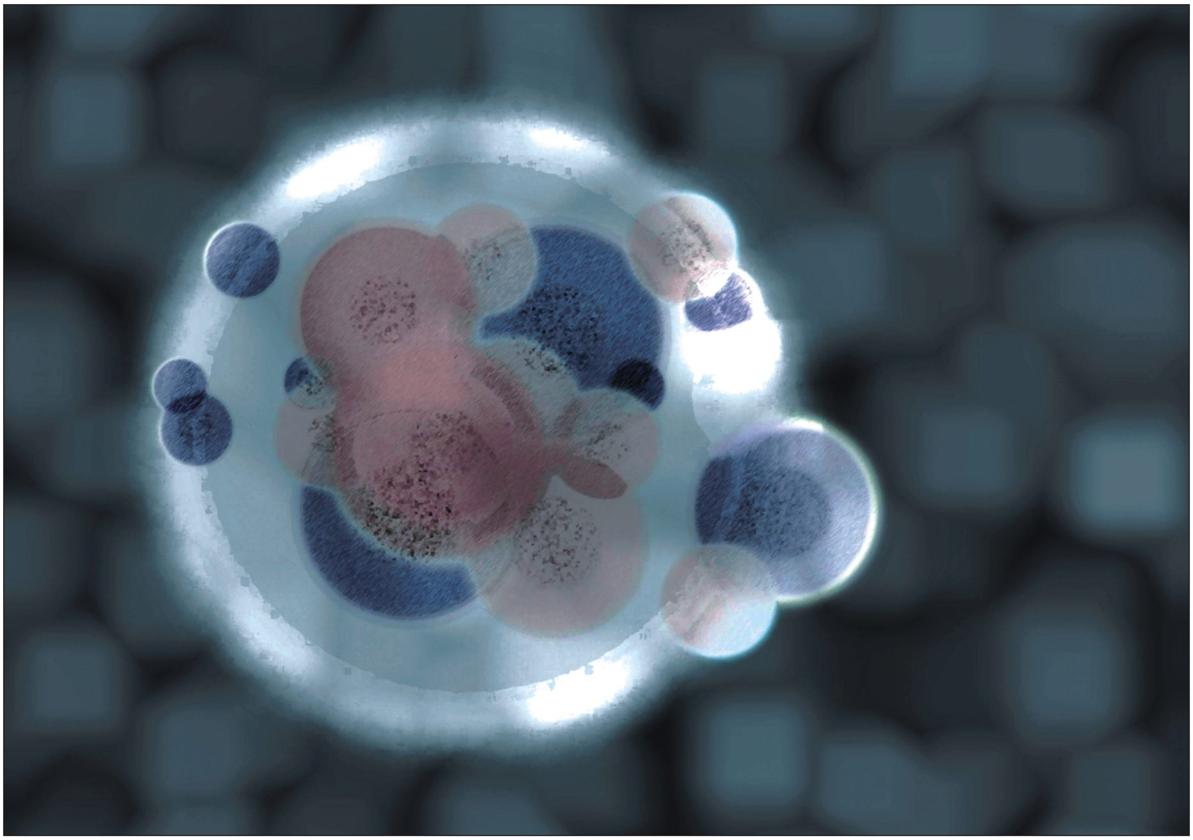

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Influence of Nitrogenous Fertilizers, Gypsum and Seed Priming on Wheat Yield under Salt Affected Soil Conditions

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Abstract: Field experiment, to evaluate the effect of nitrogenous fertilizers i.e. urea, ammonium nitrate and ammonium sulfate with and without gypsum and seed priming on productivity of wheat, was performed.The field was surveyed by EM-38 at 2x2 m grid to identify areas of uniform salinity. The experimental design was factorial randomized, having ECe values of 3.5 to 5.5, 4.0 to 6.9, 5.0 to 9.1 and 6.1 to 10.1 dS m^{-1} in R1, R2, R3 and R4 respectively. There was no significant effect of fertilizer type, gypsum and seed priming on any yield parameters. However, ammonium nitrate was better over the other two fertilizers in terms of yield. Similar to yield, soil and plant K^+, Na^+ concentrations and K/Na ratio were not affected significantly with various treatments. Leaf K^+ and K/Na ratio was positively correlated with grain yield and Na^+ concentration was negatively correlated.

