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Effect of salinity in certain exzyme activity, physiological traits and yield of rice cultivars

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Abstract: A pot culture experiment was conducted at Agricultural College and Research Institute, Trichy during 1998 to 1999 with three levels of salinity *viz.* EC < 1, 1-4, > 4 dSm^{-1} with four rice varieties *viz.* TRY1 and Co43. (Tolerant) and IR20 and ADT 39 (susceptible) to find out the effect of soil salinity on certain enzymatic activities, physiological attributes and yield. Growth and yield reductions were more at EC > 4 dSm^{-1} than other treatments. Leaf soluble protein and chlorophyll content at flowering decreased with salinity and the reduction was more in the susceptible varieties than the resistant varieties. Proline content was increased with level of salinity and was higher in tolerant than the susceptible varieties. Amylase and ATPase activities increased toward salainity. Nitrate reductase activity was stimulated more at high salinity level in tolerant varieties than the susceptible varieties. *(Key words: Salt tolerance, Rice, ATPase, NRase, Soluble protein and Proline content).*

Salt tolerance capacity of plants depends on the species as well as the type of salt in the soils. The supression of plant growth increases with rise in the concentration of soluble salts until dead. Plants obtain the essential nutrients from a saline soil solution in which the concentration of non-essential ions in disproportionately greater than that of essential elements (Abrol, 1982). Plants are able to maintain their chemiosmotic potential which have the capacity to withstand salinity (Flowers and Yeo, 1981). The build up of high osmoticum is because of metabolic change accelerated due to salinity. Therefore, a study has been conducted to find out the effect of soil salinity on certain enzymatic activities, physiological attributes and yield.

Materials and Methods

A pot culture experiment was conducted at Agricultural College and Research Institute, Trichy during 1998-99. Seeds of four varieties of rice *viz.* TRY-1 & Co 43 (tolerant) and IR-20 & ADT 39 (susceptible) were sown in earthen pots containing 7 Kg of soil under net house condition. Soils with EC 0.6, 2.3 & 3.8 dSm^{-1} classified as < 1, 1-4, >4 dSm^{-1} and pH 8.0, 8.2 & 8.1, respectively were used. Two seedlings were transplanted per pot and the treatments were replicated thrice. Salinity was maintained throughout the crop growth by irrigation using saline water. The leaf tissue samples at the flowering phase were analysed for biochemical and physiological attributes (Sadasivam and Manickam 1996). The yield and yield components were determined at maturity.

Results and Discussion

The results of the study indicated that the growth physiological, biochemical attributes and yield decreased as the salinity increased except proline (Table 1 & 2). Plant height, number of productivity tillers per hill and 1000 grain weight were significantly affected by increasing salinity level, leading to the substantial yield reduction .the grain yield of TRY-1 per pot was 36.2 g in EC<1 dSm^{-1}, decreased to 33.5 g/pot in 1-4 dSm^{-1} and declined further to 30.5 g/pot in EC>4 dSm^{-1}. Similar trend was also observed in Co 43. However in the case of susceptible genotypes *viz.* ADT 39 and IR 20, the yield reduction due to salinity was higher than the tolerant varieties. The yield of straw also followed similar trend. The differential response of cultivar to salinity may be due to the differential osmotic adjustment (Ayres *et al.* 1952).

The chlorophyll content was affected due to salinity and the effect was more prominent in susceptible varieties. Such a decrease in chlorophyll content of leaves has been described to be an effect associated with increase in chloride content (Pandey and Sharma, 1987). Leaf soluble protein, an index of measure of photosynthetic

Table 1. Effect of soil salinity on certain, biochemical attributes of rice cultivars

