INTERACTIVE EFFECT OF SALINITY AND NITROGEN ON THE YIELD OF WHEAT

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Soluble salts in soils of Pakistan adversely affect the yield of wheat crop. The nutritional deficiency becomes additive factor. A pot study was therefore conducted to evaluate the ameliorative role ofN. The salinity levels (6,12 and 18 d, m') were artificially developed with NaCl, CaCh , $2H_20$ and $MgS0_4$, $7H_20$. The ratio of Ca+Mg to Na was calculated according to the desired SAR while the ratio of Ca to Mg was 5:1. However the crop could not withstand at the highest salinity level of 18.0 ds m'. The study therefore, was repeated with salinity levels of 6,9 and 12 ds m,l during the year 1990-91.. Three N levels (0, 80 and 160 kg ha") were used with each salinity level.. The results indicated that the fresh and dry shoot weights at booting stage, plant height number of effective tillers, grain and straw yields at maturity and lOO-grain weight were negatively affected with salinity, while positively with N application. Lower rate of N (80 kg ha") was found to be economical under such adverse soil conditions.

INTRODUCTION

According to Muhammad (1983), 2.52 m ha,l are affected by salinity. Excessive quantities of soluble salts affect the nutritional and water balance of plants (Muhammad, 1981) by decreasing the water potential in soil.

Both N, and P, especially N is the nutrient element which is the most deficient all over the country. The improved maize crop production on moderately salt-affected soils was possible through judicious use of plant nutrients, particularly N (Aslam *et al., 1989).*

Agricultural crops and their varieties differ considerably with regard to salt tolerance (Qureshi, 1990). The typical response of most of the crop plants to salts seems to be the growth inhibition (Flowers *et al.,* 1991). As the salt concentration increases above threshold level, both he rate of growth and vigor of plant species are progressively decreased (Aslam *et al.* 1991). Although wheat is a moderately salt tolerant crop (Mass and Hoffman, 1977) but the growth parameters like plant height, tillering capacity are greatly reduced with increasing concentration of salts in the growth medium (Rashid, 1986). Excessive amount of salts not only affected the growth but also reduced the grain and straw yields of wheat (AI-Ani and Al-Rawi, 1977). Adverse effect of salts was also observed on grain weight (Niane, 1987). This study was thus carried out to confirm the effect of salts on the yield of wheat and to evaluate ameliorative role of N.

MATERIALS AND METHODS

The study was carried out in the wire house of Soil Chemistry Section, Ayub Agriculture Research Institute, Faisalabad during 1989-90. A non-saline soil was collected from the research area of the section. It was air dried, ground and passed through a 6 mm sieve. The sieved soil was mixed thoroughly and a representative sample was used for the determination of physical and chemical characteristics, after further girding and passing through a 2 mm sieve (Table 1). The study was undertaken with the following treatments.

Salinity levels:

i) EC, 0.88 ds m-I (control)
ii) EC,6.0 "
iii) EC, 12.0 "
iv) EC, 18.0 "

Nitrogen levels:

i) Nj,, N control
ii) Nz, 80 Kg ha-[1] (40 mg kg")
iii) N3 160 kg ha-[1] (80 mg kg")

three N levels and methodology. At booting stage of this crop, three alternate plants were harvested and fresh and dry shoot weights were recorded. Remaining three plants were grown up to maturity. At maturity, after counting the productive tillers and measuring the plant height the crop was harvested and grain and straw yield along with lOO-grain weight were recorded.

RESULTS AND DISCUSSIONS

RESULTS

The actual salinity levels obtained in soil after harvesting the crop were 1.0 (Control), 5.8, 8.9 and 11.8 dS m-I and these levels have been used in the results and discussion.

