Seed Treatment, Salinity and Temperature Impacts on Seed Germination and Growth of Atriplex

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ABSTRACT

Nearly 72% of total land in Iran is located in semi-arid and arid regions , and plant cover varies from the spare sand dune to salt vegetation of mostly halophyte communities which are prevalent over 27 million hectares of saline and sodic soils in the country. Deserts and degraded land use with 21 % of total area are the second largest land use after range land with 55% . Therefore, the most proper management and use of these crops, beside, reclamation of degraded lands, they produce animal feed of relatively good feeding value in 300 thousands hectares of atriplex plantations in the country. Since, the usual propagation and establishment of saltbushes is carried out in nurseries, there are number of factors governing the successes or failures for raising these crops for afforestation projects such as seed treatments, temperature, over watering, etc. Therefore, a laboratory study was conducted to determine the impacts of seed treatment, salinity and temperature on seed germination and growth of A. halimus and A. lentiformis, two most popular atriplex spp. in Iran. The treatments included were two salinities (0 and $10 dSm^{-1}$) , two temperature levels (25 and 35°C) and two seed treatments (dry and soaked in water) each with three replications. The overall results showed that A. lentiformis performed much better than A. halimus with +63% germination and +122 % plumule lengths. Increasing salinity had negative impacts on germination (-40 %) and plumule length (-30%). Increasing temperature, drastically reduced seed germination by 68 % and plumule length by 85 %. While, the seed treatment although, more or less, had a promising effects on germination (+2 %) and plumule length (+10 %), but changes between dry and soaked seeds used was significant in this study. Increasing salinity had positive impact on germination (+7.5%) and plumule length (41.4 %) of A. halimus while incase of A. lentiformis, negative impacts of -59.7 % and -49 % respectively, were observed. At 35°C, A. lentiformis germination (-34.9 %) and plumule length (-76 %) reduced, while no germination was observed in A. halimus compared to 25°C. Germination bioassay of A.lentiformis with respect to seed treatment was better than A.halimus.

Keywords: *Seed treatment, salinity, temperature, atriplex*

1. INTRODUCTION

Dry lands cover about 41 per cent of the earth's land surface (more than 6 billion ha) and are inhabited by more than 2 billion people, about a third of the human population. Desertification, defined as land degradation in dry lands resulting from various factors, including climatic variations and human activities (Adeel et al., 2005).

Desertification – quantified as a persistent loss in ecosystem services – is driving the loss in land productivity. Scenarios of future development show that, if desertification is not checked now, it will threaten the future of human well-being in dry lands (Adeel et al., 2005).

Water is a vital and often limiting factor in dry lands. Rainfall is low, highly variable and confined to a short winter season. Groundwater represents an important supply that can be used to increase agricultural production through irrigation. In addition, it serves as a secure and clean supply for domestic use and watering livestock.

A comparison of present and past groundwater levels, using data shows that the groundwater level has declined on a average about 60 m in approximately 15 years in Khorasan Razavi state of Iran.

Soil fertility in dry areas is constrained by, for example, environmental extremes of temperatures, inherent low soil fertility, low water-holding capacity, high pH, low levels of organic matter, and usually high salt content in the soil.

Iran has the most diverse type of physiography, climate, vegetation and biological productivity, because of her wider range in latitude and longitude. More than 30% of the country receiving less than 100mm of precipitation annually. Nearly 50% of the area is located in parts of the country with less than 350 mm rainfall, 30% in areas with 300-400 mm, less than 15% in areas with 400-500 mm and 10% in areas with more than 500 mm.

Halophytes constitute a significant part of the local flora in many parts of the country. Halophytic communities are mainly located in the vicinity of deserts, in the central, southern and south eastern parts of the country and adjacent to the Persian Gulf and Gulf of Oman.

