

Investigation Germination Characteristics of Wheat (*Triticum aestivum* L., cv. Chamran) in Response to Seed Aging

Razieh Danaiee Far*¹ Mehran Sharafizade²

1- Msc. Graduated, Department of Agronomy, Khuzestan Science and Research Branch, Islamic Azad University, Ahvaz, Iran.

2- Seed and Plant Improvement Department, Safiabad Agricultural and Natural Resources Research and Education Center, AREEO, Dezful, Iran.

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ABSTRACT

BACKGROUND: Seed aging is an important problem in developing countries which seeds stored in inappropriate condition.

OBJECTIVES: Current research was carried out to study the effect of seed aging on quantitative parameters of wheat seeds (Chamran cultivar).

METHODS: Experiment was carried out based on randomized complete block design (RCBD) with four replications. Treatment included seed aging factor at five levels (a_1 : zero or control, a_2 : 48, a_3 : 72, a_4 : 96, a_5 : 110 hr).

RESULT: According to result of analysis of variance effect of different levels of seed aging on measured traits in the laboratory including the index of seedling emergence, mean daily germination, daily germination speed, seedling vigor, radicle length, plumule length, and seedling dry weight was not significant, but the effect of treatment on mean time for germination and coefficient velocity of germination was significant at 1% probability level. Mean comparison result of different level of seed aging indicated that the longest mean time of germination was related to the aging level of 110 hr (3.72) and the lowest one belonged to control treatment with aging level of 0 hr (3.25). Also the highest mean daily germination belonged to 100 hr seed aging level (10.55) and the lowest one belonged to the control treatment with 0 hr of aging (9.65). Moreover, the maximum and minimum amount of coefficient velocity of germination belonged to control (0.85) and treatment with 110 hr aging (0.55), respectively.

CONCLUSION: Seed aging had significant effect on physiological indices especially on the mean time of germination and coefficient velocity of germination. Also temperature and duration of aging were the most important factors that affecting the occurrence and development of seed aging. Therefore, aging development by increasing temperature and its duration was predictable.

KEYWORDS: *Correlation, Radicle length, Seedling dry weight.*

1. BACKGROUND

One of the most important problems facing the farmers in developing countries is the heterogeneity and lack of suitable conditions in soil that causes decreasing in germination percent, heterogeneous emergence, unbalanced the seedling growth and competition for environmental resources such as light, nutrients and water. Subsequently, this makes difference in biomass and performance of a species of plants (Sedghi *et al.*, 2010). Germination process includes conveyance of stored minerals to embryo axis and initiating metabolic activities leading to its growth. Tolerance of plants in these two phases of plants life plays a significant role in their stand establishment which results in higher yields (Almasouri *et al.*, 2001). Seed quality and seed density are the most important factors which affect crop yield in field condition and show different reactions. These changes result from the differences in seed vigor such as genetic structure of the seed and seed aging (Gharine *et al.*, 2003). Seed quality is influenced by many factors such as cultivar, genetic purity, viability, germination, health, moisture, size and weight, color and aging of the seed among which seed aging is particularly important (Ageravel, 2005). Khajeh-Hosseini *et al.* (2003) reported that crop establishment depends on an interaction between seedbed environment and seed quality. Poor plant establishment is a common cause of reduction in plant yields in arid and semi-arid areas (Harris *et al.*, 2001). Economically, the use of low seed quality causes a lot of damage, so that about 25% of harvested grains and seeds are destroyed annually through deterioration or their quality highly decreases (Mc Donald, 1999). Seed quality is very important to optimum growth and yield production in farm which influenced by many factors

