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Effect of Salinity and Drought by Using NaCl 99.99 % and PEG 6000 on Some Growth Factors on Anabasis aphylla

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Abstract. Salinity and drought affect the plants in a similar way. Salinity delays the onset, reduces the rate and increases the dispersion of germination events, resulting in reduced plant growth and final crop yield. Drought, like salinity, plays an important role not only in determining germination rates, but also influences seedling development. The present investigation has been performed to evaluate Anabasis aphylla tolerance to osmotic stress induced by polyethylene glycol (PEG) and NaCl during germination and the early seedling stages of plant development.

Results indicate that only there is a significant affect for interaction of drought and salinity on root and shoot size and germination in different level. It means surly these factors have direct influence on this important indicator.

Keywords: Anabasis, salinity, drought, resistant, germination.

1. Introduction

Salinity and drought affect the plants in a similar way. Reduced water potential is a common consequence of both salinity and drought. Water stress acts by decreasing the percentage and rate of germination and seedling growth[17]. Among various environmental stresses, soil salinity has become a critical problem worldwide due to its dramatic effects on plant physiology and performance. Over 400 Mha across the world are affected by salinity that is about 25 % of the world's total area (including 15 % of Iran's lands)[9].

Salinity delays the onset, reduces the rate and increases the dispersion of germination events, resulting in reduced plant growth and final crop yield [1]. Between 30 and 40% of the world irrigated agricultural lands are prone to salinity [7]. In addition, salinity imposes on plants other stresses such as ion toxicity, as a result of ion entry in excess of appropriate compartmentation, and nutrient imbalances, as commonly seen in the displacement of potassium by sodium. In fact, salinity damage is mainly due to altered water relations caused by high salt accumulation in the intercellular spaces[17]. Salinity may also affect the germination of seeds by creating an external osmotic potential that prevents water uptake or due to toxic effects of $Na+$ and $Cl-$ ions on the germinating seed[14, 11,10]. Drought, like salinity, plays an important role not only in determining germination rates, but also influences seedling development [17]. Drought stress is one of the most important environmental stresses affecting agricultural productivity worldwide and can result in considerable yield reductions [13]. It is one of the main causes for crop yield reduction in the majority of agricultural and natural regions of the world. The effects of sodium nitroprusside treatment on induced drought stress were investigated[8].

It also induces several physiological, biochemical and molecular responses in several crop plants, which would help them to adapt to such limiting environmental conditions [3,4]. The physiological mechanisms involved in cellular and whole plant responses to water stress, therefore, generate considerable interest and are frequently reviewed [13]. Accumulation of protective solutes like proline and soluble sugar in the leaf is a unique plant response to environmental stresses, specifically to drought stress [16]. Changes in protein expression, accumulation, and synthesis have been observed in many plant species as a result of plant exposure to drought stress during growth [5,6]. Both quantitative and qualitative changes to proteins were detected during drought stress[15].

The present investigation has been performed to evaluate Anabasis aphylla tolerance to osmotic stress induced by polyethylene glycol (PEG) and NaCl during germination and the early seedling stages of plant development.

2. Materials and Methods

The study was conducted in a seed laboratory of the Department of Seed Sciences and Technology, Islamic Azad University, Branch Pishva - Varamin. Seeds of Atriplex lentiformis were used for this study. Seeds were washed thoroughly with double distilled water. PEG (MW: 6,000) was used for induction of drought stress according to Michel B.E. and Kaufmann M.R. 1973. The osmotic potential of polyethylene glycol 6000 and NaCl 99.99% was used for induction of salinity stress[11].

Three replications of 20 seeds were germinated in 10 cm diameter glass Petri dishes at 25±1 °C in a dark growth chamber with 50 % relativity Humidity in day and 15±1 °C in a dark growth chamber with 60 % relativity Humidity. Germinating seed were counted daily, and terminated when no further germination occurred.

The germination index (GI) which expressed as speed of germination was calculated as described in the Association of Official Seed Analysts (AOSA, 1983). Mean shoot and root lengths at the end of germination were measured per replication [2].

The experimental design was arranged in factorial based a completely randomized design (CRD) with three replications. First factor was PEG potential levels (0:d1, -5:d2, -10:d3, -15:d4,-20:d5 bar) and second was salinity potential levels (0:s1, 100:s2, 200:s3, 300:s4,400:s5 and 500:s6 mmol/lit).

Data were subjected to analysis of variance (ANOVA) procedures, and Duncan test was applied at 5 % probability level to compare the differences among treatment means.

3. Results and discussion

Results indicate that only there is a significant affect for interaction of drought and salinity on root size in 5% level. It means surly these factors have direct influence on this important indicator.

Tests of Between-Subjects Effects (Dependent Variable: root)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	40.188(a)	30	1.340	37.824	.000
Drought	.199	4	.050	1.402	.244
salinity	.395	5	.079	2.231	.063
Drought * salinity	1.893	20	.095	2.673	.002
Error	2.125	60	.035		
Total	42.313	90			

a R Squared = .950 (Adjusted R Squared = .925)

Duncan test for root shows there are just one subset between drought treatments. According to the below table, there are not any significant difference between d1 to d5 in size of root.

