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EFFECT OF SALINITY STRESS ON GROWTH AND NUTRIENT CONTENT OF RICE PLANTS (*ORYZA SATIVA* L. VAR. POKKALI)

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Effect of sodium chloride and sodium sulphate on the growth and content of some nutrients in rice plants were studied using the salinity levels of 0, 0.2 0.4, 0.6, and 0.8% of 1:1 NaCl and Na_2So_4. Both types of salinity have inhibitory effects on the growth parameters of rice, except 0.2% Na_2So_4 where growth was increased. Water content in plants leaves was increased with increasing salinity levels. The content of N, P, Ca, Na, Fe and Mn increased, while that of K decreased with both types of salinity.

Key words: Salinity stress, Rice, Nutrient composition.

Introduction

In the province of Sind about 2.56 million hectares of productive lands have become saline due to unsuitable management [1]. In the Northern (Dadu and Larkana) and in the Southern (Hyderabad and Badin) districts of the province, rice is cultivated as a major crop in salt-affected soils in kharif (May-Oct) season because it can grow well under flooded conditions. Suppression of plant growth under saline condition may either be due to osmotic reduction in water availability or to specific ion effect. The ions present in excess in saline soil bring about specific changes in some plant species [2]. The standing water benefits rice by diluting the salts, increasing the availability of Fe, Mn, N, P and Si, conserving N and eliminating water stress and leaching down the excess salts from the rooting zones [3]. The adverse effect of salinity on rice growth has been reported by various workers [4,5]. Summarizing this information, Maas [6] has calculated a yield reduction of 50% of rice crop at an electrical conductivity of 3.6 dS/m of saturated extract. Kaddah *et. al.* [5] have studied the effect of salt stress at various stages of rice crop development. The present study was undertaken to compare the effects of increasing levels of NaCl and Na_2SO_4 on growth and content of nutrients by rice plants.

Materials and Methods

A pot experiment was conducted on an alluvial soil (pH 7.9, N 0. 071%, avail P (Olson method) 3.2 ppm, EC 0.10%, CEC 12.8 meq/100g soil, exchangeable cations: Ca 29.1, Mg 2.60, K 0.693 and Na 0.871 meq/100g soil and organic matter 1.25%). The effect of NaCl and Na_2SO_4 on the growth and content of N, P, K, Ca, Na, Fe and Mn by rice plants was studied. A bulk soil sample was prepared and fertilized with 120 kg N/ha and 50 kg P_2O_5/ha and mixed well. A 9 kg fertilized soil/pot was taken. NaCl and Na_2SO_4 salinities were added separately to the pots to get 0, 0.2, 0.4, 0.6 and 0.8% salinity. One day after flooding four 21-day old seedlings were transplanted in each pot. The pots were randomized and each treatment was replicated four times. During the growth period about 2.0 mm rain was recorded. The mean maximum and minimum temperatures varied from 42° to 25°. At 8-weeks of planting plant height and tiller number were recorded. Four leaves from each treatment were also taken for leaf water content. The plants were harvested after 8-weeks of growth, dried at 60°, weighed and ground in a Wiley mill. Subsamples (1g) of ground material was digested by ashing [7]. Potassium, Na and Ca were determined by flame photometer and P was estimated by vanadomolybdophosphoric acid yellow colour method [7]. Subsample (0.5g) of plant was digested with H_2SO_4 and H_2O_2 for N analysis by the micro-Kjeldahl method. Iron and Mn were determined by orthophenanthroline and periodate reagents [7]. The data were analyzed statistically using DMRT method.

Results and Discussion

In the present experiment, the overall growth of rice plant was found to be negatively effected due to NaCl and Na_2SO_4 salinities (Table 1)., except at 0.2% Na_2SO_4 which appeared to be stimulatory one and 0.4% was neutral. The reduction in plant height, tiller number and dry matter growth was more pronounced in NaCl stressed plant than Na_2SO_4. The percent reduction at the highest salinity level (0.8%) in plant height, tiller and dry matter due to NaCl was 45, 58 and 82 and with Na_2SO_4 was 42, 50 and 67 respectively. The major inhibitory effect of salinity on growth parameters has been attributed to (a) osmotic inhibition of water availability, (b) toxic effect of ions and (c) nutritional imbalance caused by such ions [8]. Decreases in rice growth parameters with increasing salinity have also been reported [9,10]. There is a general concept that rice plant differ in their salt tolerance within the species, cultivar, inbred and variety in salt-affected water-logged soil. Rice is a medium tolerant crop, and considered as glycophyte. We can distinguish glycophytes as plants of 'sweet'or non-saline environment, normally having high K/ Na ratios in their leaves, from halophytes, the plants of salty environment, in which the K/ Na ratio tends to be lower and overall ion concentration higher. Halophytes are notably different from glycophytes. However, in their response to high salt concentrations (i.e. above 100 mM). They response positively to concentrations of salts of even 500 mM and beyond, although the specificity of this growth response is very variable between different species [11]. As far as glycophytes are concerned, such high concentrations of salts are lethal. It was also observed that leaf water content was significantly increased with increasing salinity levels of both salts (Table 1). It is reported that increased water content in plant may help in diluting the toxic effects of accumulated ions under saline condition [12].