such as genetic characteristics, viability, germination percent, vigor, moisture content, storage conditions, survival ability and seed health, but their most important is germination percent and vigor (Akbari *et al.*, 2004). Seed aging is an important problem in developing countries where seeds are stored in places usually without appropriate humidity and temperature. Temperature and seed moisture content are two main factors influencing seed viability in storage (Ghasemi *et al.*, 2014). Verma *et al.* (2003) by evaluate effect of seed quality parameters on aged seeds of canola reported due to every year storage, seedling establishment would reduce and the reduction was different among various cultivars which were studied in theory, the seed quality can affect crop yield directly or indirectly. Strong and high quality seeds can grow better and produce stronger seedlings while facing environmental stress (De Figueiredo *et al.*, 2003). Seed strength is deteriorated based on temperature and humidity during maturity, harvest, and inappropriate storage (Marshal and Luis, 2004). Seed aging and loss of germination are phenomena which cannot be suspended during the storage (Sohani *et al.*, 1996). Seed germination is an important biological process in growth cycle of the plant species (Movaghatian and Khor-sandi, 2013). Studying basic seed emergence requirements will increase the chance of successful plant establishment under different climatic conditions. Rapid, uniform and complete emergence of vigorous seedlings, leads to high seed yield potential by shortening the time from sowing to complete ground cover, allows the establishment of optimum canopy structure to minimize interplant competition, maximize crop yield and provide plants with time and spatial advantages to compete with

weeds (Soltani *et al.*, 2001). Seed germination is a critical point in seedling establishment and subsequent plant health and vigor. Seeds may be more sensitive to stresses than mature plants, because of exposure the dynamic environment close to the soil surface (Dodd and Donovan, 1999). The germination process includes conveyance of stored minerals to embryo axis and the initiating metabolic activities leading to its growth. Tolerance of the plants in these two phases of plants life plays a significant role in their stand establishment which results in higher yields (Al-masouri *et al.*, 2001). Effect of seed vigor on early seedling vigor depends on environmental conditions during early growth stages. Low seed quality may be followed by undesirable germination and lead to low vigor seedlings, especially under stressful conditions (De Figueiredo *et al.*, 2003). Seed aging reduces germination, emergence, shoot and root dry weight, seedling length, normal seedling percentage and leaf appearance rate. This might led to reduced yield potential by lengthening the days from sowing to complete ground cover and a delay in the establishment of an optimum canopy (Soltani *et al.*, 2009). Ageing is known as the process of seed quality loss along with time associated with reduction of seed vigor (Mansouri-Far *et al.*, 2015). Aging is manifested as reduction in germination percentage and those seeds that do germinate produce weak seedling (Veselova and Veselovsky, 2003). The aim of seed vigor tests is to distinct low and high vigor seed mass with each other, also these tests provide ways to examine the ability of field performance of different seeds in laboratory conditions after genetic structure; seed aging had the most effect on seed vigor (Ghasemi golezani *et al.*, 2010). Increasing deterioration severity caused decreasing germination

characteristics and seed reserve utilization (Mohammadi *et al.*, 2011). Low vigor seeds emergence lower than high vigor seeds in field conditions and produce less plantlets. Seeds deteriorate and lose their germinability during periods of prolonged aging (Ansari and Sharif-Zadeh, 2013). Seed aging is recognized by some parameters like delay in germination and emergence, slow growth and increasing of susceptibility to environmental stresses (Walters, 1998). Seed quality (viability and vigor) decreases under long storage conditions due to aging. It is the reason of declining in germination characteristics (Soltani *et al.*, 2008). Seed germination and seedling vigor is defined as the sum total of those properties of the seed which determine the level of activity and performance of the seed or seedlot during germination and seedling emergence (Flowers, 2004). Using high quality seed improved performance in two ways: first, percent of green seedling derived by high quality seeds is more than weak and exhausted ones and this can be helpful to achieve the desired density in field. Second, vigorous seed had more seedling growth rate and ununiformed emergence in germination time can be minimized (Ghasemi-golezani *et al.*, 2010). Seed vigor provides more knowledge about seeds ability to germinate in a wide range of environmental conditions. Vigorous seeds had more viability (Tekeroniy and Eglin, 1977). The aim of seed vigor tests is to distinct low and high vigor seed mass with each other, also these tests provide ways to examine the ability of field performance of different seeds in laboratory conditions (Ghasemi-golezani *et al.*, 2010). The main factors that affected seed vigor include genetic structure, environment, maternal plant nutrition, maturity stage at harvest time, mechanical damages, seed reserves, seed age, dete-

