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Full Length Research Paper

Effect of salinity and drought stress on germination of fenugreek

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The environmental stress such as, salinity (soil or water) and drought are serious obstacles for horticulture and field crops in further areas of the world, especially arid and semiarid regions. In order to investigate salinity and drought stress on fenugreek germination indices, an experiment was carried out. To create salinity stress, sodium chloride (NaCl) at the levels of 0 (as control), -3, -6 and -9 bar, and for drought stress, polyetylenglycol 6000 (PEG 6000) in osmotic levels at 0 (as control), -3, -6 and -9 bar were used. Result showed significance different between evaluated indices. Increasing of stress levels lead to reduction of germination and epicotyls and hypocotyls length. Also, both salinity and drought at -9 bars cause reduction in germination and growth indices, however, a few of the seeds conserved germination viability. Therefore, fenugreeks have relative resistance to salinity and drought stress in germination stage.

Key words: Salinity, drought, germination, fenugreek.

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is a flowering annual plant, with autogamous flowers. This crop is native to an area extending from Iran to northern India and widely cultivated in China, India, Egypt, Ethiopia, Morocco, Ukraine, Greece, Turkey, etc. (Petropoulos, 2002; Polhil and Raven, 1981). Fenugreek leaves and seeds are consumed in different countries around the world for different purposes such as medicinal uses (anti-diabetic, lowering blood sugar and cholesterol level, anti-cancer, anti-microbial, etc.), making food (stew with rice in Iran, flavor cheese in Switzerland, syrup and bitter run in Germany, mixed seed powder with flour for making flat bread in Egypt, curries, dyes, young seedlings eaten as a vegetable, etc.), roasted grain as coffee-substitute (in Africa), controlling insects in grain storages, perfume industries, etc. (Basch et al., 2003; Lust, 1986). Fenugreek can be a very useful legume crop for incorporation into short-term rotation (Moyer et al., 2003) and for hay and silage for livestock feed, for fixation of nitrogen in soil and its fertility, etc. (Sadeghzade et al., 2009). The production of this crop is affected by environmental stress such as: drought, salinity, chilling and heat in regions of Iran, in exception to northern part (Almansouri et al., 2001). Salinity is one of the main factors responsible for soil deterioration and poor agricultural productivity. In semiarid and arid regions, the extended periods of dryness as well as inappropriate intense irrigation engender a concentration of solutes in soil so that 15% of soils in these regions endure problems of salinity and a third of irrigated lands in the world are affected by the salinity (Hoffman et al., 1980; Jefferies, 1981). Also, drought (low and erratic rainfall) is a major constraint to crop production worldwide (Sadeghzade et al., 2009).

In order to meet the ever increasing demand for medicinal plants, for the indigenous systems of medicine as well as for the pharmaceutical industry, many medicinal plants need to be cultivated commercially, but soil salinity and other forms of pollutions represent serious threats to plant production (Qureshi et al., 2005).

Germination is regarded as sensitive stage in growth cycle, because of it major role in final compression. However, it has been observed that plants show relative resistance to drought and salinity in different vegetative growth stages (Javan et al., 1997). In respect to growing some medicinal plants in tropical and salty regions, understanding and extending approach for increase salinity resistance in plants is important. Truly, obtained

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Table 1. ANOVA effects due to drought on measured variables.

Source	df	Mean square		Root length	Stem length
		Germination percentage	Germination velocity		
Drought	3	0.06**	36.67**	1125.87**	158.86**
Error	8	0.005	0.58	38.68	9.61
c.v		18.2	10.74	19.05	16.4

Significant at $p < 0.01$ **.

Table 2. Effect of drought levels on measured variables.

Bar drought	Germination percentage (%)	Germination velocity (%)	Root length (mm)	Stem length (mm)
0	$0.98^{a\ Z}$	$11.76^{a\ Z}$	59.04^{a}	25.01^{a}
-3	0.87^{ab}	7.86^{b}	32.78^{b}	23.87^{a}
-6	0.77^{bc}	5.18^{c}	25.58^{b}	16.20^{b}
-9	0.67^{c}	3.67^{d}	13.18^{c}	9.42^{c}

Z values in a column followed by the same letter are not significantly different, $p \leq 0.01$, according to Turkey.

result of *in vitro* is distinguish compare to field results, according to our awareness of the environmental condition, suitable cultivar selections for culture were carried out and applied for field. The aim of this study was to evaluate the effect of drought and salinity stress on fenugreek germination and some growth indices, and also to determine moisture threshold for germination.

