The assessment of appling drought stress on different canola (*Brassica napus* L.) cultivars

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Abstract

In order to study hardness of drought stress applying in different growth time on germination and seedling growth of different canola seed cultivars, an experiment was laid out on factorial arrangement in completely randomized design with 4 replications. In this study different growth time were normal irrigation (as control), irrigation until flowering, irrigation until padding and irrigation until seed filling stages and canola cultivars namely SLM046, Licord, Opera, Zarfam, Orient, Okapi. After 7 days the whole plant and root length, root/shoot ratio, seedlings dry weight, MDG[1], FGP[2]and DGS[3]. The results showed that the cultivars had significant effect on root/shoot length ($p \leqslant 0.05$), seedling dry weight and FGP ($p \leqslant 0.01$). Less irrigation also had significant effect on whole plant, root length, root/shoot ratio, seedling dry weight, abnormal seedling ($p \leqslant 0.01$) and hard seed ($p \leqslant 0.05$). The interaction of cultivar×different less irrigation stages showed that shoot/root ratio in all stage of applying drought stress, except flowering stage ($p \leqslant 0.05$).

Key words: Rapeseed, less irrigation stress, Seedling; Root/shoot ratio.

Introduction

Environmental factors regulating germination include temperature, water, and Oxygen for seeds (Bewley and Black, 1994; Baskin and Baskin, 2001). Successful seedling establishment depends on the frequency and the amount of precipitation as well as on the ability of the seed species to germinate and grow while soil moisture and osmotic potentials decrease. Germination events and subsequent establishment are controlled by nuclear and maternal genetics, and current and maternal environments (King and Bridgen, 1990; Platenkamp and Shaw, 1993; Cabin *et al*., 1997; Foley and Fennimore, 1998; Meyer and Pendleton, 2000; Baskin and Baskin, 2001). Environmental controls regulate seed germination rate and percentage, and abnormal seedling and mortality. In this study, a standard germination test was evaluated to determine vigor and germination seed canola (*Brassica napus* L.). Canola cultivars in this study are common cultivars in Iran and origin of Zarfam cultivar is Iran because genotypic inheritance can increase plant fitness to local habitats by adaptation, which enables seeds to germinate at the right time and the right place (Bradford, 1990; Gutterman, 2000; Baskin and Baskin, 2001). A test that is similar to the standard towel germination test is and speeds of germination (AOSA, 1988). The speed of germination test is based on the rate of radical protrusion per unit time.This method does not take in to consideration the entire seeding as does the standard towel germination test. The theory behind the speed of germination test is that a relatively short time for radical protrusion is a characteristic of vigorous seeds that permits them to germinate and emerge from the soil quicker than less vigorous seeds.

Materials and Methods

Seed Quality Determination

The canola seeds cultivars (SLM046, Licord, Opera, Zarfam, Orient and Okapi) were obtained from Seed and Plant Improvement Institute, Karaj, Iran. The standard germination test (AOSA, 1988) was conducted on four 100 seed replications of each cultivar. Seed samples were planted on moistened blotter papers in box. Boxes were placed on growth chamber at 20±2ºc. After that only normal seedlings were counted for 7 days. In 7[th] day thirty plants from each box were randomly chosen and tagged for subsequent sampling. The abnormal and percent of normal seedlings were recorded and then samples dried in oven 70ºc for 24 h for measuring seedling dry weight. Daily record used to estimate as follows:

FGP is the Finally Germination Percentage. FGP is the last recorded before sampling.

MDG is the mean germination days and it is speed germination days index. MDG estimate as follow $MDG = \frac{\text{Final germination percentage}}{\text{Germination term}}$, MDG is mean germination days and it is speed germination days index.

DGS (Day Germination Speed) is time to need for germination a seed when ever reduce it, increase germination speed. This index is contrast MDG.

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[1] Mean Daily Germination
[2] Finally Germination Percentage
[3] Daily Germination Speed

Experimental Design and Statistical Analyses

All data were subjected to analysis of variance (ANOVA) appropriate to a factorial form on Complete Randomized Design with four replications in 2005. The studied factors were less irrigation at 4 levels (normal irrigation, irrigation until flowering, irrigation until padding and irrigation until seed filing stages) and 6 winter rapeseed cultivars (Orient, Okapi, Licord, SLMO46, Opera and used Zarfam). All experience data were using SAS 9.1 and the treatment means were tested by Duncan Multiple Range (DMR) and drawing picture with Excel 2003.