Key words: Salinity, gypsum, N-fertilizers, seed priming, wheat

Introduction

In Pakistan, about 5.8 million hectare land is salt affected out of which 3.1 m ha lies in the canal command irrigated area of wheat belt (Choudhri *et al*., 1978). In N.W.F.P. alone, 0.54 m ha is invariably in grip of salinity problem, which mainly occur in Peshawar valley and southern districts such as Bannu Karak and D.I. Khan area. On one hand, productive agricultural soils are deteriorating due to salinity while on the other hand the alarming rate of population in Pakistan (3.3%/annum) has increased the demand for agricultural products. It has not only threatened the sufficiency of available food resources but also has necessitated bringing marginal land under cultivation.

One of the most economic way to improve production from the available resources will be to make efficient use of fertilizer (Khan, 1994), adopting better cultural practices (Balki and Padole, 1982) and salt tolerant varieties (Khan *et al*., 1999).

Wheat as classified moderately salt tolerant crop (Maas and Hoffman, 1977) is grown on all types of land including salt affected land but the yield is greatly reduced by salinity. A major problem while studying affect of cultural practices and fertilizers on wheat in saline conditions is the wide variation in salt concentrations in the soil both spatially and temporally. Because of this uneven distribution of salts, very little work has been done in the past under field conditions while most of the work has been done under control conditions. It was considered imperative to study the influence of various management practices under field conditions. The analysis of the experimental result would cover for soil heterogeneity and be applicable not only to salinity but to any field experimental work under conditions of extreme soil variability.

The specific objectives of present research work included, evaluating the effect of different nitrogenous fertilizers and use of amendment like gypsum in combination with fertilizers and also with and without priming of seeds and fertilizer on productivity of wheat, under salt affected soil conditions.

Materials and Methods

The experiment was performed during 1997-98 in the Department of Soil Science, NWFP Agricultural University Peshawar. The research was conducted on farmer's field in salt affected area at village Gandheri, near Risalpur Cantt, Nowshera. The research site is alluvium of Kabul river. The soil has stratified profile, with light to medium textured soil and varying in salinity and sodicity status.Tube well was only source of irrigation with a salinity hazard of 4 dS m^{-1}. Physico-chemical properties of the research site is given in Table 1a.

The field was ploughed, cleaned off the weeds and surveyed for salinity by EM-38 on 2x2 m grid. The field was divided into three salinity environments, low EC (3.5-5 d Sm^{-1}), medium EC (5-8 d Sm^{-1}) and high EC (8-10.1 dS m^{-1}) salinity. The experiment was done under uniform saline area ranging in ECe of 3.5-10 dS m^{-1}. Replication wise salinity data is given in Table 1b. The experimental design was factorial randomized. Each replication was 12 m in length and 10 m in width, with 12 sub plots of 5x2 m^2. Treatments were arranged as urea with and without gypsum and seed priming or ammonium sulfate/nitrate with and without gypsum and seed priming. Wheat variety SARC was grown is test crop.

Seed priming (Presoaking): The seeds were first folded in porcelain cloth and kept in water for 24 h. and were taken out to plant.

Gypsum and fertilizer treatment: Gypsum was added at the rate of 500 kg ha^{-1} along with seed sowing. Nitrogen was applied as urea, ammonium sulfate [$(NH_4)_2SO_4$], ammonium nitrate (NH_4NO_3) at 120 kg N ha^{-1} in split doses, first half was applied at the time of sowing and second dose was applied at flowering stage. DAP was applied as a basal dose at the rate of 90 kg P_2O_5 ha^{-1}.

