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Effects of osmotic stress on germination and germination indices of synthetic wheat

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ABSTRACT

In order to investigate the synthetic wheat genotype reactions to drought stress in germination stage and to determine the resistant genotypes to osmotic stress, an experiment consisting of 12 genotypes from synthetic wheat through factorial experiment in Complete Random Design (CRD) with three repetitions has been conducted. The first factor was considered as poly ethylene glycol density (PEG) with osmotic potentials of 0, -4/0, -8/0, and -2/1 mp and the second factor was 12 types of synthetic wheat. During conduction of the experiment germination indices including: germination rate (GR), germination index (GI), mean of emergence time (MET), final germination percentage (FGP), and germination rate index (GRI) were calculated. The analysis of variance for germination indices showed that there was a significant difference between different levels of osmotic potentials and genotypes for all the investigated characteristics. The mutual effects of variance in the amount have been observed significant between the genotype and the levels of poly ethylene glycol (drought) for germination index, final germination percentage, germination rate index, length of radicle, length of plumule. Based on Fernandez index (STI), according to their germination criteria, S2 genotype was the most resistant type and S9 was the most sensitive one. In normal and drought conditions positive correlations between the germination indices, except for germination rate and wet and drought weight of plants, have been observed which were significant for characteristics of mean germination index and germination rate index.

Key Words: Poly Ethylene Glycol (PEG), Osmotic Stress, Synthetic Wheat, Germination Index (GI).

INTRODUCTION

Wheat is one of the most important crops in the world, together with rice and maize, it provides more than 60% of the calories and proteins for human nutrition [1]. The most promising approach to increase agricultural productivity and to satisfy human needs in the future is the genetic improvement of crops, which requires a continuous allocation of new sources of genetic variation [2]. Hexaploid wheat (Triticum aestivum) has no hexaploid wild relatives, but synthetic hexaploid wheat is considered a promising source of exotic alleles for introgression into wheat [3-6]. Synthetic hexaploid wheat can be produced from interspecific crosses of tetraploid T. turgidum ssp. and diploid T. tauschii. Synthetics derived from cultivated durum (T. turgidum ssp. durum) have been used in QTL studies [7]. Wheat (Triticum aestivum L.) is an important cereal crop of cool climates, and plays an important role in the food and nutritional security of India. In India, 86% of the cultivated area under wheat represents hexaploid spring type belonging to Triticum aestivum L. [3]. Stalinization is the scourge of intensive agriculture [8]. High concentration of salts has detrimental effects on germination of seeds [9], and plant growth [8]. Many investigators have reported retardation of germination and growth of seedlings at high salinity [6]. However plant species differ in their sensitivity or tolerance to salts [4]. Drought and soil salinity are major abiotic constraints on crop production and food security, and adversely impact the socio-economic fabric of many developing countries. Water scarcity, declining water quality for irrigation, and soil salinity are problems which are becoming more acute [9]. It is estimated that 20% of all cultivated land and nearly half of irrigated land is affected by salt, greatly reducing the yield of crops to well below their genetic potential [10]. Achieving genetic increases in yield under these stresses has always been a difficult challenge for plant breeders [11]. The accumulation of soluble salts in soil leads to an increase in osmotic pressure of the soil solution, which may limit the absorption of water by the seeds or plant roots. Salt damage to plants is attributed to reduction in water availability, toxicity or specific ions, and nutritional imbalance caused by such ions (James et al., 2006). Polyethylene glycol (PEG) widely used to induce water stress, is a non-ionic water polymer, which is not expected to penetrate into plant tissue rapidly [12. In contrast, Na+ and Cl- penetrate into plant cells and can be accumulated in the vacuole for the tolerant plants or in the cytoplasm for sensitive cultivars [13]. The screening of salt tolerant lines/cultivars has been attempted by many researchers on various species at seedling growth stage [11]. The relation of various seedling growth parameters to seed yield and yield component under saline conditions are important for the development of salt tolerant cultivar for production under saline conditions. Powerful new molecular tools for manipulating genetic resources are becoming available [14]. The same authors have reported that this approach identified several markers linked to a gene at a QTL designated Nax1 (Na+ exclusion). This present study was performed for evaluating the reaction of Synthetic wheat genotypes to osmotic stress at germination stage and selection the tolerant genotypes.

MATERIALS AND METHODS

To evaluating the reaction of Synthetic wheat genotypes to drought stress, an experiment using 12 genotypes was performed in a factorial experiment based on completely randomized design at 2011 in Ardabil. Osmotic potentials (Check, -0.4, -0.8 and -1.2 MPa), which were prepared PEG-6000. Each Petri dish containing 25 seeds were included in the solution of a thousand, carbixin Tiraman were disinfected. After 9 days, seven treatments including Germination rate, germination index, germination rate index, the final percentage of germination, Mean germination time, Root length and Shoot length were evaluated.

Data ware subjected to statistical analysis using ANOVA, a statistical package available from SPSS16 and MSTATC.

