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Effect of osmotic drought stress on germination indicators of eight monogerm genotypes of sugar beet

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Abstract

In order to investigate the effect of osmotic stress on germination indicators of eight genotypes of sugar beet, a factorial experiment was done in a randomized complete block design on 2011 with three replications. In this study indicators Coefficient of velocity of germination, Germination rate index, Final germination percentage, Mean germination time, Germination speed and Mean daily germination were evaluated. The results showed that the drought conditions all traits had significant difference at 1% probability level. According to result, there were significant difference between all evaluated genotypes except Mean daily at 1% and 5 probability level. Interaction of Drought stress × genotype was insignificant for all traits. Genotype 3 with an average of 9.67 percent had the highest percentage of germination, and genotype 1 with a mean of 78.66 percent had the lowest percentage of germination. Drought stress reduced the 10.99 % GI, 4.62% CVG, 47.85% MDG and 6.66% GS, and was increased the 4.61% FGP and 4.97 % MGT.

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Introduction

Drought stress is one of the main factors in reducing crop yield. Drought not only causes to change in arid regions but also contributes to the temperate regions. In temperate climates, frequent water shortages are major factors limiting the growth of sugar beet. Plant response to drought stress is associated with duration, severity of water shortages, plant species and stage of growth. Shoot growth is often limited because the soil is dry, even when swelling pressure keeps of cells water completely (Kramer, 1963). Germination involves transferring reserves to the germ axis and start metabolic and growth. This stage of Crop life plays decisive role in appropriate establishment of plant and the final performance (Almasouri *et al.,* 2001). To start seeds metabolic activity for germination, it is necessary to be absorbed a certain amount of water by them which are varied depending on the chemical composition and permeability (Misra and Dwivedi, 1995). There is significant water for each potential which germination cannot be done (Delachiava *et al*., 2003). In addition, sensitivity to drought stress during different stages of germination and root exit are different (De and Kar, 1995). Rate and percentage of seed germination and Seedlings growing are reduced during drought stress. Germination process is controlled by environmental and hormonal factors and light, oxygen, temperature and water availability are important among environmental factors (Finch *et al*., 2001). Ability of seed germination is increased during damping temperature and cause to performance yield. Some physiological and agronomic traits are important at plants to drought tolerance and these features are used in the selection of drought tolerant genotypes. The most important characteristics related to drought resistance can be referred to germination power and seedling development during lack of damping situation. Since the appropriate establishment of seedling at farm and producing strong seedlings are associated to crop yield indirectly (Balbky *et al*., 1999).

The most important characteristics related to drought resistance can be developed to power the germination and seedling growth under water deficits can be pointed out. The purpose of this study was to investigate the effect of osmotic stress on germination indicators.

Materials and Methods

Methods

This study was performed at laboratory on 2012 in form of polyethylene glycol 6000 osmotic dryness with 30% concentration. Experiment was done as factorial in form of random design three times on eight genotypes of sugar beet. In this study Coefficient of velocity of germination, Germination rate index, Final germination percentage, Mean germination time, Germination speed and Mean daily germination indicators were evaluated. For this purpose the filter paper with a 70 cm length and 13 cm width were prepared and seeds were placed on it at a 1.5 cm distance, then 10 ml of solution was added to the paper to stick together and do not move out of the seeds, then papers were rolled gently and placed at pipe with 5 cm diameter and 14 cm height. Pipe with rolled paper were placed at 4 liter plastic plate and 300 cc of solution were added, then samples were maintained at germinator for 15 days at 20 to 23 centigrade degree and 70 percent humidity.

Table 1. Genotypes used in this study.

