in various seed sizes

<table>
<thead>
<tr>
<th>Seed sizes (mm)</th>
<th>Germination rate</th>
<th>Seedling emergence (%)</th>
<th>Grain yield (kg ha(^{-1}))</th>
<th>Biological yield (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-2.2</td>
<td>58.5(^{a})</td>
<td>67.95(^{a})</td>
<td>5507.4(^{a})</td>
<td>13430(^{a})</td>
</tr>
<tr>
<td>2.2-2.5</td>
<td>58.05(^{a})</td>
<td>74.44(^{a})</td>
<td>6158.6(^{a})</td>
<td>15082.1(^{a})</td>
</tr>
<tr>
<td>2.5-2.8</td>
<td>54.08(^{a})</td>
<td>79.68(^{a})</td>
<td>6151.4(^{a})</td>
<td>15937.2(^{a})</td>
</tr>
<tr>
<td>2.8-3</td>
<td>51.54(^{a})</td>
<td>80.55(^{a})</td>
<td>6400.2(^{a})</td>
<td>16000(^{a})</td>
</tr>
<tr>
<td>&gt;3</td>
<td>51.16(^{a})</td>
<td>77.93(^{a})</td>
<td>6293.9(^{a})</td>
<td>16449.3(^{a})</td>
</tr>
</tbody>
</table>

Means with the same letter in each column have not statistically significant difference

Germination Rate: Seed size significantly affected germination rate but cultivar had no significant effect on seed germination rate (Table 1). Germination rate was reduced by increasing seed size (Table 2).

The smallest seed size had highest germination rate in compared to other seed sizes. The reason of this matter is probably because of large seed size needs water uptake more than small seed size and it is assumed that small seeds absorbed water more rapidly compared to large seeds, which resulted in increasing germination rate. In safflower, was showed that water uptake of small seeds (72%) was lower than large seeds (83%) [13]. They added the lower mean germination time in control (no salt stress level) and reduced mean germination time in small seeds compared to large seeds under all levels of NaCl explained by more rapid water uptake in small seeds by early achievement of necessary moisture content required for germination. Also some researchers found small seeds of sunflower and oat germinated faster compared to large seeds [17-19]. These results are in line with our findings.
**Fig. 2:** Means comparison interaction of cultivar × seeds size on seedling dry weight of 100 Plants. The vertical bars represent standard deviation

**Seedling Emergence Percentage:** Seed size had significant influence 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 (Table 2). Seedling emergence percentage was same among cultivars (Table 1). 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. In this situation, emergence will decrease, early growth of seedling will be slower, tillers and their vigor will decline and finally individual plants yield will be less [20]. In similar study was reported that four accession of pea (*Pisum sativum*) with 93, 92, 95 and 97% of germination produced 84, 68, 71 and 82% of seedling emergence rate in the field, respectively [21].

**Grain Yield and Biological Yield:** In this study, Significant influence of different seed sizes on grain yield and biological yield were observed (Table 1). Grain yield of seeds with smallest size (2-2.2 mm) was significantly lower than other seed sizes and this reduction was 892.8 kg ha\(^{-1}\) (by 16.9%). Also, seeds in smallest size produced 13430 kg ha\(^{-1}\) dry matter, whereas seeds in largest size produced 16449 kg ha\(^{-1}\) dry matter (Table 2). In similar study was reported that use of larger seed sizes improved grain yields by 18% and the use of small seeds reduced yield by 16% in wheat [23]. In chickpea and lentil, were observed that plants from large seeds yielded 6% more than medium seeds and 10% more than mixed seeds [24]. In barley, was reported that grain yield significantly declined by 9.8% from large seed compared to very small seed [1]. 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. 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 [20]. He reported that reduced yield associated with reduced spike density is likely indicative of less tillering capacity. Also In wheat, was resulted that spikes number of seeds with smallest size was significantly lower than other seed sizes and this reduction was 144.49 (by 19.7%) [25]. These results
showed that difference in yield components especially the number of tillers and the 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 and biological yield decreased in smallest seed size. It is obvious that increase in biological yield by increasing seed size was related to higher seedling weight and weight of 100 plants were produced by larger seed sizes.

There were no significant differences between seed size and among cultivars on harvest index. Harvest index for both seed sizes and all cultivars was 38.8-41.4 %.

**CONCLUSION**

Assessment of treatments in this study showed that seed size had no significant impact on germination percentage, but it changes 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 and biological yield of seeds with smallest seed size was significantly less than compared to other sizes. Although, seed germination was more than 90% but seedling emergence decreased to 67.95% in smallest size. It may be concluded that, due to some unfavorable condition in field, emergence declined and this reduction was occurred severely in smallest seed size.

**REFERENCES**


