

Effects of water deficit and salinity on germination properties of *Aeluropus* spp.

F. Abbassi^a, A. Koocheki^{b*}

^a Assistant professor, Biology Department, Islamic Azad University of Mashhad, Mashhad, Iran

^b Professor, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran

Received 1 January 2006; received in revised form 18 February 2007; accepted 5 December 2007

Abstract

Seed germination is an important phase of plant development during which soil water availability is crucial. Salinity can affect seed germination in two ways: 1) Change of osmotic potential of available water, 2) toxicity effects. In this experiment, interactive effects of salinity and water deficit on germination criteria of two species of *A. littoralis* and *A. logopoides* were studied in a factorial design with completely randomized arrangement and four replications. Treatments were combinations of four levels of water deficit (-0.3, -5, -10 and -15 bar), four electrical conductivity levels (0, 20, 25 and 30 dSm⁻¹) and two species of *Aeluropus*. Water deficit and salinity were induced through PEG-6000 and sodium chloride respectively. After three weeks rate, as well as percentage of germination were determined. Results showed that by increasing salinity and water deficit both criteria of percent germination and germination rate were reduced and there was an interactive effect of these stresses on germination. In general effects of salinity were more pronounced than water shortage. These results were somehow similar for either one of the species.

Keywords: *Aeluropus*; Germination; Electrical conductivity; Water deficit

1. Introduction

Due to growing water shortage worldwide, unconventional use of water is going to be inevitable. Since this type of resource shortages are prevalent mainly in stressed environments of the arid and semiarid parts of the world, an understanding of plant response to such conditions, particularly the interactive effects of such main types of stress as water deficit and salinity on physiological criteria of plants are quite important.

Water deficit is an important limiting factor of plant growth (Basra, 1997, Bhan et al., 1973, Koochaki, 2000 and Levit, 1980), occurring in arid and semiarid parts of the world with an estimate of 6150 million hectares (Koochaki, 2000). On the other hand, most saline water as well as soil resources of the world are located in these areas. The total saline soils of the world are

955 million hectares, this figure being 18 million for Iran (Koochaki and Mahallati, 1994).

The level of salinity is determined by several indexes and as related to the subject of this research one of them namely EC is selected. Electrical conductivity (EC) is the salinity indexes, the SI unit for which is Simens and in most research works dSm⁻¹ (deci Simens per meter) is employed (Flowers et al., 1977 and Tanji, 1995).

Seed germination is an important stage of plant growth which is controlled by environmental factors as well as by physiological processes. Water availability is crucial in seed germination (Devilliers, A.Y., et al., 1994).

Water is essential for the biochemical reactions of germination. Enzymes demonstrate their natural active structure in presence of enough water. The start of metabolism and growth of seed embryo depends on the amount of water available in the tissue. There are references (Bradford, K.Y., 1986, Dell'aquila, A., 1992, Pessarakli, et al., 1989, Torbati-nejad et al., 2001) which indicate that germination time could be estimated

* Corresponding author. Tel.: +98 511 8795614
fax: +98 511 8787430.
E-mail address: akooch@ferdowsi.um.ac.ir

from water content of the embryo. Dell'aquila, A (1992) demonstrated that there are strong correlations between protein synthesis of Lucien amino acid and cell water content.

The mechanism of the effect of salinity on seed germination has been studied (Basra et al., 1997, Flowers et al., 1997) and it generally has been reported through seed susceptibility and accumulation of toxic ions, both of which exhibit detrimental effects on germination.

Aeluropus species plants are tolerant to salinity and aridity (Akani and Ghorbanli, 1993, Batanouny, 1994, Golzar and Khan, 2001, Torbati-nejad et al., 2001). This species belongs to the *poaceae* family. Two species of *Aeluropus littoralis* and *Aeluropus Igopoides* are found in natural ecosystem of Khorasan and Golestan provinces of Iran (Akhani and Ghorbanli, 1993, Torbati-nejad et al., 2001).

These plants are considered as range plants and can also be used as ornamentals in green spaces as well as for sand dune fixation in the desert areas (Torbati-nejad et al., 2001).

