Annals of Plant and Soil Research 15(1): 62-64 (2013)

EFFECT OF WATER SALINITY LEVELS ON YIELD AND UPTAKE OF NUTRIENTS IN RICE VARIETIES

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Received: October, 2012

ABSTRACT

A green house experiment was conducted using six rice varieties viz. BPT-5204, Pant-4, Pant-10, Pusha Kranti, Sarju-52 and Saket-4 and four levels of water salinity viz untreated, EC 8, 12 and 16 dSm^{-1}. The results indicated that salinity levels significantly decreased the grain yield over untreated ones. Higher grain yield was noted in Pusha Kranti variety. The N, Na content and Na/K ratio increased while, P, K and Zn content decreased with increasing levels of salinity. More N, P, K and Zn content and uptake was noted in Pusha Kranti variety. However, content and uptake of Na was lowest in Pusha Kranti variety. The use of saline irrigation water adversely affected all the parameters pertaining to rice crop.

Keywords: Salinity, varieties, grain yield, Na/K ratio

INTRODUCTION

In arid and semi-arid regions supplemental irrigation is essential for successful crop production and in some areas the main source of irrigation is ground water which may contain salts of varying concentrations. Unscientific and indiscriminate usage of saline water in irrigation causes an accumulation of soluble salts in root zone and adversely affects the physical and chemical properties of irrigated soil which in turn decreases crop productivity due to reduced water availability to plants (Tripathi and Pal, 1980 and Agrawal et al. 2002)**.** The imbalance between rate of supply and uptake of nutrient in soil-plant system under salt stress environment will depend upon the degree of salinity and their interaction in which a key role is played by Na/K ratio. Rice is the most important food grain crop of the country and grown in most part of India but production is very low due to by different factors in which one main cause is quantity and quality of irrigation water. Keeping these points in view, the present study was undertaken with an objective to assess the effect of different water salinity on yield, nutrient content, uptake and Na/K ratio of rice varieties.

MATERIALS AND METHOD

The pot experiment was conducted for two years on a sandy loam soil having the following characteristics. ECe 2.4 dSm^{-1}, pH 8.3, ESP 7.5, soluble salt [Ca^{++} - 4.3, Mg^{++} 5.3, Na^{+} 13.2, K^{+} 0.2, CO_3^{--} traces, HCO_3^{-} 7.3, Cl^{-} 6.5 and SO_4 9.2 meL^{-1}], and organic carbon 1.5 g kg^{-1}, available status of NPK and zinc in soil was 177, 12, 206 kg ha^{-1} and 0.56 mg kg^{-1}, respectively. Six rice varieties viz. BPT-5204, Pant-4, Pant-10, Pusha Kranti, Sarju-52 and Saket-4 was tested in a factorial CRD design with three replications. Earthen pots of 30 cm diameter size were filled with 8 kg soil. The water salinity levels were prepared by dissolving $NaHCO_3$, Na_2SO_4, NaCl, $MgCl_2$ and $CaCl_2$ salt in tube-well water having EC-2.4 dSm^{-1}, pH 7.6, Ca^{++} + Mg^{++} 9.3, Na^{+} 14.1 and HCO_3^{-} 8.2 Cl^{-} 11.8 and SO_4^{--}4 meL^{-1}. The recommended dose of NPK and $ZnSO_4$ @ 120, 80, 60 and 50 kg ha^{-1} respectively were applied through urea, single superphosphate, muriate of potash and zinc sulphate. Two seedlings of rice were planted on July 15 in each pot in both the years. Crop was irrigated with tube-well water just after transplanting and thereafter irrigation was given with treatment water. After 10 days of transplantation crop was thinned to one plant in each pot. The data on grain yield was recorded and grain samples, were processed for chemical analysis. The modified Kjeldahl method was adopted for nitrogen estimation in grain samples. Phosphorus was determined in diacid digest following molybovamadate yellow colour method and potassium and sodium with flame photometer (Jackson 1973). Zinc was determined on atomic absorption spectrophotometer. The uptake of nutrients was calculated by multiplying nutrient concentration with yield.

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RESULTS AND DISCUSSION

The data (Table 1) indicated that influence of different water salinity significantly decreased the grain yield of rice over control. The reduction was statistically significant over lower levels of salinity and mean reduction in grain yield with EC-16 dSm^{-1} was 63 percent. The decrease in yield due to salinity is attributed to increased osmotic pressure of soil solution with higher salinity which restricted availability of water to plants resulting in the reduction of growth and grain yield (Agrawal *et al.* 2002). Pusha Kranti variety produced significantly higher grain yield (7.53 g pot^{-1}). Minimum grain yield was noted in variety BPT-5204 as compared to other varieties.