Table 1. Physical and chemical characteristics of the original soil

ECe (dS m')	pH	O.M. (%)	Avail	Avail.. K	SAR	Total N	Texture
			------ (mg kg") ------				
0.88	7.53	0.52	5.50	220	2.70	0.03	Clay Loam

The dose of PzOs and KzO @ 80 and 60 kg ha-[t] respectively was also used. The soils was artificially made saline with calculated quantities of NaCI, $CaCl_Z$, $2H_ZO$ and $MgS0_4$. 7HzO and SAR achieved was 4.5. The soil was mixed thoroughly and passed through wet and dry cycles for one month before sowing to achieve an equilibrium. Urea, SSP and potassium sulphate were used as NPK sources respectively. Half N, all PzOs and KzO were applied at sowing and remaining half N with second irrigation. Twelve seeds of wheat FD-85 variety were sown in each pot having 12 kg soil. Unfortunately the crop could not germinate at the highest salinity level of 18.0 dS m'. The trial was therefore, repeated in the next season (1990-91) with lower salinity levels (6,9 and 12 dS m') along with the same

Fresh shoot weight at booting stage

The data (Table 2) indicated that the fresh shoot weight at EC, levels of 8.9 and 11.8 dS m-I decreased by 15 and 44%, respectively compared to that from the control. At EC, 5.8 dS m' a non-significant increase in shoot weight over the control was found.

The fresh shoot weight increased by 67 and 78% over the control where N was applied @ 80 and 160 kg ha", respectively. The difference in weight in these two treatments was, however, statistically non-significant. The interaction between salinity and N on fresh weight was statistically non-significant.

Dry shoot weight at booting stage

The interaction between salinity and N on dry shoot weight was statistically significant (Table 2). It showed that salinity did not

Table 2. Effect of salinity and nitrogen on fresh and dry shoot weights (g plant") of wheat at booting stage

N level kg ha-1	Salinity level, dS m-1				Mean
	1.0	5.8	8.9	11.8	
0	15.5	15.4	12.2	8.2	128 b
80	24.3	25.6	21.6	14.1	21.4 a
160	26.9	26.9	22.9	14.8	22.9 a
Mean	22.2 a	22.6 a	18.9 b	12.4c	
	Dry shoot weight				
0	4.07 a b	4.27 a b	3.10 a b	1.90 a a	3.32
80	6.40 ab a	7.00 a a	4.33 be ab	3.00 c a	5.18
160	8.33 a a	7.93 a a	5.60b a	3.97 b a	6.46
Mean	6.26	6.40	4.34	2.96	

The letters on the right hand side of numerical values compare all means in the same row.
The letters under the numerical values compare all means in the same column.
Mean sharing same letters (s) are statistically similar at P = 0.05

significantly affect the dry shoot weight in the case of N control treatment. The dry shoot weight however, decreased significantly at EC, levels of 8.9 and 11.8 dS m-1 compared to salinity level of 5.8 dS m-1 where N was applied & 80 kg hal. At N level of 160 kg ha", the dry shoot weight significantly decreased at salinity level of 8.9 and 11.8 ds m-compared to control (1.0 dS m"). The mean dry shoot weight at EC, 5.8 dS m-I was slightly but non-significantly higher than control.

Nitrogen application significantly increased the dry shoot weight over control. However, the increase up to EC, level of 8.9 dS m', only the higher rate of N significantly increased the dry shoot weight over control while, at low salinity levels, both the rates significantly improved it over control. Nevertheless, the difference in dry shoot weight at N levels of 80 and 160 kg ha-I was statistically non-significant. At the salinity level of 11.8 dS m', N application did not significantly improve the dry shoot weight compared to control.

Plant height at maturity

Plant height (Table 3) at ECe 5.8 and 8.9 dS m-1 were statistically similar to control. However, at the highest salinity level of 11.8 dS m", it was significantly less than that in other treatments.

Nitrogen application significantly increased the plant height compared to control. The difference in plant height between 80 and 160 kg N ha-I was, however, statistically non-significantly, indicating that higher dose of N did not increase the plant height. The interaction between salinity and nitrogen was statistically non-significant.