Result and Discussion:

It is clear from the result that cultivar effects were responsible for root/shoot length, seedling dry weight and FGP. Irrigation had significant effect on whole plant, root length, root/shoot ratio, seedling dry weight, hard seed and abnormal seedling. The interaction of less irrigation stages with cultivar showed significant effects on root/ shoot ratio only. Analysis of variance 9 traits for different less irrigation stages and canola cultivars under standard germination test condition presented in Table 1.

Whole plant length: Seeds under less irrigation after padding and less irrigation after seed filling produced the maximum and minimum whole plant length, respectively (Fig. 1). The result of Castillo *et al.* (1993) on *Pisum aestivum* and Ram *et al*. (1989) on *Cicer arientinum* confirmed these results. The result of these studies showed that less irrigation in different stages of plant growth had different significant effect on length of whole plants. **Root length:** Root length in less irrigation after seed filling and normal irrigation (control) was the lowest and highest, respectively (Fig. 1). Cultivars had significant differences, Licord and Okapi had the highest root length among cultivars (Fig. 3). Generally less irrigation after seed filling decreased length of whole plants and roots and may decrease competition ability. **Root / shoot ratio:** Less irrigation after padding had the minimum Root / shoot ratio but highest Root / shoot ratio were in normal irrigation (Fig. 1). Licord had the highest root / shoot ratio among cultivars (Fig. 3). The result of Abba and Lovato, (1998) as the same results showed that less irrigation cause to decrease root and shoot compare to the normal irrigation. **Seedling dry weight:** Less irrigation after padding and less irrigation after seed filling produced the maximum and minimum seedling dry weight, respectively (Fig. 2). Among cultivars, Zarfam had the highest seedling dry weight (Fig. 4). The seedling dry weight is important factor for determination seeds vigor and germination (Hampton and Coolbear, 1990; Tekrony *et al*. 1991 and Tys and Jankowski, 2002). These result showed that less irrigation after seed filling decreased seedling dry weight. **Hard seed:** Less irrigation after seed filling had the maximum hard seeds (Table 2) and less irrigation in this stage cause to less homogenous field emergence. Hard seed coat may due to drought stress or genetics, in this situation seeds had dormancy (Johnston, 2002). **Abnormal seedling:** Normal irrigation had the maximum abnormal seedling but less irrigation after seed filling produced the minimum abnormal seedlings (Table 2). Wood stock (1969) declared that some parameter in standard germination such as normal or abnormal seedling, length of whole plant and roots could be use for determination seed vigor that this result confirmed the result of this study. **Mean Daily Germination (MDG):** Less irrigation after flowering had the most MDG (Table 2). MDG is an important scale for speed germination and vigor seed (Hunter *et al*., 1984 and verma *et al*., 2001). These results showed that good seed had low germination time and high vigor and MDG. **Daily Germination Speed (DGS):** Less irrigation after seed filing had the most DGS (Table 2) but less irrigation in this stage cause to decrease finally germination. Among cultivars, SLMO46 had the most DGS (Table 3). The result of Del Aquilla and Dituri (1996) on wheat (*Triticum aestivum* L.) and Santipracha *et al*. (1997) on maize weren't similar to this result; they declared that less irrigation in wheat and maize cause to decrease DGS. **Finally Germination Percentage (FGP):** Less irrigation after seed filing had the minimum FGP and had significant differences with other stage (Table 2). Opera had the maximum FGP with significant differences (Table 3).

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Table 1. Source of variance of traits affected by Less irrigation stages and canola cultivars under standard germination test condition

S.O.V	DF	Whole Plant (cm)	Root Length (cm)	Root/shoot ratio	Seedling Dry weight (gr)	DGS	MDG	FGP	Hard seed	Abnormal seedling
	DF	MS								
Less Irrigation Stages (A)	3	18.55 **	5.30 **	0.52 **	0.0008 **	0.00005 ns	0.44 ns	0.008 ns	0.4 *	10.13 **
Cultivar (B)	5	0.71 ns	0.74 ns	0.03 *	0.0003 **	0.00005 ns	0.41 ns	0.013 **	0.07 ns	0.21 ns
A× B	15	0.79 ns	0.56 ns	0.04 **	0.00002 ns	0.00003 ns	0.29 ns	0.006 ns	0.1 ns	0.15 ns
Error	72	0.72	0.39	0.013	0.0001	0.00002	0.21	0.004	0.16	0.16
CV		5.120	6.250	7.560	9.600	0.650	8.690	0.630	38.01	10.56

×× significant at the 0.01 level of probably, × significant at the 0.05 level of probably, ns no significant

