RESPONSE OF SPRING MAIZE CULTIVAR "AGAITTI-72" TO N FERTILIZATION UNDER SALINE-SODIC SOIL CONDITIONS

Abdul Ghafoor & Saleem Akhtar
Department of Soil Science,
University of Agriculture, Faisalabad

The response of spring maize cv. "Agaitti-72" to nitrogen rates (100, 150, 200, 250 mg kg^{-1} soil) under different salinity/sodicity levels (EC_e 2.7 + SAR 5.3, EC_e 4.2 + SAR 9.1, EC_e 8.5 + SAR 21.0, EC_e 13.0 + SAR 25.0 and EC_e 17.0 dS m^{-1} + SAR 45.0) was studied in a pot culture study. Each pot received ten kg of soil. Ten healthy seeds were sown in each pot which were thinned to 3 per pot 15 days after sowing. A basal dose of phosphorus as single super phosphate @ 44 mg per kg soil was applied. At germination stage, maize crop was found fairly tolerant to combined effect of salinity and sodicity. Dry matter yield and N concentration in maize plants increased with the application of nitrogen at all the salinity/sodicity levels.

INTRODUCTION

Soil salinity/sodicity and waterlogging are probably the most pervasive problems affecting crop production on irrigated lands in the world today including the arid and semi-arid regions of Pakistan. In Pakistan, about 5.73 million hectares are affected by salts to a level considered harmful for most of the agricultural crops (Mian, 1988).

Reclamation of such salt-problem soils through the application of amendments, like gypsum, acids, acid formers and organic materials, is one way to put the soils under crops. Another possible approach for facilitating plant growth may be the judicious and timely availability of essential plant nutrients on moderately salt-affected soils.

Corn draws heavily on available nitrogen of soil during the latter part of its vegetative growth. Prior to this stage during the period of rapid growth, maize also requires more water per acre than many other crops, though as frequent light irrigations, which may affect considerable leaching of soluble salts as well as nutrients. Since C_4 plants, including maize, fix CO_2 more efficiently (Rayle and Wedberg, 1980), the photosynthates may help osmotic adjustment in response to moisture or salt stress (Luttage and Smith, 1984). This piece of research work was undertaken to study the growth response of maize cultivar "Agaitti-72" on artificially salinated and sodicated soil through improved N supply.

MATERIALS AND METHODS

The research work was carried out at the Department of Soil Science, University of Agriculture, Faisalabad. In a pot culture study, soil (Table 1) was salinized and sodicated to five levels (EC_e 2.7 + SAR 5.3, EC_e 4.2 + SAR 9.1, EC_e 8.5 + SAR 21.0, EC_e 13.0 + SAR 25.0 and EC_e 17.0 d dS m^{-1}+ SAR 45.0) using NaCl, Na_2SO_4, $CaCl_2.2H_2O$ and $MgSO_4.7H_2O$. The calculation of salts are given by Ghafoor *et al.* (1988). Nitrogen, in two equal splits @ 100, 150, 200 and 250 mg N kg^{-1} soil as urea while the basal dose of P was applied @ 44 mg kg^{-1} soil as SSP. Seeds, 10 per pot, of a local synthetic variety "Agaitti-72" were sown on 24th February, 1987, thinned to three plants per pot on 9th March, 1987 and crop was harvested on 1st May, 1987. For growing maize up to booting stage, 40 cm of canal water was applied while 7.8 cm rain was received during this period.

Table 1. Properties of the original soil

Characteristic	Value
Textural class	Sandy clay loam
EC_e	2.7 dS m^{-1}
pHs	7.7
SAR	5.3
Total N	0.08%
Phosphorus (Olson)	12.0 ppm
Potassium (CH_3COONH_4)	110.0 ppm

Data on per cent germination, plant height and dry matter yield were recorded. Plant samples were ground and analysed for NPK concentration by appropriate methods (Cottenie *et al.*, 1979). The data collected were subjected to statistical analysis by ANOVA technique following completely randomized design and treatment means were compared according to Duncan's Multiple Range test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

a. Plant growth characteristics Germination: The data showed that emergence of maize seedlings was reduced only by 29% at the highest salinity and sodicity compared to the control (Table 2). The emergence was delayed with increasing salinity/sodicity. The results are similar to those of Rauf *et al.* (1981). It appears that the delayed seedling emergence is due to the increased solute concentration of the soil solution which might have hindered the absorption of water by the germinating seeds and even might have increased the toxic effects of certain ions. Plant height was depressed significantly at all the salinity/sodicity levels.

