Studies on Germination of *Cressa cretica* L. Seeds

M. Ajmal Khan*

ABSTRACT

The halophyte, *Cressa cretica* L. produces seeds under high salinity conditions and deposits them on saline soil. Experiments were conducted to determine the effect of scarification, temperature, salinity, and growth regulators on germination and early seedling growth. Results indicate that the hard seed coat seems to be the primary cause of dormancy. Scarified seeds have the ability to germinate at high salinity (5%); however, maximum germination occurred in the non-saline control. A temperature regime of 10-20°C was helpful in promoting germination, and few seeds germination at 20-30°C at all salinities tested. Application of GA_3 alleviated seed dormancy imposed by high salinity.

INTRODUCTION

Cressa cretica L. (Convolvulaceae) is an erect or sub-erect dwarf shrub distributed widely in warmer and tropical regions of the world. The species is a common halophyte present on coastal and inland saline flats in Pakistan. *Cressa cretica* usually is found growing in pure stands or sometimes associated with other halophytes such as *Atriplex grifithii*, Suaeda *fruticosa*, *Haloxylon recurvum*, and *Urochondra setulosa*. It is one of the dominant species of halophtic communities present in coastal and inland areas of southern Pakistan. *Cressa cretica* also found as a weed growing in the rice fields in southern Sindh. Germination of the seeds depends upon the availability of moisture. The area receives rain during the monsoon, mid June to mid august. After the rains, seeds of other weeds start geminating, due to availability of moisture and suitable temperatures, however, very little or no germination was observed in *Cressa cretica* under field conditions. Recruitment of new individuals occurred through rhizomes. New shoots appear annually during March and April, produce flower and fruits whereas the old ones gradually die out. During field observation however, we recorded only one flowering period in coastal as well as inland populations. This lack of germination in *Cressa cretica* led us to investigate the cause of their dormancy.

Many reports show a differential effect of salinity and temperature and germination of other halophytes (Ungar 1977, Ignaciuk and Lee 1980, Philipupillai and Ungar 1984, Khan and Ungar 1984ab, Khan and Weber 1986, and Khan *et al.* 1987; Ungar 1988; Badger and Ungar 1989; Morgan and Meyers 1989). Ungar (1977) reported that *Salicornia europaea* showed maximum germination in distilled water at 25°C

* Department of Botany, University of Karachi, Karachi-75270. Pakistan.

and minimum germination in salt solution at 10°C. Increased salinity inhibited gemination at all temperatures. Philipupillai and Ungar (1984) found a significant interaction between temperature and salinity on seed germination. Cold pretreatment enhanced the germination of dimorphic seeds of *Salicornia europaea*. Lower night temperature (5°C) treatment significantly promoted the germination of cold pretreated seeds at low salinity levels however, in the absence of cold pretreatment changes in alternating temperature regimes had no effect on seed gemination of *Salicornia europaea*. Khan and Ungar (1984a) studied the effect of salinity and temperature on germination of polymorphic seeds and of growth of *Atriplex triangularis* and found that the rate of germination was inversely correlated with salinity stress. Alternating temperature regime of 25°C day and 5°C night, 12h/12h, enhanced germination as compared to all other regimes used. There was a significant interaction between salinity and temperature. Khan and Weber (1986) indicated that germination in *Salicornia pacifica* var. *utahensis* was sensitive to the changes in temperature regimes At higher temperature (30-20°C. light and dark sequence), no germination occurred at 3, 4, and 5% NaCl treatments. On the other hand, 30% of the seeds germinated in the 5% NaCl treatment at 5-15°C. Badger and ungar (1989) concluded that germination of *Hordeum jubatum* seeds is inhibited by simulated warm summer-like thermoperiods. Seed of *Hordeum jubatum* will germinate at high salinities soon after dispersal if temperature conditions are available.