Halophytic communities are mainly from Chenopodiaceae, Poaceae and Asteraceae and the total number of halophytic species in Iran has been estimated to be 354 (2), which is 5.7% of the total flora of the country. Different species of Atriplex, Salsola, Kochia, Haloxylon, Chenopodium etc. are prevalent over 27 million hectares of saline and sodic soils existed in Iran.
The feeding value of two major halophyte groups, Chenopods and Grasses is relatively good and has been recognized for many years (4,7,8).

Some halophyte communities have very high grazing value both in terms of forage yield, season of production and in terms of forage quality (5,6). These plants, especially members of the genus Atriplex, have been introduced and planted in widespread areas of the world, at least since the beginning of this century, specifically for the purpose of providing feed for animals (4,9). In some cases this has been done primarily as a way of improving rangeland productivity, by supplementing and/or replacing the native vegetation (6,7).

Most artificially established forage halophytes in rainfed conditions are shrubs of Atriplex spp. Total number of Atriplex species has been estimated (7) to be 400. This figure is 20 for Iran.
The usual method of propagation and establishment of saltbushes is the growing of the nursery seedlings and later planting in the field (5,7,13).

Direct sowing may, however, be successful when certain precaution are taken such as dewinging the seeds, or soaking them in water to eliminate the sodium chloride and saponins contained in the bracts that impede germination (6,8).The approach is based on farmer's experiments with ways to achieve better use and higher returns from the available resources available and to provide suitable management to the diverse agro-ecosystems.

Pastoral improvements are carried out in deserted areas through the planting of fodder shrubs such as Atriplex halimus, Atriplex nummularia and Atriplex lentiformis and a period of three to five years allow the vegetation to regenerate naturally without any intervention..

Under rain fed conditions of Iran 500-1000 kg per hectare dry matter production of this halophyte has been reported (5,13). Under mean annual rainfall of 200-400 mm the yield of A. halimus or A. nummularia and to some extend A. lentiformis is around 2000-4000 kg DM per hectare per year (7).Since propagation and establishment of Atriplex species are of prime importance, and related research works are meager and sporadic, therefore ,this study was carried out to examine .Seed treatment, salinity and temperature impacts on germination bioassay of two Atriplex species.

2. MATERIALS AND METHODS

A laboratory experiment was conducted to study the effect of two levels of sodium chloride salinities S_0=0 and S_1= 10 dSm^{-1}) and two levels of temperatures (25 and 35°C) on treated seeds (T_0 – dry and T_1 = soaked in distilled water for 24 hr. and washed with distilled water) of Atriplex halimus and Atriplex lentiforms. Germination bioassay was conducted after preparing saline solution by dissolving calculated amount of NaCl in distilled water, on 10 × 100 mm petridish (PD) following the techniques proposed by Narwal (12). In each PD, 30 seeds of each Atriplex species dry and soaked were placed between 2 fitter papers, 5 ml of saline solution or distilled water was added per PD on the first day and thereafter, they added as needed. Petridishes were incubated at 25 and 35°C. PD was checked every two days to count seed germination. Final seed germination percentage, yield and plumule lengths were recorded at the end of experiment. Germination bioassay was conducted in completely randomized design (factorial) where each treatment was replicated three times. Analysis of variance was performed using MSTAT-C and treatment means were compared using Duncan multiple range test at $p \leq 0.05$.

3. RESULTS AND DISCUSSION

3.1 Germination Bioassay

3.1.1 Effect of Salinity

Germination percentage of Atriplex reduced significantly with increasing salinity by about 40% (table 1) which is similar with findings of Sharma (14). Plumule length of Atriplex also showed a significant reduction of 29.2% with increase in salt concentration (table 1).

3.1.2 Effect of Temperature

Germination percentage and plumule length of Atriplex reduced significantly by 67.6% and 84.7% respectively, with increasing temperature from 25°C to 35°C (table 1). Miyamoto (10) and Vengar (16) reported best germination at lower temperature than higher.

3.1.3 Effect of Atriplex Species

Germination percentage and plumule length of Atriplex lentiformis were superior by 63.4% and 122.3% respectively, compared to A. halimus (table 2).