RESULTS AND DISCUSSION

Results of analysis of variance (Table 1) showed that Between different levels of polyethylene glycol in terms of the coefficient of germination rate, Germination index, duration of germination, final germination percentage, Index of germination rate and root length, shoot length There was no significant difference in the level of a percent. Comparison showed that levels of osmotic potential Levels of osmotic potential, and ultimately reduce water availability for seed germination, Increase the rate of germination and germination index decreased, reducing the average time of germination, reduced seed germination, reduce the rate of germination, root length and shoot length.

Table 1. Results of analysis of variance

SOV	df	MS						
		CR	GI	GRI	FGP	MET	RL	SL
PEG	2	**	**	**	**	**	**	**
Genotype	11	**	**	**	**	**	**	*
P×G	22	Ns	**	**	**	Ns	**	**
Error	70	0.72	3754.42	12.27	46.37	0.000003	6.16	0.23

CR: Germination rate, GI: germination index, GRI: germination rate index, FGP: final percentage of germination, MET: Mean germination time, RL: Root length, SL: Shoot length

Between the genotypes of all the measures assessed germination percentage was a significant difference in levels, Indicates that there is considerable variation between genotypes in terms of the characteristics listed above. Interaction of genotype × levels of osmotic potential on germination index, germination percentage, Index of germination rate and root length, shoot length was a significant effect on the level of a percent. This means that the different genotypes showed different reactions to polyethylene glycol. Due to the selection screen and synthetic sources of resistance in wheat genotypes, to achieve optimum performance is more important Fernandez stress tolerance index (STI) was calculated (Table 2).

According to their genotypes consistent with higher values (STI) are synthetic wheat genotypes under consideration mean STI)) related to the three criteria germination rate index (GRI), germination index (GI), the final germination percentage (FGP) and the highest index (STI) in genotype lowest 2S and 9S in genotype was observed. The results can be concluded that Resistance to osmotic stress of water shortages or Genotypes at different stages of germination, 2S, the most resistant And 9S, is the most critical. Munns [14], with the duration of the osmotic potential solutions of mannitol and polyethylene glycol 20000 concluded that Durable medium with osmotic potential of polyethylene glycol 20,000 was provided in the -0.4 Is minimal, After 28 days, so that its effect on winter wheat seedlings (Tiriticum aestivum) was too small. Some genotypes are capable of very low osmotic potential growth are good, Fernandez concluded that the tolerance index (STI) was determined. The figures are consistent with the superior genotypes can be determined. This confirms the results can be confirmed in nourmand et al [15] noted. Correlation and standard germination characteristics in normal and dry conditions were evident in most traits (Table 3 and 4), so that the correlation between the indicators and criteria in terms of high osmotic pressure than the more normal conditions.

Table 2. Amounts of fernandez stress tolerance based on germination indices

Genotype	GRI	GI	FGP	RL	SL
S1	0.52	0.3	0.7	1.07	0.67
S2	0.68	0.39	0.86	0.69	0.36
S3	0.5	0.26	0.66	0.77	0.26
S4	0.38	0.18	0.52	0.48	0.08
S5	0.3	0.18	0.38	0.15	0.34
S6	0.33	0.23	0.41	0.32	0.63
S7	0.38	0.25	0.49	0.04	0.26
S8	0.25	0.15	0.3	0.18	0.57
S9	0.16	0.1	0.2	0.13	0.54
S10	0.56	0.43	0.69	0.41	0.47
S11	0.18	0.11	0.24	0.98	0.59
S12	0.33	0.21	0.24	0.53	0.35

CR: Germination rate, GI: germination index, FGP: final percentage of germination, MET: Mean germination time

Table 3. Correlation analysis in normal condition

	GR	GI	MET	FGP	GRI	RL	SL
GR	1						
GI	-0.807**	1					
MET	-1**	0.809**	1				
FGP	0.0007	0.006	0.003	1			
GRI	-0.99**	0.814**	0.99**	0.005	1		
RL	0.28	-0.06	0.29	0.008	-0.308	1	
SL	0.05	0.12	0.06	0.065	0.07	0.82**	1

CR: Germination rate, GI: germination index, GRI: germination rate index, FGP: final percentage of germination, MET: Mean germination time, RL: Root length, SL: Shoot length

Table 4. Correlation analysis in stress condition

	GR	GI	MET	FGP	GRI	RL	SL
GR	1						
GI	0.64**	1					
MET	-1**	0.68**	1				
FGP	-0.47**	0.96**	0.47**	1			
GRI	-0.95**	0.84**	0.95**	0.69**	1		
RL	-0.49**	0.21	0.49**	0.10	0.41*	1	
SL	-0.42**	0.24	0.42**	0.17	0.36*	0.81**	1

CR: Germination rate, GI: germination index, GRI: germination rate index, FGP: final percentage of germination, MET: Mean germination time, RL: Root length, SL: Shoot length

Correlation between fresh weight and dry weight in the index of germination under stress conditions, The mean duration of germination and germination rate in a five percent probability levels was significant, This is significant for all indicators except for germination index is negative and positive traits. Seedling fresh weight, dry weight correlated with the level of a percent positive and significant. Calculating the Pearson correlation method in two different conditions due to changing conditions is So that the correlation between traits in the osmotic tension (increasing concentrations of polyethylene glycol) is more visible. It is concluded that a change in circumstances can be investigated separately, despite the significant interaction in the calculation of average yield; Work environment can cause the loss of or change to be responsive genotypes.

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