Seed dormancy induced by salt stress in halophytes can be alleviated by the application of GA_3 (Ungar 1977, 1984; Khan and Ungar 1985, 1986; Khan and Weber 1986; Khan *et al.* 1987) kinetin (Khan and Ungar 1985, 1986; Khan *et al* 1987; Tirmizi 1988) or a mixture of GA_3 and kinetin (Ungar and Binet 1975; Ungar 1977; Tirmizi 1988). The role of plant growth regulators in alleviating seed dormancy induced by salt stress is not clearly understood.

Despite the presence of large number of seeds in the soil reserve few seeds germinate and even fewer of them get established. The present study investigated the mechanism of dormancy in the *C. cretica* seeds by studying the effect of scarification, temperature, growth regulators, and salinity on seed germination and early seedling growth in *Cressa cretica*.

MATERIALS AND METHODS

Fruits of Cretica were collected during 1986 from plants growing in salt flats on Karachi University camps. Seeds were separated from infrutescences and stored in paper bags at 4°C. Initially seeds were surface sterilized with 0.52% sodium hypochlorite solution for 1 minute after they were washed thoroughly with distilled water. Later when we started acid scarification with concentrated sulphuric acid, surface sterilization was considered unnecessary. Seeds were scarified by placing them in concentrated sulphuric acid for one minute after which they were washed thoroughly with distilled water. Germination were carried out in test tubes of 12mm in diameter and 150mm in length (Khan and Jahan 1988). In each of these test tubes a Whattman # I filter strip (2 x 13 cm) was folded in such a manner that two depressions were formed. This strip was placed in the test tube after putting 25 seeds in the depressions. Two ml of test solution was gently poured into the tubes, which then were temporarily sealed using rubber bands and polyethylene sheets. Four replicates were used for each treatment. Seeds were considered to be germinated upon emergence of radicle.

To determine the effect of temperature on germination and early seedling growth, seeds were incubated in 12/12 h alternating temperature regimes of 10-20°C, 10-25°C, 15-25°C, and 20-30°C. The higher temperatures (20, 25, and 30°C) coincided with a 12h light period (2000 lux cool-white flourescent lamps) and lower temperatures (10, 15 and 20°C) with a 12h dark period. Seeds were geminated in distilled water (control) and in 1,3 and 5% NaCl solutions under the four temperature regimes.

Gibberellic acid concentration of 10^{-3} and 10^{-4} M and kinetin concentration of 10^{-4} and 10^{-5} M were used with 0, 1, 3, and 5% NaCl solution at a temperature regime of 10-20°C. Percent germination was recorded on alternate days for 20 days. The rate of germination velocity was calculated by using index of germination velocity = G/t, where G = percentage of seeds germinated at 2 day intervals, t = total germination period (Khan and Ungar 1984a). higher value represent a more rapid rate of germination. After 20 days, weight was determined by drying the seedlings at 80±2°C.

RESULTS AND DISCUSSION

Seed germination of desert plants including halophytes in Karachi begins after the monsoon rains that usually occur between June and August. The lack of germination of *Cressa cretica* seeds could be attributed to different factors. Present study clearly demonstrate the presence of seed dormancy in *C. cretica* is primarily due to hard seed coat as in other members of family Convolvulaceae. Exposure of the seeds to different temperature regime has some effect.

The highest germination percentage of unscarified seeds was 25% at 10-20°C in distilled water (Table. 1) when seed were scarified with sulphuric acid there was a tremendous increase in the final germination percentages (Fig. 1, 2, 3 and 4) Highest percentage germination (89%) was recorded at 10 day - 20°C night in non-saline control. Germination percentages

Table 1. Final germination percentage of nonscarified *Cressa cretica* seeds at various salinity and temperature treatment.