rioration and pathogens (Perry *et al.*, 1980). After genetic structure, seed aging had the most effect on seed vigor (Ghasemi-golezani *et al.*, 2010). During aging, seed vigor is the first component of seed quality that reduced and following decrease germination capacity cut and seed survival (Travata *et al.*, 1995). Deterioration means irreversible destructive changes that reduce the germinability. Increasing deterioration severity caused decreasing vigor. Low vigor seeds emergence lower than high vigor seeds in field conditions and produce less plantlets. Vigorous seeds can increase crop yield in two ways: firstly, optimum density made by the higher seedling percentage even under abiotic stress conditions and secondly, increased growth and higher emergence rate (Ghasemi-Golezani *et al.*, 2010). Many seed priming and post priming treatments have been used to improve the performance of invigorate and damaged seeds of many crops (Farooq *et al.*, 2006). The seed vigor may be decreased during maturation, harvesting, and storage, based on temperature and humidity. High temperature during storage results in fast consumption of foods reserve of seeds by increasing respiration and thereby deteriorating the seeds. Thus, it disturbs seed germination, seedling emergence, and the establishment of wheat in the farm (Marshall and Lewis, 2004). Goodarzian Ghahfarokhi *et al.* (2014) by evaluate the effect of accelerated aging on germination characteristics of two wheat cultivars reported germination percentage, germination index, normal seedling percentage, seedling dry weight, and weight of utilized (mobilized) seed reserve decreased significantly as seed aging progressed. But, mean time to germination, electrical conductivity and malondialdehyde content increased significantly as seed aging progressed. High quality

seed is considered to be one of the most important factors in crop production. One of the components of seed quality is seed vigor (Hampton, 1995). Aging is the most important feature which affects the seed quality. Seed is the most important input in agriculture and has the largest share in increase or decrease of product yield and with regard to the importance and status of wheat, the necessity of using strong and high quality seeds is felt more than ever in order to achieve maximum yield and more productivity.

2. OBJECTIVES

This research was carried out to study the effect of seed aging on germination traits of wheat seed (Chamran cultivar).

3. MATERIALS AND METHODS

3.1. Lab and Treatments Information

This study was conducted in 2010-2011 cropping season in Agricultural Research Center of Safi Abad Dezful located at South west of Iran, at latitude 32°22 N and longitude 48°32 E, altitude is 82m above the sea level. Current research was carried out according randomized complete block design with the four replications. Treatment included seed aging at five levels (a_1 : zero or control, a_2 : 48, a_3 : 72, a_4 : 96, a_5 : 110 hr).

3.2. Lab Management

To exercise aging treatments, the seeds were put in incubator at 45°C and with 100% humidity and then they were removed from the incubator according to determined aging hours. To carry out the laboratory test, the aging seeds were placed in incubator according to International Seed Testing Association (ISTA) for Standard Germination Test. To do so, 25 seeds were cultured on two layers of Whitman paper in petri dish

and were kept at 25°C for seven days and then indices of germination and vigor of seeds and seedlings were calculated as follows. Since the second day after the experiment, the growing seeds were counted every day (growth criterion is based on the time when the root tip lengthens about 2mm).

3.3. Measured Traits

After the end of counting day (7 days) in the lab, the average of daily germination, the mean time for germination, germination coefficient of velocity were calculated using the following formulae:

Equ. 1. Mean time for germination (MTG): the mean time for germination which is considered as an index of germination velocity and acceleration is calculated by the following equation (Ellis and Robert, 1981).

$$MTG = \frac{\sum(nd)}{\sum n}$$

In this equation, n = the number of germinated seeds during days

d = the number of days since the beginning of germination

$\sum n$ = total number of germinated seeds

Equ. 2. Mean daily germination (MDG): mean daily germination which is an index of rate of daily germination is calculated by the following equation (Scot, 1984).

$$MDG = \frac{FGP}{d}$$

In this equation, FGP is the final germination percentage (viability) and d is the number of days to achieve final germination (experiment duration).