3.1.4 Effect of Seed Treatment

Seed treatment caused some changes in germination and plumule length of crop (table 3), which is similar with findings of Beadle (2).

3.1.5 Salinity Vs. Temperature Effects

Germination percentage at each level of salinity decreased significantly with increasing temperature (table 1). This reduction at So was 35.7% and at S_1 was 100%. Plumule length also had a significant reduction of 70.6% (S_0) and 100% (S_1) with increasing temperature, which is similar with findings of Miyamoto (10) and Vengar (16).

3.1.6 Salinity Vs. A. Species Effect

Germination percentage and plumule length at each salinity level differed significantly in both A. species. At S_0 level, A. lentiformis proved to be superior in germination bioassay but at S_1 its plumule length was higher (table 2). Same results were reported by Beadle (2) and Staples and Toeniessen (15).

3.1.7 Salinity Vs. Seed Treatment Effect

Germination bioassay changed under the effect seed treatment and salinity interaction effect (table 3). Soaking seeds in water performed better in higher salinity. Similar findings were reported by Mozafar and Goodin (11) and Miyamoto (10).

8) Temperature Vs. A. species effect

Increasing temperature in both species resulted in significant reduction in germination bioassay (table 4), but A. lentiformis performed much better in higher temperature than A. halimus.

Table1: Effect of salinity, temperature and their interaction on germination bioassay

Salinity (dS m^{-1}) \ Temp. (°c)		Germination (%)	($\overline{X}$)	Plumule length (mm)	($\overline{X}$)
S_0	25	53.04a	52.63A	17a	16.3A
	35	34.08b		5.0b	
$\overline{X}_{S0}$		43.56A		11A	
S_1	25	52.22a		15.58a	
	35	0c	17.04B	0c	2.5B
$\overline{X}_{S1}$		26.11B		7.79B	

Means within a column followed by the same letters are not significantly different at p =o.o5.

Table2: Effect of salinity, A. species and their interaction on germination bioassay

Salinity (dS m^{-1}) \ A. species		Germination (%)	$(\overline{X})$	Plumule length (mm)	$(\overline{X})$
S_0	A.lentiformis	61.60a	43.2A	17.2a	13A
	A. halimus	25.5b		4.8d	
S_1	A.lentiformis	24.9b		8.7b	
	A. halimus	27.4b	26.4B	5.8c	5.8B

Means within a column followed by the same letters are not significantly different at p =*o.o5*.

Table3: Effect of salinity, seed treatment and their interaction on germination bioassay

Salinity (dS m^{-1}) \ Seed treatment		Germination (%)	$(\overline{X})$	Plumule length (mm)	$(\overline{X})$
S_0	T_0	43.3a	34.5B	10.5a	8.96B
	T_1	43.8a		11.5a	
S_1	T_0	25.7b		7.4b	
	T_1	26.5b	35.2A	8.2b	9.83A

Means within a column followed by the same letters are not significantly different at p =*o.o5*.

Table4: Effect of temperature, A. species and their interaction on germination bioassay

Temp. (°c) \ A. species		Germination (%)	$(\overline{X})$	Plumule length (mm)	$(\overline{X})$
25	A.lentiformis	52.35a	43.2A	20.92a	13A
	A. halimus	52.91a		11.67b	
$\overline{X}_{25}$		52.63A		16.3A	
35	A.lentiformis	34.08b		5.0c	
	A. halimus	0c	26.4B	0d	5.8B
$\overline{X}_{35}$		17.04B		2.5B	

Means within a column followed by the same letters are not significantly different at p =*o.o5*.

3.1.9 Temperature Vs. Seed Treatment Effect

Seed treatment with increasing temperature showed a positive impact on germination bioassay (table 5).

