African Journal of Plant Science Vol. 5(1), pp. 52-56, January 2011
Available online at http://www.academicjournals.org/AJPS
ISSN 1996-0824 ©2011 Academic Journals

Full Length Research Paper

Salt effects on seed germination and seedling emergence of two *Acacia* species

Akram Kiani Abari[1]*, Mohammad Hosseini Nasr[2], Mohammad Hojjati[2] and Dariush Bayat[3]

[1]Department of Forestry, Faculty of Natural Resources, Mazandaran University, Sari city, Mazandaran province, Iran.
[2]Department of Forestry, Faculty of Natural Resources, Sari Agricultural Science and Natural Resources University, Sari, Iran.
[3]Caspian forest tree center, Mahmoud Abad city, Mazandaran province, Iran.

Accepted 9 June, 2010

Germination is the first stage in plant life cycle confronted with soil salinity and because of expanded saline areas around the world it is important to determine salt effects on this stage. In this study, we report an *in vitro* procedure for studying germination of *Acacia* spp. under salt stress with different NaCl and KCl concentrations. Seeds of *Acacia tortilis* (Forssk.) *Hayne* and *Acacia oerfota* (Forssk) *Schweinf* after subjected to sulphuric acid and boiling water, were grown in L_2 medium under eight salinity levels (0, 50, 100, 150, 200, 250 and 300 mM) in a complete randomized design under laboratory conditions. Germination of both species decreased by increasing salinity. Both *Acacia* species showed higher tolerance to increased level of NaCl than to KCl.

Key words: *In vitro* culture, *Acacia* spp., NaCl, KCl, germination percentage, germination speed.

INTRODUCTION

Soil salinity is a major factor limiting plant productivity, affecting about 95 million hectares world wide (Szabolcs, 1994). Saline soils contain sufficient soluble salts to suppress plant growth through a series of interacting factors such as osmotic potential effect, ion toxicity and antagonism, which induce nutrient imbalances (Neumann, 1995). Saboora et al. (2006) warned that there was a dangerous trend of a 10% per year increase in saline areas throughout the world. Salinity imposes serious environmental problems that affect grassland cover and the availability of animal feed in arid and semi-arid regions (El-kharbotly et al., 2003). Salt stress undesirably affects plant growth and productivity during all developmental stages. Aslam (2006) pointed out that tree planting is the cheapest and most simple natural biological approach to controlling salinity. Yeo and flowers (1980) also mentioned that utilization of halophytic plants in pasture and fodder production in saline soils is the only economic solution presently available. Laboratory investigations indicate that halophytes have adapted to saline habitats by their ability to adjust osmotically to increasing salinity levels (Clipson et al., 1985). *Acacia* is a pantropical and subtropical genus abundant throughout Australia, Asia, Africa and the Americas. *Acacia* species thrive in a diverse range of habitat and environments. Many species are well adapted to the semi-arid and savannah regions but others survive inmoist forest and riverine areas, tolerating both high pH and waterlogged soils Benninson and Paterson, 1993). With such diversity, *Acacia* has considerable potential in a range of livestock and agroforestry systems. *Acacia* trees offer other benefits such as fodder and shade for livestock improve soil fertility through nitrogen fixation and the production of leaf litter and also stabilize soils (Benninson and Paterson, 1993). *Acacia* species also provide edible fruits and seeds, gum Arabic and timber for fuel, construction and fencing (Benninson and Paterson, 1993).

Field and full-scale laboratory trials to determine the salinity tolerance of plants at the germination and early seedling growth stages generally take a considerable time and require large labor and resource inputs. Therefore, there has been interest in developing screening methods that save time and require minimum inputs (Chhipa and Lal, 1995). This study was carried out to assess and compare the salt tolerance of two *Acacia*

*Corresponding author. E-mail: akramkiani25@yahoo.com.

Table 1. Results of 2-way analysis of variance (ANOVA) of species, salinity, concentration and their interaction for the germination parameters. All of figures are significant at p < 0.01.

Source of variation	Mean squares		
	df	gp	gs
Species(sp)	1	197.04	14.39
Salts(sa)	2	70.93	12.31
Concentration(co)	7	426.64	70.40
Sp*Sa*Co	14	14.98	3.12

Where df is degree of freedom, gp is germination percentage and gs is germination speed.

species during early emergence for recommend in saline areas.

