Effect of seed size on germination and establishment of vigorous seedlings in durum wheat (Triticum durum Desf.)

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ABSTRACT

In order to determine the effect of seed size (small, medium and large) on germination in durum wheat seeds of «Waha» variety, an experiment was conducted in 2012 at Sciences Laboratory, Genetic Improvement of Plants, University of Badji Mokhtar-Annaba, Algeria. Conducted by a completely randomized design with three replications starting with seed viability which was determined by Tetrazolium test method. The results showed that the effect of seed size was highly significant on seedling length in $P \leq 0.002$, and seedling vigour in $P \leq 0.000$. Also, the results showed that the effect of seed size was highly significant on seedling dry weight in $P \leq 0.000$. But the results showed that the effect of seed size was non-significant on germination percentage. Mean comparison showed that the highest germination percentage (96.66%), seedling dry weight (1.40 gr), seedling vigour (135.32) and seedling length (18.82 cm) that were achieved, came up to large seeds. This means that larger seeds in «Waha» may be beneficial in establishing plants under dry soil conditions.

Key words: Durum wheat, seed size, seedling vigour, germination percentage, seedling dry weight.

Introduction

Durum wheat (Triticum durum Desf.) is one of the most widely used foods for human and animals [6]. It contributes more calories and protein to the world’s diet than any other food crops [14]. Well-known as an annual crop of Monocotyledonous class and Gramineae family [10]. It is the best kind suited to dry climate regions, with warm and cold days [4]. This can be cultivated in a wide range of agricultural environments [31]. But the cultivation of this crop in semi-arid regions means exposing it to various abiotic stresses like drought that very significantly minimizes the performance of grains. Because drought is a major factor limiting crop productivity world-wide [15]. Its presence in soil brings water shortage, during this, seeds germination and qualities are affected [37]. Farmers and producers trying always to better adapt varieties to the nature of the soil and climate of the region, in order to obtain the best possible performance, although less of them were interested by the different size of seeds in the same variety. Studies of the relationship between seed size and early growth have been reported since early this century [36]. Many researchers investigated in various crop species in order to understand the effect of seed size on germination by the reason that rate of seed vigor varies greatly from one species to another and even among varieties of the same species. [17], [30], [12], [20], [35], [16]. Most researches supported the theory that large seeds have a competitive advantage over smaller seeds by having higher germination rates and having greater nutrient reserves for the young seedlings, which enables the seedlings to grow larger to tap resources earlier than their small-seeded counterparts [11], [22], [33], [25], [34], [2]. Moreover, Ries, S.K., E.H. Everson (1973), have demonstrated that seed size is positively correlated with seed vigor, and larger seeds tend to produce more vigorous seedlings [29]. A similar observation was made by Chastain et al (1995), who suggests that larger seeds produce seedlings with greater early growth and increased competitive ability against weeds and pests while working with winter barley [5]. On wheat, Khah et al. (1989) found that low-vigor spring wheat seed produced lower yields only when it resulted in low plant populations or when planting was later than normal [18]. However, different researchers prove otherwise; on one hand PekÕen and al (2004) showed that cultivars with low 100 seed weight had higher germination percentage than larger seed ones in pea (Pisum sativum L.) [28]. This was sustained by Lafond and Baker (1986) which obtained faster germination from small bread wheat kernels under different temperatures and
Triticum durum Desf. Wheat (on germination and vigor of seedlings in durum relative effects of Seed size (Small, medium, large) yield. Our aim in this study was to determine the vigorous seedlings that is essential to achieving high than those of bigger ones [7]. Thus, seed size plays a major role in germination and establishment of vigorous seedlings that is essential to achieving high yield. Our aim in this study was to determine the relative effects of Seed size (Small, medium, large) on germination and vigor of seedlings in durum Wheat (Triticum durum Desf.) in Algerian varieties named «Waha».

Materials and Methods

In order to determine the effect of seed size (small, medium and large) on germination in durum wheat seeds of «Waha», one of the best suited variety to dry climate regions in Algeria, with high productivity.

