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# The Effect of Drought Stress on Germination and Early Growth of *Sesamum indicum* Seedling's Varieties under Laboratory Conditions

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## Abstract

Environmental stresses specially drought, play an important role in decreasing plant growth, particularly during germination in dry and semi dry area. To considering the effect of drought stress caused by polyethylene glycol on germination and characteristics of 2 spices of *Sesamum indicum*, we had done factorial and complete accidental plot with 4 treatments and 3 times repetition. Experimental treatments included osmotic potential in 4 levels (0, -4, -6, -10 bar) which was produced by polyethylene glycol 6000 and 2 sesame species (Safi Abadi and Dezfol). All data had been analyzed by SAS software and comparison of means had been done by Duncan test at 5% probable level. The results showed that, percentage and speed of all spices' germination decline by osmotic potential enhancement. Other measured parameters such as radicle and coleoptile length, dry and wet weight declined by increasing osmotic potential as well.

### Keywords:

Stress, Germination, Polyethylene glycol, *Sesamum indicum*

## INTRODUCTION

Sesame (*Sesamum indicum*) is a flowering plant in the genus *Sesamum*. Numerous wild relatives of it occur in Africa and a smaller number in India. It is widely naturalized in tropical regions around the world and is cultivated for its edible seeds, which grow in pods.

Drought stress with osmotic materials for producing osmotic potential are one of the important studding approach about drought stress effects on germination. While sesame has a high resistance level in drought stress condition, germination and seedling stage make it more sensitive (Orruno and Morgan, 2007). These are 2 important and critical stages when crops are grown in arid zones. At this crucial and critical stages that ultimate yield of crops are determined (Hadas 1976).

Turk *et al.*, (2004) found that one of the reasons that can reduce or delay or even prevent germination is water stress. It also decreases germination rate and seedling growth rate. There were some studies that using local sesame from Nigeria which found that low level of drought stress hadn't any significant effect on germination, by increasing levels of drought germination and seedling growth reduced, on the other hand, drought stress level has negative correlation with germination and seedling growth (Heikal *et al.*, 1982; Mensah *et al.*, 2006).

Environmental stress during seed production period can has negative impact on next seeds quality (Sediyma *et al.*, 1972).

As polyethylene glycol can make semi natural environment has a wide range of application especially under laboratory conditions (Rade and Kar, 1995). As it has heavy molecular weight, can't transfer from cell wall. So it uses for adjusting water potential in germinating laboratories. Polyethylene glycol 6000 is more suitable than smaller molecules such as 4000 for making drought stress, because seed germination percentage in polyethylene glycol 6000 solvent is equal to the soil with the same water potential (Rade and Kar, 1995).

The purpose of this experiment is considering drought stress impacts which are results of polyethylene glycol on germination of 2 sesame species.

## MATERIALS AND METHODS

This experiment was done in 2010 in agronomy laboratory of agriculture college, Zabol University. It was done in factorial and complete accidental plot with 4 treatments and 3 times repetition. Experimental treatments included osmotic potential in 4 levels (0, -4, -6, -10 bar) which was produced by polyethylene glycol 6000 and 2 sesame species (Safi Abadi and Dezfol).

Each experimental unit included 1 Petri dish with 8 cm diameters. For each treatment 25 of healthy sesame seeds from each species selected and was washed by hypochlorite sodium 10%, and was put on filter paper homogeneity then 5 ml of polyethylene glycol was added. Next Petri dishes doors were closed by Para film, and put in a small room. Germinated seeds were counted daily to determine germination race, and it took 6 days.