The purpose of the present study was to evaluate seed germination of these two species under salinity (different electrical conductivities) and water deficit conditions.

2. Materials and Methods

The experiment was conducted as a completely randomized design with four replications. Four levels of water deficit (-0/3, -5,

-10 and -15 bar) combined with four levels of salinity (0, 20, 25 and 30 dSm⁻¹) were applied to the two species of *A. littoralis* and *A. Igopoides* under laboratory conditions in 20 ± 2°C. Different water deficit levels were induced through poly ethylene glycol 6000 and salinity was induced through sodium chloride application. Seeds were disinfected prior to the experiment and placed on filter paper in Petri dishes. Five milliliters of prepared solutions were added to each Petri dish. Seeds were monitored daily and their germination evaluated on the basis of emergence of 2mm of radicle. After a lapse of three weeks, percentage and rate of germination were evaluated.

For statistical analysis the software MSTATC, and for sketching diagrams EXCEL and SLIDWRITE were employed. Means were compared using Duncan's Multiple Range Test at 5% probability.

3. Results and Discussion

Fig. 1 shows that with increase in salinity and in water deficit, levels of germination percentage were considerably reduced. On the other hand the effect of salinity on seed germination was more pronounced than the effect of water deficit, where 76.1% seed germination was recorded in salinity levels less than 5 dSm⁻¹. The same percentage was observed in water deficit more than 5 bars. This could be attributed to the toxic effect of salt ions as well as to deficit in water availability to seed due to the presence of salt.

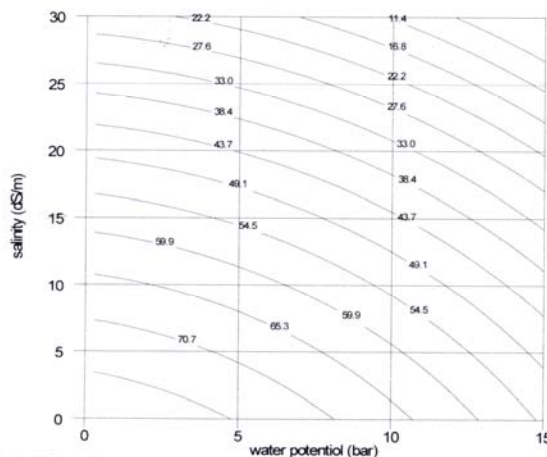


Fig. 1. Effect of salinity and water deficit on seed germination (%) in *Aeluropus* spp.

Interactive effects of salinity and water deficit were also considerable. The negative effect of water deficit on germination was more

pronounced with increase in salinity levels. In other words, under control conditions, percentage of germination was 79.5% while by increase in

salinity and in water deficit levels this figure was reduced such that under the highest levels of these two parameters, germination was reduced to only 6% (table1). Although there are numerous references (Mikhiel et al., 1992, Bradford, 1986, Pessarakli et al., 1989) in literature which indicate negative effects of salinity and water deficit on seed germination (e.g. Koocheki and Zarif Ketabi (1996) in an experiment on effect of salinity and water deficit on seed germination of several range land species found that with increase in water deficit as well as in salinity seed germination was reduced), nevertheless. EL-Darier and Youssef

(2000) have found that the highest seed germination percentage was found to be obtained with 50 m mol of NaCl as compared with control.

In the present experiment the trend of negative effect of salinity on germination percentage in either one of the species was similar (fig 2), while under water deficit levels there was a difference observed between their germination percentages (fig 3), in which with increase in water deficit germination in *A. littoralis* had a negative trend, while in the other species this parameter initially increased and then was reduced.

Table 1. Effect of salinity and water deficit on seed germination (%) of *Aeluropus* spp.

