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Proline and Total Protein Status as an Indication of Salinity Tolerance in Rice

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ABSTRACT

To elucidate the effects of salinity stress in rice, three different salinity tolerant varieties Jaya, Dandi, CSR-27 and one sensitive variety GR-3, were selected. Fifteen day old seedlings of these cultivars were exposed to 0, 100,150 and 200 mM of NaCl for 24, 48 and 72hr.Study on biochemical parameters revealed that Protein content was increased up to 150 mM, there after it decreased, proline content continuously increased with salinity levels in all the varieties. From this investigation, it can be concluded that tolerant varieties showed high values of proline and protein contents under salt stress conditions than sensitive variety. From this research we proved that GR-3 is sensitive to salt stress as well as remaining three cultivars jaya, Dandi and CSR-27 are tolerant.

Key words : Proine, Protein, Rice, Salinity.

Rice (*Oryza sativa* L.) is the staple food of 60% of the world population (2.4 billion people), the number will increase to 4.6 billion people by 2050 (Mishra, 1998). The crop is grown in 152 million hectares in the world with the production of 586 mt (Mahadevappa, 2004). Cultivation of rice is affected by various biotic and abiotic stresses, among the abiotic stresses salinity is a severe threat, from the total cultivable land, 8.57 million hectares are salt affected of which 1.21 million hectares is in Gujarat. Salinity is a major problem in agriculture today. Soil salinization and alkalization are serious land degradation problems affecting approximately 10% (about 952 mha) of the total land surface of the globe (Singhal, 2003). Study for the response of plants/ crops to salinity under natural saline conditions is not feasible due to extreme variability in soil salinity both spatially and temporally. Present study reveals the comparative differences for salt tolerance among varieties under artificial salinized conditions. Salinity affects the plants at all stages of development and in some cases sensitivity varies with the growth stage of crop. Rice has been found to be tolerant during germination, very sensitive at early seedling growth and more tolerant at vegetative growth stage (Kadlag *et al*., 1993). Proline and protein contents have positive response with salinity stress.

MATERIAL AND METHODS

Four varieties of rice *viz* Jaya, CSR-27, Dandi and GR-3 differing in degree of salt stress tolerance were procured from Main Rice Research Station, Anand Agricultural University, Navagam, Gujarat. Protein content was estimated using the method described by Lowry *et al*. (1951) and expressed as mg g^{-1} fresh weight. The proline content from seedlings was estimated as per the method described by Malik and Singh (1980) and expressed as mg g^{-1} fresh weight.

RESULTS AND DISCUSSION

Total Soluble Protein

Changes in soluble protein content have been shown in Table 1. Among the four varieties CSR-7 recorded maximum protein content (68.59 mg g^{-1}) at 24 h salinity treatment period. Maximum variation in protein content was observed with regards to salinity stress in all three tolerant varieties than sensitive variety.

Among the salt levels 150 mM NaCl recorded the maximum (64.21 mg g^{-1}) protein content followed by 100 mM NaCl (60.63 mg g^{-1}). The salt doses had distinct effects. At 48 h treatment period Jaya recorded highest protein content (90.14 mg g^{-1}) followed by Dandi (86.15 mg g^{-1}). Where as at 72h

Table 1. Changes in total soluble protein content in seedlings of rice varieties treated with different levels of sodium chloride salinity at different time intervals

Total Soluble Protein (mg g^{-1} fresh $weight^{-1}$)