Equ. 3. Daily germination speed (DGS): this index is the inverse of mean daily germination and is calculated by the following formula (Hunter *et al.*, 1984):

$$DGS = \frac{1}{MDG}$$

Equ. 4. Coefficient velocity of germination (CVG): this index is the velocity

and acceleration of seeds germination which is calculated by the following formula (Maguire, 1962):

$$CVG = \frac{G_1 + G_2 + G_3 + \dots + G_n}{(1 \times G_1) + (2 \times G_2) + (3 \times G_3) + \dots + (n \times G_n)}$$

G_1 - G_n shows the number of germinated seeds from the first day to the last day.

5. Seedling vigor index: after determining usual and unusual seedlings, 10 ones of each group were randomly selected and then the length of the seedling and primary leaves and roots, wet weight, and dry weight were measured. By means of recent data, two indices of seedling vigor index were calculated by the following formula (Abdul Baki, 1973): **Equ. 5.** Seedling vigor index (SVI): (Mean length of primary root + mean length of primary stem) × Viability.

The length of small root, small stem, seedling, and also the dry weight of seedling were calculated. To do so, five plants were randomly selected and the length of small roots and stem, and the length of seedling were calculated and then these organs were placed in oven at 70°C for 48 hours in order to measure dry weight.

3.4. Statistical Analysis

The data were analyzed by MSTATC software and mean comparisons were done by Duncan test at 5% probability level.

4. RESULTS AND DISCUSSION

According to result of analysis of variance effect of different levels of seed aging on measured traits in the laboratory including the index of seedling emergence, mean daily germination, daily germination speed, seedling vigor, radicle length, plumule length, and seedling dry weight was not significant, but the effect of treatment on mean time for germination and coefficient velocity of germination was significant

at 1% probability level (Table 1). Moshatati and Gharineh (2012) by evaluate effect of seed weight on some quantitative and qualitative characteristics of the seed showed that in standard germination test, seed weight had not significant effect on germination percent, germination rate and mean of germination time. In seedling growth

test, thousand grain weights had significant effect on seedling lengths and seedling dry weight. Also, comparison of means revealed that in trait of seedling dry weight, maximum amount (0.02g) related to maximum of thousand grain weight and minimum amount (0.016g) belonged to minimum of thousand grain weight.

Table 1. Results of analysis of variance of measured traits in laboratory

S.O.V.	df	Index of seedling emergence	Mean time for germination (MTG)	Mean daily germination (MDG)	Daily germination speed (DGS)
Replication	3	11.73 ^{ns}	0.035 ^{ns}	0.151 ^{ns}	0.58 ^{ns}
Seed aging	4	47.20 ^{ns}	0.112 ^{**}	0.564 ^{ns}	2.40 ^{ns}
Error	12	21.06	0.02	0.252	0.023
CV (%)	-	4.97	4.13	4.90	4.81

^{ns}, * and ** are non-significant and significant at 5 and 1% probability levels, respectively

Continue Table 1.

S.O.V.	df	Coefficient velocity of germination (CVG)	Seedling vigor index (SVI)	Radicle length	Plumule length	Seedling dry weight
Replication	3	0.003	68111.31 ^{ns}	3.92 ^{ns}	0.916 ^{ns}	0.004 ^{ns}
Seed aging	4	0.034 ^{**}	67451.41 ^{ns}	0.752 ^{ns}	0.455 ^{ns}	0.011 ^{ns}
Error	12	0.252	38055.157	1.157	0.314	0.008
CV (%)	-	4.90	6.19	6.34	3.27	13.81

^{ns}, * and ** are non-significant and significant at 5 and 1% probability levels, respectively

Germination speed is one of the most important indices in determining the seed quality. Further percentage of seed germination in less time indicates higher percentage of germination and had better quality and more seed vigor. The percentage and speed of growth in seeds with high vigor is more than the seeds with low vigor. Mean comparison result of different level of seed aging indicated that the longest mean time of germination was related to the aging level of 110 hr (3.72) and the lowest one belonged to control treatment with aging level of 0 hr (3.25) (Fig. 1). Result of mean comparison of effect of different level of seed aging showed that the highest mean daily germination belonged to 100 hr seed aging level (10.55) and the lowest one belonged to the control treatment with 0 hr of aging (9.65) (Fig. 2).