3.1.10 A. Species Vs. Seed Treatment Effect

Seed treatment in both species had a positive impact on germination bioassay. Germination percentage and plumule length on A. halimus increased by 36.4% and 11% respectively, in soaked seeds compared to untreated seeds (table 6). Incase of A. lentiformis soaking of seeds reduced germination percentage by 14.7% but plumule length increased by 6.4% compared to untreated seeds.

3.1.11 Salinity Vs. Temperature Vs. Seed Treatment Effect

Increasing salinity at 25°C (table 7) had more negative impacts on germination bioassay in untreated seeds than soaked ones, but at 35°C, increasing salinity resulted a drastic reduction in both treated and untreated seeds. Sharma (14), Vengar (16) and Miyamoto (10) reported same results.

3.1.12 Salinity Vs. A. Species Vs. Seed Treatment Effect

Soaking seeds in both A. species at each level of salinity increased germination bioassay compared to untreated seeds. But with increasing salinity, germination bioassay in A. lentiformis reduced, while in A. halimus, salinity increased it to some extent (table 8). A. lentiformis with respect to seed treatment and increasing salinity proved to be superior to A. halimus.

Table5: Effect of temperature, seed treatment and their interaction on germination bioassay

Temp. (°c)	Seed treatment	Germination (%)	($\overline{X}$)	Plumule length (mm)	($\overline{X}$)
25	T_0	52.36a	34.51B	15.52a	8.96B
	T_1	52.9a		17.17a	
$\overline{X}_{25}$		52.63A		16.3A	
35	T_0	16.67b		2.5b	
	T_1	17.42b	35.2A	2.5b	9.83A
$\overline{X}_{35}$		17.04A		2.5B	

Means within a column followed by the same letters are not significantly different at p =o.o5.

Table 6: Effect of A. species, seed treatment and their interaction on germination bioassay

A. species	Seed treatment	Germination (%)	($\overline{X}$)	Plumule length (mm)	($\overline{X}$)
A.lentiformis	T_0	46.67a	34.5B	12.6b	9.0B
	T_1	39.8b		13.41a	
$\overline{X}_{len.}$		34.2A		13A	
A. halimus	T_0	22.36d		5.53d	
	T_1	30.55c	35.2A	6.13c	9.8A
$\overline{X}_{hal.}$		26.45B		5.8B	

Means within a column followed by the same letters are not significantly different at p =o.o5.

Table7: Effect of salinity vs. temperature vs. seed treatment on germination bioassay

Salinity (dS m^{-1})	Temp. (°c)	Untreated seeds		Treated seeds	
		Germination (%)	Plumule length(mm)	Germination (%)	Plumule length(mm)
S_0	25	53.33a	16.0ab	52.17a	18.0a
	35	33.33b	5.0c	34.83b	5.0c
S_1	25	51.38a	14.38b	53.06a	16.33ab
	35	0d	0d	0d	0d

Means within a column followed by the same letters are not significantly different at p =o.o5.

Table8: Effect of salinity vs. seed treatment (T_0, T_1) vs. A. species on germination bioassay

Salinity (dS m^{-1})	Seed treatment	A.lentiformis		A. halimus	
		Germination (%)	Plumule length(mm)	Germination (%)	Plumule length(mm)
S_0	T_0	66.67a	16.33d	20.0d	5.5ef
	T_1	56.48b	18.0d	31.1c	5.67ef
S_1	T_0	26.67cd	8.5e	24.72cd	5.57ef
	T_1	23.06d	9.1e	30.0c	6.6e

Means within a column followed by the same letters are not significantly different at p =o.o5.

4. CONCLUSION

Halophytes constitute a good proportion of the total flora of Iran, and little has been done on their propagation utilization and potential uses. Although these are very tolerant to saline and alkali conditions, but as shown in this study at germination and early seedling growth stages, they seems to be sensitive to increasing salt and temperature. Therefore, strategies to overcome these problem can be achieved by considering proper management for A. species with respect to the divers agro-ecosystems in order to achieve better use, higher returns and good conservation practices from the available resources.

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