Effect of seed size on germination and seed vigor of two soybean (glycin max L.) cultivars

Roshanak Rezapour1*, Hamdollah Kazemi-arbat1, Mehrdad Yarnia1 and Parisa Zafarani-Moattar2

1. Islamic Azad University of Tabriz, Faculty of Agriculture, Department of agronomy, Tabriz, Iran
2. University of Tabriz, Faculty of Agriculture, Department of Plant Eco-physiology, Tabriz, Iran

Corresponding author email: rezapoor.roshanak@gmail.com

ABSTRACT: In order to evaluate the effects of seed size on germination and seed vigor of two soybean cultivars, an experiment was carried out at seed technology laboratory of Islamic Azad University of Tabriz in 2008. This experiment was arranged out as factorial, based on CRD design with four replications. Treatments were three seed sizes (small, medium and large) and two soybean cultivars (Williams and TMS). Results showed that medium seeds had higher germination percentage than that for large and small seed sizes. Highest and lowest amount of root and shoot length, seedling length, and seedling dry weight belonged to medium and small seeds, respectively. But there was not a significant effect of seed size on germination rate.

Key words: Seed size, Seed germination, Seed vigor, Cultivar, Soybean

INTRODUCTION

Soybean has a important role in human and animal feeding because of its high protein and oil resources (Mazaheri-Tehrani and Ahmadi, 1992). Seed size is one of the important yield components which has a effective role on cultivar adaptation to different condition with affecting the seed vigor (Morrison and Xue, 2007). Seed vigor includes all of the features that can cause to rapid and uniform seedling emergence in a wide range of environmental condition following the seed planting (Copeland and Mcdonald, 1985). Robust test is a seed vigor indicator of the responsible seeds quality measurement in prediction of early seedling growth (Sarmadnia, 1996). Seed vigor prediction gives some information about seed quality. Geneva (2008) reported that seed vigor is a complex feature, which is dependent on plant genetics and environmental position of plant, crop harvesting and processing.

Between the genetically factors, seed size has a special role in crop production. There have been immense studies on seed size in various plant species. The effect of seed size on germination, ground cover and performance of plant has been confirmed. Seed size is one of the most important characteristics of seeds that can affect the seed development duration.

Farokhi and Galeshi (2005) and Grant and James (2000) reported that there is a negative correlation between soybean tolerance to climatic factors and its seed size, because large seeds require more water resources for their vital activities and consequently they can be damaged by reduction of osmotic potential.

Egli et al (1987) with a study on soybean seed size differences reported that determination of seed size on yield and yield components of soybean and other important legumes has highest importance and seed size in soybean is influenced by genetic and environmental factors.

Studies of Roozrokh et al (2005) on chickpea showed that large seeds of chickpea had high germination percentage, more seedling dry weight and better electrical conductivity in compare with small seeds. This is related by more food storages of large seeds which is clearly affected by genetic structure and environmental conditions during grain filling stage.

Ries et al (1976), Evans and Ward low (1976) with study on wheat protein content and seed size, found that large seeds contain more protein and produced higher seedling dry weight than that for small seeds. Similar results has been detected for Cowpea (Francis and Coolbear, 1984; Lush et al., 1980) and Barley (Roebuck and Treneey, 1987).

Gray and Stechel (1986) showed that seedlings emergence of large seeds of Carrots and Gordenleed was improved after planting. Mckersie et al (1981) reported the similar results for Clover.

Cavar (1977) with classification of wheat seeds size in four seed categories found that small seeds have rather lower production in compare with large seeds. Puri and Qualset (1978) reported similar results in
their studies on durum Wheat. Despite numerous reports about positive role of large seeds in seed vigor increase, Robertson and Curtis (1976) reported that there is not any difference between large and small Wheat grain yield in the field. Similar results were reported by Kandra (1977) on Turnip. Hawkins and Copper (1979) suggested that Clover yield was not increased by planting the large seeds when seeds with different sizes were planted in two different sites.

Because of the importance of seed size on seed vigor of many crops and by noting that there were little studies on the effect of seed size on growth of Soybean. This research conducted to evaluate the effect of different seed sizes on germination percentage and seedling growth of two soybean cultivars.

**MATERIALS AND METHODS**

In order to evaluate the effect of three seed sizes (small, medium and large) on seed vigor of two Soybean cultivars (Williams and TMS) an experiment was carried out at seed technology laboratory of Islamic Azad University of Tabriz in 2008. Williams and TMS were prepared from Tehran oil Seeds Company. The seeds were grouped in three sizes as small, medium and large. This separation was conducted with pores of three and five mm diameters. In order to have a real classification, 100 seeds weight of each seed size were determined.

The 100 seeds weight for large, medium and small seeds of Williams were 13.20, 12.24 and 8.60 gr respectively. While the 100 seeds weight for large, medium and small seeds of TMS were 20.16, 16.63 and 14.61 gr, respectively.

This experiment was arranged out as factorial, based on CRD design with four replications. 25 normal seeds from each seed size were placed in each Petri dish. Two layer of filter paper were laid on seed bed. At first time, all of the laboratory equipments and desktop were disinfected with alcohol 95% and all of Petri dishes were put into germinator devise under 25 temperature. Germination test and the seedling growth analysis were conducted during 12 days. Germination percentage, root length, shoot length, seedling length, seedling dry weight and germination rate were determined at 4, 7, 10 and 12 days of experiment.

Germination percentage was detected by Dividing the number of germinated seeds to total seeds number (Gharine et al., 2004) and germination rate was calculated with following equation (Roozrokh et al., 2002):

\[
\bar{D} = \frac{\sum (D_n)}{\sum n}
\]

\[
\bar{R} = \frac{1}{\bar{D}}
\]

In this equation, \(n\) is number of germinated seeds on day \(D\), \(D\) is day number after the start of germination test, \(D'\) is average of germination time and \(R\)' is average of germination rate.

