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EFFECT OF SEED SIZE ON SEED GERMINATION BEHAVIOR OF SAFFLOWER (*Carthamus tinctorius* L.)

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ABSTRACT

In order to evaluate the effect of seed size on different aspect of Safflower (*Carthamus tinctorius* L.) germination, an experiment was conducted at Seed and Plant Certification and Registration Research Institute, Karaj, Iran. The experiment was carried out in a 4×3 factorial design based on randomized complete blocks with three replications. Experimental units included four cultivars (Goldasht, Padideh, Esfahan and Sina) and three seed size (small, large and control). Germination percent, germination speed, seedling length, radical length, coleoptiles length, seedling fresh and dry weights, coleoptiles fresh and dry weights and 1000 seed weights were measured. Variance analysis results revealed that some measured indices such as germination percent, germination speed, coleoptiles fresh and dry weights, radicle fresh weight, radicle length and 1000 seed weights affected by cultivars. Mean comparisons based on Duncan method indicated that Goldasht cultivar produced the highest germination percent, stem fresh weight, stem dry weight, radicle fresh weight and 1000 seed weights among cultivars. The effect of seed size on germination percent, germination speed, coleoptiles fresh weight, radicle dry weight and 1000 seed weights were significant. Large seeds produced the highest germination percent, coleoptiles fresh weight, coleoptiles dry weight, radicle fresh weight and 1000 seed weights compared other seed size.

Keywords: safflower, seed size, seed germination, seedling weight, radicle length.

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is one of the prospective oil-seed crops, because it yields about 32-40% seed oil. Its oil is widely utilized in industries mainly as edible and dying purposes (Siddiqi *et al*., 2007). In principle, seed size has influences on many characters both in the field and laboratory tests. The storage and handle of different seed size of cultivars are similar in many countries. Although genetic background of seeds in individual lines or cultivars is similar, seed sizes in individual lines or cultivars may affect other agronomic characters. Different seed size accompany with various levels of starch in each cultivar might be as one factor which influences the expression of physiological-dependent character (Hoy and Gamble 1987; Sexton *et al*., 1994). Seed is considered as approaching factor of yield potential in respect of quantitative and qualitative production (Agrawal 1980). Seed multiplying, seed control and seed certification programs have had significant effect on genetic ancestry preservation and provision of the seeds for farmers.

One of the most important aspects for safflower seed production is related to rapid emergence and good seedling establishment in the field. In the other hand germination and emergence are important issues in plant production and they have significant effect on the next stages of plant growth in the field. Traits that are in relation to seed size are important in agronomy (Siddiqi *et al*., 2007). Rapid and uniform field emergence is essential to achieve high yield with good quality and quantity in annual crops (Yari *et al*., 2010).Germination and seedling vigor are the main factors for plant establishment and making optimum plant density and plant production. Some researchers (Castilo *et al*., 1993) noticed 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. Comish and Hindmarsh (1988) classified two wheat cultivars to four categories based on coleoptiles length (2-2.25, 2.25-2.50, 2.5-2.75 and more than 2.75 mm). They observed that the effect of seed size on coleoptiles length was significant at 1% level. The effect of seed size on germination and seedling emergence of different crop species has been the subject of numerous published studies (Kawade *et al*., 1987; Roy *et al*., 1996; Guberac *et al*., 1998; Larsen and Andreasen 2004). However, results from these studies revealed more variety among species. Large seed of pearl millet (*Pennisetum glaucum* L.) produced higher germination and emergence compared to small seed (Kawade *et al*., 1987). furthermore some researchers also observed increased germination percentage and decreased median germination time with increasing seed mass in slender creeping red fescue (*Festuca rubra* L. subsp. litoralis Vasey), perennial ryegrass (*Lolium perenne* L.), and Kentucky bluegrass (*Poa pratensis* L.) (Larsen and Andreasen 2004). Willenborg *et al*., (2005) that have been studied about germination specification of six oat cultivars with three seed size (less than 1.95, 1.95-2.35 and more than 2.35 mm) at water stress condition (0, -.4, -.2 mega pascal) resulted that oat cultivars genotypes with large seed size under different osmotic potential produced high germination rate. It was reported by Hasstrupt *et al*., (1993) that wheat and barely yield would be decreased by increasing of seed germination duration in order to low seed vigor. Based on studies it will be clear that what kind of seed size would be able to produce highest quality. Furthermore seeds segregation would be possible at seed processing operations in the respect of the seed size. Also

seeds which put in one category based on seed size have identical qualitative traits (germination and emergence in field). So 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. The main objective of the present study was to evaluate the effects of different seed size on seed germination behavior of Safflower.