Number	Name of genotype	Number	Name of genotype
1	30906	5	31291
2	30908	6	31262
3	30915-88	7	31266
4	31290	8	Jolghe

Method of computations

During these 15 days, second, third, fourth, fifth, eighth, thirteenth, fifteenth germination was done. Among each plots 15 seedlings were selected randomly and their traits were (Figure 1)

Coefficient of velocity of germination (CVG):

$$CVG = 100 \times \sum Ni / \sum NiTi$$

Where, Ni is the number of germinated seeds for each day, Ti is number of days as of the start of experiment, Germination index (GI):

$$GI = (13 \times N1) + (12 \times N2) + ... + (1 \times N13)$$

where, N1 and N2 and … are the number of germinated seeds in first and second days, respectively, and so forth; numbers 10, 9 and … are weights applied on the number of germinated seeds at first and second days and so forth.

Germination rate index (GRII):

$$GRII = G1/1 + G2/2 + ... + Gx/x$$

G1 = germination percentage at first day

G2 = germination percentage at second day and so forth

Mean germination time (MGT): (Andalibi et al., 2005)

$$MGT = \sum NiTi / \sum Ni = 100 / CVG$$

Where, Ni is number of germinated seeds for each day, Ti is number of days as of the start of experiment, Final germination percentage (FGP): (Al-Mudaris, 1998; Gharineh et al., 2004)

$$FGP = Ng / Nt \times 100$$

Where, Ng is total number of germinated seeds, Nt is total number of evaluated seeds, Germination speed (Rs): was estimated based on Magour method and by using the following equation, (Rajabi and Poustini, 2005).

$$Rs = \sum Si / Di$$

Where, Si is the number of germinated seeds in ith day, Di is day number to nth counting Mean daily germination (MDG), which is an index of daily germination and is calculated using the following equation:

$$MDG = FGP/d$$

Statistical analysis

Before data analysis, establish the assumption of normal distribution of deviations, homogeneity of variance was examined. The mean yield using Duncan test at 5% probability level by SPSS-18 software and graph drawing was done by Excel.

Table 2. Variance Analysis of germination indicators of sugar beet genotypes under drought stress.

S. O. V	df	MS					
		Coefficient of velocity of germination	Germination rate index	Final germination percentage	Mean germination time	Germination speed	Mean daily germination
Stress level	1	5.594**	61.783*	243*	1.315*	0.0006**	100.38**
Genotypes	7	1.973*	44.272**	236.14**	0.53*	0.0002*	20.021
Stress level × Genotypes	7	0.392	6.233	29.667	0.108	0.00003	11.912
Error	32	0.691	11.635	38.667	0.2	0.00007	19.349
CV (%)		5.77%	17.48%	7.04%	6.4%	5.81%	21.28

* and ** Significantly at $p < 0.05$ and < 0.01, respectively.

Results and discussion

After examining the normality of data distribution, variance analysis of data at Greenhouse and Drought stress conditions was described in Table (2) and showed that the Drought stress conditions all traits were significant at 1% probability level. According to result, there were significant difference between all evaluated genotypes except Mean daily at 1% and 5 probability level. Interaction of Drought stress × genotype was insignificant for all traits. Drought stress reduced the 10.99 % GI, 4.62% CVG, 47.85% MDG and 6.66% GS, and was increased the 4.61% FGP and 4.97 % MGT (Diagram 2, 3 and 4). Results showed that Genotype 6 with an average of 15.14 was highest and genotype 1 with 13.4 averages was lowest rate of CVG (Diagram 5). Genotype 5 with 22.36 averages was in superior group and genotype 1 with 14.98 averages was in D statistical group (Diagram 6). Genotype 3 with 96.67 averages had highest percentage of germination and was placed with 2, 4 and 8 genotypes at superior group. Genotype 1 with average 78.66 with 6 and 7 genotypes were placed at E statistical group (Diagram 7). Genotype 1 with 7.52 averages has highest and Genotypes 7, 5, 7 and 2 have lowest rate of MTG (Diagram 8). Results showed that Genotype 6 with 0.15 averages have highest germination rate and Genotype 1 with 0.13 averages had lowest germination rate and placed at C statistical group. Effect of drought stress on reduction germination speed compared to salinity stress at similar potential ¬ has been reported in recent studies (3, 8). A different reaction of drought and salinity stress on germination stage has been demonstrated by other researchers (8, 10).