Temperature (°C)	NaCl (%)			
Night - Day	0	1	3	5
10 - 20	25 ± 2.0	18 ± 1.8	8 ± 1.4	4 ± 0.6
10 - 25	15 ± 1.8	9 ± 1.1	5 ± 1.2	3 ± 1.1
15 - 25	10 ± 1.9	7 ± 0.8	4 ± 0.6	2 ± 0.5
20 - 30	8 ± 4.0	6 ± 4.0	3 ± 0.8	0 ± 0.0

± = Standard error of mean

Table 2. Index of germination velocity of *Cressa cretica* seedlings at various salinity and temperature treatment.

Temperature (°C)	NaCl (%)			
Night - Day	0	1	3	5
10-20	30.4	25.6	11.9	4.9
10-25	23.4	12.0	8.2	3.5
15-25	7.3	5.3	3.9	1.7
20-30	6.3	4.9	1.8	0.0

± = Standard error of mean

Table 3. Final germination percentage of scarified *Cressa cretica* seeds at various salinity and temperature treatment.

Temperature (°C)	NaCl (%)			
Night - Day	0	1	3	5
10-20	89 ± 6.8	78 ± 4.5	39 ± 8.1	16 ± 4.2
10-25	60 ± 4.3	32 ± 3.1	20 ± 1.2	9 ± 2.4
15-25	32 ± 1.2	30 ± 4.2	16 ± 1.6	6 ± 1.0
20-30	28 ± 2.8	20 ± 1.8	4 ± 1.1	0 ± 0.0

± = Standard error of mean.

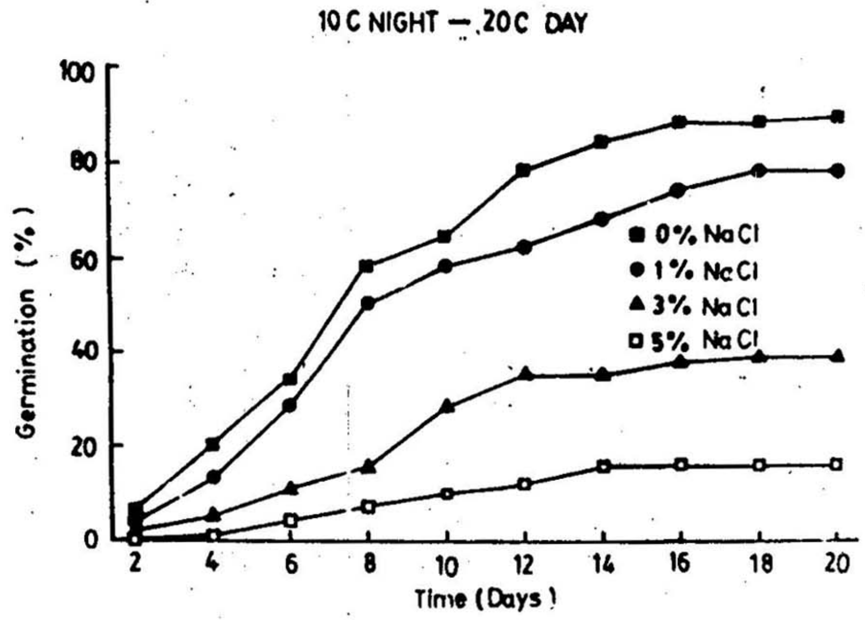

Figure 1. Germination of *Cressa cretica* seeds in 0-5% NaCl at a 10-20^{0}C thermoperiod and 12 h photoperiod.