Water potential (bar)	EC (dSm ⁻¹)	control	20	25	30
Control		79.50 ab	53.50 cde	23 fghi	32.50 efgh
-5		81.50 a	57.50 bcd	15.00 hi	18.00 ghi
-10		69.00 abc	40.75 defg	16.25 hi	9.00 i
-15		45.50 def	15.50 hi	16.50 hi	6.00 i

*Values denoted by similar letter are not significantly different

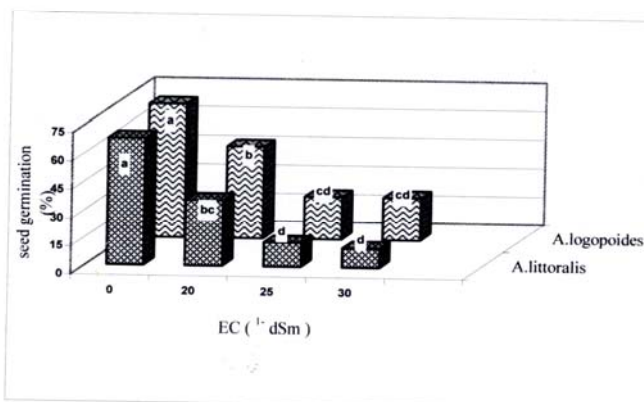


Fig. 2. Effect of salinity on seed germination in two species of *Aeluropus*. Values denoted by the same letters are not significantly different

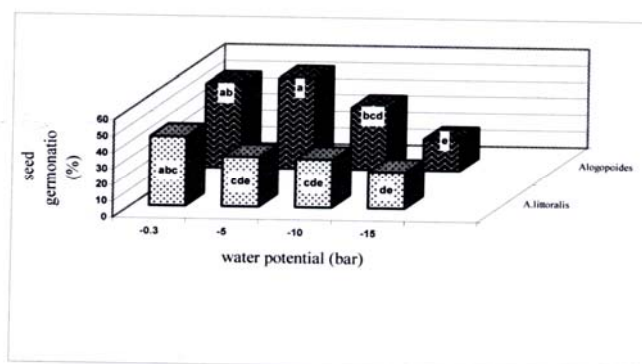


Fig. 3. Effect of water deficit on seed germination in two species of *Aeluropus*. Values denoted by the same letters are not significantly different

From figure 4 it becomes evident that under low salinity levels the rate of germination was somehow enhanced but while with increase in salinity the reduction effect was considerable. In general salinity exerted a more negative effect on seed germination rate than did water deficit. Interactive effect of these stresses on germination rate was similar to that of percent seed germination. This has been reflected in Koochaki and Ketabi, 1996 and Tekrone et al., 1991.

The effect of salinity, on germination rate, was more pronounced than the effect of water deficit. Also the trend was similar for both species (figs 5 and 6) but the degree of reduction in germination rate was more pronounced in the case of *A. littoralis* under water deficit. This difference was

clearer in the 5 bar treatment (fig 6), and confirmed by Koochaki and Ketabi, 1996.

The mechanism of the effect of salinity on seed germination has been reported by Ayers, A. D (1952). He considered this negative effect to be due to reduction in water absorption and accumulation of toxic ions. This has also been reported by other researchers. Mikhiel et al (1992) reported several mechanisms for germination reduction in *Atriplex* spp. under salinity stress. In a study on *Kosteletzkya virginia*, Poljakoff-Mayber et al (1994) observed that NaCl reduced seed germination in *K. virginia* which they attributed to osmotic pressure and toxic effects of NaCl.

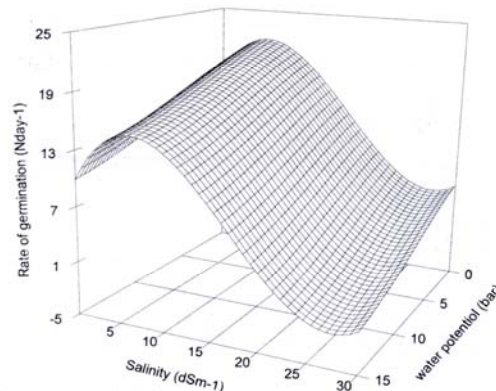


Fig. 4. Effect of water deficit and salinity on germination rate of *Aeluropus* spp.

Table 2. Effect of water deficit and salinity on germination rate of *Aeluropus* spp.

