Pak. J. Weed Sci. Res. 18(3): 367-377, 2012

EFFECT OF SEED SIZE AND ECOLOGICAL FACTORS ON GERMINATION OF *Emex spinosa*

Muhammad Shoab[1], Asif Tanveer*, Abdul Khaliq and Hafiz Haider Ali

ABSTRACT

The effect of ecological factors on germination of Emex spinosa was examined in laboratory experiments. Seeds were graded manually into large, medium and small, having weights 3.333, 1.952 and 0.886 g /100 seeds, respectively. Seeds germinated over a range of 10-20°C, with optimum germination (89.17%) at 15°C, showing a trend towards decrease in germination percentage, germination index and markedly increasing mean germination time with lowering temperature. Seed germination was observed under both light and complete darkness. Emex spinosa germination was 77.5% with distilled water and 41.66% at 150 mM NaCl concentration, while mean germination time increased and germination index decreased by increasing the salinity levels. Germination of E. spinosa decreased from 68.33% to 0.83% as osmotic potential increased from 0 to -0.8 M Pa. Mean germination time and germination index also decreased by increasing water stress. Emex spinosa seedling emergence was at its highest (50.83) at soil surface, and no seedling emerged at a depth of 8 cm, while mean germination time and germination index decreased by increasing seeding depth. Seed size showed non-significant results on all germination traits. Our results indicate that E. spinosa have ability to germinate under various conditions but the percentage that germinates will be different under different ecological conditions.

Key words: Drought, *Emex spinosa*, germination, salinity, seeding depth, temperature.

INTRODUCTION

Devil's thorn or spiny emex (*Emex spinosa* L. compd.), a member of the polygonaceae family, native to the Mediterranean region is considered as noxious weed. It is associated with cereals like wheat (*Triticum aestivum* L.), pulses like gram (*Cicer arietinum* L.), and fodders like Lucerne (*Medicago sativa* L.) and barseem (*Trifolium alexandrinum* L.). Due to high competitive ability and reproductive potential, this specie is expected to be a serious threat to cereals and pastures in near future for Pakistan (Siddiqi, 1973).

Seed germination is one of the critical phases in plant development. Each plant species has specific environmental

[1] Department of Agronomy, University of Agriculture, Faisalabad, Pkistan.
*Corresponding author's email: drasiftanveeruaf@hotmail.com

requirements for germination (Baskin and Baskin, 1989). Various environmental factors such as light, moisture, salt stress, pH and seed burial depth affect weed germination (Chauhan *et al*., 2006). Temperature and light are considered the most important environment signals regulating germination, species distribution and ecological interaction (Chauhan and Johson, 2008). Moisture stress may delay, reduce or prevent germination and growth of plant (Norsworthy and Oliveira, 2006). Ability to germinate under conditions of moisture stress may enable a weed to take advantage of conditions that limit the growth of other species.

Chachalis *et al.* (2008) observed that the germination of venice mallow (*Hibiscus trionum*) was 28 to 58% with a broad range of pH (3-11) and seeds were rather tolerant to low water potential (20% germination at -1.2 M Pa). Germination is delayed and reduced when salt stress exceeds to a critical level by decreasing the ease with which seed imbibe water or facilitating the entry of ions in an amount high enough to be toxic (Romo and Eddleman, 1985). The level of salinity at which germination is reduced varies with species, genotype, environmental conditions, osmotic potential and specific ions (Ungar, 1991). Seed burial depth affects germination and emergence (Koger *et al*., 2004) by influencing the availability of moisture, temperature and light exposure (Rao *et al*., 2008).

A better understanding of germination of *E. spinosa* could facilitate development of effective weed control options. The information would also be helpful in predicting its potential for spreading into new areas. Therefore, the present studies were conducted to determine the effects of temperature, light, salt stress, drought and seeding depth on seed germination of *E. spinosa*.