Salinity per treatment was determined at harvesting time. At boot stage, 10 young fully expanded leaves from each treatment plot for all replications were collected for ions determination.

Plant characters: Data on number of plants per m^2, number of tillers per plant, 1000 grain weight (g), grain yield (kg ha^{-1}) and total dry matter (kg ha^{-1}) yield was recorded during the experiment. At harvesting time, soil samples up to 30 cm depth per treatment were collected for the estimation of soluble salts.

Soil analysis: The soil samples collected were analyzed for the general physico-chemical properties. Before analysis, the soil was air dried and then ground with mortar and pestle, passed through 2 mm sieve. All the standard methods for the salinity (Richards, 1954) measurement were followed.

Organic matter was determined by Wakley and Black Method (Black, 1965).

Soil texture was determined by dispersing the sample with sodium carbonate and taking reading by Buoyoucos hydrometer after 40 seconds and two hours Moodie *et al*. (1954). Salinity profile was determined before crop growing and after crop harvesting with the help of EM 38 (Table 1b, c).

Leaf analysis: The fresh ear leaves were washed thoroughly with tap water, followed by two washing with distill water. Then leaves were blotted with tissue paper, air dried and kept in oven at 70°C for 24 h. for constant weight. The leaves were ground in Wiley Grinding Mill. For analysis, 200-250 mg of leaf sample was digested with 1 ml 1N HNO_3 solution over night, boiled in water bath for 15 min. 10 ml distill H_2O added and re-boiled for 10 min. Supernatant liquid was transferred to 100 ml volumetric flask. Total volume was made to 100 ml with distilled H_2O (Rashid, 1986). Potassium and sodium in the diluted aliquot were estimated by Flame Photometer.

Statistical analysis: All data were analyzed using statistical package MSTAT C factorial design. Means were compared using the least significant difference (LSD) test.

Results

Number of plants/m^2: Analysis of variance for number of plants/m^2 showed that fertilizers, gypsum and seed priming had no significant affect and so was their interaction. From the Table 2, it is evident that urea was slightly better with an average of 32.25 plants/m^2 among fertilizers followed by NH_4NO_3 and than $(NH_4)_2SO_4$, while equal number of plants were noted both in gypsum treated plots and non gypsum plots. Furthermore, priming did not produce any significant changes in the number of plants.

Number of tillers/plant: Number of tillers/plant were not affected significantly by the application of either fertilizers, gypsum or seed priming and so was their interaction. By comparing fertilizer means (Table 3), it is evident that $(NH_4)_2SO_4$ produced more tillers compared to urea and NH_4NO_3 treated plots. Non gypsum plots proved better than the gypsum. Similarly, non-priming proved to be slightly more effective with an average of 6.87 tillers per plant than priming.

Table 1a: Physico-chemical properties of salt affect field. General properties at sowing time

Soil properties	Units	Values
Clay	%	22.16
Silt	%	40.46
Sand	%	37.38
Textural class	-	Loam
Organic matter	%	0.60
Available K^+	mg kg^{-1}	60.0
Lime	%	12.25
pH of saturation paste	-	8.2
ECe	dS m^{-1}	5.9
Soluble $Ca^{++}+Mg^{++}$	m mol L^{-1}	41.00
Soluble Na^+	mmol L^{-1}	17.25
Sodium Adsorption Ratio (SAR)	-	2.67

Table 1b: Salinity calibrated from horizontal EM-38 readings (0-30 cm) depth at the time of sowing

Plots	Rapl. 1	Repl. 2	Repl. 3	Repl. 4
	---------------------------dS m^{-1}---------------------------			
1	4.3	4.2	6.1	7.9
2	5.0	5.0	5.3	6.4
3	4.7	5.3	6.8	8.1
4	4.1	5.5	6.2	9.6
5	4.8	4.0	5.0	9.0
6	4.2	6.9	5.0	8.6
7	5.3	6.2	5.1	10.1
8	3.5	5.1	5.5	7.4
9	4.9	5.2	8.7	6.2
10	5.5	5.0	9.1	6.1
11	5.1	5.0	6.3	7.3
12	5.5	6.0	5.0	8.8
Mean	5.64	5.72	6.98	9.21