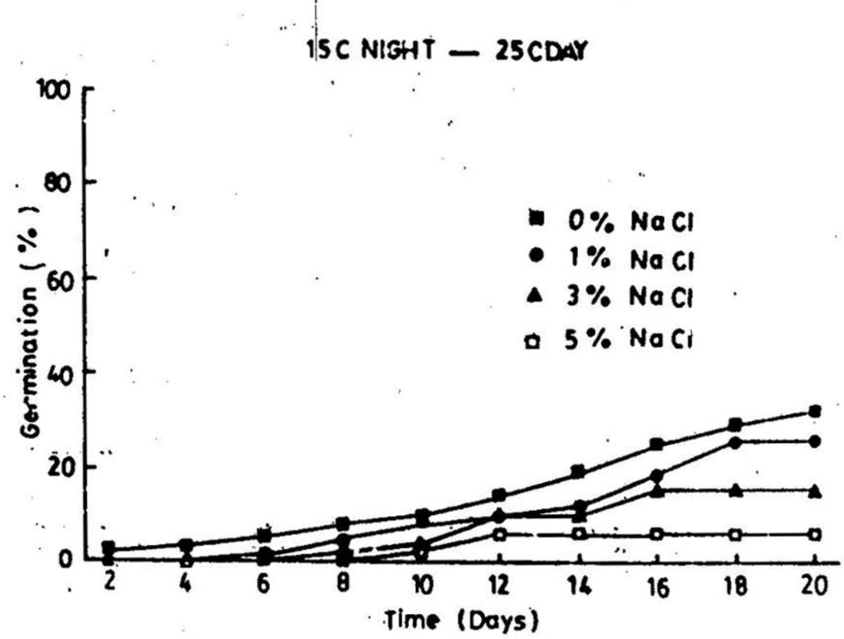

Figure 2. Germination of *Cressa cretica* seeds in 0-5% NaCl at a 15-25^{0}C thermoperiod and 12 h photoperiod.

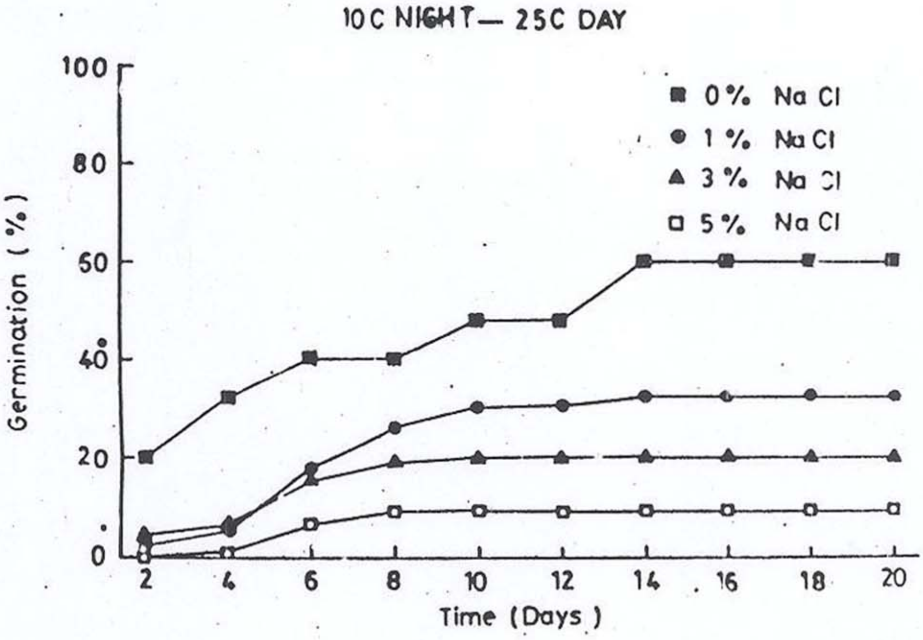

Figure 3. Germination of *Cressa cretica* seeds in 0-5% NaCl at a 10-25^{0}C thermoperiod and 12 photoperiod.