MATERIALS AND METHODS

Seed description

Experiments were conducted at Weed Science Laboratory, Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during winter 2009-10. Mature seeds of *E. spinosa* were collected from wheat crop at maturity in April, 2009; dried at room temperature (25° C) for a week, and then stored in paper bags at room temperature until used. Seeds were graded manually into large, medium and small, having weights 3.333, 1.952 and 0.886 g /100 seeds, respectively. Details of different ecological factors studied are:

Temperature

Ten seeds of each size of *E. Spinosa* were placed evenly on Whatman No. 10 filter paper in 9 cm diameter Petri dishes separately. Initially 5 ml distilled water was given to each Petri dish, then the

water was applied whenever needed. Petri dishes were placed in the germinators having temperature of 10, 15 and 20 °C.

Light

Ten seeds of each size of *E. Spinosa* were placed evenly on Whatman No. 10 filter paper in 9 cm diameter Petri dishes. Petri dishes were covered with single layer of aluminum foil to ensure no light penetration, or left uncovered to allow continuous light exposure. Initially 5 ml distilled water was given to each Petri dish, then the water was applied whenever needed. Petri dishes were placed in a germinator having temperature of 20°C.

Salinity

The saline solutions were made by dissolving 58.8g NaCl in distilled water in 1000 ml flask. This gave the stock solution. After that with the help of this stock solution, the solutions of required concentrations were prepared i.e. 25, 50, 75, 100, 125 and 150 ml of stock solution were dissolved in distilled water to fill the 1000 ml flask separately for 25, 50, 75, 100, 125 and 150 mM solutions, respectively. Ten seeds of each size of *E. Spinosa* were placed evenly on Whatman No. 10 filter paper in 9 cm diameter Petri dishes. Sodium chloride (NaCl) solution of known concentration was applied in Petri dishes for salt stress. Initially 5 ml solution each of 25, 50, 75, 100, 125 and 150 mM according to salinity level was given to each Petri dish separately, then the solution of required concentration was applied whenever needed. Petri dishes under controlled conditions received distilled water. Petri dishes were placed in a germinator having temperature 20°C.

Drought Stress

For making the required concentration of osmotic potential polyethylene glycol (PEG-6000) was used in distilled water. For this 11.76, 14.5, 17.8 and 21.1g PEG was used to prepare -0.2, -0.4, -0.6 and -0.8 M Pa concentration, respectively in 100 ml of distilled water keeping in mind that the solution was of 100 ml inclusive of PEG. After making the solutions, these were tested by the apparatus named osmometer. Ten seeds of each size of *E. Spinosa* were placed evenly on Whatman No. 10 filter paper in 9 cm diameter Petri dishes. Five ml solution of osmotic potential of 0, -0.2, -0.4, -0.6 and -0.8 M Pa according to drought level was given to each Petri dish separately and then was applied whenever needed. Petri dishes under controlled conditions received distilled water. Petri dishes were placed in a germinator having temperature 20°C.

Seeding Depth

Ten seeds of each size of *E. spinosa* were placed evenly according to seeding depths (0, 2, 4, 6, 8 cm) in 10 cm diameter plastic pots separately for each depth. Sand was used as media for

germination in pots. Initially, 150 ml distilled water was given to each pot and then was applied whenever needed. These pots were placed in a germinator, having temperature 20°C.

Statistical analysis

All experiments were conducted in a completely randomized design with factorial arrangements. Treatments of each experiment were replicated four times. Each replication was placed on a different shelf in the germination incubator. Germination counts were made every day for 2 weeks. A seed was considered germinated when the tip of the radical (2 mm) had grown free of the seed coat. Each experiment was carried out two times and statistical analysis was performed on mean of the two repeats. Data regarding seed germination percentage, germination index (GI), (AOSA, 1990) and mean germination time (MGT) (Ellis and Roberts, 1981) were recorded up to 14 days and then analyzed statistically analyzed using the Fisher's analysis of variance function of M STAT C statistical computer package and LSD at 5% probability was used to compare the treatment's means (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Temperature and Germination

The data presented in Fig. 1 and 2 showed that the effect of temperature on germination percentage, mean germination time and germination index was significant. The highest germination percentage (89.17%) of *E. spinosa* was found where 15°C temperature was maintained which was statistically at par with the germination percentage (88.33%) at 20 °C. The lowest germination percentage (55.83%) was observed where 10 °C temperature was maintained. Similar results were obtained by Gorai and Neffati (2007) in a laboratory experiment where germination response of *Reaumuria vermiculata* to temperature between 10 °C and 30 °C seem to be favorable for the germination of this species. Germination was inhibited by decreased temperature.