Table 1c: Salinity status at harvesting time (0-30 cm) depth

Plots	Rapl. 1	Repl. 2	Repl. 3	Repl. 4
1	6.9	4.8	6.4	8.3
2	5.3	5.3	5.6	6.9
3	7.7	5.6	7.2	9.0
4	4.6	5.9	6.5	13.1
5	5.2	4.3	5.4	12.0
6	4.7	7.6	5.3	11.9
7	5.7	6.7	5.4	11.4
8	4.0	5.3	4.9	8.4
9	6.2	5.7	12.1	6.4
10	5.9	5.4	13.0	5.4
11	5.8	5.3	6.7	7.6
12	5.7	6.8	5.3	9.8
Mean	5.64	5.72	6.98	9.21

1000 grain weight: Analysis of data regarding 1000 grain weight showed that fertilizers, gypsum and seed priming had no significant affect and their interaction was also non significant. From the Table 4, it is clear that non-gypsum plots had heavier seed weight than gypsum while priming had better results than non priming. In case of different fertilizers, again NH_4NO_3 was better than $(NH_4)_2SO_4$ while urea was least effective in producing heavier grain under salt affected soil conditions.

Grain yield (kg ha^{-1}): Grain yield of wheat grown under saline field conditions indicated that fertilizers, gypsum and priming proved to be statistically non-significant and so were their interactions. Grain yield decreased significantly with increase of field salinity. From Table 5, it is clear that ammonium nitrate produced maximum yield of 1262 kg ha^{-1} followed by urea and the minimum yield was obtained when ammonium sulfate was applied. It is further concluded that addition of gypsum and seed priming did not effect the yield, rather comparatively more yield was obtained in non-gypsum and non-priming plots. This indicates that gypsum additions at low level are not beneficial.

Total dry matter yield: Dry matter yield as affected by various treatments is given in Table 6. The results indicated that

Table 2: Effect of N-fertilizers, gypsum and seed priming on number of plants/m^2 in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	32	34	33.0	30	33	31.5	31.0	33.5	32.25
NH_4NO_3	29	28	28.5	34	31	32.0	31.5	29.0	30.25
$(NH_4)_2SO_4$	29	28	28.5	26	27	26.5	27.5	27.5	27.50
Mean	30	30	30.0	30	30	30.0	30.0	30.0	-----

Table 3: Effect of N-fertilizers, gypsum and seed priming on number of tillers/plant in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	6.17	6.30	6.23	5.65	7.26	6.45	5.91	6.78	32.25
NH_4NO_3	5.97	5.53	5.75	6.61	7.10	6.85	6.29	6.31	30.25
$(NH_4)_2SO_4$	6.78	7.02	6.90	6.96	8.04	7.50	6.87	7.53	27.50
Mean	6.30	6.20	6.29	6.40	7.46	6.93	6.35	6.87	-----

Table 4: Effect of N-fertilizers, gypsum and seed priming on 1000 grain weight (g) in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	36.3	35.2	35.8	39.1	40.7	39.9	37.7	38.0	37.8
NH_4NO_3	36.3	33.4	34.8	41.5	41.7	41.6	38.9	37.5	38.2
$(NH_4)_2SO_4$	39.7	35.7	37.7	37.8	39.2	38.5	38.8	37.4	38.1
Mean	37.4	34.8	36.1b	39.4	40.5	40.0a	38.4	37.6	-----

Table 5: Effect of N-fertilizers, gypsum and seed priming on grain yield (kg ha^{-1}) in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	979	1173	1076	1094	1340	1217	1036	1255	1147
NH_4NO_3	1090	1292	1191	1537	1130	1334	1313	1211	1262
$(NH_4)_2SO_4$	1208	979	1094	1109	1109	1109	1159	1206	1101
Mean	1092	1148	1120	1247	1193	1220	1169	1224	----