Experimental data were analysed by MSTATC software and the averages were compared with Duncanes new multiple range test in 5 percent probability.

**RESULTS AND DISCUSSION**

Variance analyses of germination percentage of data showed that root length, shoot length, seedling length and seedling dry weight were significantly affected by both seed size and interaction of cultivar×seed size. Germination rate was affected by only seed size. But cultivar had not significant effect on these traits. The effect of cultivar, seed size and interaction of cultivar×seed size were not significant on germination rate (Table 1).

Table1. Analyses of variance of data for germination traits under different seed sizes

<table>
<thead>
<tr>
<th>Germination speed</th>
<th>Germination Percentage</th>
<th>Seedling dry weight</th>
<th>Seedling length</th>
<th>Shoot length</th>
<th>Root length</th>
<th>Df</th>
<th>s.o.v</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/042**</td>
<td>96**</td>
<td>10/08**</td>
<td>5/023**</td>
<td>0/188**</td>
<td>7/031**</td>
<td>1</td>
<td>Cultivar</td>
</tr>
<tr>
<td>5/542**</td>
<td>1544**</td>
<td>205/835**</td>
<td>1237/432**</td>
<td>25/51**</td>
<td>907/728**</td>
<td>2</td>
<td>Seed size x Cultivar</td>
</tr>
<tr>
<td>4/102**</td>
<td>8**</td>
<td>22/542**</td>
<td>671/019**</td>
<td>3/101**</td>
<td>601/325**</td>
<td>2</td>
<td>Seed size</td>
</tr>
<tr>
<td>5/097</td>
<td>65/778</td>
<td>3/237</td>
<td>14/171</td>
<td>0/502</td>
<td>10/643</td>
<td>18</td>
<td>Error</td>
</tr>
<tr>
<td>12/23</td>
<td>10/14</td>
<td>10/26</td>
<td>6/62</td>
<td>6/09</td>
<td>7/21</td>
<td>23</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CV</td>
</tr>
</tbody>
</table>

ns, * and ** non significant and significant at 5% and 1% probability levels, respectively.

Means of differences showed that the highest amount of root length was detected by medium seeds of Williams and the lowest amount of root length was detected by small seeds of Williams (Fig 1).
The medium seeds had the highest amount of root length during 4th to 12th sampling days of germination process. However the small seeds had the higher root length than large seeds between 6th to 10th sampling days of germination process. But then the root length of small seeds was decreased while the root length of large seeds was increased by proceeding the seed germination process (Figure 2).

The highest and the lowest amount of shoot length were determined by medium seeds of Williams and small seeds of TMS respectively (Fig 3). The medium seeds had the largest amount of shoot length during 4th to 12th sampling days in the germination process. At the end of 12th day of seed germination process, the shoot length of large seeds were slightly higher than that for small seeds (Fig 4). Mut and Akay (2010) reported that decreasing the seed size can cause to decrease the germination percentage, root and shoot length of Naked oat.
The largest amount of seedling length was detected by medium seeds of Williams and the differences between medium seeds of this cultivar with medium seeds of TMS was significant. The lowest amount of seedling length was detected by small seeds of Williams and the differences between small seeds of Williams and TMS was also significant in this case (Fig 5). Similar results were observed by Nobbe (1976) on cereal seeds, Bartee and Kreig (1974) and Kreig and Carrol (1978) on Cotton, Mckersie et al (1981) on clover. However the studies of Kaydan and Yagmur (2008) on Triticale showed that the seedling growth of larger seeds was rather than of small seeds.
The medium seeds had the highest seedling length in all stages of seed germination process (Fig 6). The highest and the lowest amount of seedling dry weight of soybean seeds were detected by medium and small seeds of Williams (Fig 7).

Mean differences showed that Germination percentage of large seeds was significantly higher than that for medium seeds. The lowest amount of seed germination was detected by small seeds (Fig 8). All of the three seed sizes had a similar rate of germination percentage from 4th day. But after achieving to a maximum value the germination percentage of small seeds was lower than that for medium and large seeds (Fig 9). Hojjat (2011) reported that the germination parameters were significantly related by seed weight and large seeds germinated early and showed better germination than small seeds of Lentil genotypes. Similar results were obtained from Roozrok et al. (2005) on chickpea, Taleghani et al. (2002) on sugar beet and Burris et al. (1973) on soybean. However Johnson et al. (1974) in their research about seed size on soybean germination and grain yield, reported that seed size had no effect on seed germination and yield of soybean. They also observed that the interaction between seed size and cultivar was not significant. By looking at the results it can be seen that seed size has a significant effect on germination percentage, seedling growth and consequently can cause to increase the grain yield of the crops. Perry (1980) reported that there is a close correlation between seed size and seed nutritional resources, therefore it is expected that an increase in seed size has a positive role in seedling growth and subsequently increasing the seed yield. In favorable germination and growth condition large seeds will produce larger seedling in compare with small seeds and it can cause to increase the crop production in the field (Perry, 1980). But in this research the medium seeds had the highest amount of germination parameters between the different seed sizes of soybean because soybean is a oily crop and the increasing of seed weight from medium seed size, can cause to the oxidative stress due to the oily components in the seed and this can cause to seed brittle and consequently decrease the germination percentage of the seeds.

REFERENCES


Roozrokh M, Shams K, vghar M. 2005. Effects of seed size and seedling depth on seed vigor of chick pea, First National Legume Congress. Mashhad Ferdowsi University, Mashhad, Iran.