Considerable differences in the mineral nutrient content of rice plant at different salinity levels of two salts were observed (Table 2). The N content was increased with increasing salinity levels of both salts. Bernstein [13] has reported an increased N content in plants at high levels of NaCl. Decrease in N content with different crops have also been reported [14,15]. The phosphorus content was increased due to salt stress in rice plant under both salt levels. Similar findings have also been reported [16,17]. On the other hand, a suppression of P uptake due to salt stress has been reported [9]. Leaf potassium content decreased at all levels of both salts. Similar findings have been reported by others with different crops [18]. The severe depressive effect of NaCl on K absorption might caused by the competitive relation between monovalent cation.

Calcium content in the rice leaves was increased due to both salts. Different workers [19,20] have reported that Ca content increased with increasing salinity. The predominance of Ca in plant leaf in salts environment may be due to its preferential absorption and translocation via xylem and it being immobile in phloem is trapped in the leaves [21]. In the present study, it was observed that though the

TABLE 1. EFFECT OF SALT STRESS ON GROWTH OF RICE PLANTS (CV. POKKALI).

Salinity treatment (%)		Plant height (cm)	Tiller number/ plant	Dry matter yield (g/pot)	Moisture (%)
	0.0	64 a	11.4 a	17.41 a	65.5 e
	0.2	60 a	10.3 b	12.04 b	67.3 d
NaCl	0.4	55 b	8.7 c	8.12 c	69.4 c
	0.6	41 c	6.5 d	5.19 d	72.2 b
	0.8	31 d	4.8 e	3.21 e	73.2 a
	0.0	63 b	10.2 b	16.63 b	65. 2 e
	0.2	67 a	12.5 a	21.34 a	66.8 d
Na_2SO_4	0.4	61 b	8.7 c	16.50 b	71.1 c
	0.6	54 c	6.8 d	9.15 c	74.6 b
	0.8	38 d	5.1 e	5.50 d	76.7 a

Scripts followed by same letters do not differ significantly at 5% level by DMRT.

TABLE 2. EFFECT OF SALT STRESS ON NUTRIENT CONTENT BY RICE PLANT (CV. POKKALI).

Salinity treatment		Nutrient content (% of dry wt.)					μg/g dry wt.	
(%)		N	P	K	Ca	Na	Fe	Mn
	0.0	1.91 d	0.203 d	3.75 a	0.189 c	0.162 e	139 d	138 e
	0.2	2.35 c	0.218 c	3.10 b	0.313 b	0.578 d	145 d	235 d
NaCl	0.4	2.43 c	0.225 c	2.91 c	0.332 b	0.742 c	169 c	282 c
	0.6	2.68 b	0.248 b	2.73 d	0.341 b	0.863 b	195 b	313 b
	0.8	3.05 a	0.273 a	2.38 e	0.372 a	0.950 a	225 a	351 a
	0.0	2.06 d	0.208 c	3.70 a	0.17 d	0.16 e	135 e	131 d
	0.2	2.62 c	0.274 b	3.24 b	0.20 c	0.62 d	146 d	358 c
Na_2SO_4	0.4	2.76 c	0.278 b	3.21 b	0. 20 c	0.78 c	175 c	386 b
	0.6	2.89 b	0.283 b	3.11 c	0.23 b	0.88 b	202 b	422 a
	0.8	3.17 a	0.330 a	2.18 d	0.26 a	0.96 a	219 a	428 a

Scripts followed by same letters do not differ significantly at 5% level by DMRT.

leaves of salt stressed plants contain greater amount of Ca, but it fails to overcome the salinity hazards due to the disturbed mineral metabolism.

With increased NaCl and Na_2SO_4 salinities the concentration of sodium in the rice plant was greatly increased. It has been reported [9,22,23] that sodium concentration increased with saline irrigation. Increased Na content disturbed the nutrient balance, osmotic regulation and causes specific ion toxicity under saline conditions [24]. The exceptionally high increases in Na content in rice may have disturbed the nutritional balance particularly K/Na and this resulted in lower yield of this variety under high salinity levels. The decreases in K and increases in Na concentration in rice plant with increasing salinity symbolizes the antagonism between Na and K [25]. Both Fe and Mn content increased with increasing salinity levels in rice plants. Increase in Fe content was more pronounced than Mn. Strogonov [2] has observed decrease in Fe content due to NaCl salinity. Maas *et. al.* [26] found that roots and tops of Nacl treated tomato, squash and soybean were more richer in Fe. Verma and Neue [25] observed that Fe concentration was increased with increasing salinity levels.

Conclusion

From the above discussion, it may be concluded that growth parameters of rice was adversely affected under increasing salt stresses of NaCl and Na_2SO_4. However, chloride salt has slightly more damaging effect on the growth than sulphate salt. The concentration of N, P, K and Ca were generally higher in rice plants from NaCl treated plants than Na_2SO_4 treated plants, whereas the concentration of Na, Fe and Mn by rice plants were equally affected. In view of the adversed responses of pokkali rice at higher salinity level under this study its field performance should be evaluated under suitably replicated study with a view to assess its value in direct utilization of salt affected soil under flooded conditions.

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