Root: Duncan

Drought	N	Subset
		1
d5	18	.59722
d4	18	.61111
d2	18	.62500
d3	18	.68056
d1	18	.72222
Sig.		.080

Means for groups in homogeneous subsets are displayed. Based on Type III Sum of Squares The error term is Mean Square (Error) = .035. a Uses Harmonic Mean Sample Size = 18.000. b Alpha = .05.

Duncan test for salinity shows that there are two subsets between salinity treatments. According to the below table, there are significant difference between S4 with S5 and S6. Table does not show any significant difference betweenS1 with S4, S3and S2 and S1, S2, S3 with S6 and S5.

Root: Duncan

		Subset	
salinity	N	1	2
s4	15	.55000	
s1	15	.58333	.58333
s2	15	.63333	.63333
s3	15	.66667	.66667
s6	15		.71667
s5	15		.73333
Sig.		.127	.054

Means for groups in homogeneous subsets are displayed. Based on Type III Sum of Squares The error term is Mean Square (Error) = .035.a Uses Harmonic Mean Sample Size = 15.000. b Alpha = .05.

Results also indicate that there are significant affects for drought, salinity and interaction of drought and salinity on shoot size in 5% level. It means surly these factors have direct influence on this important indicator.

Tests of Between-Subjects Effects (Dependent Variable: shoot)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	73.541(a)	30	2.451	51.040	.000
Drought	.649	4	.162	3.380	.015
salinity	.841	5	.168	3.503	.008
Drought * salinity	2.090	20	.105	2.176	.011
Error	2.882	60	.048		
Total	76.423	90			

a R Squared = .962 (Adjusted R Squared = .943)

Duncan test for shoot size shows there are two subsets between drought treatments. According to the below table, there are significant difference between d1 with d4, d2 and d5. Table does not show any significant difference between d3 with d4, d2 and d5 and between D3 and D1.

Shoot: Duncan

		Subset	
Drought	N	1	2
d5	18	.79167	
d2	18	.81111	
d4	18	.86111	
d3	18	.91667	.91667
d1	18		1.02778
Sig.		.124	.134

Means for groups in homogeneous subsets are displayed. Based on Type III Sum of Squares The error term is Mean Square(Error) = .048. a Uses Harmonic Mean Sample Size = 18.000. b Alpha = .05.

Duncan test for shoot size about salinity shows there are two subsets between drought treatments. According to the below table, there are significant difference between S4 with S3, S6, S2 and S5. Table does not show any significant difference between S4 with S1, S1 with S3, S6, S2 and S5.

Shoot: Duncan

		Subset	
salinity	N	1	2
s4	15	.70000	
s1	15	.82333	.82333
s3	15		.88333
s6	15		.95000
s2	15		.95000
s5	15		.98333

Sig.		.129	.078

Means for groups in homogeneous subsets are displayed. Based on Type III Sum of Squares The error term is Mean Square(Error) = .048.a Uses Harmonic Mean Sample Size = 15.000. b Alpha = .05.

Germination velocity is a valuable and vital indicator in apposing of drought and salinity. This factor helps to the plant for settling and stabling in adverse situation. Results show that there are significant effects for drought, salinity and interaction of drought and salinity on velocity of germination in 5% level. It means surly these factors have effective influence on this important indicator.

Tests of Between-Subjects Effects (Dependent Variable: speed)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	1.149(a)	30	.038	51.040	.000
Drought	.010	4	.003	3.380	.015
salinity	.013	5	.003	3.503	.008
Drought * salinity	.033	20	.002	2.176	.011
Error	.045	60	.001		
Total	1.194	90			

a R Squared = .962 (Adjusted R Squared = .943)

Duncan test for velocity of germination shows there are two subsets between drought treatments. According to the below table, there are significant difference between d1 with d4, d2 and d5. Data do not show any significant difference between d1 with d3 and d3 with d4, d2 and d5

Speed: Duncan

		Subset	
Drought	N	1	2
d5	18	.09896	
d2	18	.10139	
d4	18	.10764	
d3	18	.11458	.11458
d1	18		.12847
Sig.		.124	.134

Means for groups in homogeneous subsets are displayed. Based on Type III Sum of Squares The error term is Mean Square(Error) = .001. a Uses Harmonic Mean Sample Size = 18.000. b Alpha = .05.

In salinity like drought, Duncan test shows there are two subsets between salinity treatments too. According to the below table in the same situation, there are significant difference between S4 with S3, S6, S2 and S5. Findings do not show any significant difference between S4 with S1 and S1 with S3, S6, S2 and S5.

Speed: Duncan

		Subset	
salinity	N	1	2
s4	15	.08750	
s1	15	.10292	.10292
s3	15		.11042
s6	15		.11875
s2	15		.11875
s5	15		.12292
Sig.		.129	.078

Means for groups in homogeneous subsets are displayed. Based on Type III Sum of Squares The error term is Mean Square(Error) = .001. a Uses Harmonic Mean Sample Size = 15.000. b Alpha = .05.

Data show germination will be continuing in all treatments. It means anabasis have good resistance to the unsuitable natural factors. Therefore using of salty water or limitation of water can not be a ban for growing of anabasis. A good thing about this plant in reaction to salinity and drought this is that velocity of germination decrease with increasing of salinity and drought until the middle of treatment but after that germination velocity increased nevertheless increasing of both limitations. It may be because of interaction salinity and drought.

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