The highest mean germination time (8.84 days) was observed in the treatment where the temperature maintained was 10°C, whereas minimum mean germination time (4.42 days) was obtained where the temperature was 20°C which was statistically at par with that where temperature maintained was 15°C. It means that mean germination time increased by lowering the temperature and vice versa. The highest germination index (6.36) was obtained at 20 °C, while significantly lowest germination index (1.54) was found where temperature maintained was 10°C.

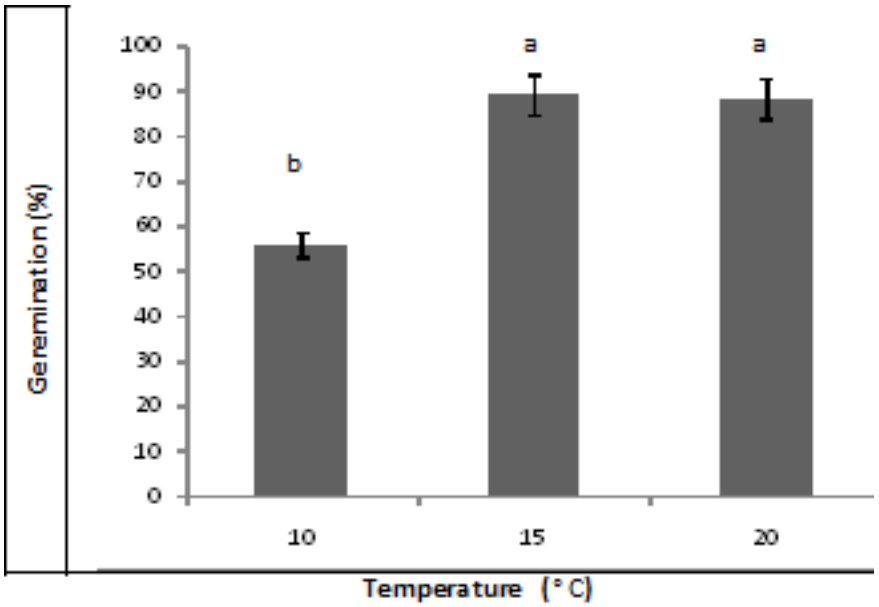

Figure 1. Effect of temperature on germination of *Emex spinosa.*
Means followed by the same letter did not differ significantly according to LSD test ($P < 0.05$).

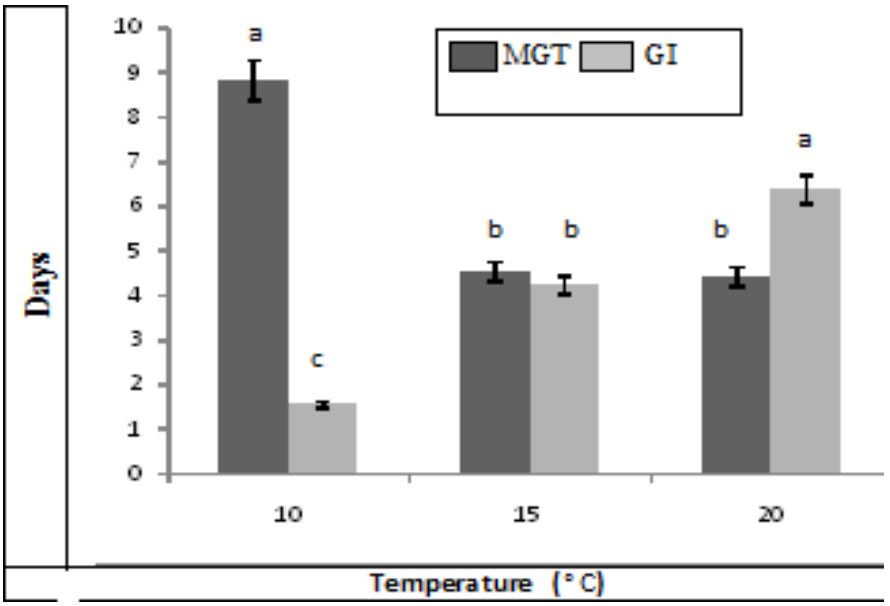

Figure 2. Effect of temperature on MGT and GI of *Emex spinosa.*
Means followed by the same letter did not differ significantly according to LSD test ($P < 0.05$).