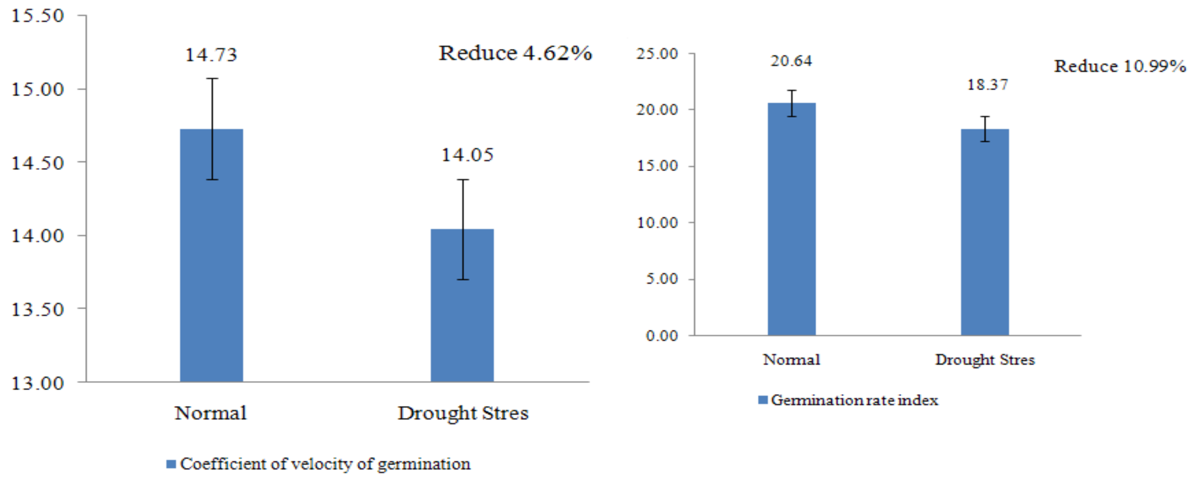

Fig. 1. Effect of drought stress on CVG and GRI and reduction rate of these indicators.

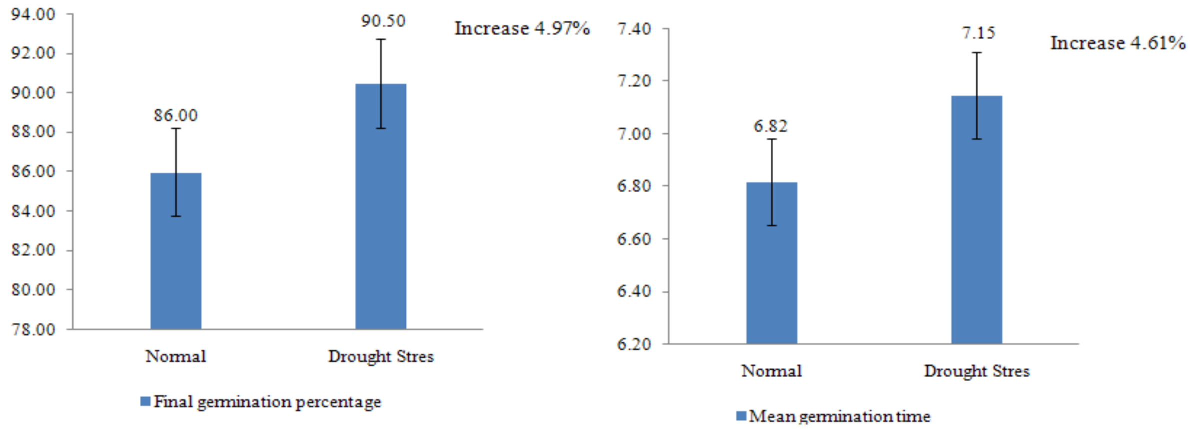

Fig. 2. Effect of drought stress on FGP and MGT and increasing rate of these indicators.