An experiment was conducted in 2012 at Sciences Laboratory, Genetic Improvement of Plants, University of Badji Mokhtar-Annaba- Algeria. Conducted by a completely randomized design with three replications starting with seed viability which was determined by Tetrazolium test method. After disinfecting Seeds initially with a 1.0% solution of sodium hypochlorite for 3 min for surface sterilization [24]. Residual chlorine was eliminated by thorough washing of seeds with distilled water; seeds were put in a disinfected Petri dish. Each Petri dish contained 100 seeds to determine germination percentage. For seedling length test, three replicates of 100 seeds were put between double layered rolled papers; the layered paper with seeds was put into sealed plastic bags to avoid moisture loss. All of the Petri dish and layered paper was irrigated by distilled water. Seeds were allowed to germinate at 20 ± 1°C for 10 days. The results of both experiments were recorded after the 10th day; Germination was interpreted as the percentage of seeds producing normal seedlings according to the International Seed Testing Association rules [3], with the following formula:

**Germination percentage = Number of germinated seeds / Number of total seeds × 100**

Germination percentage obtained in the germination test was used to calculate vigor index. The vigor index was calculated adopting the method of Abdul Baki [1], by the following formula:

**Seedling vigor = Germination percentage × Seedling dry weight**

**Statistical Analysis:**

Data analysis was performed using the Minitab software for Windows (version.13). Mean separation was performed by ANOVA test at 5% level.

Results and Discussion

The results showed that the effect of seed size was highly significant on seedling dry weight in P ≤ 0.002 (Table 1, Fig 4), and seedling vigour in P ≤ 0.000 (Table 1, Fig 3). Also, the results showed that the effect of seed size was highly significant on seedling dry weight in P ≤ 0.000(Table 1, Fig 2). But the results showed that the effect of seed size was non-significant on germination percentage (Table 1, Fig 1).

Also germination percentage, seedling dry weight, seedling vigor and seedling length tests, indicated that large seed was the highest one between the three categories (Fig 1, 2, 3 and 4). Which clarify that good and quick germination in bigger sized seeds could be due to the presence of higher amount of carbohydrates and other nutrients than in medium and small sized seeds. Similar observations have been recorded in many tropical species. For instance, Manonmani et al. (1996) [21], and Gunaga et al. (2007) [13], have recorded well seed germination and seedling vigor by using bigger sized seeds in (Pongamia pinnata) and (Vateria indica). Mathur, et al. (1982) were also reported, that seed germination percentage was higher in large seeds in comparison with small seeds while working with oat (Avena sativa L) [23]. This trend with the report on (Atriplex triangularis) by Ellison, A.M., (1987) who declared that large seeds have more indigenous food reserve compared to those grown from smaller ones [8]. Thus, 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 in environmental hazards [9]; those theories supported our experiments in which we found that larger seeds have larger food reserves or greater dry matter (1,40g) (Table1, fig 2) whichever increased percentage of germination (96,66%) (Table1, fig 1), and produce a greater seedling (18,82cm) with higher vigor (135,32) (Table1, fig 4 , 3). This means that bigger seeds statistically produced seedling of very high vigor index compared to the small seeds which produce seedling that have low vigor index [26]. Conversely, smaller seed of some species form seedlings of lesser size but an initially higher relative growth rate, perhaps adaptive for establishment in more open, disturbed microsites with abundant growth resources [27] Soltani et al (2002) explains that the possible effect of seed size on germination is associated with the length of the structure that forms the seedling, but not necessarily with the subsequent conversion of biochemical reserves in storage tissues of germinating [32]. But on this study the low
germination and vigor of small seeds maybe be due to mass shortage of the nutritive elements in small seeds which decreased the seedling dry weight and produced lower vigorous seedlings relative to bigger ones.

Table 1: Means Comparison

<table>
<thead>
<tr>
<th>Treatment (Seed size)</th>
<th>Seedling length (cm)</th>
<th>Seedling vigour</th>
<th>Seedling dry weight (gr)</th>
<th>Germination percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>13.64 a</td>
<td>34.28 a</td>
<td>0.37 a</td>
<td>92.66 a</td>
</tr>
<tr>
<td>Medium</td>
<td>15.01 b</td>
<td>81.12 b</td>
<td>0.86 b</td>
<td>94.33 a</td>
</tr>
<tr>
<td>Large</td>
<td>18.82 c</td>
<td>135.32 c</td>
<td>1.40 c</td>
<td>96.66 a</td>
</tr>
</tbody>
</table>

Fig. 1: Effect of seed size on germination percentage in durum wheat.

Fig. 2: Effect of seed size on seedling dry weight in durum wheat.

Fig. 3: Effect of seed size on seedling vigor in durum wheat.

Fig. 4: Effect of seed size on seedling length in durum wheat.

Conclusion:

Under normal conditions, the germination percentage, seedling dry weight, seedling vigor and seedling length increased by increasing seed size. Higher vigor index in large seeds of «Waha» varieties have little advantage compared to other seed sizes. Under stress conditions, Willenborg et al. reported that large oat seeds had greater final germination that resulted in better stand establishment, particularly where low spring soil moisture limits stand establishment than that of small seeds conditions. Therefore, higher vigor index of larger seeds in «Waha» may be beneficial in establishing plants under dry soil conditions, which
mean that large seeds of this variety can alleviate the negative effects of drought stress on seedlings.

References