Salinity and Germination

The data presented in Figure 3 show that maximum germination percentage (77.50%) of *E. spinosa* was found where distilled water was applied which was statistically at par with the treatments where 25, 50 and 75 mM saline solutions were applied. While the significantly lowest germination percentage (41.66%) was obtained where 150 mM saline solution was applied which was statistically at par with the seeds receiving 125 and 150 mM saline solution. Data show that germination was observed even at higher levels of salinity. These results are synchronized by the findings of Zia and Khan (2004). They investigated seed germination responses of *L. stocksii* at different salinities (0, 100, 200, 300, 400, and 500 mmol/L NaCl) and recorded the highest percentage of germination (about 100%) at 0, 100, and 200 mmol/l NaCl , and a further increase in salinity resulted in a gradual decrease in germination.

The results are also confirmed by those of Nandula *et al.* (2006). They observed that the germination of horseweed (*Conyza canadensis*) was > 20% at < 40 mM NaCl concentration and lowest (4%) at 160 mM NaCl. The highest mean germination time (8.07 days) of *E. spinosa* seed was found where the treatment applied was 150 mM level of salinity which was statistically at par with those receiving 125 mM saline solution (Fig. 4). The lowest mean germination time (4.25 days) was obtained where 25 mM saline solution was applied which was statistically at par with the treatments receiving distilled water, 50, 75 and 100 mM saline solution. The significantly highest germination index (5.68) of *E. spinosa* was found in control treatment which was statistically at par with treatments where 25, 50 and 75 mM saline solutions were applied. The highest germination index (2.7) was obtained where 100 mM saline solution was applied which was statistically at par with the treatments receiving 125 and 150 mM saline solution.

Drought stress and Germination

The significantly highest germination percentage (68.33%) of *E. spinosa* was found in control (distilled water) treatment, while the significantly lowest germination percentage (0.83) was obtained at -0.8 M Pa which was statistically at par with the treatment receiving -0.6 M Pa level of drought. Data shown in Figure 5 revealed that by increasing the drought, germination percentage decreased corroborated with Nandula *et al.* (2006). They found that germination of horseweed (*C. canadensis*) decreased as osmotic potential increased from 0 (distilled water) to -0.8 M Pa. Germination of pitted morning glory (*Ipomoea lacunosa*) in laboratory and green house experiments also decreased with increasing moisture stress, with less than 3% normalized germination at -0.1 M Pa (Oliveira and Norsworthy, 2006).

