Effect of seed aging on germination and seedling growth indices on three canola cultivars (*Brassica napus* L.)

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Abstract

In order to evaluate the relationship between seed deterioration (accelerated aging test) on germination and seedling growth indices a germinator experiment was conducted by using three cultivars of canola: SLM, Elyte and Zarfam, that germinated at the Seed Technology Laboratory of Yasouj University, Iran, in 2010. The accelerated aging test was carried out at three different temperatures: 30, 40 and 50°C with four duration periods of 24, 72, 120 and 144 hr and a relative humidity of 100% in factorial experiment that laid out in complete randomized design with three replications. The results showed that accelerated seed aging and cultivar, temperature and duration period interactions have significant effect on germination percentage (GP), Index (GI) and rate (GR) and seed vigor (SV). All germination indices (GP, GI, GR, and SV) and seedling growth included length and weight of root and shoot and allometric coefficient decreased in three cultivars with increasing in seed aging temperature and duration period. Results indicated that Zaefam cultivar has maximum rate of germination and seedling growth indices rather than two other cultivars that this good quality will continued in accelerated seed aging. So that Zarfam, Elyte and SLM germination percentage under 40 °C and 144h accelerated seed aging declined from 80 percent to 64 and 29 percent respectively. Zarfam and SLM were having the highest and lowest seed quality and resistance to storage conditions respectively under long period of storage in hot and humid weather.

Keywords: Canola, Seed deterioration, Germination, Seed vigor, Seed storage condition

Introduction

High-quality seeds are of great socio-economic significance because seeds supply the popular of our food supply and are important sources of animal and industrial feedstock. Accelerated aging of seeds induced by several days of experience to high temperature and high humidity is known as an accurate indicator of seed vitality and storability. The seeds that deteriorate quickly under accelerated aging conditions usually showed an obvious depression in their ability to germinate (McDonald, 1999). The deleterious effect of accelerated aging on the germination method are connected with the damage happening at the membrane, nucleic acid and protein levels (Fujikura and Karssen, 1995). Accelerated aging also resulted in increased lipid peroxidation, decreased levels of anti-oxidants and reduced activity of numerous enzymes involved in scavenging of free radicals and peroxides (Chiu *et al*., 1995; Hsu and Sung, 1997; Bailly *et al*., 1998). Ageing leads to a progressive decrease in their vigor, and then in a loss of their viability during storage of seeds (McDonald, 1999; Priestley, 1986; Smith and Berjak, 1995). As in pearl millet (Kameswara Rao *et al*., 1991), tomato (Demir and Ellis, 1992) and bean (Bailly *et al*., 2001), seed sensitivity to accelerated ageing decreases during the maturation drying period of wheat grain maturity (Ellis and Pieta Filho, 1992; Lehner *et al*., 2006). Accelerated aging is one of the vigor tests broadly used to conclude the quality of seed lots. Hampton and Tekrony (1995) suggested that a temperature of 41°C for 72 hr must be used for the accelerated aging (AA) vigor test for soybean [*Glycine max* L. (Merrill)] and canola (*Brassica napus* L.).

Material and Methods

In order to evaluate the relationship between seed deterioration (accelerated aging test) on germination and seedling growth indices a germinator experiment was conducted by using three cultivars of canola: SLM, Elite and Zarfam, that germinated at the Seed Technology Laboratory of Yasouj University, Iran, in 2010. The standard germination test (AOSA, 1998) was conducted on 50-seed samples of each cultivar at 20±1 °C for 7 d on moistened Whiteman papers in dark growth chamber. Only normal seedlings were counted.

The AA test was performed according to the method known as “gerbox” (11×11×3 cm), in a chamber; samples containing three grams of seeds were utilized, distributed so as to form a simple layer over the surface of the metallic screen suspended inside each plastic box (internal compartment), containing 40 ml water. The boxes, were covered with lids, remained inside the chamber during four aging periods (24, 72, 120 and 144 h), at temperature (30, 40 and 50°C) and 100% relative humidity. The experiment was laid out in Completely Randomized Design with two factor factorial (3×4) arrangement, with three replications. During the aging period, the seeds absorbed moisture from the humid environment within the inner chamber. Seeds were then placed for germination according to methodology described for the germination test. The evaluation was performed seven days after germination was beginning and the results were expressed as mean percentage, germination index, of normal seedlings for each lot. The germination factors were calculated as described in the Association of Official Seed Analysts (AOSA, 1983) by following formulae:

1) Germination percentage =Ni / N

2) Germination rate =∑ (Ni/Ti)

3) Seed Vigor = Germination percentage × Shoot Length

The data were analyzed using statistical package, SAS average compared by LSD method, at 5 % level of probability.