Plant height: Maximum plant height (173.0 cm) was obtained for the control (EC_e 2.7 dS m^{-1} and SAR 5.3) while minimum (139.7 cm) for the highest salinity/sodicity level. Nitrogen fertilizer rates showed no statistical effect on plant height. The results are similar to those of Rauf *et al.* (1981).

Dry matter yield: The dry matter yield increased significantly with the application of nitrogen at all the salinity/sodicity levels, being maximum with 250 mg N per kg soil. An increase in cation exchange capacity of roots (Bear, 1964) and growth dilution factor in response to N application might have played a role to induce tolerance against the prevalent stress environment. The highest dry matter (71.8 g pot^{-1}) was obtained from the control but it decreased progressively with increasing salinity/sodicity of the growth medium. The results are similar to those of Cox and Reisenauer (1973).

b. Chemical composition of plants: The nitrogen percentage in the shoot increased with increasing N levels, being maximum 1.71% with N_{250} and minimum of 1.10% with N_{100} treatment (Table 3). Similarly, maximum nitrogen (1.66%) was observed at the highest salinity/sodicity (ECe 17.1 + SAR 45.6) while minimum (1.23%) at the lowest salinity level. The results are similar to those of Khalil *et al.* (1967) and Ravikovitch and Porath (1971).

Phosphorus percentage decreased with increasing rates of nitrogen, being maximum 0.124% with N_{100} and least with N_{250} rate. Phosphorus in plants increased with increasing levels of soil salinity/sodicity, being maximum 0.123% at the highest salinity/sodicity level and minimum 0.114% at the lowest level. The results are similar to those of Hassan *et al.* (1970) and Patel *et al.* (1975).

Table 2. Effect of salinity and nitrogen on growth of the maize crop

EC_e	SAR	Rate of N application				Mean
		N_{100}	N_{150}	N_{200}	N_{250}	
		Seedling emergence (%)				
2.7	5.3	96.6	100.0	100.0	93.3	97.4 a
4.2	9.1	93.3	93.3	90.0	90.0	91.6 a
8.5	21.0	90.0	86.6	90.0	93.3	89.9 a
13.0	25.0	93.3	73.3	83.3	86.3	84.1 ab
17.0	45.0	66.6	73.3	76.0	86.6	75.6 b
Mean		88.0	85.3	87.8	89.9	
		Plant height (cm)				
2.7	5.3	70.7	72.2	73.6	75.7	31.1 a
4.2	9.1	69.1	68.4	69.8	65.3	68.2 b
8.5	21.0	65.4	68.4	62.3	63.7	64.9 c
13.0	25.0	53.4	53.5	56.8	53.7	54.2 d
17.0	45.0	42.5	40.3	38.0	38.3	39.7 e
Mean		62.2	60.6	60.1	59.3	
		Dry matter yield (g pot^{-1})				
2.7	5.3	45.5	71.5	78.4	82.0	71.8 a
4.2	9.1	31.2	56.6	68.1	75.0	57.7 b
8.5	21.0	25.4	60.7	70.5	80.3	59.2 b
13.0	25.0	29.9	53.4	63.4	71.5	54.6 c
17.0	45.0	22.3	35.6	42.4	51.8	38.0 d
Mean		32.9 d	55.6 bc	63.1 b	72.4 a	

Figures followed by the same letter(s) in a row or column of each growth characteristic are statistically similar at P = 5%.

Potassium percentage decreased with increasing rates of nitrogen application. Plants from the N_{100} treatment showed maximum K (1.90%), while minimum (1.78%) K was observed with N_{250} treatment. Increase in salinity/sodicity decreased the K concentration of maize plants, being maximum 1.93% at the lowest salinity/sodicity level. Results are similar to those of Khalil *et al.* (1967). salinity/sodicity tended to decrease the dry matter. Application of nitrogen increased

