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Variation in Growth and Ion Uptake in Salt Tolerant and Sensitive Rice Cultivars under NaCl Salinity

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Abstract: Pot cultured experiment consisting of two rice cultivars Basmati-370 (Salt sensitive) and IR6 (salt tolerant) with five replicates each having two different salinity levels was conducted at wire house of Soil Biology Division, NIAB, Faisalabad using randomized complete block design. Growth and chemical analyses of plant samples were carried out at different harvest levels. Results indicated that increasing levels of salinity furnished proportional relationship with increase in Na^+ and Cl^- content with decrease in growth of Basmati-370 whereas K, Ca, N and P content were highly significant in IR-6.

Key words: Rice cultivars, salinity, ion uptake, salt tolerant

INTRODUCTION

Salinity is agro-environmental problem limiting plant growth and development in most of the coastal, arid and semi arid regions of the world[1]. Plants are generally most sensitive to salinity during germination and early seedling growth[2]. Salinity affects the time and rate of germination, metabolism, the size of plants, branching, leaf size and overall plant anatomy[3]. As different crop species have different responses to salinity[4] one finds a spectrum of responses within same species where various cultivars and genotypes show a response which may be classified as tolerant or sensitive to salinity. The heretibility of salt tolerance has been demonstrated in several species for instance in rice[5]. Pakistan annual rice export stands at about 1.5 million tones[6]. The present studies have been planned to investigate the differential response of rice (*Oryza sativa* L.) cultivars against salinity.

MATERIALS AND METHODS

Seeds of two rice varieties Bas-370 (salt sensitive) and IR-6 (salt tolerant) were obtained from Mutation Breeding Division NIAB, Faisalabad. Soil texture was loamy and other parameters were, pH 7.88, saturation percentage 35 and EC 4.37 dSm^{-1}.

Two factor factorial design was laid out in Completely Randomized Block Design. Nursery of rice seedlings was prepared by sowing seed in field and 30 days old seedlings were transferred to plastic pots. When plants were 50 days old, the salinity treatments were applied which comprised of two salinity levels viz. 10 dSm^{-1} and control (4.0 dSm^{-1}). During growth of the crop four harvests were taken at an interval of 10 days each after imposition of salinity treatment. For each harvest two plants from each pot were randomly selected and kept in an oven at 70±2°C for 72 h to get constant weight and weighed on electric balance. Means were used for comparison of treatments.

The dried plant material at different harvests was ground to pass through 2mm sieve. The dried material (0.2 g) was digested with sulphuric acid and hydrogen peroxide according to the method of Wolf[7]. Na^+, N and Ca^{2+} were analyzed by flame photometer (Jenway PFP-7) and phosphorus spectrophotometer (Hitachi 220). For chloride determination test tubes containing 0.1 g of sample and 10ml deionized water were placed in an autoclave for 10 min. Then filtration was carried out and solution was made upto 50ml. Chloride concentration in the extract was determined with a digital chloride meter (Chloride-meter 920, Corning, U.K.). Nitrogen uptake estimation was estimated according to Kjeldahl's method.

RESULTS AND DISCUSSION

Dry weight: Results regarding plant biomass showed inverse relationship with increasing levels of salinity. A general trend of decrease in dry weight of plant with

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Table 1: Mean values for growth rate and ion concentrations in two rice cultivars at two different salinity levels

		Growth dry weight	Na	K	Ca	N	P	Cl^-
	T_0	1.08±0.333	6.80±1.31	19.98±1.45	3.37±0.49	16.96±1.72	8.09±1.60	16.62±0.53
V_1	T_1	0.61±0.022	1.32±0.18	17.67±1.71	4.31±0.45	22.13±1.77	9.06±2.09	23.70±1.92
	T_0	0.90±0.006	6.80±0.12	21.08±1.12	5.64±0.74	22.66±1.67	5.74±1.20	13.26±0.95
V_2	T_1	0.84±0.009	9.44±1.42	18.86±0.77	5.14±0.71	25.10±0.78	7.45±1.70	17.65±1.00