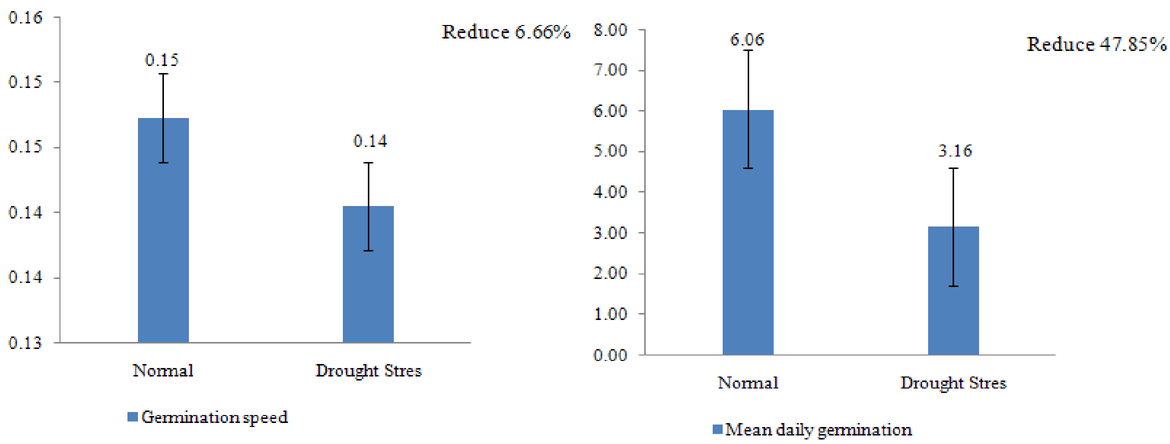

Fig. 3. Effect of drought stress on GS and MDG and reduction rate of these indicators.

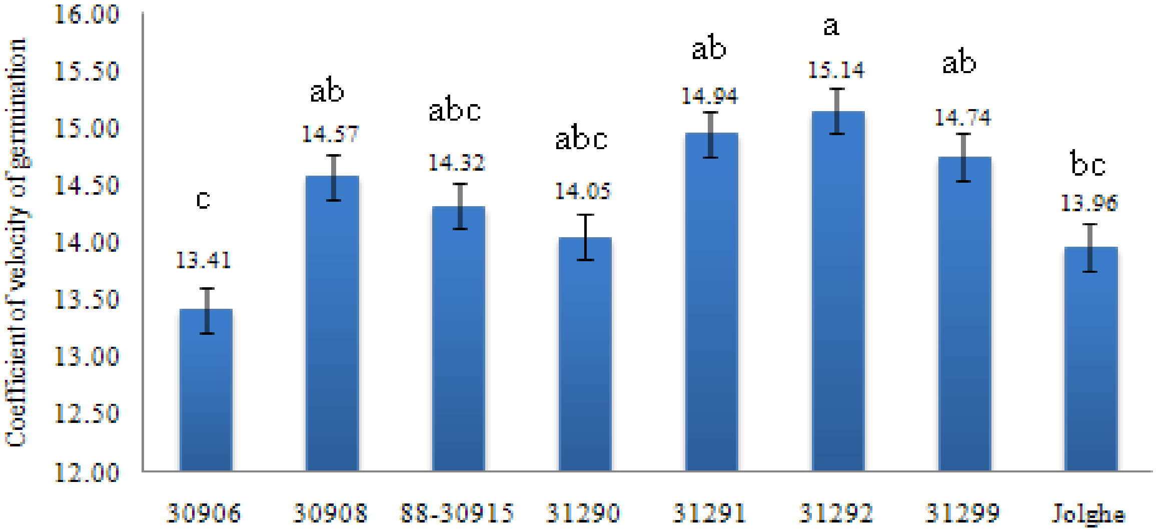

Fig. 4. Average studied genotypes for CVG trait.