Result and Discussion

There were significant differences among the germination percentage of canola cultivars in different times and temperatures of ageing applied (Table 1). The results showed that the highest germination percentage in each cultivar was achieved at 30 ºC for 24 hours temperature and duration of ageing applied and increasing exposure temperature and duration of it decreased the germination percentage significantly (Table 2). SLM cultivar shown 80% (from 84 to 4 percent) germination percentage decreasing with applied 20°C increasing temperature from 30°C for 120 hour. While the Zarfam had maximum germination percentage (25%) in accelerated aging (Table 2).

Table-1. Variance analysis of the accelerated ageing (AA) effects on germination parameter and seedling growth of three canola cultivars.

Variance source	Df	Germination (%)	Germination rate	Root weight	Shoot length	Root length	Seed Vigor
Cultivars (C)	2	20788.96**	2644.71**	14.62**	36.69**	16.17 ns	2159292**
Temperatures (T)	2	29012.96**	5626.03**	21.23**	51.62**	74.31**	3617736**
AA period (P)	3	16803.07**	3232.07**	26.12**	34.22**	141.47**	3639300**
P × C	4	885.04**	109.14 ns	1.60**	7.14**	7.07**	275691**
T × C	6	1260.81**	136.53 ns	2.57ns	5.36**	7.38 ns	58187 ns
P × T	6	7478.59**	681.05*	0.53 ns	10.94**	7.89*	209219**
P × T × C	12	3661.18**	523.94**	1.82**	1.95*	8.67 ns	263696**
Error	72	3293.33	996.41	4.17	17.81	70.63	802508
C.V%		11.08	19.34	12.21	13.50	29.28	21.45

* Significant at the 0.05 level, ** Significant at the 0.01 level and ns = not Significant.

Table 2. Mean values of seed germination percentage affected by temperature and time for aging in three canola

Cultivar	Temperature (°C)	Time of exposure(h)			
		24	72	120	144
SLM	30	84 a	72 b	57 c	41 de
	40	70 b	35 ef	33 ef	29 fg
	50	47 cd	21 g	6 h	4 h
Elyte	30	86 a	81 a	81 a	83 a
	40	85 a	79 a	75 ab	64 b
	50	83 a	66 bc	18 c	18 c
Zarfam	30	91 a	89 b	87 b	85 b
	40	83 b	80 bc	81 bc	80 bc
	50	83 bc	70 c	25 d	25 d

Means with same letter in each cultivar are not significant difference in the 5% probability level according to LSD test.

Seeds based on the production mode and how they are maintained, had different quality and seed vigor and this condition can be affected directly on shoot and root length. By comparing the shoot length averages under seed deterioration was determined the SLM and Zarfam cultivars respectively allocated the highest and lowest shoot length with increasing temperature and accelerated aging time that showed Zarfam cultivar had high resistance to seed deterioration conditions (Figure 1).

Root and shoot length of the main traits determining the quality of seeds is affected by genotype and environmental conditions. With increasing temperature from 30 to 50 °C and deterioration time from 24 to 144 hours root length showed a significant decrease. Among the rapeseed cultivars studied, Zarfam had the most (3.84 cm) and SLM had the lowest (2.90 cm) root length (Figure 2). Small and weak seedlings indicate low seed vigor. Also seedling length is indicating the seed vigor and in many plants, the correlation between seedling length and vigor approved.

Another seed quality indicator is measured by germination rate. The cultivars that have a greater germination percentage in less time have desirable seed quality and higher seed vigor. Germination variance analysis showed that the interaction between cultivar, temperature and duration of accelerated aging on germination rate at 1 percent probability level was significant (Table 1). So that seed deterioration rising of each variety by increasing the amount and duration of exposure to high temperature was declined seed germination rate significantly. The lowest and highest reduction intensity was seen in the Zarfam and SLM cultivar respectively, so that germination rate in Zarfam by 20 °C and 120 hours increasing of temperature and duration of the aging decreased from 35.8 to 3.5 seeds per day and in SLM from 30.2 to 0.4 seed per day (Figure 3).