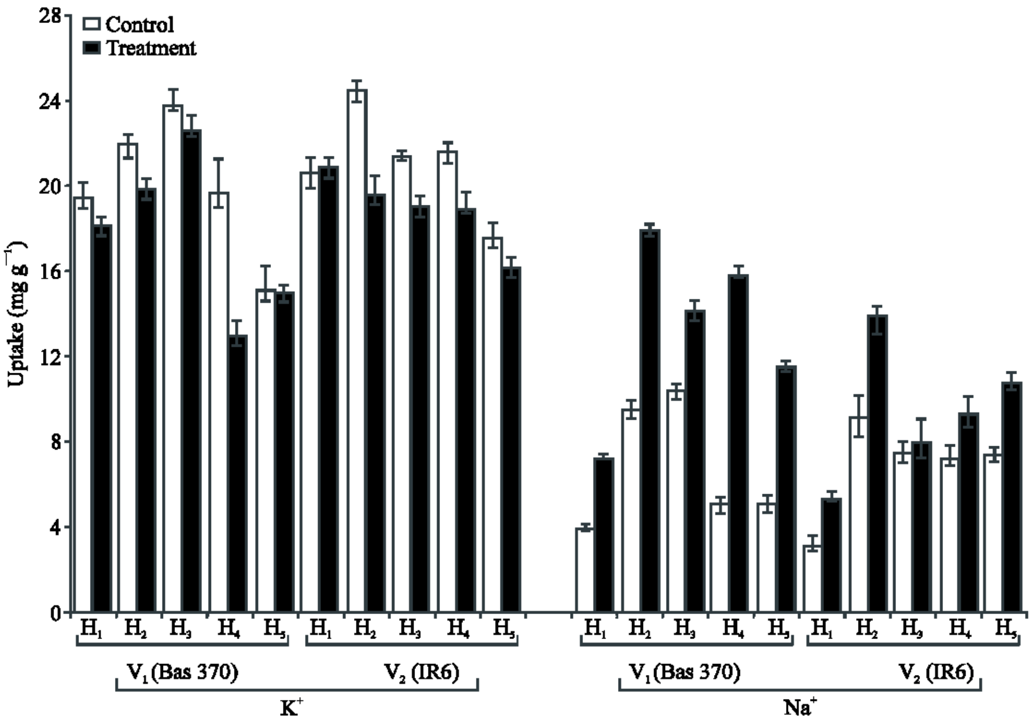

Fig. 1: Effect of salinity on potassium and sodium uptake (mg g^{-1}) in rice

salinity was noted in both varieties. The mean values for dry weight were higher in Basmati-370 in control conditions. It may be due to the genetic make up of Basmati-370 because it is tall variety and requires high input to obtain the optimum plant growth and production. Although IR-6 showed reduction under saline conditions yet it did not exceed 20-30% while it was more than 70% in Bas-370. Ashraf and Bhatti[8] showed that salt tolerant varieties had more plan growth under stress condition, which may be due to the adoptability of salt tolerant varieties to stress environments. Analysis of Variance showed a significant increase in Na^+ and Cl^- uptake with increasing salinity. Varietal means were highly significant and maximum increase in Na^+ uptake was recorded in Basmati-370 (18.69%). Harvest means showed that Na^+ uptake increased with passage of time but at maturity there was decline in Na^+ content in both varieties (Fig. 1). Increasing level of salinity accomplished a good linear relationship with increase in Cl^- uptake (Table 1). Variety x treatment interaction revealed an, increase in Na^+ and Cl^- uptake over control in Basmati-370 and IR-6, respectively. However, it was less in IR-6 furnishing tolerance in IR-6.

Specific ion toxicities results due to penetration of injurious concentrations of Na^+ and Cl^- in protoplast which may lead to an inactivation of enzymes, inhibition of protein synthesis, change in membrane permeability and damage to cell organelles. Ionic imbalance or nutritional imbalance results in salt stressed plants due to competition of salt ions with nutrients[9,10]. Other enzymes are also affected by salinity as reported by Tikhaya *et al.*[11] that in plasma membrane when Na^+ is substituted for K^+, Mg^{+2} ATPase activity is inhibited by 22%, ion transport is affected by salinity, obviously Na^+ uptake increase with increase in external NaCl concentration[12]. Varieties differed significantly for K^+, Ca^2, P and N uptake. Data about harvested mean revealed that K^+ and Ca^{2+} uptake increase with the passage of time (Fig. 1). However, as regard Ca^{2+} Basmati-370 and IR-6 showed 45.20 and 15.55% decrease over control. VxT interaction was non-significant which indicate similar response of two varieties under salinity treatment. Results showed that IR-6 performed better for K^+ and Ca^{+2} uptake than BAS-370, Ca^{2+} reduce with salinity[13]. Increasing level of salinity furnished proportional relationship with increase in P and N uptake. An increase of 23.21% uptake of P was recorded in Basmati-370 as compared to IR-6. P contents increased significantly in the plants treated with NaCl under all harvests (Fig. 1). As regarding N uptake IR-6 accumulated more (22.16%) as compared to Basmati-370 under control and saline conditions.

N contents increased significantly in the plants treated with NaCl under all harvests in both varieties. Our results are in accordance with Rashid[14] increasing levels of salinity increased N and P contents but decreased K^+ contents.

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