Pak. J. Bot. 33 (special issue) 2001

RESPONSES OF CORN (*ZEA MAYS* L.)TO COMPOUND TYPE OF SALINITY

HUMAIRA ABDUL WAHID

**Department Of Botany, University Of Balochistan, Quetta.*

Abstract

Studies on the effects of compound type of salinity (NaCl, Na_2SO_4, $CaCl_2$, $MgCl_2$) were carried out in sand culture media on two cultivars i.e. EV5085 and, Gawhar of corn. Salinity retards the water uptake by seeds. The germination was directly proportional to the water uptake by the seeds. Salinity also slow down the rate of seeding growth. EV 5085 was found to be relatively salt tolerant than Gawhar.

Introduction

Salinity is undoubtedly the most important problem of the world. Szabolcz (1990) reported that nearly 10 percent of the total area of the world is affected by salinity and sodicity problem. According to Malcolm (1993) about 20 million hectares is going out of plough each year due to salinity problem. In Pakistan 5.8 million hectares of cultivated land is salt effected (Qureshi et al., 1993) including 3.1 million hectares canal irrigated land. The selection of proper crop and crop cultivar having economic potential for growing in salt affected area is a pre-requisite for handling this problem. Maize is the basic food of the new world and is widely grown in all inhabited continents. On world scale maize comes third in area sown and quantity produced after wheat and rice. Many workers (Kayani and Rahman, 1987, 1988; Rahman and Kayani, 1988; Wahhab, 1964; Dhingra and Varghese, 1986) have reported the effects of salinity on this crop. The work presented here deals with effects of mixed type of salinity (NaCl, Na_2So_4, $CaCl_2$, $MgCl_2$) on two cultivars of corn (*Zea mays* L).

Materials and methods

The seeds of corn cultivars namely Gawhar, EV 5085 were procured from Agricultural Research Institute, Quetta. All the investigations were carried out in 15 cm plastic perforated pots containing 1 kg washed sand. These pots were irrigated by half strength Hoagland's solution. There were four salinity treatments having osmotic potential 0.00, -4.75, -9.51 and-14.27 bars. Osmotic potential 0.00 bars served as control. These treatments were prepared by dissolving calculated amount of NaCl, Na_2SO_4, $CaCl_2$, $MgCl_2$ in a ratio 4:10:5:1 (Mahmood and Malik, 1986) in Hoagland's solution. 10 seeds were sown in each pot at a depth of 1.5 cm. Each treatment was replicated thrice. The pots were irrigated by 100 ml solution of respective treatment daily. All the studies were carried out at ambient temperature (25°C + - 5)

Water uptake: Water uptake was recorded after an interval of 6, 12, 24, and 36 hours. Water uptake percent was calculated by the formula given below:

$$\text{Water uptake \%} = \frac{W_2 - W_1}{W_1} \times 100$$

W_1 = Initial weight of seed
W_2 = Weight of seed after absorbing water in a particular time.

Germination: The emergence of epicotyl from the germinating media was taken as an index of germination. The germination percent was recorded at an interval of 5 days up to 20 days.

Recovery Test: Recovery test was applied on those seeds, which did not germinate in the scheduled time. Non germinated seeds were washed with distilled water and sown in petriplates on Whatmann, s No.1 filter paper in an incubator at 25^{0} C +- 1. Five milliliter distilled water was added to each petriplate daily.

Seedling Growth: From each treatment 5 plants were harvested after 10 weeks of sowing and the following observations were made:

1. Root /shoot length
2. Root/shoot dry weight

Salt Tolerance: Salt tolerance was calculated by the formula (Mirza and Khalid, 1986) given below:

$$\text{Water up take} = \frac{\text{Germination /seedling growth In particular treatment}}{\text{Germination / seedling Growth in control}} \times 100$$

Results

Water uptakes: Fig.1 and table .1 showed that water uptake had direct relationship with the passage of time and osmotic potential of the medium, irrespective of cultivars. This decrease in water uptake with an increase in salinity was significant (p=0.05) in both cultivar. Maximum decrease was observed in cultivars EV 5085 i.e.59.45 percent with respect to control at osmotic potential –14.27 bars after 36 hours of sowing.