MATERIALS AND METHODS

Growth condition and plant material

This experimental study was carried out under laboratory conditions in February 2009. Ripe fruit of *Acacia tortilis* and *Acacia oerfota* were collected in September 2008 from mature and healthy appearance trees growing in Minab in the south of Iran (Hormozgan Provence). The empty *Acacia* seeds were removed by floating them in water because of low weight comparing with intact seeds. Seeds of *A. oerfota* and *A. tortilis* were treated by sulphuric acid (Rostami and Shahsavar, 2009) and boiling water (Aref, 2000), respectively. Seeds were then soaked for 15 and 1 m in 0.1% $HgCl_2$ and 70% ethanol, respectively and rinsed repeatedly with distilled water. Then, seeds were cultured in L_2 (Philips and Collins, 1979) medium. Solution of the NaCl and KCl were used at concentrations of 0 (control), 50, 100, 150, 200, 250 300 and 350 mM in L_2 medium. Thirty seeds (10 seeds in each repetition) were used in each salinity treatment. The bottles which seeds implant on were maintained in the germinator at day/night temperatures of 25/15°C (±2°C) and relative humidity of 90% with a 16 h photoperiod. The number of germinant seeds was counted every 6 days up to 30 days and the seeds were considered germinated when the radicle emerged.

Data record and analysis

At the end of the germination period, the germination percentage and germination speed for *Acacia* seeds subjected to salinity treatments were calculated using appendix equations:

Final germination percentage = $GP = \frac{n_i}{N} \times 100$

Germination speed = $GS = \sum_{i=1}^{n} \left(\frac{n}{t} \right)$

For data analyze, we used a completely randomized design (CRD) with 3 replicates per treatments. Comparisons of germination speed and germination percentage among different salinity treatments were made using 2-way analysis of variance (ANOVA). When significant main effects existed, differences were tested by Duncan test at p ≤ 0.05.

RESULTS

Plant growth inhibition is a common response to salinity and plant growth is one of the most important agricultural indices of salt stress tolerance (Al-Thabet et al., 2004). Increasing salinity concentration in germination media often causes osmotic and/or specific toxicity which may reduce or retard germination percentage. The results of this study show that NaCl and KCl salt stress, decreased germination percentage and speed in *A. oerfota* and *A. tortilis.* The germination percentage in these species for NaCl and KCl stopped at 350 and 300 Mm and 300 and 150 Mm, respectively.

The results of ANOVA manifested that germination speed and germination percentage of these Acacia species were significantly affected by type and concentration of salts (p < 0.01) (Table 1).

However, *A. oerfota* shows less reduction in germination percentage and speed in response to salt stress for both salts than *A. tortilis*. As the figures 1 to 4 shows, the tolerance of *A. oerfota* against NaCl is higher than for KCl. In this species, the germination percentage was relatively high compaired to *A. tortilis* even at concentration of 250 mM and 300 mM for KCl and NaCl, respect-tively (Figures 1 and 2). For *A. tortilis*, as we shows, the tolerance against to KCl was poor and ceased at 150 mM (Figure 3) but tolerance for NaCl was higher and stopped in 300 mM (Figure 4). For *A. oerfota* decreases in germination is linear and decreased as the salt level increased (Figures 1 and 2), but for *A. tortilis* it is irregular, especially for KCl which slump at the second highest concentration and then increased slightly at the third highest concentration and finally stopped in forth (200 mM) concentration. It shows that this species is sensitive to KCl in germination stage.