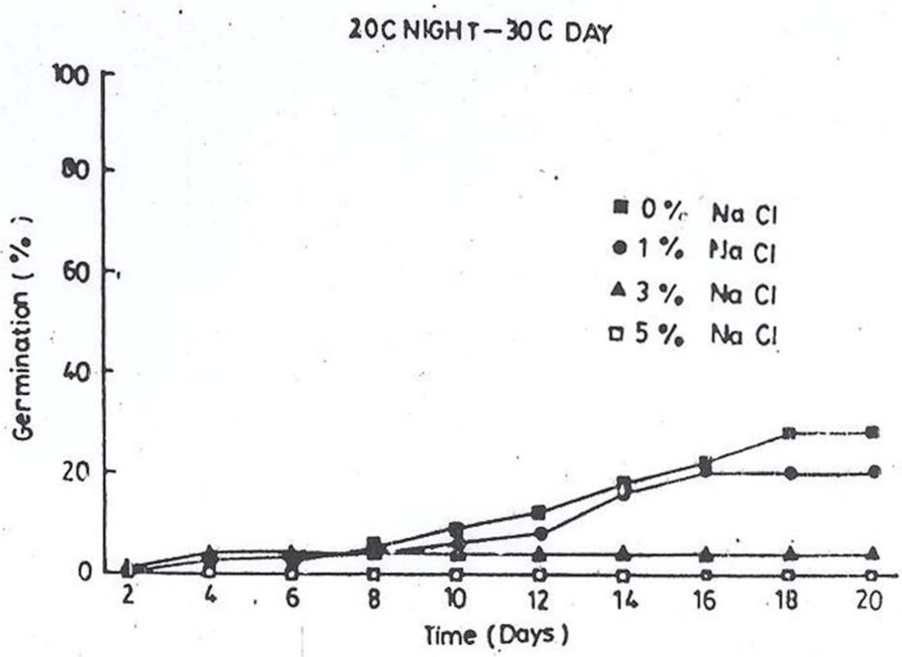

Figure 4. Germination of *Cressa cretica* seeds in 0-5% NaCl at a 20-30^{0}C thermoperiod and 1 photoperiod.

decreased progressively with increase in temperature. At the highest thermoperiod (20°C Day - 30°C night) only 19% seeds germinated in non saline control. High salinity treatment (5% NaCl) were injurious to seed germination, only 10% seed germinated at best temperature regime (10-20°C). The highest rate of germination at non saline control was at 10 - 20°C (Table 2). All salinity treatments at the 10 - 20°C regime resulted in a higher germination as compared to other temperature treatments. However, increase in salinity progressively inhibited the germination. The lowest rate of germination was obtained at 20 - 30°C. Total germination percentage of scarified *C. cretica* seed under various salinity and temperature treatments are presented in Table 3. The highest gemination percentage were obtained in non saline treatment at 10 - 20°C. Increase in salinity resulted in corresponding decrease in final germination percentages. At the temperature treatment of 20 - 30°C final germination percentages were significantly low.

Increase in salinity progressively inhibited the growth of *C. cretica* (Table 4). However, in contrast to germination 20 - 30°C. regime stimulated growth. Growth was poor at 10 - 20°C under all salinity regimes. Pretreatment of the seeds with gibberellic acid and kinetin had little or no effect in alleviating the growth of *C. cretica* seedlings under saline as well as non saline conditions.

Treating seeds with GA_3 caused an increase in the percentage germination (Fig. 5). Germination in3% NaCl increased from 40% in the control to 55% in GA_3-treated sample. Other GA_3 concentrations were less effective.

C. cretica is distributed in, highly saline inland and coastal communities. However, no relationship exists between the presence of plant species in saline zones and their gemination response to salinity (Khan and Ungar 1984a). Optimal germination occurs under reduced salinity even in highly salt tolerant species (Ungar 1977, Khan and Ungar 1984ab, Khan and Weber 1986, Kim *et al.* 1986, Aslam *et al.* 1987, and Khan *et al.* 1987). These observation could be of ecological significance since rainfall not only results in increased availability of water but also reduces soil salinity. A few weeks after the rains, water and salinity stress increase causing a high seedling mortality.

