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GROWTH RESPONSE OF RICE AND WHEAT TO $(NH)_2SO_4$-N RATES IN SALT-AFFECTED SOILS

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A series of four trials on a sodic field were conducted to evaluate the effect of various levels of ammonium sulphate on yield and quality of rice and wheat from 1986-87 to 1987-88. The N was applied @ 0, 30, 60, 90, 120 and 0, 60, 120, 180, 240 kg ha^{-1} alongwith a basal dose of P and K @ 50, 30 and 80, 50 kg ha^{-1} for rice and wheat, respectively. It was found that grain and straw yield, number of productive tillers and NPK uptake by plants increased with increasing rates of N application. Maximum productive tillers and yield of rice was recorded at 90 kg N ha^{-1} and of wheat with 180 N kg ha^{-1} except wheat productive tillers during 1987-88. The NP uptake in rice and that of NPK in wheat were found maximum with 90 and 180 kg N ha^{-1}, respectively. The K uptake by rice was maximum at 120 kg N ha^{-1}.

INTRODUCTION

Some research workers have studied the subject under their own prevailing conditions. The grain yield of two rice varieties "Giza 159 and IR 579" was increased by N application in soils having EC_e of 7.8, 9.2 and 12.8 dS m^{-1} (Jalil *et al.*, 1979). Hasan *et al.* (1980) concluded that grain yield and grain mineral content of rice decreased with increasing salinity levels. Bajwa (1982) noted in a pot experiment that with an increase in SAR, the yield of rice and concentration of in shoots and roots of rice decreased. Chillar and Dargan (1982) observed that the grain yield of wheat variety HD 2009 increased with an increase in N rates in a semi-reclaimed sodic soil. Similarly Chaudhry *et al.* (1989), in a pot experiment, reported that N uptake in plants increased with increasing salinity upto 60 me L^{-1} but decreased with further increase in salinity. Keeping all this in view, an experiment was planned to assess the growth response of rice and wheat to $(NH_4)_2SO_4$-N rates in salt-affected soils.

Rice			Wheat		
N	P_2O_5	K_2O	N	P_2O_5	K_2O
kg ha^{-1}					
0	0	0	0	0	0
0	50	30	0	80	50
30	50	30	60	80	50
60	50	30	120	80	50
90	50	30	180	80	50
120	50	30	240	80	50

MATERIALS AND METHODS

Four field trials were conducted at Soil Salinity Research Institute, Rakh Pindi Bhattian on rice and wheat crop during 1986-87 and 1987-88 to study the efficiency of ammonium sulphate as nitrogen source in salt-affected soils. Before sowing, a composite soil sample was taken from each site and analysed for physico-chemical characteristics (Table 1). The pHs, EC_e and SAR of soil at 4 different sites varied from 8.52 to 8.88, 1.6 to 2.87, 17.02 to 33.26, respectively. The varieties sown were Basmati 370 and Pak 81 of rice and wheat, respectively. The experiment was laid out in randomized complete block design with four replications. The treatments for rice and wheat were as follows:

with two plants $hill^{-1}$ while wheat sowing was done with single row cotton drill with line to line distance of 1'. At maturity before harvesting plant samples were taken for NPK determination. The analyses were done according to methods described by U.S. Salinity Lab. Staff (1954), N by that of Jackson (1962) and P in soil by Watanabe and Olsen (1965) method. The NPK uptake was calculated by the formula:

$$\text{NPK uptake (kg ha}^{-1}) = \frac{\text{\% conc. in dry matter x dry matter yield (kg ha}^{-1})}{100}$$

Productive tiller m^{-2}, grain and straw yield, were recorded. All the data were

Table 1. Physical and chemical characteristics of soils before transplanting/sowing of crops

Property	Rice (Bas 370)		Wheat (Pak 81)	
	1986	1987	1986-87	1987-88
pHs	8.88	8.52	8.58	8.57
ECe (dS m^{-1})	2.87	2.17	1.62	2.24
SAR (m mol $L^{-1})^{\frac{1}{2}}$	33.26	17.65	18.93	17.02
ESP	32.34	19.81	21.01	19.23
Available P (ppm)	6.0	5.4	5.9	7.3
Total N (%)	0.028	0.031	0.026	0.029
Extractable K (mg kg^{-1} soil)	140.00	127.00	131.00	124.00
Saturation percentage	22.50	22.50	22.00	24.30
Soil texture	loamy sand	loamy sand	loamy sand	loamy sand

Half of the N and all the P_2O_5 and K_2O were applied at tranplanting/sowing in the form of ammonium sulphate, super phosphate and potassium sulphate, respectively. The remaining ½ N was applied 25 days after transplanting and at first irrigation to rice and wheat, respectively. Rice crop was transplanted in lines at a distance of 25 cm

statistically analysed according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

a. Rice: The paddy yield (Table 2) increased with increasing rates of nitrogen during both the years. Maximum paddy yield was ob-

tained where N was applied @ 90 kg ha^{-1}. The straw yield increased with increasing rates of nitrogen. During both the years, maximum straw yield was recorded in the treatment receiving 120 kg N ha^{-1} but these results remained statistically similar with T_5 (90-50-30). These results are in agreement with Jalil *et al.* (1979). Productive tillers m^{-2} increased with increasing rates of nitrogen. Maximum productive tillers m^{-2} were obtained where N was applied @ 90 kg ha^{-1} during both the years. The reason for increasing paddy and straw yield and productive tillers might be that in salt affected under flooded conditions nitrogen in ammonical form is largely absorbed on the cation exchange complex, with only a small amount present in the soil solution. a small percentage of NH_4-N may be fixed in a non-exchangeable form between the lattices of silicate minerals (Patrick *et al.*, 1985). In this way, the N remains available to crop plants for longer periods of time which helps the plants to maintain their growth inspite of the deleterious effects of the sodium present in sodic soils.