DISCUSSION

The mechanism of inhibition of germination and seedling growth by NaCl, maybe related to radicle emergence due to insufficient water absorption, or may be ascribed to toxic effects on the embryo (Azza et al., 2007). Uhvits (1964) observed in *Alfalfa* plants that seeds absorbed an insufficient amount of water and accumulated a large amount of Cl when the osmotic pressure of the substrate was increased by salinity and As a result, the seeds emerged slowly and at higher concentrations could not germinate. Waisel (1972) founded that increasing salinity concentration often causes osmotic or specific toxity which may reduce or cease seed germination. Reduction in germination of plants by increasing salinity levels has been described by numerous authors (Breen et al., 1997; El-Tayeb, 2005; Abdul karim et al., 1992; Abbad et al., 2004). In contrast Seedling emergence and survival under

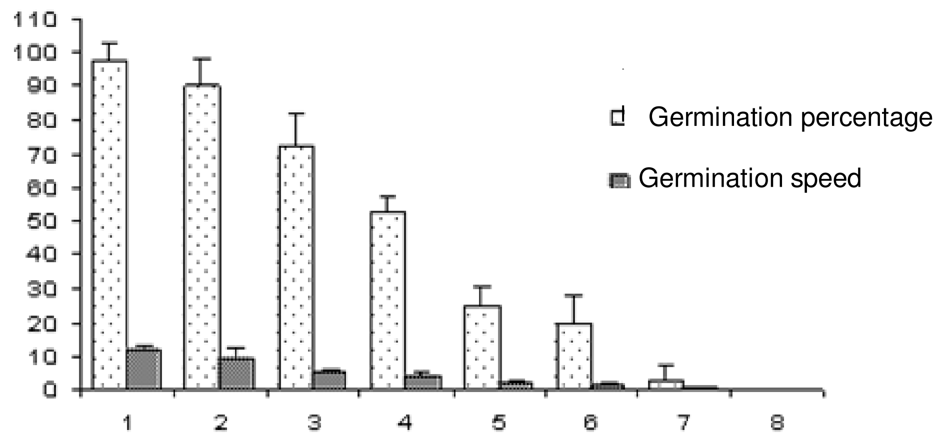

Figure 1. Effects of KCl stress on germination percentage and speed in *Acacia oerfota* seeds. The mean values and standard errors (vertical bars) of three replicates are shown. Number 1 to 8 is salinity levels from 0 to 350 mM.

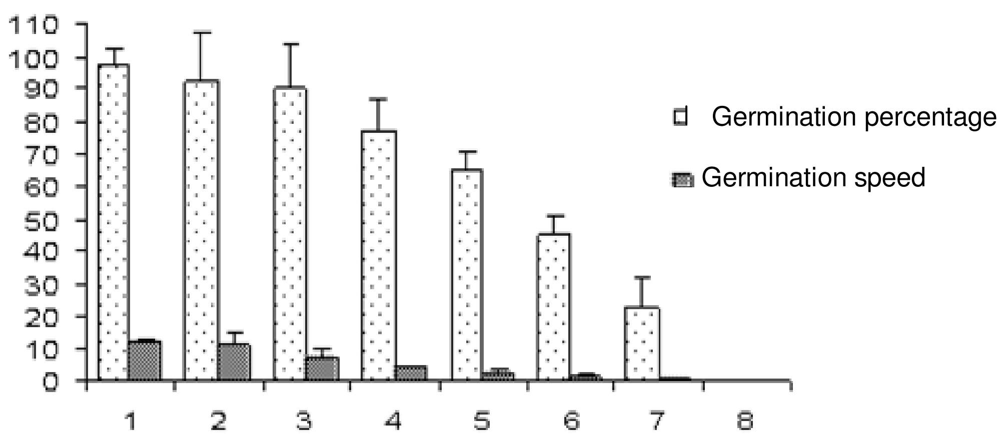

Figure 2. Effects of NaCl stress on germination percentage and speed in *Acacia oerfota* seeds. The mean values and standard errors (vertical bars) of three replicates are shown. Number 1 to 8 is salinity levels from 0 to 350 mM.