Rate and final percentages of germination of *C. cretica* seeds at 10 - 20°C was faster than at higher temperature regimes. Similar interaction between salinity and alternating temperature were reported by Mahmoud *et al* (1983). They found that seeds of the perennial halophytes *Halopeplis perfoliata* and *Limonium axillare* germinated at an alternating temperature regime and low salinity under the laboratory conditions. Although *Salicornia pacifica* var

Table 4. Seedling growth (mg/seedling) of *Cressa cretica* seedling at various salinit and temperature treatments.

Temperature (°C)	NaCl (%)			
Night - Day	0	1	3	5
10 - 20	0.18 ± 0.04	0.11 ± 0.01	0.10 ± 0.02	0.08 ±
10 - 25	0.19 ± 0.01	0.21 ± 0.03	0.18 ± 0.01	0.10 ±
15 - 25	0.22 ± 0.02	0.16 ± 0.02	0.16 ± 0.03	0.10 ±
20 - 30	0.24 ± 0.05	0.46 ± 0.01	0.18 ± 0.01	0.13 ±

+ = Standard errores mean.

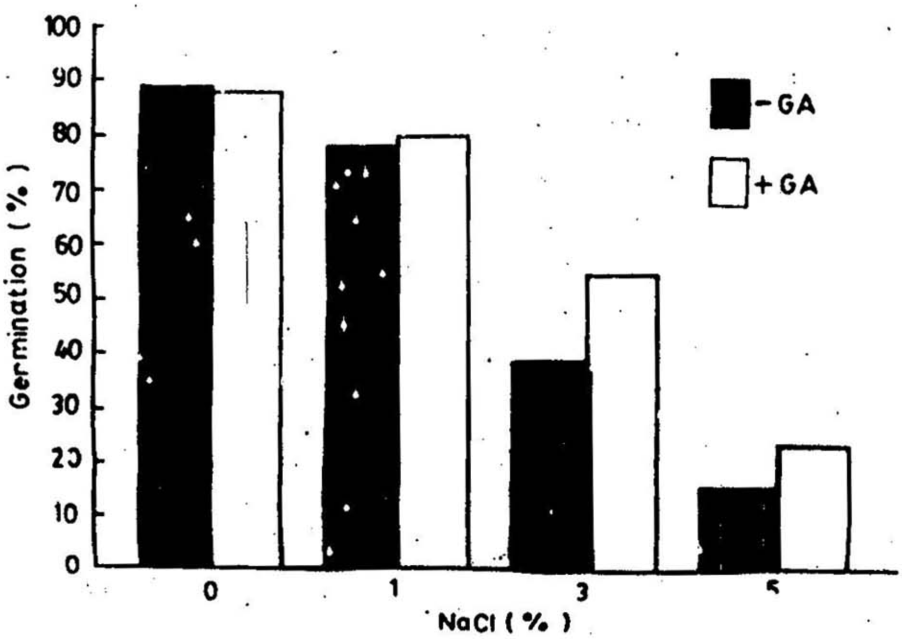

Figure 5. Effect of GA_3 on salinity-induced inhibition of germination of *Cressa cretica* seeds a 10-20°C thermoperiod and 12 h photoperiod.

utahensis grows in the highly saline region of an inland salt playa at Goshan, Utah (Khan and Weber 1986), seed germination was inhibited by increased salinity. However, alternating temperature regime of 5 - 15°C stimulated germination in all salinities tested. A similar pattern was observed in C.cretica. Differential effect of temperature and salinity in affecting seed germination was also reported for *Crithmum maritimum* (Okusanya 1977); *Atriplex triangularis* (Khan and Ungar 1984). This report demonstrates the presence of seed dormancy in *C. cretica*, which was partially alleviated (25%) by low alternating temperatures. Growth regulator treatment was ineffective in overcoming seed dormancy. From this result it appears that dormancy in *Cressa cretica* like in other members of Convolvulaceae is caused by hard (water impermeable) seed coat. Moderate temperature and low salinity will promote germination of scarified seeds under field conditions.