b. Wheat: The grain yield (Table 3) increased with increasing rates of nitrogen. During 1986-87, maximum grain yield was obtained with N @ 180 kg ha^{-1}. While next year during 1987-88, N @ 240 kg ha^{-1} gave the maximum grain yield. However, these remained statistically similar with T_5, where 180 kg N ha^{-1} was applied. The straw yield increased with increasing rates of nitrogen. In the year 1986-87 and 1987-88, N @ 180 kg ha^{-1} gave the maximum straw yield. Similar is the case regarding productive tillers m^{-2}. It might be due to that the application of ammonium salts can undergo cation exchange reactions and/or precipitation of insoluble reaction products e.g. calcium sulphate ($CaSO_4$) from ammonium sulphate. This $CaSO_4$ helps in reducing injurious effects of Na in these soils, improving soil physical properties and thus crop yields. Similar results were obtained by Chillar and Dargan (1982) in a semi-reclaimed sodic soil.

Table 2. Effect of N application on productive tillers, grain and straw yield of rice (1986 and 1987)

Treatment				Productive tillers m^{-2}		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	N	P_2O	K_2O						
	e	(kg ha^{-1})		1986	1987	1986	1987	1986	1987
T1	0	0	0	54 c	62 d	580 c	1528 e	2397 c	5000 c
T2	0	50	30	66 b	82 cd	1103 bc	1769 d	5234 bc	5444 bc
T3	30	50	30	71 ab	114 bc	1107 bc	2139 c	4629 bc	6104 b
T4	60	50	30	74 a	140 ab	1536 ab	3639 b	6447 ab	10178 a
T5	90	50	30	76 a	151 a	1937 a	3889 a	9215 a	11000 a
T6	120	50	30	75 a	154 a	1841 a	3787 ab	9243 a	11178 a

Figures followed by similar letter(s) differ non-significantly at P = 5%.

Table 3. Effect of N application on productive tillers, grain and straw yield of wheat (1986-87 to 1987-88)

Treatment				Productive tillers m^{-2}		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	N	P_2O	K_2O						
	e	(kg ha^{-1})		1986-87	1987-88	1986-87	1987-88	1986-87	1987-88
T1	0	0	0	178 d	98 b	1640 d	1313 d	5970 c	2458 c
T2	0	80	50	191 c	99 b	1787 d	1875 c	6286 bc	1917 c
T3	60	80	50	212 c	178 c	2565 b	2448 b	9124 ab	5354 b
T4	120	80	50	245 b	197 b	2634 c	2500 d	9713 a	6333 a
T5	180	80	50	277 a	205 a	2775 a	3208 a	11037 a	6375 a
T6	240	80	50	295 a	173 a	2649 a	3458 a	11941 a	5542 b

Figures followed by similar letter(s) differ non-significantly at P = 5%.

Table 4. The uptake of NPK by crops (kg ha^{-1}) as affected by N application on sodic soil

Treatment				N		P		K	
				Wheat					
	N	P_2O	K_2O						
		(kg ha^{-1})		1986-87	1987-88	1986-87	1987-88	1986-87	1987-88
T1	0	0	0	59 d	32 e	16 b	11 d	171 f	78 e
T2	0	80	50	62 c	37 d	17 b	15 c	183 e	72 f
T3	60	80	50	87 b	67 c	26 ab	23 b	277 b	173 d
T4	120	80	50	90 b	75 b	27 ab	26 b	302 c	201 b
T5	180	80	50	97 a	85 a	32 a	36 a	345 b	214 a
T6	240	80	50	93 a	86 a	32 a	37 a	367 a	193 c
				Rice					
				1986	1987	1986	1987	1986	1987
T1	0	0	0	18 d	39 e	5.02 d	12.04 e	68 a	140 e
T2	0	50	30	36 c	44 d	9.34 c	14.19 d	145 d	158 d
T3	30	50	30	36 c	53 c	10.50 c	18.45 c	146 d	189 c
T4	60	50	30	31 b	86 b	16.44 b	34.05 b	203 c	325 b
T5	90	50	30	72 a	92 a	21.37 a	38.36 a	299 b	362 a
T6	120	50	30	71 a	92 a	19.54 a	37.34 a	311 a	360 a

c. NPK uptake by rice: The uptake of NPK (Table 4) increased with increasing rates of N. Maximum uptake of NPK during 1986-87 were recorded in the treatment receiving 90 kg N ha^{-1}. The minimum NPK uptake in the year 1986-87 was obtained in the control. The reason for increasing NPK uptake might be that in flooded soils, NH_4-N is adsorbed on exchange complex whereas P and K are in soil solution and plants do not suffer from their deficiency inspite of higher concentrations of toxic sodium. But its deleterious effects are reduced by K which antagonise the Na absorption. Similar results have been reported by Bajwa (1982) and Chaudhry *et al.* (1989).

NPK uptake by wheat: The uptake of NPK (Table 4) increased with increasing rates of N application. Maximum NPK uptake in the year 1986-87 and 1987-88 was noted in the treatment receiving N @ 180 kg ha^{-1}. Minimum NPK uptake were recorded in the control. This may be due to the reason that $(NH_4)_2SO_4$ by forming $CaSO_4$ in sodic soils reduces the toxic effects of Na which otherwise competes with K and NH_4 uptake by plants. Similarly, the P uptake was also increased and increased dry matter yield. Similar results were obtained by Chaudhry *et al.* (1989).

It may be concluded that with the application of N in the form of ammonium sulphate @ 90 kg ha^{-1} and 180 kg ha^{-1} my increase the yield of rice and wheat, respectively.

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