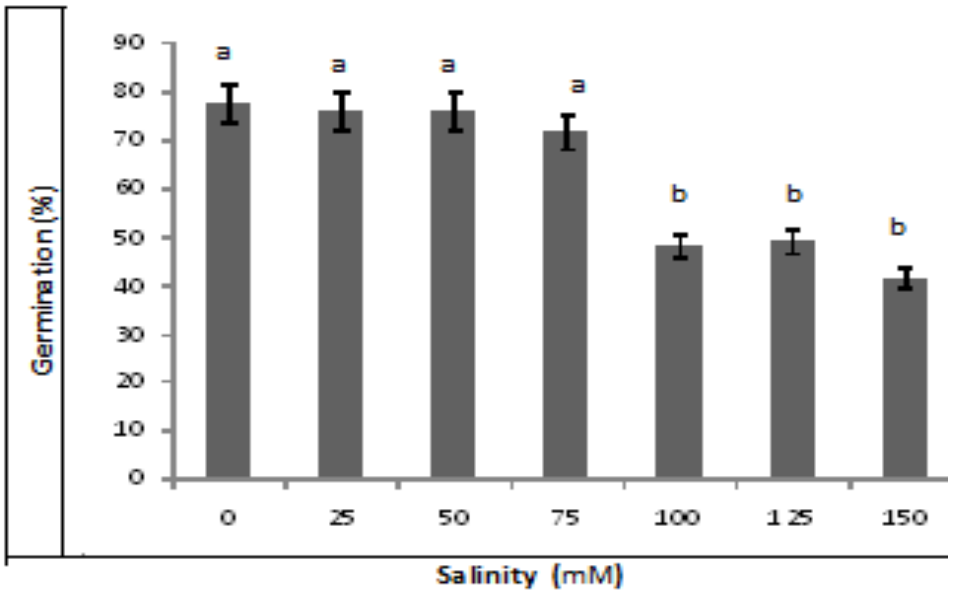

Figure 3. Effect of salinity on germination of *Emex spinosa.*
Means followed by the same letter did not differ significantly according to LSD test ($P < 0.05$).

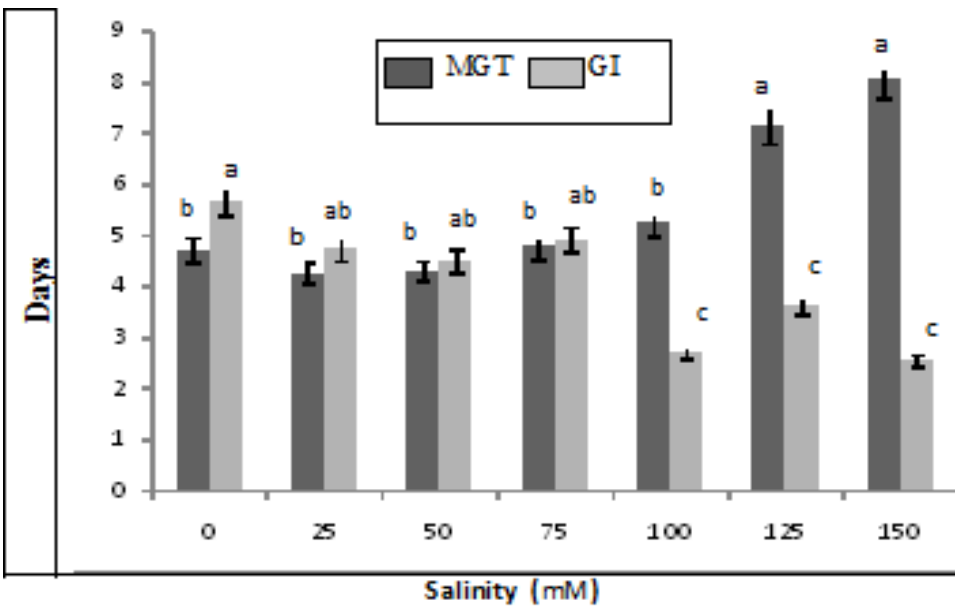

Figure 4. Effect of salinity on MGT and GI of *Emex spinosa.*
Means followed by the same letter did not differ significantly according to LSD test ($P < 0.05$).