MATERIALS AND METHODS

The experiment was conducted in Horticultural Laboratory of the Agricultural Faculty of Guilan University, Rasht, Iran in the summer of 2010. To create salinity stress, sodium chloride (NaCl) at the levels of 0 (as control), -3, -6 and-9 bar, for drought stress polyetylenglycol 6000 (PEG 6000) in osmotic levels at 0 (as control), -3, -6 and -9 bar were used. The seeds of fenugreek were surface sterilized with 0.1% mercuric chloride for 30 s and rinsed several times with distilled water in glass Petri dishes of approximately 9 cm, Whatman No.1 and other instruments sterilized in autoclave for 2 h at 120℃ and rinsed several times with distilled water. Each replication contains 50 fenugreek seeds. After labeling the Petri dishes, seeds were established between two Whatman No.1 in Petri dishes. Irrigation with different concentration of salinity and drought was carried by pipet between treatments in same as water after absorption by Whatman No.1 were not translocated with bent Petri dishes, along one or two drops of water stay in dishes. The dishes covered with Slophan paper (in order to reduce evaporation), and placed in incubator (23 ± 1℃ temperature and 70% humidity). The criterion used for seed germination was taken as emergence, 2 mm radicle at the time of observation (Odoemena, 1988). Germination counts were recorded at 2 days intervals for 12 days after sowing and the seedlings were allowed to grow. The germination percentages of the seeds were finally determined for each of the treatments. The germination velocity (GV) was evaluated according to the formula of Hartmann and Kester (1964).

$$GV = \frac{\text{Total number of seedlings}}{A_1T_1 + A_2T_2 + A_x \ldots T_x}$$

Where, A, is the number of seedlings emerging on a particular number of days (T) and subscripts 1, 2 … x are respective number of germinated seeds per respective number of days after sowing of the seeds. After 21 days, the experiment was terminated, and the growth parameters estimated after uprooting and cleaning the seedlings. The root and shoot lengths were measured in centimeter using a meter rule. Data were subjected to analysis of variance in SAS (SAS, Inc., Cary, N.C.) and means separated using the Tukey test.

RESULTS

Drought stress

ANOVA indicated the significant difference between all indices (Table 1). The seeds germination percentage and velocity reduced with increasing of drought. The highest and lowest germination were observed in control and at -9 bar levels (Table 2). Also, with increasing of drought, the rootlet and stem let length were reduced.

Salinity stress

ANOVA indicated the significant difference between all indices (Table 3). The high salinity levels appeared where there is lower germination percentage and velocity. However, the control treatment had higher amount in all indices, but had no significant difference with -3 and -6 bar in relation to germination velocity and rootlet (Table 4). In all, more levels at -6 bar amount of indices reduced significantly.

DISCUSSION

Salinity is a biotic stress that affects seed germination

Table 3. ANOVA effects due to salinity on measured variables.

Source	df	Mean square		Root length	Stem length
		Germination percentage	Germination velocity		
Salinity	3	0.21**	53.23**	1237.59**	209.84**
Error	8	0.01	1.21	40.81	37.45
c.v		14.03	17.48	20.22	33.93

Significant at $p < 0.01$**.

Table 4. Affect of salinity levels on measured variables.

Bar salinity	Germination percentage (%)	Germination velocity (%)	Root let length (mm)	Stem let length (mm)
0	0.99 a ^{Z}	11.76 a ^{Z}	59.04 a	25.01 a
-3	0.88 b	6.74 a	31.23a	21.5 b
-6	0.65 b	5.1 a	25.65 b	19.7 b
-9	0.39 c	1.62 b	10.4c	5.9 c

Z values in a column followed by the same letter are not significantly different, $p \leq 0.01$, according to Tukey.

(Misra and Dwivedi, 2004) and created many problems for plant growth. In the first experiment, the effect of salinity on plant can be as a result of reduce osmotic potential in root medium, ion specific toxicity and nutrient deficient, as with increasing salt concentration, growth reduction is significant (Ashraf and Orooj, 2006; Munns et al., 2006). Similar results were reported on seedlings of fennel (*Vulgare foeniculum*) and Psyllium (*Plantago psyllium*) in relation to effect of salinity inhibition (Sadeghzade et al., 2009; Hosseini and Rezvani, 1385). Some workers also expressed that with increase of salinity concentration through osmotic potential and by creation of external osmotic potential, water absorption is reduced through the negative effect of Na and Cl ions (Khajeh-Hosseini et al., 2003; Murillo-Amador et al., 2002), and germination is reduced or retarded (Todd, 2001). In the second experiment, all plant germination indices reduced through drought stress, because preliminary absorption rate of seed is reduced. Those seeds that can germinate are significant in stress condition at arid and semiarid regions are valuable. In all, increase of osmotic potential reduces germination indices. Polyetylenglycol with creating of drought stress lead to hydrolyze seed endosperm and ultimately germination is reduced. In fact, in primary stage with low moisture, water absorption and germination, the amount of germination decreased. The minimum moisture requirement of seed has no relation with minimum moisture of soil for germination and is dependent on seed composition which is greater. On the other hand, germination velocity reduced greatly because of moisture limitation (Khan, 1980; Kochaki et al., 1370). With increase of drought stress, germination percentage is reduced because of the decline of primary absorption rate. Finally, effect of drought stress on germination velocity and percentage is greater compared to other characteristics. Therefore, fenugreek seed has higher tolerance to drought stress compared to salinity stress.

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