Salinity Level (dsm^{-1})	Varieties	Chlorophyll (mg/g)	Soluble protein (µg/g)	Proline (µg/g)	Amylase (a)	ATPase (b)	Nitrate reductase (c)
< 1	TRY - 1	2.30	12.70	0.63	62.0	675.0	235.0
	Co 43	2.52	12.90	0.65	59.5	692.0	192.0
	ADT 39	2.35	12.50	0.67	68.5	360.0	260.0
	IR 20	2.10	11.88	0.66	50.8	489.0	315.0
	Mean	2.31	12.49	0.65	60.2	544.0	250.0
1 - 4	TRY - 1	2.10	12.50	0.67	78.2	984.0	324.0
	Co 43	2.34	12.45	0.80	79.0	921.0	264.0
	ADT 39	2.10	11.40	0.73	180.5	640.0	240.0
	IR 20	2.03	11.62	0.66	120.0	710.0	260.0
	Mean	2.14	11.99	0.72	144.3	813.0	272.0
> 4	TRY - 1	1.85	12.00	1.25	140.8	2085.0	595.0
	Co 43	2.18	12.25	1.25	172.5	1982.0	550.0
	ADT 39	1.72	11.15	0.71	205.1	905.0	205.0
	IR 20	1.70	11.00	0.68	160.3	849.0	180.0
	Mean	1.86	11.35	0.97	169.7	1005.0	383.0
	CD (P = 0.05)						
	Salinity (S)	0.029	0.29	0.028	6.3	11.5	12.6
	Variety (V)	0.039	0.39	0.037	7.9	19.87	21.4
	S x V	0.064	0.065	0.063	12.1	27.4	29.3

a. Amylase- µ mol. Maltose/10 mts/ mg protein
b. ATPase - µ mol. P released/30 mts/ mg protein
c. Nitrate reductase-µ mol. NO_2 released/hr/ g.f.wt.

ability, also decreased due to salinity. Leaf proline content increased with salinity. However, the increase was higher in the resistant varieties compared to susceptible varieties. Proline has the ability to stabilize the conformation and functions of protein in solution of higher osmotic strength (Gowrishankar, 1988). The Amylase activity was lower in salt tolerant varieties than the salts susceptible varieties. Thus it is evident that amylase activity is strongly associated with tolerance of rice. This is in line with the findings of Krishnamurthy *et al.* (1987). There was tremendous enhancement of ATPase activity in salt tolerant genotype. Increasing salinity level increased the activity of the nitrate reductase. Cultivar difference in nitrate activity in the present study indicate the ability of the rice plant to utilize the nitrogen in a better manner. (Giridhar 1988).

From the present study, it could be concluded that the effect of soil salinity was more in the susceptible varieties than the tolerant verities. The variations in the activity of amylase, ATPase and nitrate reductase could be used as possible indicators of salt tolerance of rice.

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Table 2. Effect of soil salinity on plant height, yield and yield components of rice varieties

Salinity Level (dSm^{-1})	Varieties	Plant height (cm)	Productive tillers/hill	1000-grain weight (g)	Straw yield (g/pott)	Grain yield (g/pot)
< 1	TRY - 1	115.8	13.0	21.0	45.1	36.2
	Co 43	78.1	13.0	20.0	41.6	33.0
	ADT 39	72.1	11.0	18.0	37.3	28.0
	IR 20	75.0	11.0	18.0	38.2	30.0
	Mean	85.2	12.0	19.3	40.6	31.8
1 - 4	TRY - 1	110.2	12.0	19.0	42.4	33.5
	Co 43	76.3	13.0	18.0	38.5	30.0
	ADT 39	68.1	11.0	16.0	35.6	27.0
	IR 20	71.2	10.0	16.0	37.3	28.2
	Mean	81.5	11.5	17.1	38.5	29.7
> 4	TRY - 1	98.6	10.0	16.0	39.4	30.5
	Co 43	61.8	11.0	15.6	35.1	28.0
	ADT 39	62.5	9.0	13.0	31.4	23.0
	IR 20	63.4	8.0	13.0	30.7	23.5
	Mean	71.6	9.5	14.4	34.2	26.3
	CD (P = 0.05)					
	Salinity (S)	0.25	0.27	0.20	0.23	0.21
	Variety (V)	0.34	0.36	0.27	0.32	0.28
	S x V	0.57	0.59	0.44	0.53	0.47

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