Table 6: Effect of N-fertilizers, gypsum and seed priming on TDM (kg ha^{-1}) in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	5450.5	5255.8	5352.8	4968.0	7123.3	6045.6	5208.9	6189.5	5699.0
NH_4NO_3	6430.0	6140.3	6284.9	7723.5	5431.8	6577.6	7076.5	5786.0	6431.3
$(NH_4)_2SO_4$	6171.5	5858.5	6015.0	5770.3	5811.8	5791.0	5970.9	5835.1	5903.0
Mean	6016.9	5751.5	5884.2	6153.9	6230.3	6138.1	6085.4	5936.9	----

Table 7: Effect of N-fertilizers, gypsum and seed priming on leaf Na^+ conc. (%) in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	2.07	1.65	1.86	1.69	1.35	1.52	1.88	1.50	1.69
NH_4NO_3	1.71	1.49	1.60	1.33	1.79	1.56	1.52	1.64	1.58
$(NH_4)_2SO_4$	1.56	1.95	1.75	1.61	1.71	1.66	1.58	1.83	1.71
Mean	1.78	1.69	1.74	1.54	1.62	1.58	1.66	1.66	----

Table 8: Effect of nitrogenous fertilizers, gypsum and seed priming on leaf K^+ (%) in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	2.50	2.84	2.67	2.66	2.90	2.78	2.58	2.87	2.72
NH_4NO_3	2.57	2.92	2.75	3.29	2.77	3.03	2.93	2.85	2.89
$(NH_4)_2SO_4$	2.63	2.42	2.52	2.63	2.51	2.57	2.63	2.46	2.55
Mean	2.58	2.73	2.65	2.86	2.72	2.79	2.71	2.73	----

Table 9: Effect of N-fertilizers, gypsum and seed priming on leaf K^+/Na^+ ratio in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	1.40	2.01	1.70	2.06	2.25	2.16	1.73	2.13	1.93
NH_4NO_3	1.74	2.58	2.17	3.26	2.07	2.66	2.50	2.33	2.42
$(NH_4)_2SO_4$	1.95	1.45	1.70	1.97	1.85	1.91	1.96	1.65	1.81
Mean	1.70	2.02	1.86	2.43	2.06	2.24	2.06	2.01	----

Table 10: Effect of N-fertilizers, gypsum and seed priming on soil Na^+ (mmol L^{-1}) in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	31.52	39.40	35.64	32.30	31.97	32.13	31.91	35.68	33.80
NH_4NO_3	26.45	28.50	27.47	34.30	31.77	33.03	30.37	30.13	30.25
$(NH_4)_2SO_4$	31.00	30.25	30.62	31.00	30.55	30.77	31.00	30.40	30.70
Mean	29.65	32.71	31.18	32.53	31.43	31.98	31.09	32.07	----

Table 11: Effect of N-fertilizers, gypsum and seed priming on soil Na^+ (mmol L^{-1}) in a saline field

Fertilizer	Gypsum			Non Gypsum			Fertilizer x priming		Cumulative Mean
	Seed priming	No seed priming	Mean	Seed priming	No seed priming	Mean	Seed priming	No seed priming	
Urea	7.37	6.60	6.98	7.52	5.77	6.65	7.45	6.18	6.81
NH_4NO_3	7.40	6.70	7.06	5.65	7.37	6.51	6.52	7.05	6.78
$(NH_4)_2SO_4$	6.35	7.60	6.97	6.90	7.42	7.16	6.62	7.51	7.06
Mean	7.04	6.97	7.00	6.69	6.85	6.77	6.86	6.91	----

Table 12a: Relationship between wheat leaf Na, K, K/Na ratio and soil ECe with grain yield

Leaf ion/ECe	Correlations coefficient (r)	Regression constant (a)	Regression constant (b)
	Grain Yield		
Na	-0.8081**	2290.81	-667.7
K	0.8317**	186.29	501.3
K/Na ratio	0.8134**	392.37	378.3
ECe	-0.7937**	2492.30	191.9

