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Influence of salt stress on nutrient contents in rice *(Oryza sativa L.)* genotypes

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ABSTRACT
A field experiment was conducted under sodic soil condition prevailing at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli to determine the effect of salt stress on nutrient contents in 10 rice (oryza *sativa l.)* genotypes. The tolerant cultivars showed higher P content compared with other genotypes indicating their ability to take up and effectively utilize the nutrient for the metabolic functions than the susceptible ones. The K content which acts as an osmoticum under situation of unfavourable environment, invariably keeps the plant to withhold more water even in the presence of higher osmotic potential in the external salt solution. In the present study among the 10 genotypes tested the cultivars APMS 5B, IR 68885B, TRY(R) 2 and CO 43 recorded higher NPK content. The genotypes CORH 2, IR 68885B, APMS 5B and CO 43 expressed low Na/K ratio, which can be grouped as salt tolerant.

Key words : *Oryza sativa L,* Salt stress, Nutrient contents.

INTRODUCTION

Soil salinity is a major problem in arid and semi-arid regions, where rainfall is insufficient to leach salts and excess sodium ions move down and out of the root zone. Today, salinization of millions of hectares of land continues to reduce crop productivity severely worldwide. Of the approximately 13 billion hectares total land on earth, about 1 billion is affected by salinity/sodicity. According to a report, saline/sodic soils cover about 26 per cent of the cultivated land world wide (Alam *et al*., 2001). Rice is considered to be a salt sensitive crop (Flowers and Yeo, 1981). However, considerable variability for salinity resistance among rice varieties is also apparent (Yeo and Flowers, 1982). This paper reports the effect of salt stress on nutrient contents of different rice genotypes.

MATERIALS AND METHODS

Field experiments were conducted under sodic soil condition at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli. Ten rice genotypes were raised in the nursery under moderate level of soil sodicity. Transplanting of seedlings was done 28 days after sowing in the main field under sodic soil condition. Two to three seedlings per hill were planted in the main field in the spacing of 20 x 10 cm. The study was conducted in the wet season (2002-2003) in Randomized Block Design and each treatment was replicated thrice. Plant samples were collected at different phenological stages for assessing nutrient content of different rice genotypes. The total nitrogen content of the plant samples was estimated by microkjeldhal method as proposed by Yoshida *et al.* (1972) and expressed as mg g^{-1} on dry weight basis. Phosphorus, sodium and potassium content was analysed as per the method (Jackson, 1973). The mean values of the above mentioned observations were subjected to the statistical analyses and the genotypes were tested for their significance by adopting the procedure of Panse and Sukhatme (1961).

RESULTS AND DISCUSSION

High ion concentrations can injure plant cells by different mechanisms *viz.,* specific ion toxicity, ionic strength, ion imbalance or deficiency and osmotic imbalance. Sodium has specific ion effect, which differs from their osmotic effect. On the other hand, ion concentration can increase to such an extent that protein complexes fall apart due to interference with normal electrostatic interaction. For rice, high K/Na ratio in its shoot was proposed as criteria for salt tolerance (Balasubramanian and Sakharam Rao, 1977; Hedge and Joshi, 1974). Dutt and Bal (1988) reported that rice varieties that accumulate less Na^+ in the shoots at peak tillering stage are more tolerant to salinity than varieties that accumulate higher amounts of Na^+. Krishnamurthy *et al.* (1988) reported that salt tolerant cultivars maintain higher level of total nitrogen than the salt sensitive cultivars when grown in saline medium. Sodicity resulted in sharp rise in Na/K ratio in shoot of each variety which further increased with the plant age. Tolerant variety had a low Na concentration and high K/Na ratio but it is reverse in susceptible variety. Low concentration of Na during early growth could be achieved either by restricted uptake and transport of Na to the shoot or faster rate of growth (Qadar, 1991).

The nutrient analysis of the cultivars for N, P and K status showed significant variation, among the rice cultivars tested. The hybrid CORH 2 had recorded higher contents for N, P and K indicating its tolerance to salt stress and this was followed by the cultivars APMS 5B, IR 68885B, , TRY(R) 2 and CO 43 (Table 1). Similar findings were reported by Wadleigh and Ayers (1945) and Benzioni *et al.* (1968). It was also observed that the salinity curtailed the ATPase bond vital for synthetic process thus affecting the P content yield (Strogonov *et al*., 1974). The tolerant cultivars showed higher P content compared with other genotypes indicating their ability to take up and effectively utilise the nutrient for

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the metabolic functions than the susceptible ones. The present investigation confirmed the findings of Singh and Abrol (1987) and Gill and Singh (1992) who noticed reduced N and K content besides increasing Na content with increasing salinity. The tolerant cultivars CORH 2, IR 68885B, APMS 5B, TRY(R) 2 and CO 43 recorded higher K content in all the stages of the crop growth (Table 1). Joshi and Naik (1980) and Bohra (1991) explained the role of K in mitigating the ill effects of Na. The K content which acts as an osmoticum under situation of unfavourable environment, invariably keeps the plant to withhold more water even in the presence of higher osmotic potential in the external salt solution. In otherwords, K aided in the maintenance of osmotic balance. Presence of high K content in the tolerant genotypes of the study had resulted in higher yielding ability even under salt environment. This is in accordance with Joshi *et al.* (1980).