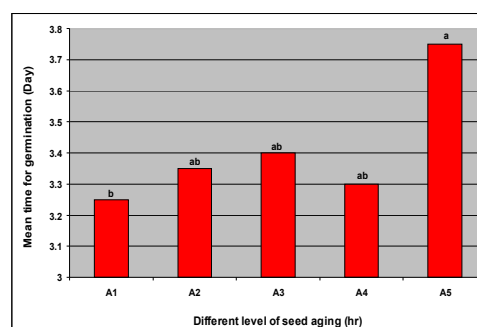


Fig.1. Mean comparison of effect of different level of seed aging on mean time for germination by Duncan test at 5% probability level.

According to the mean comparison result of different level of seed aging the highest coefficient velocity of germination was related to the control (0.85) and the lowest one belonged to the treatment with 110 hr aging (0.55) (Fig. 3).

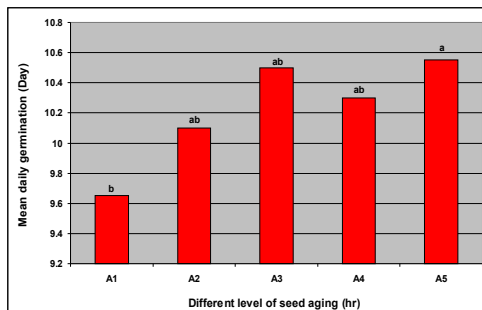


Fig.2. Mean comparison of effect of different level of seed aging on mean daily germination by Duncan test at 5% probability level.

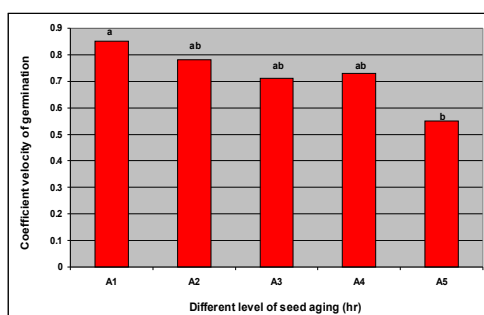


Fig.3. Mean comparison of effect of different level of seed aging on coefficient velocity of germination by Duncan test at 5% probability level.

Jahanbakhsh Godakahriz (2012) by investigate the effects of safflower seed vigor on germination indexes reported aging affect all traits significantly. For example with increase aging in 4 and 6 days germination percent reach from 99.8 (in control) to 90 and 64.4%, respectively. Increasing aging levels caused reducing some trait such as germination percent, normal germination percent, means daily germination and coefficient of velocity of germination. In all characteristics that listed above, control (without deterioration) had the highest and 6 days after aging (with 80 germination percent) had the lowest values. But rest of traits increased with aging levels and 6 days after deterioration was the highest one. Mentioned

results were similar with the results of Ram *et al.* (1999) on the study of seed aging of two wheat cultivars that showed non-aged seeds of wheat had a higher germination speed in comparison to aged seeds. By studying the effect of seed aging on the storage and heterotrophic growth of wheat seedling, Soltani *et al.* (1996) stated that aged seeds had lower germination rate than the control ones and for every day of increased aging period, this speed decreased as much as 0.00009. In this research, it was observed that temperature and aging time were the most effective factors on the occurrence and development of seed aging. As a result, aging development by increasing temperature and its duration was predictable. According to this research it could be said that it is impossible to achieve appropriate and desired yield through the use of low quality and aged seeds. With regard to the results obtained by Ghasemi goloazani *et al.* (1996), the decrease of yield might be due to the field which of course it is possible to sort of compensate for it by using higher density of crops during planting. Considering the importance of seed storage, it is recommended to apply accelerated aging test before sowing the seeds to determine the seed quality. On the other hand, due to importance of determining the seed vigor and quality at high temperature and humid storage conditions it is recommended that seed distributing centers ensure the accuracy of the seed vigor before distributing the seeds among the farmers. Ghasemi Goloazni *et al.* (1996) studied effect of aging on wheat seed and stated seedlings with higher germination speed had stronger seeds while seedlings with low vigor seeds, in spite of stressful environment conditions, either lacked germination or had lower and slower germination and growth in comparison to stronger seeds.

