INT. J. BIOL. BIOTECH., 13 (2): 279-282, 2016.

EFFECT OF SALINITY ON SEED GERMINATION OF SOME MALVACEOUS SPECIES

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ABSTRACT

The effects of salinity were studied on germination of *Gossypium hirsutum, Kosteletzkya virginica* and *Thespesia populnea* under different concentrations of sea salt i.e. non saline control (EC_{iw}: 0.4 $dS.m^{-1}$), 0.5% sea salt (EC_{iw}: 6.2 $dS.m^{-1}$), 1.0% sea salt (EC_{iw}: 12.95 $dS.m^{-1}$), and 1.5% sea salt (EC_{iw}: 18.90 $dS.m^{-1}$) in irrigation medium. An increase in germination was noticed at 0.5% salinity (EC_{iw}: 6.2 $dS.m^{-1}$) in *K. virginica* and *T. populnea*, but germination was completely inhibited at 1.5% salinity (EC_{iw}: 18.9 $dS.m^{-1}$). There was regular decline in germination under increasing salinities in *G. hirsutum.*

Key-words: Salinity, seed germination, *Gossypium hirsutum, Kosteletzkya virginica, Thespesia populnea.*

INTRODUCTION

Salinity generally causes reduction in growth and yield of crop plants (Greenway and Munns, 1980). The concentrations at which salinity restricts plant growth vary widely among plant species. Some crops are sensitive to even low salinity while others are moderately salt tolerant and still others are more salt tolerant (Greenway and Munns, 1980).

Salt sensitivity changes with growth stage (Shanon *et al.,* 1993). Bayuelo-Jimenez *et al.* (2002) showed that different *Phaseolus* species showed different abilities at germination and seedling stage. *Indigofera oblongifolia* exhibited more or less similar tolerance to salinity at germination and growth phase (Khan and Ahmad, 1998). Inhibition in germination may be due to osmotic as well as ionic effects (Song *et al.,* 2005).

The establishment of plant population is greatly dependent on the germination response of their seeds under saline condition. Germination and establishment of seedling is important because the loss of plant at this stage will result in reduction of plant population density which will ultimately result in significant reduction in yield (Mass *et al.,* 1996). Different plant species show varying tolerance to salinity during germination. Seeds of halophytes are more tolerant to salinity (Malcolm *et al.,* 2003), however increased salinity causes reduction in germination of both glycophyte and halophyte seeds (Ungar, 1982). Information of sensitivity of a crop to salinity at certain growth stage is helpful to adopt suitable management practices during that phase.

In this paper effect of different concentrations sea salt on seed germination of three different plant species of family malvaceae are studied.

MATERIALS AND METHODS

Seeds of *Gossypium hirsutum* L. cv. Niab-78 were obtained by the courtesy of Prof. M. Ashraf, University of Agricultural Faisalabad, and that of *Kosteletzkya virginica* (L.) Presl. were kindly sent by Prof. John Gallagher, University of Delaware college of Marine and Earth studies, USA. Seeds of *Thespesia populnea* L. Sol. Ex. Corr. were collected from the trees growing in the campus of University of Karachi, Karachi, Pakistan. Their germination responses were studied in Petri dish experiment under non saline control (EC_{iw}: 0.4 $dS.m^{-1}$), and different sea salt solutions i.e. 0.5% (EC_{iw}: 6.2 $dS.m^{-1}$), 1.0% (EC_{iw}: 12.95 $dS.m^{-1}$), and 1.5% (EC_{iw}: 18.9 $dS.m^{-1}$). *G. hirsutum* seeds were delinted using concentrated sulphuric acid, *K. virginica* seeds were used as such and *T. populnea* seeds were scarified with concentrated H_2SO_4. The seeds of all the three species were surface sterilized with 0.1 % solution of $HgCl_2$ for five minutes, washed thoroughly in distilled water and then soaked in distilled water for half an hour before keeping them for germination at sterilized Petri dishes on filter paper. Three replicates of five seeds each were kept for all plants. Two ml of distilled water or respective sea salt solution was added to keep filter paper moist throughout the studies. Emergence of radical was considered as germination.