The tissue concentration of sodium and potassium and its ratio (Na/K) has been suggested as one of the useful parameters for screening genotypes of any crop under salt stress condition (Boetella ef *al.,* 1997; Singh and Singh, 1999). Bay *et al.* (1992) stated that in salt sensitive varieties

Table 1: Effect of salt stress on N, P and K content (mg g^{-1}) in 10 rice genotypes at different phenological stage

S. No.	Genotypes	Tillering			Panicle initiation			Flowering			Harvest			Mean		
		N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
1.	IR 62829B	19.8	1.73	12.70	19.30	2.03	12.45	16.5	3.12	12.80	6.60	2.02	10.80	15.60	2.23	12.19
2.	IR68888B	20.0	1.80	13.50	19.50	2.22	13.83	16.70	3.25	14.10	6.70	2.25	12.75	15.70	2.38	13.55
3.	IR69616B	17.2	2.07	13.35	18.50	2.42	13.88	16.00	3.03	14.10	6.50	2.30	12.20	14.60	2.46	13.38
4.	IR 68885B	20.4	2.35	18.15	19.50	3.08	18.75	16.70	3.90	12.35	6.70	3.00	16.65	15.80	3.08	16.48
5.	ARMS 5B	21.5	2.20	18.80	20.00	2.82	17.70	17.70	3.52	17.10	7.20	2.75	16.30	16.60	2.82	17.48
6.	TRY (R) 2	21.8	2.22	17.30	19.30	2.65	16.90	17.00	3.70	17.80	7.00	2.55	16.25	16.30	2.78	17.06
7.	CO 43	20.7	2.30	18.35	19.50	2.62	17.50	17.10	3.66	17.25	7.40	2.50	17.10	16.20	2.77	17.55
8.	ADT39	19.2	1.94	15.20	18.00	2.32	17.93	16.50	3.35	18.10	6.00	2.10	13.38	14.90	2.43	16.15
9.	CORH 2	22.2	2.50	18.65	20.20	3.10	18.93	17.90	3.83	16.65	7.30	2.98	16.53	16.90	3.10	17.69
10.	WHITE PONNI	17.9	1.85	14.80	17.80	2.03	15.20	15.50	3.25	13.30	5.80	1.90	12.50	14.30	2.26	13.95
	Mean	20.07	2.10	15.87	19.16	2.53	16.21	16.76	3.46	15.15	6.72	2.43	14.25	CD	CD	CD
	S													0.21**	0.27**	0.97**
	G													0.50**	0.64**	0.48**
	S x G													0.99**	0.28**	0.97**

CD (P=0.05)

Table 2: Effect of salt stress on Na content (mg g^{-1}) in 10rice genotypes at different phenological stages

S.No.	Genotypes	Tillering	Panicle Initiation	Flowering	Harvest	Mean
1.	IR 62829B	2.81	2.72	2.42	2.18	2.53
2.	IR 68888B	2.75	2.63	2.30	2.10	2.45
3.	IR69616B	2.80	2.68	2.42	2.21	2.53
4.	IR 68885B	2.38	2.25	2.12	1.98	2.18
5.	APMS 5B	2.26	2.16	1.98	1.75	2.04
6.	TRY (R) 2	2.32	2.25	2.00	1.98	2.14
7.	CO 43	2.19	2.15	1.91	1.72	1.99
8.	ADT39	2.65	2.51	2.10	1.98	2.31
9.	CORH2	2.12	2.05	1.88	1.65	1.93
10.	WHITE PONNI	2.92	2.62	2.21	2.12	2.47
	Mean	2.52	2.40	2.13	1.97	

	Sed	CD (P=0.05)
S	0.02	0.03"
G	0.04	0.07"
SXG	0.07	0.14"

Table 3: Effect of salt stress on the ratio of Na/K content (mg g^{-1}) in 10 rice genotypes at different phenological stages

S.No.	Genotypes	Tillering	Panicle Initiation	Flowering	Harvest	Mean
1.	IR 62829B	0.221	0.218	0.224	0.170	0.208
2.	IR 68888B	0.204	0.190	0.180	0.149	0.181
3.	IR69616B	0.210	0.193	0.198	0.157	0.190
4.	IR 68885B	0.127	0.121	0.122	0.104	0.119
5.	APMS 5B	0.125	0.115	0.119	0.142	0.125
6.	TRY (R) 2	0.123	0.127	0.123	0.116	0.122
7.	CO 43	0.119	0.123	0.112	0.100	0.114
8.	ADT39	0.174	0.140	0.157	0.109	0.145
9.	CORH2	0.116	0.111	0.113	0.098	0.110
10.	WHITE PONNI	0.197	0.172	0.177	0.159	0.176
	Mean	2.52	2.40	2.13	1.97	

	Sed	CD (P=0.05)
S	0.001	0.002**
G	0.002	0.005**
SXG	0.005	0.010**

sodium is accumulated at the cost of potassium, which is evaded by salt resistant varieties by an osmoregulatory process. At the tillering and grain filling stages, lengths of root and shoot, dry weight and K content was positively correlated with grain yield and negatively correlated with salinity level. Sodium content of root and shoot and the Na/K ratio were positively correlated with each other but negatively correlated with growth characters and yield at maturity (Gill and Singh, 1995). Increase in K content acts as an osmoticum which prevents Na^+ influx into the root and its further translocation to the more sensitive shoots (Jacoby, 1999). In this study, the genotypes like CORH 2, IR 68885B, APMS 5B and CO 43 had expressed low Na/K ratio and are therefore, grouped as tolerant types (Table 2 &3). The high Na/K ratio leads to metabolic disorders such as reduction in protein synthesis and enzyme activities (Brady *et al*., 1984). Low concentration of Na during early growth could be achieved either by restricted uptake and transport of Na to the shoot or faster rate of growth (Qadar, 1991). The greater adverse effects of chloride salinity were observed to be mediated through a decline in soluble carbohydrates, protein synthesis, N and K contents and K/Na ratio concomitant with more accumulation of proline and amino acids leading to decrease in water availability.

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