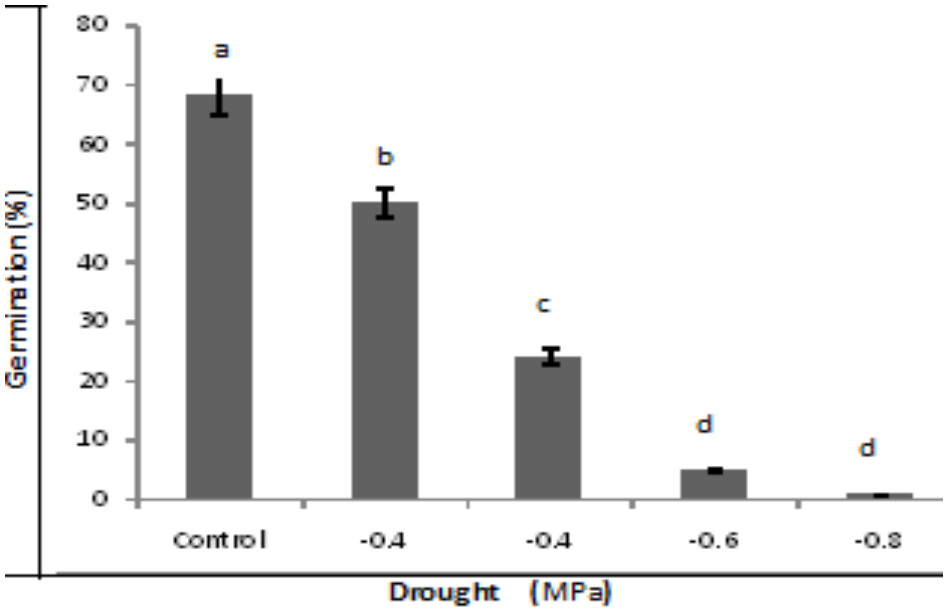

Figure 5. Effect of drought on germination of *Emex spinosa.*
Means followed by the same letter did not differ significantly according to LSD test ($P < 0.05$).

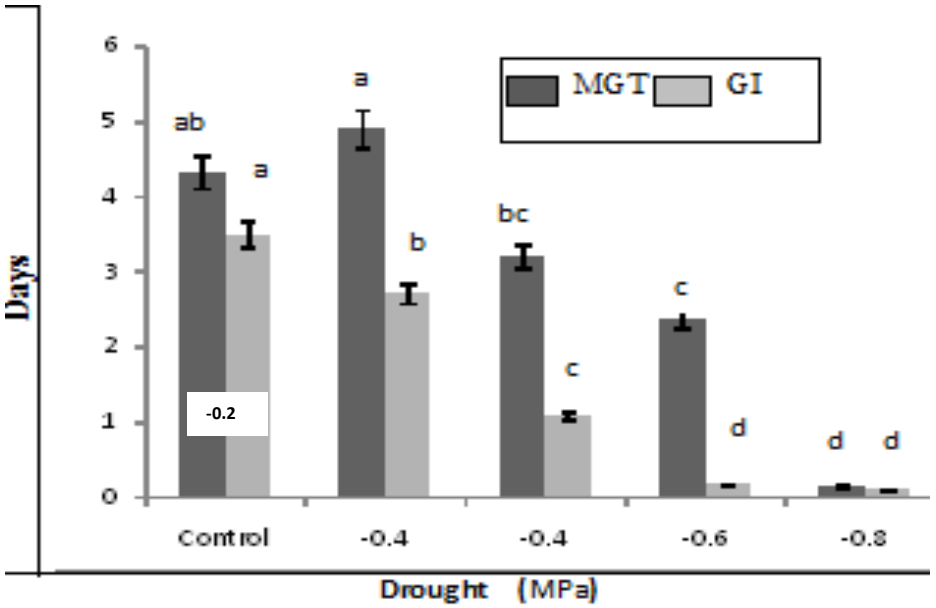

Figure 6. Effect of drought on MGT and GI of *Emex spinosa.*
Means followed by the same letter did not differ significantly according to LSD test ($P < 0.05$).

Maximum mean germination time (4.90 days) of *E. spinosa* was found at -0.2 level of drought which was statistically at par with that of control (Fig. 6). Statistically minimum mean germination time (0.14 days) was obtained with -0.8 MPa level of drought. Data shown in Figure 6 revealed that mean germination time was decreased by increasing drought level. Statistically maximum germination index (3.49) of *E. spinosa* was found at (0 MPa) level of drought while minimum germination index (0.16) was obtained at -0.6 MPa level of drought which was statistically at par with the treatment receiving -0.8 MPa level of drought. Generally, germination index decreased with increase in drought stress.

Seeding depth and Germination

Statistically maximum emergence percentage (50.83%) of *E. spinosa* was found where seeding depth was zero while statistically minimum emergence percentage (0%) was obtained where seeding depth was 8 cm (Fig. 7). It was also confirmed by Rao *et al*. (2008). They reported that seedling emergence of American sloughgrass (*Beckmannia syzigachne*) was highest when seeds were placed on the soil surface (91%) but declined with burial depth. Statistically maximum mean germination time (8.25 days) of *E. spinosa* was found at zero seeding depth while statistically minimum mean germination time (4.55 days) was recorded at 2cm seeding depth (Fig. 8).