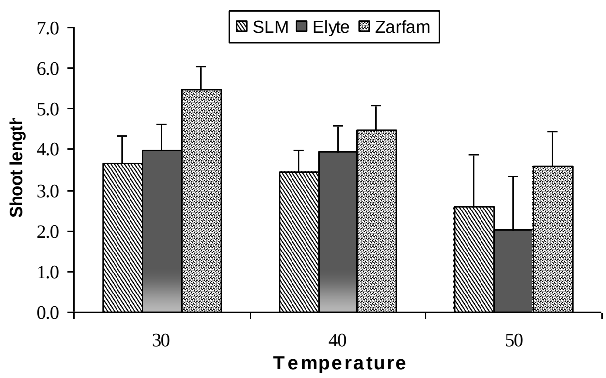

Figure 1. Means comparison shoot length under aging temperature for canola cultivars according to LSD test at 5% probability level.

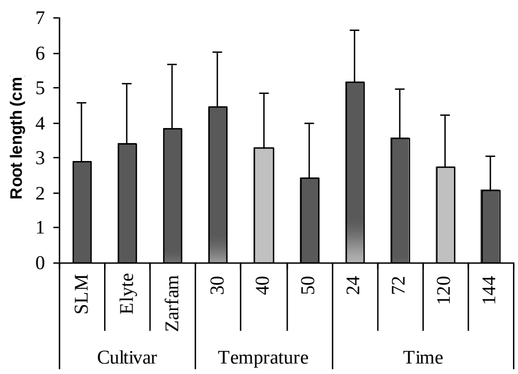

Figure 2. Means comparison root length under aging temperature and time for canola cultivars according to LSD test at 5% probability level.

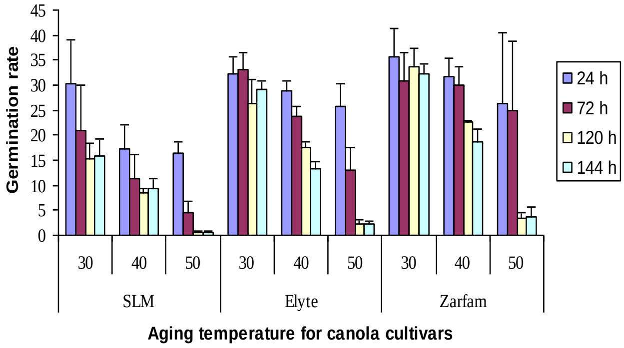

Figure 3. Means comparison germination rate under aging time and temperature for canola cultivars according to LSD test at 5% probability level.

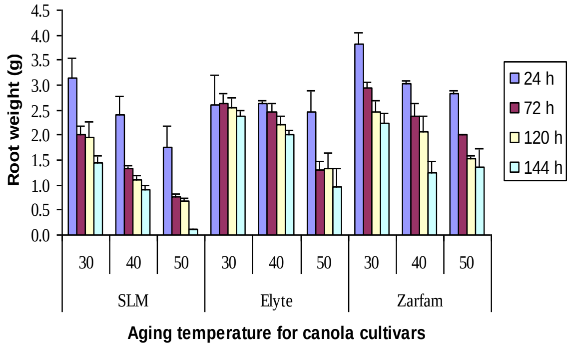

Figure 4. Means comparison root weight under aging temperature and time for canola cultivars according to LSD test at 5% probability level.

With increasing seed deterioration temperature and time in each variety, root dry weight can be significantly reduced. So that the highest (3.8 mg) and lowest (0.1 mg) root dry weight was belonged to Zarfam at 30 ºC for 24 hours and SLM in 50 °C for 144 hours of deterioration conditions respectively (Figure 3).

In conclusion, Germination indices of canola cultivars in different tests showed that the seeds by strong vigor were less affected by accelerated aging. And the seed vigor weaker is the more stress sensitive. It was found that Zarfam cultivar for many characters such as the germination percentage, germination rate and vigor index than other cultivars showed the high superiority. As a result, among the cultivars for long storage in hot and humid weather, Zarfam and SLM cultivars were shown the highest and lowest seed quality and resistance to storage conditions, respectively.