Table 3. Effect of salinity and nitrogen on NPK in maize dry matter

EC_e	SAR	N_{100}	N_{150}	N_{200}	N_{250}	Mean
			Nitrogen (%)			
2.7	5.3	0.98	1.23	1.32	1.40	1.23 e
4.2	9.1	1.40	1.40	1.49	1.63	1.39 d
8.5	21.0	1.12	1.53	1.69	1.81	1.53 c
13.0	25.0	1.16	1.64	1.75	1.85	1.60 b
17.0	45.0	1.20	1.74	1.83	1.87	1.66 a
Mean		1.10 d	1.50 c	1.61 b	1.71 a	1.71 b
			Phosphorus (%)			
2.7	5.3	0.120	0.115	0.114	0.110	0.114 d
4.2	9.1	0.122	0.118	0.116	0.113	0.117 c
8.5	21.0	0.126	0.117	0.119	0.114	0.119 bc
13.0	25.0	1.126	0.121	0.120	0.117	0.121 ab
17.0	45.0	0.127	0.123	0.121	0.122	0.123 a
Mean		0.124 a	0.118 b	0.118 b	0.115 c	-
			Dry matter yield (g pot^{-1})			
2.7	5.3	1.95	1.92	1.96	1.79	1.93 a
4.2	9.1	1.93	1.93	1.90	1.88	1.91 a
8.5	21.0	1.90	1.82	1.78	1.78	1.82 b
13.0	25.0	1.88	1.80	1.77	1.69	1.78 c
17.0	45.0	1.84	1.78	1.76	1.68	1.76 d
Mean		1.90 a	1.85 b	1.83	1.78 d	-

Figures followed by the same letter(s) in a row or column for each nutrient element are statistically similar at P = 5%.

It is concluded that, at germination stage, maize crop is fairly tolerant to combined stress of salinity and sodicity. The dry matter yield increased with the application of nitrogen at all the salinity levels whereas the N concentration at all the salt levels. It appears that on moderately saline-sodic soils, relatively higher application of N may improve the fodder yield of maize crop.

REFERENCES

Bear, F.E. 1964. Chemistry of the Soil. Reinhold Pub. Co., USA.

Cox, W.J. and M.H. Reisenauer. 1973. Growth and ion uptake by wheat supplied with N as nitrate and ammonium or both. Plant and Soil. 38: 363-380.

Cottenie, A., M. Verloo, G. Velghe and L. Kichens. 1979. Analytical Methods for Plant and Soils. Lab. of Analytical and Agrochemistry, State Univ., Ghant, Belgium.

Ghafoor, A., M.M. Ahmad, S. Muhammed and N. Ahmad. 1988. Efficiency of gypsum grades and quality of leaching water for reclaiming a saline-sodic soil. I. Amount and solute concentration of effluents. Pak. J. Agri. Sci. 25: 239-249.

Hassan, N.A.K., J.V. Drew, D. Kauden and R.A. Olson. 1970. Influence of soil salinity on production of dry matter and uptake and distribution of nutrients in barley and corn. Agron. J. 62: 46-48.

Khalil, M.A., F. Amer and M.M. Elgabally. 1967. Salinity-fertility interaction on corn and cotton. Soil Sci. Soc. Am. Proc. 31: 683-686.

Luttge, U., J. Andrew and C. Smith. 1984. Structural, biophysical aspects of the role of leaves in plant adaptation to salinity and water stress. P. 125-150. In: Salinity Tolerance in Plants (Richards, C.S. and H.T. Gray, eds.). Wiley Interscience, NY, USA.

Mian, M.A. 1988. Land resources of Pakistan. P. 10-16. Proc. "Managing Soil Resources." First Natl. Congr. Soil Sci. Oct. 6-8, 1985, Lahore, Pakistan.

Patel, P.M., A. Wallace and G.F. Walliham. 1975. Influence of salinity and NP fertility on mineral contents and growth of sorghum in sand culture. Agron. J. 67: 622-625.

Rauf, A., Q. Javaid, S. Muhammed and W. Muhammad. 1981. Salt tolerance studies on wheat seeds collected from salt-affected areas. In: Proc. Biophysics and Development of Salt Tolerance in Plants. March 11-12, 1978, Faisalabad, Pakistan.

Ravikovitch, S. and A.P. Porath. 1967. The effect of nutrients on the salt tolerance of crops. Plant and Soil 26: 49-71.

Rayle, D.L. and H.L. Wedberg. 1980. Photosynthesis. P. 43-45. In: Botany: A Human Concern. Hart and Winston. West Washington Square, Philadelphia.

Steel, R.G.D. and J.H. Torrie. 1980. Principles and Practices of Statistics (2nd Ed.). McGraw Hill Book Co. NY, USA.