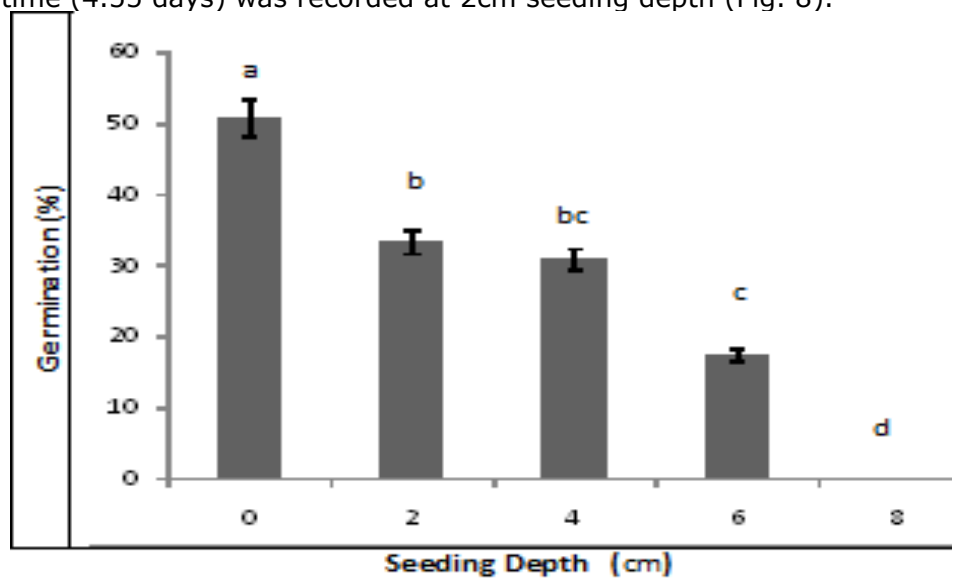

Figure 7. Effect of seeding depth on germination of *Emex spinosa.*

Means followed by the same letter did not differ significantly according to LSD test ($P < 0.05$).

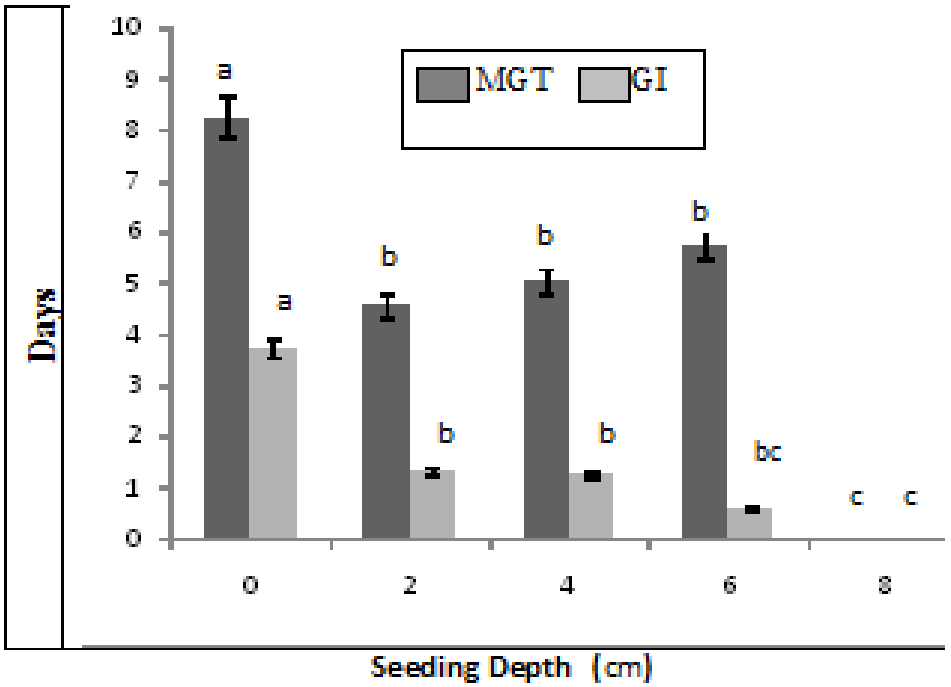

Figure 8. Effect of seeding depth on MGT and GI of *Emex spinosa.*

Means followed by the same letter did not differ significantly according to LSD test ($P < 0.05$).