Number of effective tillers at maturity

The tillers number, no doubt, decreased with increasing salinity levels (Table 3) but it was not significantly reduced except at EC, level of 11.8 dS m-I at the higher rate of N.

Number of effective tillers progressively increased with the increasing levels of nitrogen. The number being maximum in the treatment where N was applied @ 160 kg ha'! and minimum in the case of control.. The efficiency of N however, decreased with increasing salinity levels because upto EC, level of 8.9 dS m', the higher rate of N increased it significantly over N control treatment, but at EC, 11.8 dS m'] N application did not significantly increase the tiller number.

Nitrogen application significantly increased the grain yield over control except at 11.8 dS m', where only higher rate of N (160 kg ha') improved it significantly. The difference in yield due to N levels of 80 and 160 kg ha" was statistically non-significant except for the control.. The yield was maximum where N was applied & 160 kg ha'! while minimum in control.. The additional increase in grain yield with higher dose of N was comparatively less than with lower supply of nitrogen.

Table 3. **Effect of salinity and nitrogen on plant height and number of effective tillers of wheat at maturity.**

N level kg ha']	Salinity level, dS m']				Mean
	1.0	5.8	8.9	11.8	
			Plant height		
0	81.2	81.8	80.5	77.0	80.1 b
80	86.0	85.8	82.0	79.3	83.3 a
160	84.7	85.1	83.8	77.2	82.7 a
Mean	84.0 a	84.2 a	82.1 a	77.8 b	
			Number of Effective Tillers		
0	1.67 a b	1.33 a b	1.43 a b	1.10 a a	1.38
80	3.10 a b	2.90 a ab	3.10 a ab	2.43 a a	2.88
160	5.57 a a	4.23 ab a	3.67 ab a	3.23 b a	4.18
Mean	3.45	2.82	2.73	2.25	

The letters on the right hand side of numerical values compare all means in the same row.
The letters under the numerical values compare all means in the same column.
Mean sharing same letters (s) are statistically similar at $P = 0.05$

Grain yield

The data (Table 4) indicated that the interaction between salinity and N on grain yield of wheat was significant.. However the grain yield of wheat was not significantly affected with increasing salinity levels except at 11.8 dS m'] with the higher rate of N. The reduction in mean grain yield was 8, 20 and 44% at ECe 5.8, 8.9 and 11.8 dS m', respectively compared to control Fifty percent reduction in grain yield occurred at salinity level of 13.4 dS m'! (extrapolated).

Straw yield

The interaction between salinity and N on straw yield indicated that the straw yield was negative but non-significantly affected with increasing levels of salinity (Table 4). The mean straw yield decreased by 15, 32 and 38% at EC, levels of 5.8, 8.9 and 11.8 dS m-L, respectively compared to control.

Nitrogen application increased the straw yield over control.. However, in non-saline soil, the increase because of N level of 80 kg ha'l was statistically significant over N control treatment only, while in other cases all the N rates produced statistically similar yields.

Hundred - grain weight

The results (Table 4) indicate that 100-grain weight decreased with increasing salinity levels. However, it was non-significantly affected up to salinity level of 5.8 dS m'l whereas, it significantly decreased at EC, 8.9 and 11.8 dS m'l. The difference between these two salinity levels was statistically non-significant.

Nitrogen application did not significantly affect the jOO-grain weight. The interaction between N and soil salinity was statistically non-significant.

DISCUSSION

Sensitivity of a crop plant to salts stress in usually manifested as reduced growth. **In** the present study, salinity reduced all the growth parameters like fresh and dry shoot weights. plant height, lOO-grain weight, number of

Table 4. Effect of salinity and nitrogen on grain and straw yields (g plant") and 100-grain weight (g) of wheat.