OBSERVATION AND RESULTS

Germination percentage of three different plant species belonging to the family Malvaceae is presented in (Table1). Maximum germination percentage was shown by *Thespesia populnea*, whereas *Gossypium hirsutum and Kosteletzkya virginica* occupied second and third position respectively under non saline conditions. It may be noted that germination percentage in *K. virginica* and *T. populnea* increased over non saline control under 0.5% sea salt solution (EC_{iw}: 6.2 $dS.m^{-1}$), whereas decrease is shown in *G. hirsutum* at this salinity. Reduction in percentage of germination is evident at 1.0% sea salt (EC_{iw}: 12.95 $dS.m^{-1}$), with exception of *K. virginica* which still shows 17.66% promotion over non saline control. The seeds of all the three species failed to germinate at 1.5% (EC_{iw}: 18.9 $dS.m^{-1}$) salinity level.

Table 1. Germination percentage of the three different species belonging to the family Malvaceae under various level of sea salt salinity.

Treatment	*G. hirsutum*	*K. virginica*	*T. populnea*
Control (EC_{iw}: 0.4 $dS.m^{-1}$)	86.7 a ± 0.7	73.6 a ± 0.3	93.3 a ± 0.9
0.5% (S.S) (EC_{iw}: 6.2 $dS.m^{-1}$)	46.7 b ± 0.3 (-46.15)	100 a ± 0.0 (+35.87)	100 b ± 0.0 (+7.18)
1.0% (S.S) (EC_{iw}: 12.95 $dS.m^{-1}$)	26.7 b ± 0.3 (-69.23)	86.6 a ± 0.6 (+17.66)	86.6 b ± 0.3 (-7.18)
1.5% (S.S) (EC_{iw}: 18.9 $dS.m^{-1}$)	0 ± 0 c	0 ± 0 b	0 ± 0 c
$LSD_{0.05}$	1.1	1.5	1.3

Means followed by different letters in the same column differ significantly at 95% Probability level according to New Duncan's Multiple Range Test.
Figures in parentheses indicate % promotion (+) and reduction (-) over control.

DISCUSSION

All the three Malvaceous plants showed variation in salt tolerance at germination stage. Germination decreased proportionally in *G. hirsutum* with the linear increase of sea salt irrigation. Inhibition in germination of *G. hirsutum* under saline condition was also noticed by various workers (Malik and Makhdum, 1987; Chaudhry *et al*., 1989; Khan *et al.*, 1995; Qadir and Shams, 1997; Perveen *et al.*, 1997; Javaid *et al*., 2001; Jafri and Ahmed, 2002). In spite the decrease in germination percentage seeds were able to germinate up to 1% salinity level. Ashraf *et al.* (2002) have shown that salinity decreases activity of α-amylase in cotton seeds which is associated with changes in reducing and non reducing sugars during germination. In their studies they showed that comparatively in salt tolerant cotton variety reduced α -amylase activity was sufficient to break the starch into sugars to fulfill the necessary requirement of energy during germination stage and suggested that cotton seeds were capable of maintaining the integrity of their enzyme system under salinity by utilizing of reducing and non reducing sugars in osmotic adjustment needed for growing seedling. Germination of *K. virginica* in present study showed increase in upto 1.0% (EC_{iw}: 12.95 $dS.m^{-1}$) sea salt solution. Beyond this concentration seed failed to germinate. Somers (1982) has also reported failure in germination of *K. virginica* seeds beyond 1% sea salt concentration. Poljakoff-Mayber *et al.* (1994) reported strong inhibition in the germination of *K. virginica* seeds beyond 300 mOsmol NaCl and attributed it due to osmotic as well ionic effect. He also indicated increase in proline content in response to salinity, suggesting the possible role of proline during germination under saline condition. Germination in *T. populnea* showed 7.18 % increase at 0.5% (EC_{iw}: 6.2 $dS.m^{-1}$) sea salt solution and decreased by 7.18% at 1.0% (EC_{iw}: 12.95