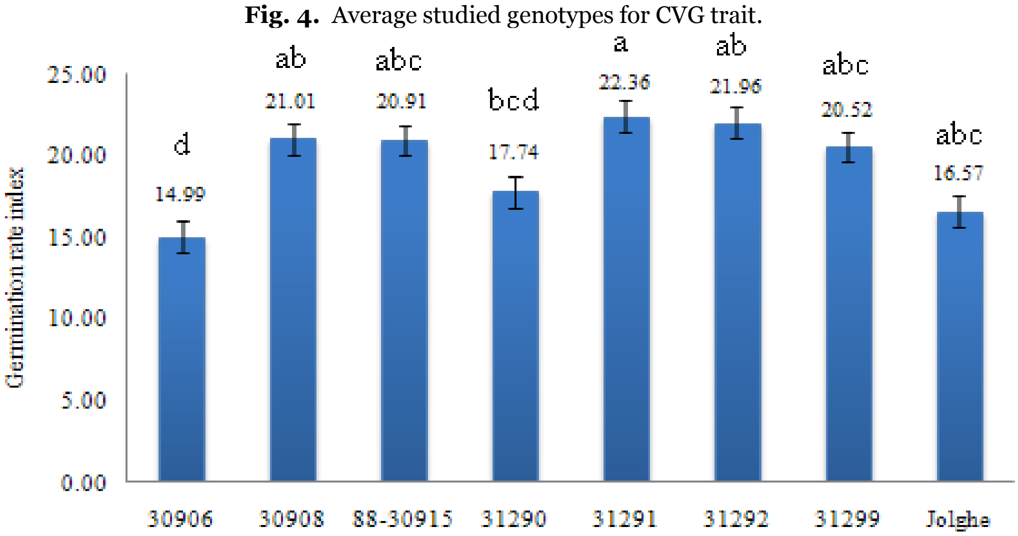

Fig. 5. Average studied genotypes for GRI trait.

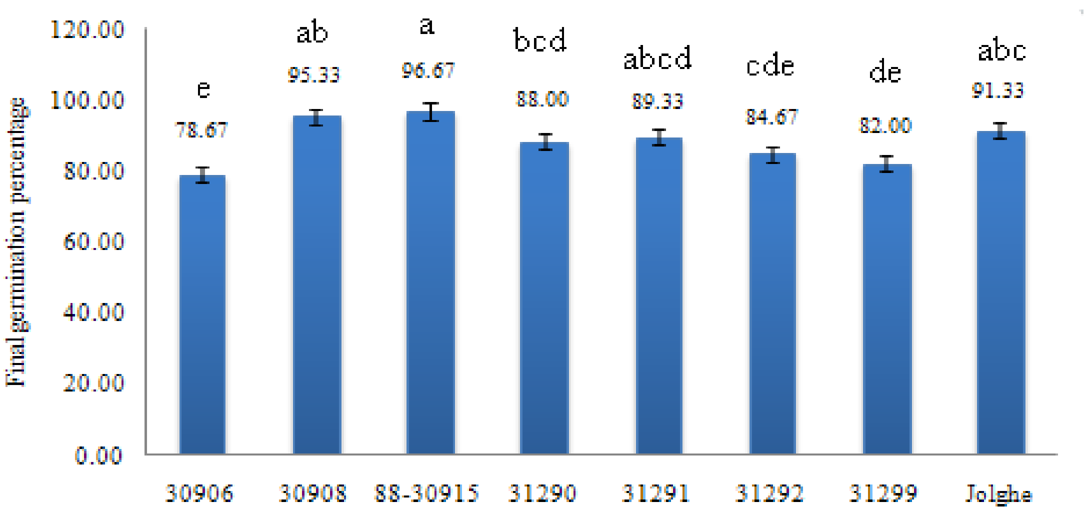

Fig. 6. Average studied genotypes for FGP trait.