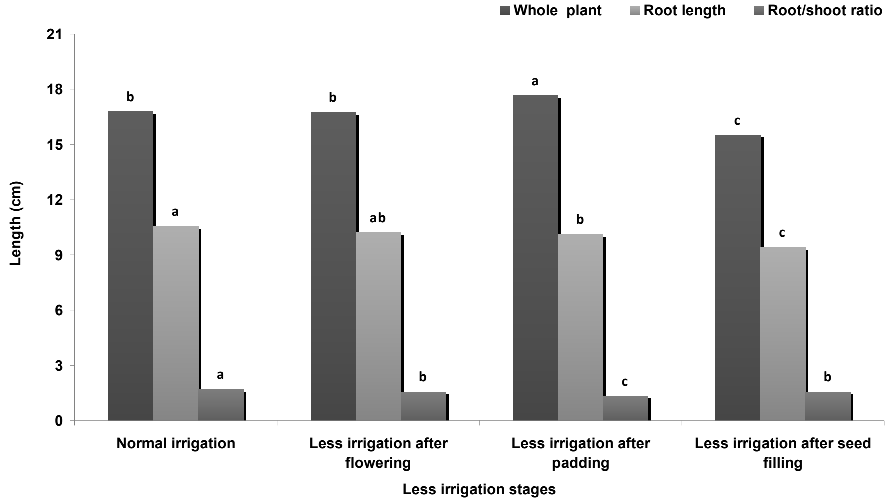

Fig 1. Multiple comparison of whole plant, root length and root/shoot ratio affected by Less irrigation stages under standard germination test condition.Mean followed by the same letters in each column are not significantly different(Duncan multiple rang 5 %)

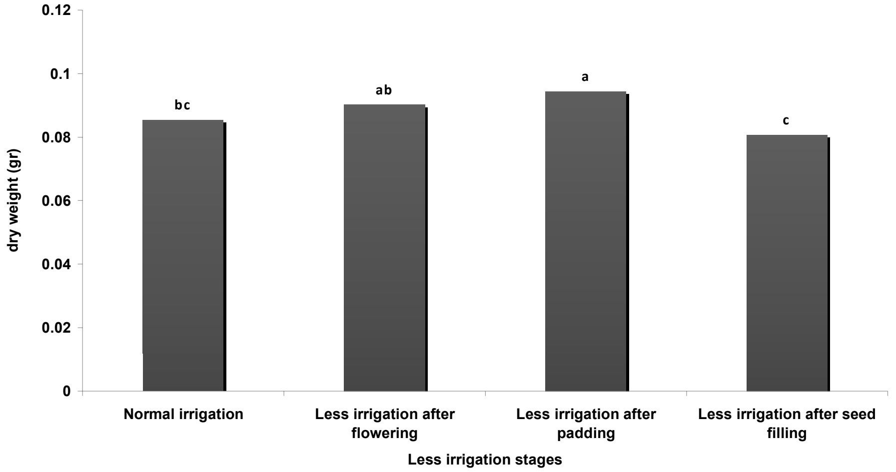

Fig 2. Multiple comparison of seedling dry weight affected by Less irrigation stages under standard germination test condition. Mean followed by the same letters in each column are not significantly different (Duncan multiple rang 5 %)

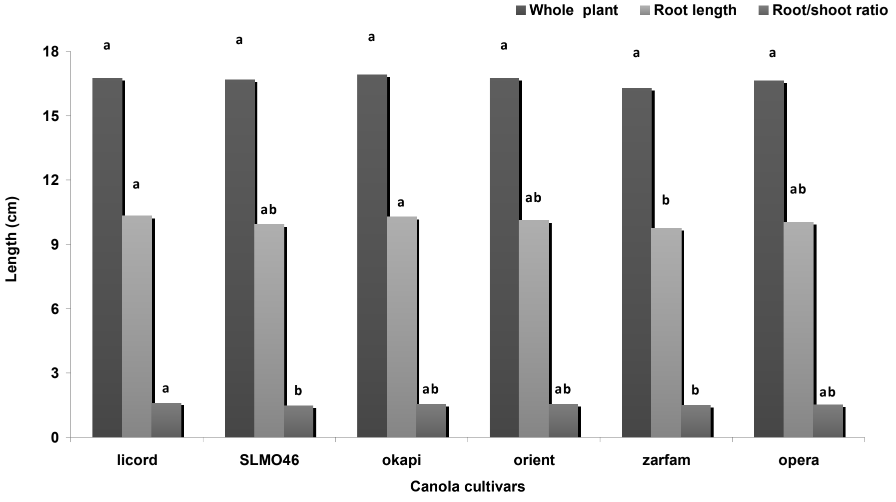

Fig 3. Multiple comparison of whole plant, root length and root/shoot ratio affected by canola cultivars under standard germination test condition. Mean followed by the same letters in each column are not significantly different (Duncan multiple rang 5 %)