Water potential (bar)	EC (dSm ⁻¹)			
	control	20	25	30
Control	18.21 a	9.816 b	2.545 def	6.991 bcd
-5	18.04 a	7.844 bc	1.529 ef	1.869 ef
-10	9.874 b	4.73 cdef	3.828 cdef	0.7837 f
-15	6.04 bcde	3.569 cdef	1.704 ef	0.7413 f

Values denoted by the same letters are not significantly different

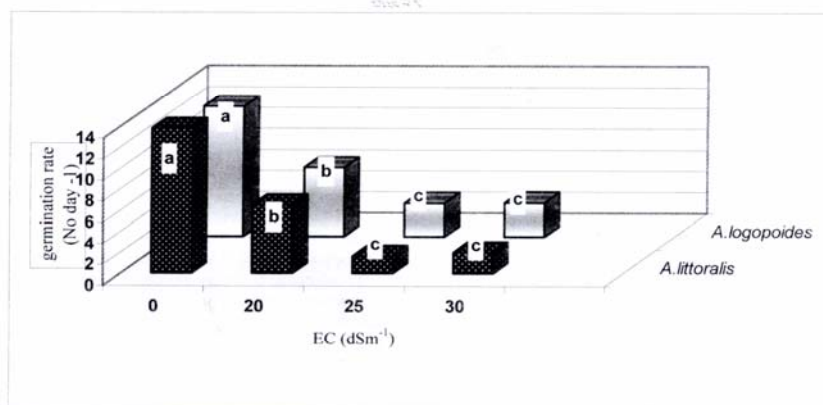


Fig. 5. Effect of salinity on germination rate of *A. littoralis* and *A. logopoides*. Values with the same letter are not significantly different

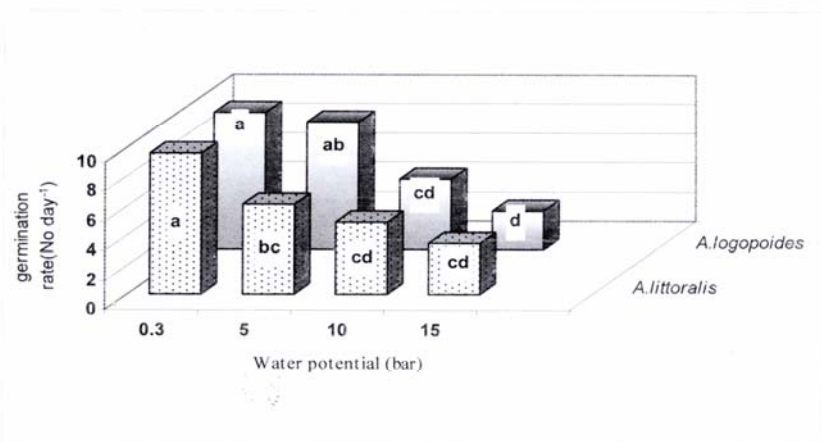


Fig. 6. Effect of water deficit on germination rate of *A. littoralis* and *A. logopoides*. Values with the same letters are not significantly different

Finally it was concluded that salinity and water deficit reduced both germination percentage and rate. The combined effects of these two parameters on germination were conspicuous. The effect of salinity was more than that of water deficit, and *A. logopoides* exhibited more tolerance than *A. littoralis* under water deficit condition.

References

- Akhani, H. and M. Ghorbanli, 1993. A contribution to the halophytic vegetable and flora of Iran. In: H. Leith and A. A. Al Masoom (eds). Towards the Rational Use of High Salinity Tolerant Plants. T:VS 27; P: 35-44.
- Ayers, A.D., 1952. Seed germination as affected by soil moisture and salinity. Agron J. 44:82-84.
- Basra, A.S. and P.K. Basra, 1997. Mechanisms of environmental stress resistance in Plants. Hardwood Academic Publishers. P: 83-111.
- Batanouny, K.H., 1994. Halophytes and halophytic plant communities in the Arab Region. In: Victor R. Squires and Ali T. Ayoub (eds). Halophytes As a Resource for Livestock and for Rehabilitation of Degraded Lands. T: VS 32: 139-163.
- Bhan, S., H.G. Singh and A. Singh, 1973. Note on root development as an index of drought resistance in Sorghum (*Sorghum bicolor* L. Monech) Indian J. Agric. Sci. 43: 828-830.
- Bradford, K.Y., 1986. Manipulation of seed water relations via osmotic priming to improve germination under stress conditions. HortScience. 21(5) 1105-1112.
- Dell'aquila, A., 1992. Water uptake and protein synthesis in germinating wheat embryos under the osmotic stress of polyethylene glycol. Annals of Botany. 69:167-171.
- Devilliers, A.Y., M.W. Vanroyan, G.K. Theronand, H.A. Deventrer, 1994. Germination of three namagual and