Table 12b: Relationship between dry matter yield, leaf Na, K, K/Na ration and soil ECe

Leaf ion/ECe	Correlations coefficient (r)	Regression constant (a)	Regression constant (b)
	Dry matter yield		
Na	-0.7318**	11410.6	-3274
K	0.7157**	231.0	2137
K/Na ratio	0.8322**	2559.2	1680
ECe	-0.8087**	12289.0	-911

** = Significant at 1% level of probability

various treatments did not effect yield significantly and so was their interaction. Cumulative mean values shows that maximum dry matter yield (though non-significant) was obtained when ammonium nitrate was applied. By comparing gypsum and non gypsum treatment, it is clear that non gypsum with seed priming and ammonium nitrate with seed priming proved better than non priming and treating with gypsum.

Leaf Na^+ concentrations: The analysis of variance for leaf Na^+ contents is given in Table 7. The results were non-significant when various management practices were employed. Their interaction was also non-significant. Leaf Na^+ contents increased with increasing salinity. Leaf Na^+ contents of 1.71, 1.69 and 1.58% were found in $(NH_4)_2SO_4$, urea and NH_4NO_3 respectively. Gypsum treatment slightly increased leaf Na^+ content than non -gypsum treated leaves. Similarly priming did not effect leaf Na^+ content.

Leaf K^+ concentrations: The analysis of variance for leaves K^+ contents (Table 8) also proved to be non-significant for fertilizers, gypsum, and seed priming and so were their interactions. Leaf K^+ decreased with increase of root zone salinity of field. Plants in low saline area had high K^+ content and higher saline area had an adverse effect. Leaf K^+ content for urea was 2.72%, $(NH_4)_2SO_4$ 2.55% and NH_4NO_3 2.89%. Comparatively more leaf K was found in non-gypsum plot than gypsum treated plots. Seed priming was slightly better in terms of enhance K accumulation than non- priming.

Leaf K^+/Na^+ ratio: The Leaf K^+/Na^+ ratio for fertilizers, gypsum, seed priming was non significant (Table 9). Maximum ratio of 2.42 was noted when NH_4NO_3 was applied while the ratio in urea treated plot was 1.93. The ratio was higher in non-gypsum treatment.

Soil Na^+ content: Data regarding soil Na^+ content (Table 10) shows that various treatment did not affect significantly soil Na^+ content. Plots treated with urea had 33.80 mg kg^{-1} while NH_4NO_3 treated plot had 30.25 mg kg^{-1}. For gypsum it was 31.18 mg kg^{-1} and non-gypsum 31.98 mg kg^{-1}. Na concentration of soil in primed and non-primed soil was also the same.

Soil ECe: ECe of soil was not affected significantly by the addition of either fertilizers or gypsum and seed priming. From the Table 11, it is evident that it was highest for treatments with ammonium sulfate, followed by urea and ammonium nitrate. It was also high for plots with gypsum treatment than non-gypsum. There was less variation among priming and non-priming treatments.

Relationship studies: The following relationships were studied.
1. Grain yield with leaf ions and ECe.
2. Dry matter yield with leaf ions and ECe.

While recognizing the spatial variability in the field with respect to salinity and supported by significant effect of replicates, the data for individual replicated treatment and mean value was calculated for yield with ECe, and also for yield with Na^+, K^+ and K/Na ratio (Table 12a, b).

Correlation between grain yield and leaf Na was negative but significant while with leaf K^+ was positively significant. Similarly K^+/Na^+ ratios with grain yield were positively significant. Grain yield had a negative but significant relationship with ECe.

The relationship between dry matter yield and leaf Na^+ content was also significant but negatively correlated, while its correlation with leaf K^+ was positive and significant. It was also positively significant for K^+/Na^+ ratios. The correlation between dry matter yield and ECe was negatively significant.