To determine needed poly ethylene glycol 6000 for solvent of each stress level, the following formula used separately: (Michel and Kaufman, 1973).

$$\text{Water potential} = - (1.18 \times 10^{-2}) C - (1.18 \times 10^{-4}) C^2 + (2.67 \times 10^{-4}) CT + (8.39 \times 10^{-7}) TC^2$$

C= polyethylene glycol concentration (gr/ water kg)  
T= temperature (C) (Michel and Kaufmann, 1973)

In the following formula water potential unit is Mega Pascal.

$$0.1 \text{ Mpa} = 1 \text{ bar or } 105 \text{ pa} = 1 \text{ bar}$$

### The following characteristics were studied: Germination Percentage (GP):

From second day, the germinated seeds were counted daily in specific time. At that time, those seeds were considered germinated which their radical length was more than 3 mm.

Counting continued till we could count more germinated seeds and the resulted final counting considered as final germination percentage.

$$\text{GP: } Ni / N \times 100$$

Ni: number of germinated seed till ith day)

N= total number of seeds.

### Germination Race (GR):

In order that, from the second day to 6<sup>th</sup> once

a 24 hours we counted germinated seeds and its race was determined by Maguire equation (1962):

$$GR = \sum_{i=1}^n \frac{S_i}{D_i}$$

GR: Germination Race (number of germinated seed in each day)

$S_i$ : number of germination seeds in each numeration

$D_i$ : number of days till nth numeration.

n: number of numeration times.

At the end of experiment, 10 plants were selected from each Petri dish, radicle and pumule separated and measured. After this stage, each repetition put on filter paper separately and to dry it, we put it in oven and measure dry weight. SAS and MSTAT-C software was used to analysis.

## RESULTS AND DISCUSSION

### 1. Germination Percentage (GP)

The effect of water potential was significant on germination percentage ( $P<0.01$ ) (Table 1). Totally by increasing solvent concentration, ger-

mination percentage will decrease. Therefore, sesame species' germination percentages has significant differences in reaction to stress ( $P<0.01$ ) (Table 1).

The interaction effects between two factors (water potential and species) were significant ( $P<0.01$ ) on germination percentage (Table 1). Germination percentage was 100 in Dezfol specie and 0 water potential and it reached to zero in Safi Abadi specie and -10 water potential (Table 3).

### 2. Germination Race (GR)

The effect of water potential on germination race of sesame was significant also ( $P<0.01$ ) (Table 1). Sesame species' germination races had significant differences in reaction to stress ( $P<0.01$ ) (Table 1).

Interaction effects between water potential and sesame species were significant on germination race ( $P<0.01$ ) (Table 1). Germination race in Dezfol and 0 water potential was 2.51, and it reached to 0 in Safi Abadi and -10 water

Table 1: Variance analysis of drought and variety effect on *Sesamum indicum*.

S.O.V	df	GP (%)	GR	RL (cm)	CL (cm)	FW (mg)	DW (mg)
Varieties	1	504.16**	1.79**	1.36**	1.66**	247.17**	1.042**
Water potential	3	10701.4**	5.16**	17.39**	3.87**	1366.03**	62.63**
Varieties × Water potential	3	262.5**	0.61**	0.24**	0.28**	40.84**	0.241**
Error	16	29.16	0.018	0.018	0.017	6.19	0.062
C.V (%)		10.53	12.85	8.12	15.69	17.58	9.35

Note: \*\* indicate significant difference at 1% probability level.

GR: Germination rate, GP: Germination percentage, CL: Coleoptile length, RL: Radicle length, FW: Fresh weight, DW: Dry weight.

Table 2: Mean comparison of seedlings germination and growth indexes under different drought levels and varieties of *Sesamum indicum*.

Treatment	GP (%)	GR	RL (cm)	CL (cm)	FW (mg)	DW (mg)
<b>Varieties</b>						
Dezfol	55.83a	1.32a	1.9a	1.11a	0.017a	0.0028a
Safi Abadi	46.66b	0.77b	1.41b	0.6b	0.011b	0.0024b
<b>Drought level (Bar)</b>						
0	94.16a	1.99a	3.85a	1.83a	0.034	0.007a
-2	76.66b	1.63b	2.1b	1.12b	0.015b	0.0032b
-4	33.33c	0.55c	0.6c	0.41c	0.006c	0.00037c
-8	0.83d	0.0045d	0.02d	0.014d	0.0001d	0.000005d

GR: Germination rate, GP: Germination percentage, CL: Coleoptile length, RL: Radicle length, FW: Fresh weight, DW: Dry weight.