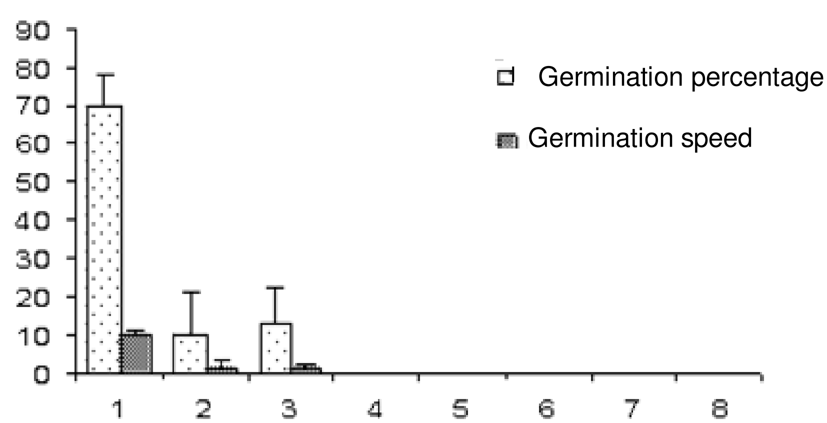

Figure 3. Effects of KCl stress on germination percentage and speed in *Acacia tortilis* seeds. The mean values and standard errors (vertical bars) of three replicates are shown. Number 1 to 8 is salinity levels from 0 to 350 mM.

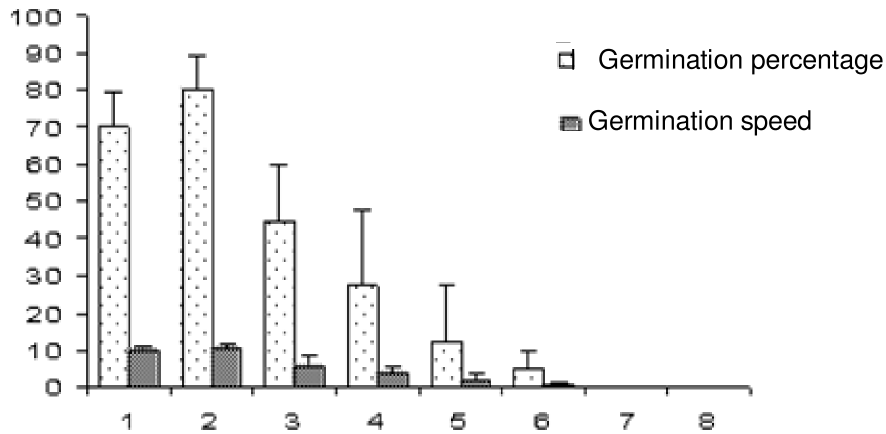

Figure 4. Effects of NaCl stress on germination percentage and speed in *Acacia tortilis* seeds. The mean values and standard errors (vertical bars) of three replicates are shown. Number 1 to 8 is salinity levels from 0 to 350 mM.

saline conditions in *A. salicina* were observed at 200 mM NaCl or 20 ds/m and said this species is salt tolerant (Madsen and Mulligan, 2006). Also Mehari et al. (2006) found in a glasshouse experiment that *A. tortilis* and *A. nilotica* are salt tolerant and even survived at 300 mM NaCl. But *A. nilotica* is more tolerant than the other species. Marcar et al. (1991) showed that *Acacia* species differed in their tolerance of salt with species being killed between 200 and >400 mM NaCl and they are salt tolerant species. In consistent, Mariam and Wedad (2009) found that sodium chloride concentrations did not inhibit germination of barley grains. Barley seedling development was promoted under concentrations up to 500 mM of sodium chloride. The results reported in this study, suggest that both Acacia species are salt tolerance and *A. oerfota* is one of the more salt tolerant *Acacias* and very suitable for planting in high salt soils. However, the effect of salinity on plant growth is related to the stage of plant development at which salinity is imposed. For example, it has been reported that salinity delays germination but does not appreciably reduce the final percentage of germination (Ayers and Westcot, 1985). In conclusion, based on the obtained results it seems that *A. oerfota* is more tolerant than *A. tortilis* against salinity. The reductions in seed germination under salinity for both salts in *A. tortilis* were occurring earlier than in *A. oerfota*. Therefore, we suggest the use of *A. oerfota* for reclamation in arid and semi-arid areas, where salinity affects vegetation development, could lead to suitable results.

ACKNOWLEDGEMENTS

The authors thank Mr. Yahya Kooch (Department of Forestry, University of Tarbiat Moddares) for statistical analyses. We would like to acknowledge the staff and expert of Bandar Abbas Natural Resources office for providing us with *Acacia* seeds.

REFERENCES

Abbad A, El Hadrami A, Benchabane A (2004). Germination responses of the Mediterranean Saltbush (*Atriplex halimus* L.) to NACl Treatment, J. Agron., 3(2): 111-114.