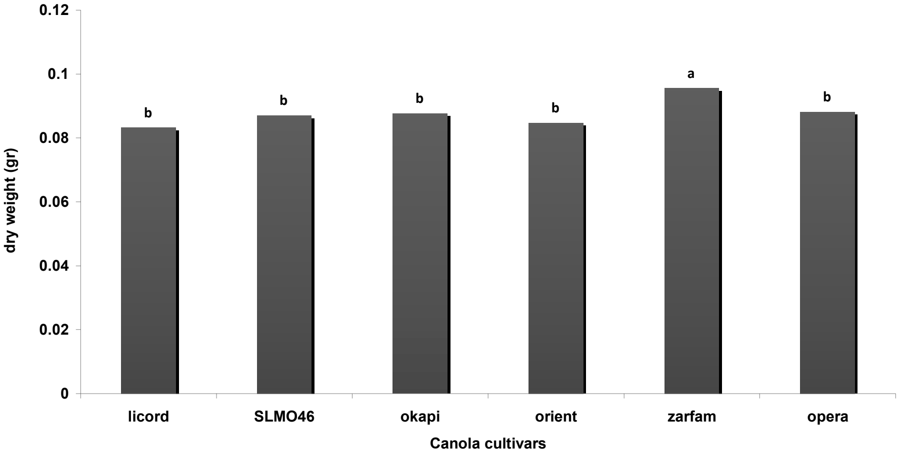

Fig 4. Multiple comparison of seedling dry weight affected by canola cultivars under standard germination test condition. Mean followed by the same letters in each column are not significantly different (Duncan multiple rang 5 %)

Table 2. mean traits for four Less irrigation stages under standard germination test condition

Less irrigation stages	DGS	MDG	FGP	Hard seed	Abnormal seedling
Normal irrigation	0.0367 ab	28.34 ab	98.29 ab	0.875 ab	22.29a
Less irrigation after flowering	0.034 b	30.01 a	98.87 a	0.541 b	12.20 b
Less irrigation after padding	0.034 b	29.35 ab	98.25 ab	0.541 b	13 b
Less irrigation after seed filling	0.039 a	26.83 b	98 b	1.208 a	10.41 c

Mean followed by the same letters in each column are not significantly different (Duncan multiple rang 5 %)

Table 3. mean traits for six canola cultivars under standard germination test condition

Cultivars	DGS	MDG	FGP	Hard seed	Abnormal seedling
Licord	0.038 ab	26.72 a	98.18 bc	0.81 a	15.25 a
SLMO46	0.039a	27.10 a	98 bc	0.81 a	14.75 a
Okapi	0.037 ab	27.60 a	98.43 abc	0.87 a	14.18 a
Orient	0.033 b	30.50 a	97.56 c	0.98 a	14.06 a
Zarfam	0.034 ab	30.02 a	98.75 ab	0.68 a	15.31 a
Opera	0.034 ab	29.87 a	99.18 a	0.56 a	13.31 a

Mean followed by the same letters in each column are not significantly different (Duncan multiple rang 5 %)

Table 4. Interaction of traits measurements for six canola cultivars and Less irrigation stages

Less irrigation	Canola cultivars	Root/shoot ratio
Normal irrigation	Licord	1.643 ab
	SLMO46	1.608 abc
	Okapi	1.504 bcde
	Orient	1.718 a
	Zarfam	1.355 e
	Opera	1.616 abc
Less irrigation after flowering	Licord	0.6950 f
	SLMO46	0.7840 f
	Okapi	0.7443 f
	Orient	0.7341 f
	Zarfam	0.7080 f
	Opera	0.7254 f
Less irrigation after padding	Licord	1.465 bcde
	SLMO46	1.371 de
	Okapi	1.434 bcde
	Orient	1.448 bcde
	Zarfam	1.320 e
	Opera	1.415 cde
Less irrigation after seed filling	Licord	1.581 abcd
	SLMO46	1.526 abcde
	Okapi	1.363 e
	Orient	1.451 bcde
	Zarfam	1.455 bcde
	Opera	1.414 cde

Mean followed by the same letters in each column are not significantly different (Duncan multiple rang 5 %)