In this research, as the aging levels increased the seed germination speed decreased as well. Result of correlation coefficients between measured traits (Table 2) in laboratory showed that daily germination speed had a negative significant correlation with seedling vigor, seedling emergence, and seedling dry weight. However, this trait didn't have a significant correlation with coefficient velocity of germination, radicle and plumule length. Moreover, mean

time for germination had a negative significant correlation with velocity coefficient of germination. There was a positive significant correlation between mean daily germination and daily germination speed, seedling vigor, seedling emergence, and the seedling dry weight at 1% probability level. There was also a positive correlation between the seedling vigor and seedling emergence, radicle length, and seedling dry weight (Table 2).

Table 2. Correlation coefficients between measured traits in laboratory

Traits	1	2	3	4	5	6	7	8	9
1	1								
2	0.317 ^{ns}	1							
3	0.303 ^{ns}	0.999**	1						
4	-0.908**	-0.358 ^{ns}	0.349 ^{ns}	1					
5	0.326 ^{ns}	0.722**	-0.719**	0.295 ^{ns}	1				
6	0.317 ^{ns}	0.999**	-0.999**	0.358 ^{ns}	0.722**	1			
7	0.200 ^{ns}	0.660 ^{ns}	-0.620 ^{ns}	-0.157 ^{ns}	0.704**	0.660 ^{ns}	1		
8	-0.133 ^{ns}	-0.308 ^{ns}	0.306 ^{ns}	0.263 ^{ns}	0.295 ^{ns}	-0.308 ^{ns}	0.511*	1	
9	0.299 ^{ns}	0.999**	-0.999**	-0.339 ^{ns}	0.722**	0.999**	0.640 ^{ns}	-0.304 ^{ns}	1

^{ns}, * and ** are non-significant and significant at 5 and 1% probability levels, respectively.

1: Mean time for germination, 2: Mean daily germination, 3: Daily germination speed, 4: Coefficient velocity of germination, 5: Seedling vigor index, 6: Index of seedling emergence, 7: Radicle length, 8: Plumule length, 9: Seedling dry weight.

Pre-aging test not only determines the absolute amount of seed but also provides with its viability after the period when the seeds were under high temperature and moisture stress. In addition, other tests of seed vigor (standard germination) as complementary tests can provide us with more information about the yield of different crops. Aquila *et al.* (2002) observed the significant decrease of viability by aging white cabbage seeds, which were harvested at 13% moisture and 20°C and 85% relative humidity of environment, for three days and then placing the seeds inside aluminum foils at 40°C for five days.

4.1. CONCLUSION

Results of the research indicated that seed aging affected the indices of mean

time required for germination and velocity coefficient of germination in lab and also the number of grains per spike, spike density, biological yield, grain yield, and harvest index of the field. Therefore, this test could be used to study and to determine the quality of seed masses of crops especially the wheat. In other words, standard germination test could be performed on the seeds which are aged by means of heat and high moisture (accelerated aging) to determine the quality of seeds and different cultivars of wheat and also to predict the field outcomes such as germination process, biological yield, and ultimate optimum yield. As observed in this research, temperature and aging time are the most effective factors on occurrence and development of seed aging, so aging development was pre-

dictable by increasing temperature and its duration. According to result of current research it could be said that is impossible to achieve appropriate and desired yield through the use of low quality and aged seeds.

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FOOTNOTES

CONFLICT OF INTEREST: Authors declared no conflict of interest.

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