REFERENCES

Aslam, Z. M., M. Salim, R. H.Qureshi and G. R. Sandhu. 1987. Salt tolerance of Echinochloa crusgalli. Biol. Plant. 29: 66-69.

Badger K. S. and I. A. Ungar. 1989. The effects of salinity and temperature on the germination of the inland halophyte *Hordeum jubatum*. Can. J. Bot. 67: 1420-1425.

Ignaciuk, R. and J. A Lee. 1980. The germination of four annual strand-line species New Phytol. 84: 581-591.

Khan, M. A. and I. A. Ungar. 1984a. The effect of salinity and temperature on the germination of polymorphic seeds and growth of Atriplex trianagularis Willd. Amer. J. Bot. 71: 481-489.

Khan, M. A. and I. A. Ungar. 1984b. Seed polymorphism and germination responses to salinity stress in *Atriplex triangularis* Willd. Bot. Gaz. 145: 487-494.

Khan, M. A. and I. A. Ungar. 1985. The role of hormones in regulating the germination of polymorphic seed and early seedling growth of *Atriplex triangalaris* under saline conditions. Physiol. Plant. 63:109-113.

Khan, M. A. and I. A. Ungar. 1986. Inhibition of germination in *Atriplex triangularis* seed by application of phenols and reversal of inhibition by growth regulators. Bot. Gaz. 147: 148-151.

Khan, M. A. and D. J. Weber. 1986. Factor influencing seed germination in *Salicornia pacifica* var. *utahensis*. Amer. J. Bot. 73: 1163-1167.

Khan, M. A.; N. Sankhla, D. J. Weber and E. D. McArthur. 1987. Seed germination characteristics of Chrysothamnus nauseosus ssp. viridulus (Astereae, Asteraceae). Great Basin Nat. 47: 220-226.

Khan, M. I. and B. Jahan. 1988. Allelopathic potential of senesced anthers of *Bombax ceiba* L. inhibiting germination and growth of lettuce seeds. Pak. J. Bot. 20: 205-212.

Kim, K. S., Y. S. Moon and C. K. Lim. 1986. Effect of sodium chloride on germination of *Atriplex gemelni* and *Phragmites communis*. Korean J. Bot. 28: 253-259.

Mahmoud, A., A. M. Elsheikh, and S. Abdul Baset. 1983. Germination of two halophytes: *Halopeples perfoliata* and *Limonium axillare* from Saudi Arabia. J. Arid Environ. 6: 87-98.

Morgans, W. C. and B. A. Meyers. 1989. Germination of the salt-tolerant grass *Diplachne fusca*. I. Dormancy and temperature responses. Aust. J. Bot. 37: 225-237.

Okusanya, O. T. 1977. The effect of sea water and temperature on the germination behaviour of *Crithmum maritimum*. Physiol. Plant. 41: 265-267.

Phillipupillai. J. and I. A. Ungar. 1984. The effect of seed dimorphism on the germination and survival of *Salicornia europaea* L. Populations. Amer. J. Bot. 71: 542-549.

Tirmizi, S. A. S. 1988. Factors influencing germination and dormancy of *Honkenya peploides* (L) EHRH. Part I. Improvement of germination. Pak. J. Sci. Ind. Res. 31: 842-847.

Ungar, I. A. 1977. The relationship between soil water potential and plant water potential in two inland halophytes under field conditions. Bot. Gaz. 138:498-501.

Ungar, I. A. 1987a. Population characteristics, growth and survival of the halophyte *Salicornia europaea*. Ecology 68: 369-575.

Ungar, I. A. 1988. Effects of the parental environment on the temperature requirements and salinity tolerance of *Spergularia marina* seeds. Bot. Gaz. 149: 432

Ungar, I. A. and P. Binet 1975. Factors influencing seed dormancy in *Spergularia media* (L) C., Presl. Aquat. Bot. 1: 45-55.