Table 3: Mean comparison of interaction effects of drought stress and *Sesamum indicum* varieties in germination stage.

Varieties	Osmotic Potential (Bar)	GP (%)	GR	RL (cm)	PL (cm)	WW (mg)	DW (mg)
Dezfol	0	100a	2.51a	4.23a	2.267a	40a	7.3a
	-2	90b	2.22b	2.53c	1.583b	21c	3.7c
	-4	31.66d	0.54e	0.76e	0.566e	8.23e	0.456e
	-8	1.67e	0.009f	0.4g	0.028g	0.206g	0.01f
Safi Abadi	0	88.33b	1.48c	3.46b	1.407c	29.33b	6.66b
	-2	63.33c	1.05d	1.66d	0.66d	10.2d	2.83d
	-4	35d	0.56e	0.53f	0.266f	4.23f	0.3e
	-8	0e	0f	0g	0g	0g	0f

GR: Germination rate, GP: Germination percentage, PL: Coleoptile length, RL: Radicle length, WW: Wet weight, DW: Dry weight.

potential (Table 3).

One of the important indexes for assessing drought stress tolerance is germination rate; species with high germination rate are likely to become green rapidly than other species under drought stress. It seems that high speed in water absorbance leads to increase in germination rate (Marchner, 1995). If there appear any interfere in water absorbance or it happens slowly, germination metabolically activities will do slowly in seeds, so germination rate will decrease (Abnos, 2001).

### 3. Radicle and coleoptile length

Water potential had significant difference on radicle and coleoptile length ( $P < 0.01$ ) (Table 1). By increasing solvent concentration, radicle and coleoptile length decreased.

Interaction effects between water potential and species had significant difference on radicle and coleoptile length of sesame seedlings ( $P < 0.01$ ) (Table 1).

### 4. Dry and Fresh weight of seedlings

Means comparison showed that among species, the driest weights were related to Dezfol and Safi Abadi orderly (Table 2).

Interaction effects comparison showed that Dezfol species and 0 level of stress had the most dry and fresh weight of seedling, and Safi Abadi species and -10 level of stress had the least dry and fresh seedlings' weight (Table 3).

Some researchers reported that under stress conditions, coleoptile growth was more than

radicle growth and weight decrease more than length. But others believe that stress will decrease radicle length more than coleoptile, but weight remain stable (Sediyma *et al.*, 1972).

Reduction in the yield percentage of these initial processes can be referred to lower in fusibility in water uptake of seed under stress condition (Turk *et al.*, 2004). Germination process consists of 2 stages, firstly enzymatic hydrolysis of stored material and secondary building of new tissue by hydrolysis (Bahrami *et al.*, 2012). Moisture deficit can affect enzymatic activity and consequently germination percentage decreases under the more negative osmotic potential.

Water absorption and seed swelling considered as the first step in germination, while cell division and elongation are last steps. By decreasing osmotic potential, water absorption will decrease as well as cell division (Zaefizadeh *et al.*, 2011).

Another important feature for drought stress is root length, because it has direct contact with soil and water absorbance. As result, root length make important clue to a plants response to drought stress (Mostafavi *et al.*, 2011).

The primary organ of young plant extension is hypocotyls, which after emergence of radicle emerge; in drought stress, radicle will develop faster than hypocotyls to compensate for water stress (Zhu *et al.*, 2005). So at germination stage growth of hypocotyls and radicle reflects tolerance of shoot to drought (Shi and Ding 2000). From aforementioned studies can conclude that reduction of root and shoot could be referred



to reduction of cell division which is caused by water stress. In addition, cause of root and shoot dry weight's reduction is reductions in root and shoot lengths.

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