MATERIALS AND METHODS

The Experiment was conducted in the laboratory of the Seed and Plant Certification and Registration Research Institute, Karaj, Iran in 2008 to determine seed size effects on different aspects of Safflower germination. Experimental units were arranged factorials (4×3) in a completely randomized design with three replications. Experimental units included four cultivars (Goldasht, Padideh, Esfahan and Sina) and three seed size (small, large and control). Precise determination of seed moisture percent was done through constant temperature oven method low at 153 ± 2 °C during 17 ± 1 hour. The other condition was prepared according to standard germination test at 20-30 °C on germination paper. The number of germinated seeds was recorded 7 days after planting as final germination percent (FGP) (ISTA 1993 and ISTA 1999). Also the seed daily germination index (SDG) was calculated through counting the number of daily germinated seeds as described in Hunter and Naylor (1984) (eq. 1), where FGP and D shows the final germination percent and daily number germination seed, respectively.

$$SDG = \frac{1}{FGP / D} \quad (1)$$

The seedling vigor index (SVI) was calculated as in Abdul-Baki and Anderson (1973) (eq. 2).

$$SVI = seedlingdryweight * seedvigor \quad (2)$$

Seedling Dry Weight (DSW) can be measured by putting the seedling in oven at 75 °C as long as 48 hours. The seedling length was measured before the weigh of dry seedling.

Experimental data were analyzed using SAS (Statistical software, SAS institute 2002) and treatment means were compared using Duncan's multiple range test.

RESULTS

According to the results of variance analysis, effect of cultivar on germination percent, germination rate, coleoptiles fresh weight, seedling dry weight, radicle dry weight, radicle length and 1000 grain weight was significant (Table-1). Means comparisons by using Duncan's multiple range test revealed that Goldasht cultivar produced the highest germination percent (86%), coleoptiles fresh weight (3.18 gr), coleoptiles dry weight (0.166 gr), radicle dry weight (0.43 gr) and 1000 grain weight (48.4 gr) among other cultivars (Table-2). There was not significant difference between cultivars from the aspect of radicle dry weight, seedling length and coleoptiles length. Also it was observed that Sina cultivar which had high adaptability to water deficit and dry condition produced the highest radicle length. The effect of seed size on seed germination percent, germination rate, coleoptiles fresh weight, radicle dry weight and 1000 grain weight was significant (Table-1). Also it was obvious that large seed size was superior compared to the other seed size (Table-2). Large seed size produced the highest germination (79.91%), coleoptiles fresh weight (2.85 gr), coleoptiles dry weight (0.168 gr), radicle dry weight (0.41 gr) and 1000 grain weight (44.51 gr) among other cultivars (Table-2). As it is recognized (Table-2) the germination rate (19.53) of small seed size was the highest among other cultivars. Also this research made clear that, the speed of germination in small seed size was faster than other seed size.

Negative Correlation coefficient (Table-3) between germination rate with radicle dry weight (r = -0.30) and coleoptiles dry weight was observed.

Table-1. Variance analysis of germination behavior of safflower under different seed size and cultivars.

		Mean squares (MS)									
SOV	**Df**	**Germination rate**	**Germination speed**	**Coleoptiles fresh weight**	**Coleoptiles dry weight**	**Radicle fresh weight**	**Radicle dry weight**	**Seedling length**	**Coleoptiles length**	**Radicle length**	**1000 grain weight**
Cultivar	3	896.07**	53.31**	1.98**	0.0047**	0.071**	0.0008^{ns}	2.22^{ns}	2.01^{ns}	4.532**	4.532**
Seed size	2	146.19**	17.78*	1.39^{ns}	0.0123**	0.045*	0.0013^{ns}	2.30^{ns}	0.35^{ns}	0.0549^{ns}	0.549^{ns}
Cultivar × seed size	6	16.26^{ns}	0.81^{n}	0.079^{ns}	0.0007^{ns}	0.0004^{ns}	0.0009^{ns}	1.51^{ns}	0.26^{ns}	0.0681^{ns}	0.681^{ns}
Error	35	-	-	-	-	-	-	-	-	-	-

ns, * and **: not significant, significant at the 5 and 1 % levels of probability, respectively.

Table2: Means comparisons of germination behavior of safflower under different seed size and cultivars by Duncan multiple Range tests (DMRT).