Abdul Karim MD, Utsunomiya N, Shigenaca SH (1992). Effects of sodium chloride on germination and growth of Hexaploid Triticale at early seedling stage. Japanese. J. Crop. Sci., 61(2): 279-284.

Al-Thabet SS, Leilah AA, Al-Hawass I (2004). Effects of NaCl and Incubation Temperature on Seed Germination of Three Canola (*Brassica napus* L.) Cultivars. Sci. J. King. Faisel. Univer., 5(1): 81-91.

Aref IMI (2000). Effects of pre-germination treatments and sowing depths upon germination potential of some *Acacia* species. Res. Bull., 95: 5-17.

Aslam Z (2006). Saline agriculture. In: Pakistan Agriculture Management and Development. Quraishi MAA, Zia MA , Quraishi MS (Eds.). A-One Publishers, Lahore, Pakistan, pp. 210-221.

Ayers R, Westcot W (1985). Water quality for agriculture. Irrigation and drainage paper No. 29 (revised), FAO, Rome.

Azza Mazher AM, Fatma EL-Quensi EM, Farahat MM (2007). Responses of ornamental plants and woody trees to salinity. World J. Agric. Sci., 3(3): 386-395.

Benninson JJ, Paterson RT (1993). Use of tree by livestock *ACACIA*. Natural resources institute. United Kingdom.

Breen CM, Everson C, Rogers K (1997). Ecological studies on Sporobolus virginicus (L.) Kunth with particular reference to salinity and inundation, Hydrobiol., 54: 135-140.

Chhipa BR, Lal P (1995). Na/K ratios as the basis of salt tolerance. Australian. J. Agric. Res., 46: 533-539.

Clipson NJW, Tomos AD, Flowers TJ, Wyn jones RG (1985). Salt tolerance in the halophyte *Suaeda maritime* L. Dum. The maintenance of turgur pressure and water-potential gradients in plant growing at different salinities. Planta., 165: 392-396.

El-kharbotly A, Maghloub O, Al-subhi A, al-halhali A (2003). Indigenous grass species with potential for maintaining rangeland and livestock feeding in Oman. Agric. Ecosyst. Environ., 95: 623-627.

El-Tayeb MA (2005). Response of barely grains to the interactive e.etc. Of salinity and salicylic acid. J. plant growth Regulation, 3: 215-224.

Madsen PA, Mulligan DR (2006). Effect of NaCl on emergence and growth of a range of provenances of *Eucalyptus* citriodora, Eucalyotus populea, *Eucalyotus camaldulensis* and *Acacia salicina*,

Forest. Ecol. Manage., 228: 152-159.
Marcar NE, Dart P, Sweeney C (1991). Effect of root-zone salinity on growth and chemicaal composition of three *Acacia* species at two nitrogen levels, New phytol., 119: 567-573.
Mehari A, Ericson T, Weih M (2006). Effect of NaCl on seedling growth biomass production and water status of *A. nilotica* and *A. tortilis*. J. Arid. Environ., 62: 343-349.
Neumann PM (1995). Inhibition of root growth by salinity stress. In: Structure and Function of Roots. Baluska F, Ciamporova M, Gasporikova O, Barlow PW (Eds.). Kluwer Academic Publishers, Netherlands, pp. 299-304.
Rostami AA., Shahsavar A (2009). Effects of seed scarification on seed germination and early growth of *Olive* seedlings. J. Boil. sci., 9(8): 825-828.
Saboora A, Kiarostami K, Behroozbayati F, Hashemi SH (2006). Salinity (NaCl) tolerance of wheat genotypes at germination and early seedling growth, Pakistan. J. Biol. Sci., 9(11): 2009-2021.
Szabolcs I (1994). Soils and salinization. In: M. Pessarakli (Ed), handbook of plant and crop stress. Marcel Dekker, New York, pp: 3-11.
Uhvits R (1964). Effects of osmotic pressure on water absorption and germination of alfalfa seeds, Am. J. Bot., 33: 278-285.
Yeo AR, Flowers TJ (1980). Salt tolerance in the halophyte *Suaeda maritime* L. Dum: Evaluation of the effect of salinity upon growth. J. Exp. Bot., 31: 1171-1183.