$dS.m^{-1}$) sea salt. Partridge and Wilson (1987) reported that the germination of halophytic species such as *Atriplex prostrate*, *Lolium* sp., *Polypogon monspeliensis*, *Spergularia media* at lower NaCl concentration, was more than or equal to control whereas reduction in germination of various levels was observed in these species at higher NaCl concentration. Song *et al.* (2005) consider that the inhibition in germination is due to osmotic as well as ionic effect in halophytic species, *Suaeda physophora*, *Haloxylon ammodendron* and *H. persicum*. Specific ion toxicity of Na^+ and Cl^- is shown responsible for the inhibition in the process of germination (Waisel, 1972). Katembe *et al.* (1998) reported that germination and seedling root elongation in *Atriplex prostrate* and *Atriplex patula* was more severely affected in NaCl than PEG solution which suggest the involvement of these ions in bringing toxic effect. Pujol *et al*. (1999) while working on five halophytic species showed that germination was inhibited due to osmotic effect by inducing temporary dormancy and when the stress conditions were alleviated germination is recovered and rate was stimulated. Similar results were obtained for *Suaeda depressa* (Williams and Unger, 1972) and wild *Chenopodium quinoa* (Prado *et al*., 2000). Inhibition of germination was found to be more in scarified *K. virginica* seeds than in intact seeds under salinity, indicating that seed coat acts as partial barrier to Na^+ influx (Poljakoff-Mayber *et al.*, 1994). Halophytes generally are reported to remain viable for long period under highly saline condition and germinate when the stress is alleviated (Keiffer and Unger, 1995).

Comparative studies of the three Malvaceous plants used in present investigation show that germination percentage of *G. hirsutum* seeds decreased all the way with increase in salinity. Whereas, in *T. populnea* it increased up to 0.5% (EC: 6.2 $dS.m^{-1}$) sea salt and in *K. virginica* up to 1.0% (EC_{iw}: 12.95 $dS.m^{-1}$) sea salt solution. Further increase in salinity beyond above mentioned sea salt percentage inhibited germination in these plants.

REFRENCES

Ashraf, M.Y., G. Sarwar, M. Ashraf, R. Afaf and A. Sattar (2002). Salinity induced changes in α- amylase activity during germination and early cotton seedling growth. *Biologia Plantarum*, 45(4): 589-591.

Bayuelo-Jimenez, J.S., R. Craig and J.P. Lynch (2002). Salinity tolerance of Phaseolus species during germination and early seedling growth. *Crop Science*, 42: 1584-1594.

Chaudhry, F.I., M.N.A. Malik and S.I. Hussain (1989). Salt tolerance of nine cotton cultivars at germination stage. *The Pak. Cottons*, 33: 72-75.

Greenway, H. and R. Munns (1980). Mechanism of salt tolerance in nonhalophytes. *Annual Review of Plant Physiology*, 31:149-190.

Jafri, A.Z. and R. Ahmed (2002). Comparative performance of upland and Desi cotton cultivars at germination stages of growth under different salinity levels. *J. Res. Sci*., 13(2):161-166.

Javaid, A., M. Yasin and G. Nabi (2001). Effect of seed pre treatments on germination and growth of cotton (*Gossypium hirsutum* L.) under saline conditions. *Pakistan Journal of Biological Sciences*, 4(9): 1108-1110.

Katembe, W.J., I.A. Ungar and J.P. Mitchell (1998). Effect of salinity on germination and seedling growth of two *Atriplex* species (Chenopodiaceae). *Annals of Botany*, 82: 167-175.

Keiffer, C.H. and I.A. Ungar (1995). Germination responses of halophyte seeds exposed to long hyper-saline conditions. In: *Biology of salt tolerant plants* (Khan, M. A. and I.A. Ungar, Eds.), pp. 371-379. Department of Botany, University of Karachi, Karachi, Pakistan.