Germination: Data regarding germination percent in various levels of salinity with the passage of time of two cultivars in Fig.2 and table 2 showed that there was almost same pattern of germination in both the cultivars. The decrease in germination with an increase salinity level was significant at P=0.05. The increase in salinity level not only decreased the germination percent but also decreased the rate of germination. In both cultivars i-e EV 5085 and Gawhar maximum decrease in germination was observed in Gawhar i.e., 43.34% and minimum in EV 5085 i.e., 33.34% at osmotic potential –14.27 bars after 20 days. The germination rate was higher in control and lower in –14.27 bars osmotic potential treatment.

Recovery Test: Table.3 showed that better recovery was observed in lower level of salinity. The recovery was 100 percent at salinity level – 4.75 bars osmotic potential in both the cultivars under study. While at –9.51 and –14.27 bars osmotic potential the recovery range was from 45.45 to 80.00 percent and 23.07 to 27.72 percent, respectively.

Seedling Growth: All the growth parameters (root/shoot length, dry weight) decreased with an increase in salinity stress in both the cultivars.

The decrease in root/shoot length was significant (P=0.05), irrespective of cultivars (Fig.3). Maximum recede in root/shoot length observed was 60.62, 58.83 percent in EV 5085 as compared to control at –14.27 bars osmotic potential. Data also exhibited that relatively greater reduction was occurred in roots than the shoots. A significant (p=0.05) reduction in dry weight of root was also observed in both cultivars in all levels of salinity, whereas in case of shoot it was significant (p=0.01) in Gawhar (Fig.3). The decline in root dry weight was prominent as compared to shoot. The reduction in dry weight varies from 30.94-60.49 percent in case of root while 54.14-56.08 percent in case of shoot. Utmost decline in shoot dry weight was noticed in Gawhar.

Salt Tolerance: Data regarding salt tolerance during germination and seedling growth showed that it was decreased with an elevation of salinity level (Table-4). Results also disclosed that both cultivars have greater salt resistance at germination stage than at seedling growth.

Discussion

Germination and water uptake: Salinity decrease the uptake of water, which in turn delayed the germination of seeds (Ashraf and Rasul, 1988; Kayani *et al.* 1990). The increase in salts concentration in the medium decreased the osmotic potential of the medium, which retards the uptake of water. The results are in line with ziglstra (1946) that water uptake by the seeds is directly related to germination. Because due to the absorption of water by the seed, the activity of the dormant biochemical reaction is restored and the enzymatic activity of the seeds is renewed too. The embryo use the products of biochemical reactions and grow. Another fact in the delay and retardation of germination is the kinds of salts and their concentration. Greater recovery was observed in seeds of lower salinity level (Table 3), which is probably due to the less accumulation of ions in seeds. Some of the seeds were not germinated even after the application of recovery test (Table 3) it is thought that probably their embryo was damaged due to the excess of ions (Na^+, Cl-/SO_4). The salt tolerance of plant is also depends upon the types of salts (Khan et al., 1984). Kayani and Rahman (1987) reported that chloride type of salinity is more toxic to corn at germination stage than sulphate. Salinity resistance varies within the cultivars .Wahhab (1964) has also reported significant varietal difference in salt tolerance of maize.

Seedling Growth: An increase in salinity stress decreased the seedling growth of plants (Kayani and Rahman, 1988; Rahman and Kayani, 1988). This decrease in growth may be due to less mobilization of reserved food (Kayani et al., 1990) suspension of cell division and enlargement (Meiri and Poljakoff-Mayber, 1970) hypocotyl injury (Assadian and Miyamoto, 1987) and decrease in production of growth hormones (Itai et al., 1968) Salinity reduced the turgor pressure of cells which results growth retardation because growth and turger pressure of cells are directly related to each other (Kramer, 1969). The results are in line with those of Khan and Sheikh (1976) and Eaton (1942) that salinity depressed root growth more than shoot growth. Wadleigh *et al.* (1947) reported that salinity restricts the development of roots.

Salt tolerance: Present studies showed that both the cultivars have greater salt tolerance at germination stage than growth phase while reverse have been reported by Khan and patel (1972) and Mahmood and Malik (1986). Ayers and Hayward (1984) reported that there may not be a positive correlation between salt tolerance at germination and during later phases of growth. In our result cultivar EV 5085 exhibited greater salt resistance in higher salinity levels with respect to other cultivars.