Discussion

Salinity affects plants in a number of ways. The most common of these are general reduction in plant growth and yield. As the salt level increases, the effects become more dominant the ultimate size of crop plant is decreased. However this rate of growth reduction vary widely among different crop species and these reduction rates can be altered with efficient use of fertilizer, keeping in view the existing salts and a careful use of chemical amendments like gypsum in combination with sound cultural practices. With proper management, economical yield can be obtained even from problem soils. As in a saline soil, there is a mixture of different salts, specific ion effects are minimal and osmotic effects predominate in growth suppression of crops.

All the agronomic traits and grain yield components of wheat (SARC-3) decreased with increasing salinity. Wheat crop is moderately salt tolerant (Maas and Hoffman, 1977) and similar adverse effect of root-zone salinity on its plant traits have been reported by Gill *et al*. (1993). On an average grain and straw yield were declined more with root zone salinity.

Salinity effect on crop alters during the growing season. With wheat crop, salinity suppresses the tiller formation during the vegetative and early reproductive stage (Maas and Hoffman, 1996). In the present experiment, it was observed that many seedlings died in early growth period and some seeds even failed to germinate. The number of tillers and ultimately yield reduced per unit area. Increased root zone salinity, produced shriveled seed, although treatments with NH_4NO_3, without gypsum and seed priming produced slightly more seed but none came good, statistically.

Na^+ ions concentration increased with the increasing salinity, and K^+ content of leaves was decreased, ultimately grain yield decreased. This was also reported by Than (1994). As K^+ is one of compatible solutes for osmotic adjustment in plant, plays role in the translocation of metabolites to grain (Sink) and activates enzymes. But its uptake is decreased by increased Na content of soil and Na concentrations of leaves are increased rather. N fertilization generally increases K uptake and decreases Na concentrations in leaves as reported by Yasin(1991). Such relationship of toxic Na^+ and compatible K^+ ions and shoot grain yields of wheat have been also reported by Rashid(1986).

Gypsum was added at much lower rate and it did not bring any significant changes. Treatment with gypsum mostly had lower yields and other plant traits were affected as compared to non-gypsum. This might be due to the fact that lower gypsum added to electrical conductivity and hence salinity, because of increased frequency of rains and poor drainage, as for gypsum to be affective it requires good infiltration into the soil and than leaching as reported by Shainberg *et al*. (1982). If the above conditions are not met than gypsum added has an adverse effect in saline soil as it maintains a good electrolyte concentration in soil and hence salinity as reported by Shainberg *et al*. (1982).

The treatments with pre-soaked seeds had good initial germination but at latter stages it did not make a significant difference. Soaking accelerated germination but did not affect the final percentage of germination and at higher salinity levels soaking failed to improve germination as reported by Idris and Aslam (1975). Though presoaking has some other significant affects on crop like it improves the plant growth (Chhipa and Lal, 1978) and uptake of nutrients by the plants is enhanced (Balki and Padole, 1982), but over all the presoaking did not make a significant difference in either yield or any of the yield components. Thus the increased amount of Na^+ in soil and leaves suppressed the yield and other agronomic characters significantly in high saline treatments.

Significant negative correlation of leaf Na^+ and significant positive correlation of leaf K^+ and K/Na ratios with grain yield indicated that wheat plants that accumulated more Na^+ had poor yield and which maintained higher tissue K^+ had better grain yield (Khattak, 1987). ECe had a negatively significant relationship with grain yield suggesting that this can be the limiting factor in grain yield when present at a high rate (Chhipa and Lal, 1978).

It is concluded that among the fertilizers, ammonium nitrate proved effective than urea and ammonium sulfate in a saline soil. Gypsum addition did not effect yield but added to already existing salinity by increasing electrolytic concentration. Seed priming did not prove better than non-priming, though initial germination was good with it, but at lateral stages, it did not have a significant effect. Negative correlation of grain yield with Na^{+} and ECe may be the possible reason for obtaining low yield under salt affected soil conditions.

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