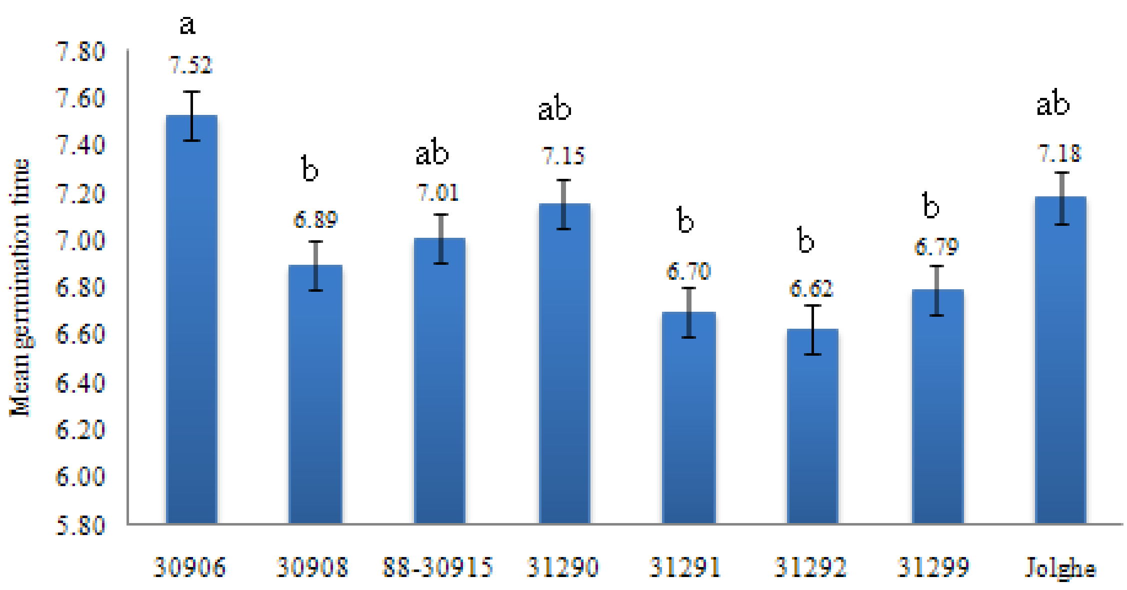

Fig. 7. Average studied genotypes for MGT trait.

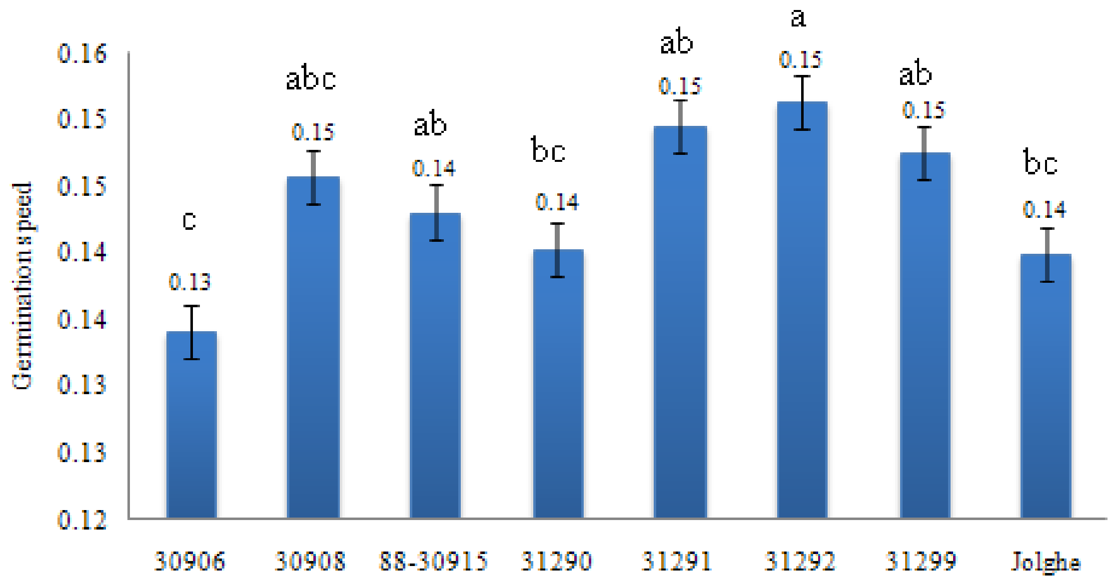

Fig. 8. Average studied genotypes for GS trait.

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