Table 1. Effects of various salinity treatments on water uptake, % of corn cultivars.

Treatments	L.Sd AT p =0.05	
Osmotic Potential (Bars)	EV 5085	Gawhar
0.00	3.24	2.63
-4.75	4.09	3.34
-9.51	4.95	3.95
-14.27	5.76	5.11

Table 2. Effects of various salinity treatments on germination, % of corn cultivars.

Treatments	L.Sd AT p = 0.05	
Osmotic Potential (Bars)	EV 5085	Gawhar
0.00	Not Significant	Not Significant
-4.75	16.04	18.83
-9.51	10.30	11.04
-14.27	05.76	08.80

Table 3. Recovery of Corn (Zea Mays L.) Cultivars at germination stage .

Treatments Osmotic Potential (Bars)	EV 5085	Gawahr
-4.75	(1) 100-00	(2) 100-00
-9.51	(7) 57.14	(11) 45.45
-14.27	(10) 40.00	(13) 23.07

() No. Of non-germinated seeds sown in each treatment

Table 4. Effects of salinity stress on the salt tolerance index of corn cultivars at germination and growth stage

Treatments	EV 5085		Gawhar	
Osmotic Potential (Bars)	Germination	Growth	Germination	Growth
-4.75	96.66	78.78	93.33	75.46
-9.51	76.66	58.79	63.33	59.00
-14.27	66.66	49.31	56.66	47.97

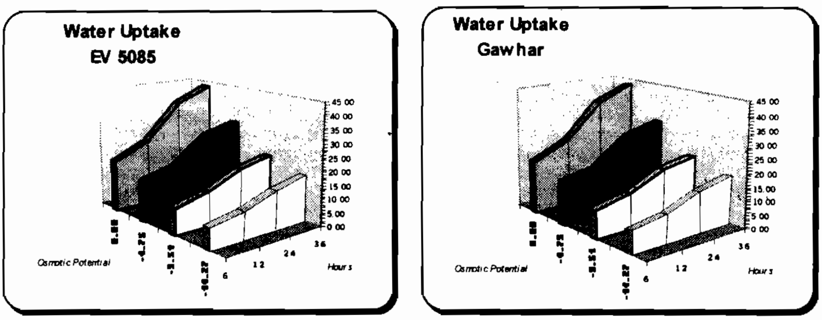


Figure 1

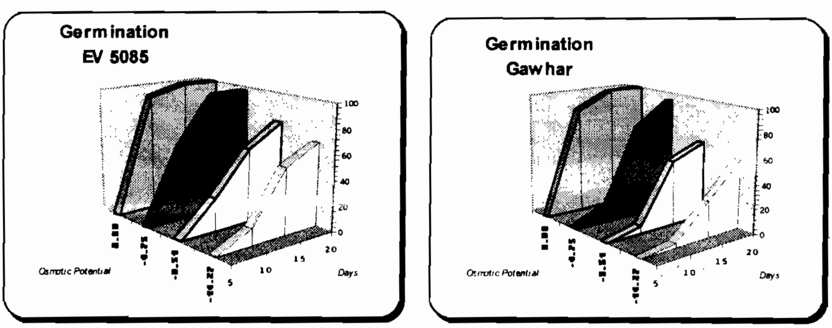
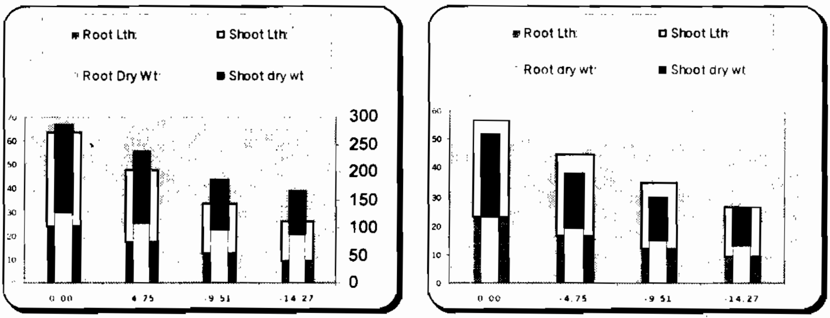


Figure 2



EV 5085 Gawhar

Figure 3

Refrences

Ashraf. M and E Rasul. 1988. Salt tolerance of Mungbean (Vigna radiata L. Wilezek) at two growth stages. *Plant and Sci.*, 110:63-67.