N level kg ha"	Salinity level, dS m'l				Mean
	1.0	5.8	8.9	11.8	
		Grain yield			
0	2.87 a	2.43 a	2.13 a	1.70 a	2.28
	c	b	b	b	
80	5.80 a	5.77 a	5.10 a	3.77 a	5.11
	b	a	a	ab	
160	9.17 a	8.20 a	6.97 ab	4.47b	7.20
	a	a	a	a	
Mean	5.95	5.47	4.73	3.31	
		Straw yield			
0	4.1 a	4.4 a	3.6 a	2.0 a	3.5
	b	a	a	a	
80	8.4 a	7.4 a	7.1 a	7.1 a	7.5
	ab	a	a	a	
160	3.8 a	10.8 ab	7.3 ab	7.2 b	9.8
	a	a	a	a	
Mean	8.8	7.5	6.0	5.1	
		Hundred grain weight			
0	6.5	6.3	6.1	6.0	6.2
80	6.4	6.2	6.0	5.9	6.1
160	6.0	6.0	5.6	5.7	5.8
Mean	6.3 a	6.2 a	5.9 b	5.9 b	

The letters on the right hand side of numerical values compare all means in the same row.
The letters under the numerical values compare all means in the same column.
Mean sharing sameletters (s) are statistically similar at P = 0.05

effective tillers and grain and straw yields. The reduction in fresh shoot weight over control was 15 and 44% at EC, levels of 8.9 and 11.8 dS m', respectively while, dry shoot weight reduced by 30 and 53% at these salinity levels (Table-2). Similarly, the reduction in grain yield was 20 and 44% and straw yield was reduced by 32 and 38% at salinity levels of 8.9 and 11.8 dS m', the fresh and dry shoot weights and plant height were slightly improved than the control treatment but grain and straw yields were not significantly affected at this salinity levels. The increase in shoot weight of wheat at lower salinity could be due to more ammonium ion desorption and low NH_4 fixation in soil resulting in the increased supply of N to plants, a better nutritional balance for plant growth (see Bernal and Bingham 1973). An improved dry matter yield at lower salinity has also been reported by AI-Ani and AI-Rawi (1977).

Various reasons have been advanced for reduction in plant growth under saline media. Salinity affect almost all plant processes because of its effects on soil properties, because of osmotic effects of high ionic concentration, because of competitive interference with nutrient uptake and because of toxic effects within the plant tissues (Yeo and Flowers, 1986; Flowers *et al.,* 1991, Alsam *et al.,* 1993 b).

Most of the plant species seem to adjust osmotically to saline conditions (Bernstein, 1961). Inspite of osmotic adoption of plants, the reduction in growth is proportional to osmotic potential of the external solution (Greenway and Munns, 1980). Gale and Zeroni (1984) argued that the reduction may be due to the decreased photosynthetic rate as well as increased "maintenance respiration" under saline conditions. Stavarek and Rains (1984) hypothesized that the respiratory energy competing with growth increased as the salinity of growth medium increased, leaving a small portion of energy to maintain the plant growth. Mass and Nieman (1978) reported that salinity disturbed the carbohydrate as well as protein metabolism.

In the present study the reduction in shoot weights (Table 2), number of effective tillers (Table 3) and grain weight (Table 4), consequently reduced the grain and straw yields of wheat (Bernal *et al.,* 1974; Jodav *et al.,* 1976). However, grain yield was more severely affected than straw yield. This findings confirms the reports of Qureshi *et al.,* (1990) that wheat is more sensitive to salinity at booting stage. Fifty percent reduction in grain yield occurred at salinity level of 13.4 dS m'l (extrapolated) suggesting that FD 85 variety of wheat may be economically grown up to this salinity level in soil.

The reduction in grain weight under saline environmental seems due to the poor development of seeds as a result of limiting supply of essential metabolites (Murty and Rao, 1967; Niane, 1978). Grain yield was significantly improved with N application. However, under saline conditions lower rate of N by and large improved it significantly while the difference between lower and higher rate of N was statistically non-significant indicating that the lower rate of N may be sufficient to meet the N requirement of wheat under such adverse soil conditions.

CONCLUSION

Fresh and dry shoot weights, plant height, number of effective tillers, grain and straw yields and 100 grain weight were negatively affected with salinity, while positively with N application.

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