Khan, A.N., R.H. Qureshi and N. Ahmed (1995). Performance of cotton cultivars in saline growth media at germination stage. *Sarhad Journal of Agriculture*, 11(5): 643-646.

Khan, D. and R. Ahmad (1998). Effects of saline water irrigation on germination, growth and mineral distribution in *Indigofera oblongofera* Forsk. *Hamdard Medicus* XLI (4): 81-94.

Maas, E.V., M.S. Lesch, L.E. Francois and C.M. Grieve (1996). Contribution of individual culms to yield of salt stressed wheat. *Crop Sci*., 36: 142-149.

Malcolm, C.V., V.A. Landley, J.W.O'Leary, H.V. Runciman, and Barrett-Lennard (2003). Halophyte and glycophyte salt tolerance at germination and the establishment of halophyte shrubs in saline environment. *Plant and Soil*, 253: 171-185.

Malik, M.N. and M.I. Makhdum (1987). Salinity tolerance of cotton cultivar (*Gossypium hirsutum* L.) at germination. *The Pak Cotton*, 31: 157-168.

Partridge, T.R. and J.B. Wilson (1987). Germination in relation to salinity in some plants of salt marshes in Otago, New Zealand. *New Zealand Journal of Botany*, 24: 255-261.

Perveen, K., I.A. Khan, T. Kausar, B. Saadia and K.N. Shah (1997). Phenotypic stability analysis of seedling traits of cotton cultivars across NaCl treatments. *Journal of Agricultural Research*, 35(5): 315-321.

Poljakoff–Mayber, A., G.F. Somers, E. Werker and J.L. Gallagher (1994). Seeds of *Kosteletzkya virginica* (Malvaceae) their structure germination and salt tolerance. II. germination and salt tolerance. *American Journal of Botany* 81(1): 54-59.

Prado, F.E., C. Boero, M. Gallardo and J.A.Gonzalez (2000). Effect of NaCl on germination growth and soluble sugar content in *Chenopodium Quinoa* Willd seeds. *Bot. Bull. Acad. Sin*., 41: 27-34.

Pujol, G.A., J.A. Calvo and L. Ramirez-Diaz (2000). Recovery of germination from different osmotic conditions by four halophytes from south eastern Spain. *Annals of Botany*, 85: 279-286.

Qadir, M. and M. Shams (1997). Some agronomic and physiological aspects of salt tolerance in cotton (*Gossypium hirsutum* L). *Journal of Agronomy and Plant Science*, 179(2): 101-106.

Shannon, M.C., F.N. Dalton and F.S. El Sayed (1993). Physiological responses of crop to sea water: minimizing constraints that limit yield. In: *Towards rational use of high salinity tolerant plants* (Leith, H and A.A. Al Masoom, Eds.). pp. 3-12. Vol. 2. Kluwer Academic Publ. Dordecht, 1992.

Somers, G.F. (1982). Food and economic plants, general review. In: *Biosaline research: a look to future* (A. San Pietro, Ed.), pp. 127-148. Plenum Press New York, NY.

Song, J., G. Feng, C. Tian, and F. Zhang (2005). Strategies for adaptation of *Suaeda physophera*, *Haloxylon ammodendron* and *Haloxylon persicum* to a saline environment during seed germination stage. *Annals of Botany*, 96(3): 399-405.

Ungar, I.A. (1982). Germination ecology of halophytes. In: *Contribution to ecology of halophytes* (Sen D.N. and Rajprohit, K.S. eds.). Tha Hague: Dr. W. Junk publishers. 143-154.

Waisel, (1972). *Biology of halophytes*. Academic press. New York and London.

William, M.D. and I.A.Unger (1972). The effect of environmental parameters on germination, growth and development of *Suaeda depressa* (Pursh) Wats. *American Journal of Botany*, 59: 912-918.

(*Accepted for publication March 2016*)