Statistically maximum germination index (3.72) of *E. spinosa* was found where seeding depth was zero while statistically minimum germination index (0.6) was obtained at seeding depth of 6 cm. Effect of light and seed size on all germination traits was non significant.

Study indicates that *E. spinosa* seeds of different size have equal potential to germinate under different ecological conditions. In our study, maximum *E. spinosa* emergence occurred from seeds sown on soil surface it can also be concluded that tillage practice that achieve burial of *E. spinosa* seed will discourage its seedling emergence.

REFERENCES CITED

AOSA. 1990. Rules for testing seeds. J. Seed Technol. 12: 1-112.

Baskin, J.M. and C.C. Baskin. 1989. Physiology of dormancy and germination in relation to seed bank ecology. Ecology of soil seed bank. San Diego, CA: Academic, pp. 53-965.

Chachalis, D., N. Korres and E.M. Khah. 2008. Factors affecting seed germination and emergence of venice mallow (*Hiviscus trionum*), Weed Sci. 56: 509-515.

Chauhan, B.S. and D.E. Johson. 2008. Germination ecology of Southern crabgrass (*Digitaria ciliaris*) and India crabgrass (*Digitaria longiflora*): Two important weeds of rice in tropics. Weed Sci. 56: 722-728.

Chauhan, B.S., G. Gilland and C. Preston. 2006. Factors affecting seed germination of annual sowthistle (*Sonchus oleraceus*) in southern Australia. Weed Sci. 54: 854-860.

Ellis, R.A. and E.H Roberts, 1981. The quantification of aging and survival in orthodox seeds. Seed Sci. Technol., 9:373-409.

Gorai, M and N. Neffati. 2007. Germination response of *Reaumuria vermiculata* to salinity and temperature. Annals of Applied Biol., 151: 53-59.

Koger, C.H., K.N. Reddy and D.H. Poston. 2004. Factors affecting seed germination, seedling emergence and survival of tesasweed (*Caperonia palustris*). Weed Sci. 52: 989-995.

Nandula, V.K., T.W. Eubank, D.H. Poston, C.H. Koger and K.N. Reddy. 2006. Factors affecting germination of horseweed (*Conyza Canadensis*). Weed Sci. 54: 898-902.

Norsworthy, J.K. and M.J. Oliveira. 2006. Sicklepod (*Senna obtusifolia*) germination as affected by environmental factors and seedling depth. Weed Sci. 54: 903-909.

Oliveira, M.J. and J.K. Norsworthy. 2006. Pitted morning glory (*Ipomoea lacunosa*) germination and emergence as affected by environmental factors and seeding depth. Weed Sci. 54: 910-916.

Rao, N., L. Dong, J. Li and H. Zhang. 2008. Influence of environmental factors on seed germination and seedling emergence of American slough grass (*Beckmannia syzigachne*). Weed Sci. 56: 529-533.

Romo, J. and L. Eddleman. 1985. Germination response of greasewood (*Sarcobatus vermiculatus*) to temperature, water potential and specific ions. J. Range Manag. 38: 117-120.

Siddiqi, M. A. 1973. New plant records for West Pakistan-1. Pak. J. Fores. 23: 128-132.

Steel, R.G.D, J.H. Torrie and D.A. Dickey. 1997. Principles and Procedures of Statistics. A Biometrical Approach 3rd Ed. McGraw Hill Book Co., Inc., Singapore. Pp. 172-177.

Ungar, I. 1991. Ecophysiology of vascular halophytes. Boca Raton, FL: CRC Press, pp. 209.

Zia, S. and M.A. Khan. 2004. Effect of light, salinity, and temperature on seed germination of *Limonium stocksii*. Can. J. Bot. 82(2): 151-157.