Assadian ,N.W and S. Miyamoto , 1987. Salt effects on alfalfa seedling emergence. *Agron . J.*, 79: 710-714.

Ayers, A.D. AND H.E. Hayward, 1984. A Method for measuring the effect of soil salinity on seed germination with observation on several crop plants. *Soil Sci, Soc Hort . Sci* U.S.A 13:224-226.

Dhingra, H.R and T.M Varghese. 1986. Effect of salinity on the activities of amylase and invertase in Zea mays L. *pollen Ann Bot* . 57:101-104.

Eaton, F.M, 1842. Toxicity and accumulation of chloride and sulphate in plants. *J. Agric. Res.*, 64:359-399.

Itai, C. A.E Richmond and Y. Vaadia, 1968. The role of cytokinins during water and salinity stress , *Israel J,Bot.*, 17: 187-195.

Kayani, S.A. and M Rahman 1987. Salt tolerance in corn (Zea mays L.) at the germination stage . *Pak ..J Bot..*, 19(1):9-15.

Kayani,S.A. AND M. Rahman 1988. Effects of NaCl salinity on shoot growth, stomatal size and its distribution in zea mays L. *Pak .J. Bot.*, 20(1): 75-81.

Kayani, S.A., H.H Naqvi and I.P. Ting 1990 Salinity effect on germination and mobilization of reserve in jojoba seed. *Crop Sci.*, 30(3): 704-708.

Khan, D., S.S. Shaukat and M. Faheemuddin. 1984. Germination studies of certain plants. *Pakistan. J. Bot.*, 16: 231-254.

Khan, M.i. and M.Z. Patel, 1972, Physiological effects of NaCl on wheat. I. Protein and amino acid metabolism in germination seeds. *Pak. J. Biochem., 4(1): 25-28.*

Khan, S.S. and K.H. sheikh, 1976. Effects of different level of salinity on seed germination and growth of *Capsicum annuum* L. *Biologia.*, 22: 15-25.

Kramer, P.J., 1983. *Water relation of plants.* Academic Press Inc., New York.

Mahmood, K.and K Malik, 1986. Studies on salt tolerance of *A triplex undulate*. Prospects for Biosaline Research, Proc. Us-Pak Biosaline Res. Workshop, R. Ahmad and Sanpietro (eds.).Bot. Dep. Karachi University.

Malcolm, C.V. and T.C. Swaan, 1989. Screening shrubs for establishment and survival on salt affected soils under natural rainfall in southwestern Australia. West. Aust. Dept. of agric. Tech. Bull, 81, 35 pp.

Meiri, A. and A. poljakoff-Mayber, 1970. Effect of various salinity regimes on growth, leaf expansions and transpiration rate of bean plants. *Plants soil Sci.*, 109: 26-34.

Mirza, R.A. and M. Khalid, 1986. Comparative effect of sodium chloride and sodium carbonate on germination, growth and ion accumulation in *phaseolus aureus* Roxb, C.V. 6601. *Biologia.*, 32(1): 257-268.

Qureshi, R.H., M. Aslam and M. Rafiq, 1993.Expansion on the use of forage halophytes in Pakistan. *In: Productive* use of saline Land (Eds, N. Davidson and R. Galloway), ACAJR proc. 42, 85-87, proc of workshop, Perth, Western Australia.

Rahman, M. and S.A. Kayani, 1988. Effects of chloride type of salinity on root growth and anatomy of corn (Zea Mays L.). *Biologia.*, 34(1): 123-131.

Szabolcz, I., 1991. Desertification and salinization .In: Plant salinity Research: New challenges (Ed. R. Choukrallah), pp.3-18, Proc. Int. Conf. On Agricultural Management of salt affected Areas, Agadir, Morocco.

Wadleigh, C.H., H.G. Gouch and D.C. Strongs, 1947. Root penetration and moisture extraction in saline soil by crop plant. *Soil Sci.*, U.S.A. 63:341-349.

Wahhab, A., 1964. *Salt tolerance of various varieties of agriculture crops at the germination stage*, In UNESCO Publication, Paris, pp. 185-192.