- pioneer species as influenced by salinity, temperature and light. *Seed Science and Technology*. 22:427-433.
- EL-Darier, S.M. and R.S. Youssef, 2000. Effect of soil type salinity and allelochemical on germination and seedling growth of a medical plant *lepidium sativum* L. *Ann. Appl. Biol.* 136:273-279.
- Flowers, T.J., P.F. Torke and A.R. Yeo, 1977. The mechanism of salt tolerance in halophytes. *Ann. Rev. Plant. Physiol.* 28:89-121.
- Gulzar, S. and E. Khan, 2001. Seed germination of a halophytic grass *Aeluropus logopoides*. *Annals of Botany*. 87(3) 319-324.
- Koocheki, A., 2000. Potential of saltbush (*Atriplex spp.*) as a fodder shrub for the Arid Lands of Iran. In: G. Gintzburger, M. Bounejmate and A. Nefzaoui (eds). *Fodder shrub development in arid and semi-arid zones*. ICARDA, pages 178- 183.
- Koocheki, A. and M.N. Mohallati, 1994. Feed value of some halophytic range plants of arid regions of Iran. In: Victor R. Squires & Ali T. Ayoub (eds). *Halophytes As a Resource for Livestock and for Rehabilitation of Degraded Lands*. P: 249-253.
- Koocheki, A., H. Zarif Ketabi, 1996. Determination of optimum temperature of germination and study of the effects of salinity and aridity on several pasture species. *Biaban*, 1(1); p: 45-55.
- Levit, J., 1980. Responses of plants to environmental stress. Academic Press. New York. 2: 30-42.
- Mikhiel, G.S., S.E. Meyer and R.L. Pendleton, 1992. Variation in germination response to temperature and salinity in shrubby *Atriplex* species. *J. of Arid Environments*. 22: 39-49.
- Ministry of Science and Higher Education of Islamic Republic of Iran. Ferdowsi University of Mashad, 1999. Studies of salt water and salt lip resources of water shed basins of Tabas and Saravan. 7, p:11-12.
- Modi, A.T., M.B. McDonald and Y.G. Streeter, 2002. Water status influences common events of soluble carbohydrate accumulation during soybean seed development and germination. *CAN. J. BOT.* 80:262-270
- Pessarakli, M., J.T. Huber and T.C. Tucker, 1989. Protein synthesis in green beans under salt stress conditions. *J. of Plant Nutrition*. 12(10) 1105-1121.
- Poljakoff-Mayber, A., G.F. Somers., E. Werker and J.L. Gallagher, 1994. Seeds of *Kosteletzkya virginica* (Malvaceae): their structure, germination, and salt tolerance. *American J. of Botany*. 81(1): 54-59.
- Takebe, M., T. Yoneyama., H. Inada and T. Murakami, 1990. Spectral reflectance ratio of rice canopy for estimating crop nitrogen status. *Plant and Soil*. 122: 295- 297.
- Tanji, K.K., 1995. Agricultural salinity assessment and management. Scientific Publisher, Jodhpur.
- Tekrony, D.M. and D.B. Egli, 1991. Relationship of seed vigor to crop yield: a review. *Crop Sci.* 31: 816-822.
- Torbati-nejad, N.M., H. Maghsud-Lorad and A.M. Gharebashi, 2001. Determination of feed value of two species of *Aeluropus logopoides* and *Aeluropus litoralis* in sheep. *J. Agric. Sci. Natur. Resour.* 7 (2); p: 31-45.
- Wiese, A.M. and L.K. Binning, 1987. Calculating the threshold temperature of development for weeds. *Seed Science*. 35: 177-179.