SOV	Germination rate (%)	Germination speed	Coleoptiles fresh weight (gr)	Coleoptiles dry weight (gr)	Radicle fresh weight (gr)	Radicle dry weight (gr)	Seedling length (cm)	Coleoptiles length (cm)	Radicle length (cm)	1000 grain weight (gr)
Cultivar										
Esfahan	74.22^{b}	19.42^{ab}	2.43^{b}	0.134^{b}	0.24^{c}	0.029^{a}	17.35^{a}	5.60^{a}	11.76^{ab}	36.90^{b}
Padideh	80.55^{b}	20.41^{a}	2.15^{b}	0.114^{b}	0.31^{bc}	0.044^{a}	16.56^{a}	5.59^{a}	10.79^{b}	35.57^{b}
Goldasht	86^{a}	17.94^{b}	3.18^{a}	0.166^{a}	0.43^{a}	0.049^{a}	16.16^{a}	5.46^{a}	10.74^{b}	48.40^{a}
Sina	62.77^{d}	14.83^{c}	2.22^{b}	0.122^{a}	0.40^{ab}	0.030^{a}	16.78^{a}	4.61^{a}	12.16^{a}	33.40^{c}
Seed size										
Small seeds	73.75^{b}	19.53^{a}	2.17^{b}	0.105^{c}	0.29^{b}	0.047^{a}	16.85^{a}	5.43^{a}	11.40^{a}	33.63^{c}
Large seeds	79.91^{a}	17.24^{b}	2.85^{a}	0.168^{a}	0.41^{a}	0.040^{a}	16.22^{a}	5.12^{a}	11.13^{a}	44.51^{a}
Control seeds	74^{b}	17.68^{b}	2.46^{ab}	0.129^{b}	0.34^{ab}	0.026^{a}	17.07^{a}	5.40^{a}	11.55^{a}	37.56^{b}

Mean followed by the same letters in each column are not significantly different (LSD test 5 %)

Table-3. Simple correlation coefficients between studied criteria under the effect of cultivar and seed size.

	Germination rate	Germination speed	Coleoptiles fresh weight	Coleoptiles dry weight	Radicle fresh weight	Radicle dry weight	Seedling length	Coleoptiles length	Radicle length	1000 grain weight
Germination rate	1									
Germination speed	0.40*	1								
Coleoptiles fresh weight	0.45**	-0.06^{ns}	1							
Coleoptiles dry weight	0.42*	-0.3^{ns}	0.50**	1						
Radicle fresh weight	0.15^{ns}	-0.37^{ns}	0.69**	0.44**	1					
Radicle dry weight	0.20^{ns}	-0.16^{ns}	0.15^{ns}	0.016^{ns}	0.03^{ns}	1				
Seedling length	-0.23^{ns}	0.28^{ns}	-0.06^{ns}	-0.42*	-0.21^{ns}	0.17^{ns}	1			
Coleoptiles length	0.17^{ns}	0.54**	0.11^{ns}	-0.27^{ns}	-0.16^{ns}	0.21^{ns}	0.79**	1		
Radicle length	-0.53**	-0.1^{ns}	-0.17^{ns}	-0.36*	-0.16^{ns}	0.07^{ns}	0.82**	0.32^{ns}	1	
1000 grain weight	0.67**	-0.09^{ns}	0.61**	0.80**	0.46**	0.05^{ns}	-0.22^{ns}	0.06^{ns}	-0.36*	1

ns, * and **: not significant, significant at the 5 and 1 % levels of probability, respectively.

DISCUSSIONS

There was not significant difference between cultivars from the aspect of radicle dry weight, seedling length and coleoptiles length. Also it was observed that Sina cultivar which had high adaptability to water deficit and dry condition produced the highest radicle length. It seems that this priority in this cultivar is related to its resistance to water stress. The Difference between Goldasht cultivar with other cultivars is probably because of its larger seed size which shows more seed food storage. This result has been confirmed by Mathur, Sinha and Sing (1982) and Willenberg *et al*., (2005). Seeds with Large size in all cultivars had priority in studied traits in comparison with other size of seeds. These findings are in agreement with some researcher as Guberac *et al*., (1998) and Likewise, Mathur *et al*., (1982) that observed increasing of germination in large seeds versus small seeds. They reported that seed size had significant effect on seedling dry weight.

The germination rate of small seed size was the highest amount among other seed sizes. The reason of this matter is probably because of less need for water

absorption compared to large seed size. Large seed size needs water absorption more than small seed size and because of this issue it takes more time the seeds germinate and finally will be resulted in decrement of germination rate. The results of Ghorbani *et al*., (2008) in a research about the effect of salinity and seed size on response of wheat germination and seedling growth are in line with our findings. They reported that seed size had significant effect on seedling dry weight. Also it was noticed that, Increment of coleoptiles, radicle and seedling dry weight in large seed size was in order to more seed food storages in their endosperms. Also they showed that small seed size produced higher germination rate compared to large seed size which is in agreement with our results. Also this research made clear that, the speed of germination in small seed size was faster than other seed size which is in line with Lafond and Bakers (1986) and Roy *et al*., (1996) results. Negative Correlation coefficient (Table-3) between germination rate with radicle dry weight (r = -0.30) and coleoptiles dry weight showed that, by increasing seed size the germination rate would be decreased while it will produce more strength seedling with more seed dry weight. Overall it could be concluded that large seed size was superior among different seed size and Goldasht cultivar was the best cultivar in the respect of traits which were investigated in this study. So it is recommended that special seed screens should be used in seed cleaning system for segregating seeds to achieve good results.

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