Table 1: Yield, content, uptake of nutrients and Na/K ratio in rice varieties with respect to water salinity (mean of 2 years)

Treatments	Grain yield (g pot^{-1})	Nutrient content (%) and uptake (mg pot^{-1}) of grain										Na/K ratio
		Nitrogen		Phosphorus		Potassium		Zinc (mg pot^{-1})		Sodium		
		Content	Uptake	Content	Uptake	Content	Uptake	Content	Uptake	Content	Uptake	
EC levels (dSm^{-1})												
Untreated	8.38	1.17	98.89	0.21	18.23	0.62	53.2	32.0	270.2	0.12	10.6	0.20
8	6.33	1.26	80.08	0.20	13.17	0.56	36.5	29.4	187.7	0.16	9.9	0.29
12	4.85	1.32	62.54	0.18	8.82	0.45	22.7	23.3	115.0	0.19	9.1	0.42
16	3.28	1.37	45.03	0.13	4.25	0.36	12.3	17.6	60.2	0.23	7.7	0.65
CD(P=0.05)	0.31	0.01	4.12	0.002	0.61	0.013	1.62	0.33	8.04	0.009	0.62	0.029
Rice varieties												
BPT-5204	3.48	1.24	42.17	0.18	6.88	0.45	16.8	24.0	89.7	0.19	6.3	0.46
Pant-4	4.30	1.28	55.99	0.18	8.70	0.46	21.9	23.8	114.8	0.18	7.0	0.42
Pant-10	6.45	1.30	82.23	0.18	13.09	0.52	36.9	25.4	179.5	0.17	10.1	0.38
Pusha Kranti	7.53	1.32	98.03	0.18	14.34	0.56	44.0	27.6	217.0	0.17	12.2	0.33
Sarju-52	6.93	1.28	87.43	0.17	13.19	0.53	38.6	24.4	193.6	0.17	11.0	0.33
Saket-4	5.60	1.26	69.49	0.18	10.50	0.49	28.9	26.35	155.1	0.18	9.5	0.40
CD(P=0.05)	0.26	0.013	3.36	0.002	0.75	0.016	1.98	0.41	10.4	0.011	0.76	0.036

Increasing levels of water salinity significantly increased the N content in grain of rice crop. Maximum N content was recorded at 16 dSm^{-1} level. However, N uptake in grain significantly decreased with increasing levels of salinity. Maximum reduction of N uptake was noted at EC 16 dSm^{-1} which may be ascribed to lower grain yield. The adverse effect of EC on N uptake is in accordance with those of Lal and Singh (1974). The Pusa Kranti and BPT-5204 recorded maximum and minimum N content and uptake, respectively. Each higher level of salinity significantly decreased the P content and uptake in grain over control. Minimum P content and uptake in grain was noted at EC 16 dSm^{-1}. This may be due to higher concentration of anions in soil solution which compete with P for absorption sites on root surface for their absorption. Similar findings were also reported by Janki and Singh (2001)**.** Phosphorus content and uptake were influenced markedly by genetic variation of rice. Maximum P content in grain was noted in BPT-5204. The uptake of phosphorus in grain was recorded higher in Pusha Kranti variety. The K and Zn contents and uptake by rice were significantly influenced by water salinities. Each higher level of water salinity significantly decreased the K and Zn in grain as compared to lower levels and lowest values of K and Zn were recorded under EC 16 dSm^{-1}. Pusha Kranti variety contained more content and utilization of K and Zn by grain. Sodium content significantly increasesd with increase in levels of salinity and maximum value was recorded with EC 16 dSm^{-1} level. Similar result was noted by Lal *et al.* (1999). Pusa Kranti and Sarju-52 cultivar had the lowest Na content while BPT-5204 contained the highest amount of sodium. The uptake of Na significantly decreased with increasing levels of salinity. The mean reduction in Na was higher with EC 16 dSm^{-1}. Gandhi and Paliwal (1975) noted the decline in Na uptake by rice which may be due to reduction in grain yield by increasing level of salinity.

Interaction effect between salinity and varieties on Na content and uptake (Table 2) was significant. The results indicated that the increasing levels of salinity enhanced Na content and decreased Na uptake as compared to preceding lower levels of salinity. The maximum values of Na content in all the varieties were noted under 16 dSm^{-1} level of water salinity. On the hand, maximum values of Na uptake by rice varieties were noted under control level of

Table 2: Interaction effect of salinity and varieties on sodium content and uptake in grain of rice (mean of 2 years)

EC (dSm^{-1})	BPT-5204	Pant-4	Pant-10	Pusha Kranti	Sarju-52	Saket-4	BPT-5204	Pant-4	Pant-10	Pusha Kranti	Sarju-52	Saket-4
	Sodium content (%)						Sodium uptake (mg/pot)					
Control	0.14	0.12	0.11	0.12	0.14	0.14	6.8	9.2	10.9	12.2	13.3	11.2
8	0.18	0.17	0.17	0.15	0.14	0.15	7.1	7.1	13.5	11.3	11.0	8.9
12	0.20	0.21	0.20	0.19	0.17	0.18	6.0	6.5	9.81	13.3	10.5	8.8
16	0.26	0.24	0.22	0.22	0.23	0.26	5.2	5.2	6.37	11.0	5.4	9.1
CD (P=0.05)	0.023						1.70					

water salinity.

The Na/K ratio in rice varieties significantly increased with increasing levels of water salinity. Each higher level of salinity resulted significantly high Na and low K. Highest Na/K ratio was observed under EC 16 dSm^{-1} water salinity level. The data on Na/K ratio in rice was markedly affected with variation in rice strains. Highest and lowest Na/K ratio in grain was recorded under BPT-5204 and Pusa Kranti variety respectively. However, Sarju-52 variety was at par in Na/K ratio with Pusa Kranti.

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