Treatment	Control (S_1)	100 mM (S_2)	150 mM (S_3)	200 mM (S_4)	Varietal mean
Variety			**24 hour**		
Jaya (V_1)	87.63	73.13	89.56	81.64	59.26
Dandi (V_2)	45.25	77.95	63.72	52.12	59.76
CSR-27(V_3)	62.62	58.65	79.55	73.56	68.59
GR-3 (V_4)	44.38	32.60	23.51	16.53	34.52
Treatment mean	59.98	60.63	64.21	55.95	
	V	S	V x S		
S.Em.	1.34	1.34	2.67		
C.D.	3.85	3.85	7.78		
C.V. %		7.68			
			48 hour		
V_1	90.88	80.71	98.62	74.37	90.14
V_2	54.79	87.36	67.48	47.27	86.15
V_3	79.89	70.32	83.16	71.87	76.14
V_4	47.10	38.77	29.66	19.16	39.29
Treatment mean	65.67	70.13	69.55	53.19	
	V	S	V x S		
S.Em.	1.35	1.35	2.78		
C.D.	3.90	3.99	7.82		
C.V. %		7.26			
			72 hour		
V_1	97.41	82.24	102.54	78.71	61.73
V_2	59.14	92.70	71.29	61.71	71.26
V_3	76.29	65.57	85.87	71.10	75.19
V_4	50.06	43.16	32.35	14.31	36.96
Treatment mean	71.14	70.91	73.03	58.47	
	V	S	V x S		
S.Em.	1.27	1.27	2.59		
C.D.	3.68	3.68	7.36		
C.V. %		6.45			

treatment period CSR-27 recorded the highest protein content (75.19 mg g^{-1}) followed by Dandi (71.26 mg g^{-1}). These results are in agreement with the findings of Pushpam and SreeRangasamy (2000) and Reddy and Vaidyanath (1986). Reduction in protein content may be due to the diversion of some quantum of energy (proteolysis) for growth and metabolism to over come the stress situations.

Proline

Results on changes in proline content have been presented in Table 2. Among the different varieties at 24 h period proline content was high in Dandi (2.09 mg g^{-1}) and least in GR-3 (0.69 mg g^{-1}). Variation was noted due to the differences in degree of tolerance. Salinity stress creates a maximum demand for proline during stress conditions in tolerant varieties to withstand against salinity stress than sensitive cultivars. There was significant difference between varieties and salinity levels; proline content increased with increasing salinity levels. It was maximum at 200 mM salinity level compared to control in all the varieties. Similar trend of results observed in 48 h and 72 h salinity treatment periods. But maximum proline accumulation was seen at 24 h and 72 h salinity treatment periods than 48 h. Under 72 h treatment periods GR-3 recorded maximum proline followed

Table 2. Changes in proline content in seedlings of rice varieties treated with different levels of sodium chloride salinity at different time intervals.

Proline (mg g^{-1} fresh $weight^{-1}$)

Treatment	Control (S_1)	100 mM (S_2)	150 mM (S_3)	200 mM (S_4)	Varietal mean
Variety			**24 hour**		
Jaya (V_1)	0.77	1.49	1.64	2.27	1.52
Dandi (V_2)	1.57	2.06	2.31	2.43	2.09
CSR-27(V_3)	0.66	0.95	1.23	1.54	1.09
GR-3 (V_4)	0.39	0.54	0.85	0.98	0.69
Treatment mean	0.83	1.25	1.50	1.80	
		V	S	V x S	
S.Em.		0.03	0.03	0.07	
C.D.		0.09	0.09	0.19	
C.V. %			8.79		
			48 hour		
V_1	0.29	0.38	0.45	0.56	0.41
V_2	0.58	0.56	0.60	0.68	0.60
V_3	0.33	0.55	0.56	0.68	0.53
V_4	0.39	0.42	0.49	0.48	0.44
Treatment mean	0.39	0.48	0.52	0.59	
		V	S	V x S	
S.Em.		0.01	0.01	0.02	
C.D.		0.03	0.03	0.06	
C.V. %			7.34		
			72 hour		
V_1	1.14	1.87	2.21	2.57	1.93
V_2	0.73	1.16	1.56	1.68	1.28
V_3	0.59	0.76	0.97	1.29	0.91
V_4	0.66	1.99	2.59	2.97	2.06
Treatment mean	0.78	1.43	1.83	2.13	
		V	S	V x S	
S.Em.		0.03	0.04	0.07	
C.D.		0.10	0.10	0.20	
C.V. %			7.90		

by Dandi. The increase in proline content was nearly twice in all the varieties at 200 mM NaCl level than the control. With increase in the level of salt stress, an increase in the level of proline was observed in all the varieties. These results indicated that proline has a positive relation with salt stress, which act as an inorganic nitrogen reserve and helps in recovery during stress situations (Mansour ,1998). It may also work as an intra cellular osmolytes (Basu *et al*., 1996). Proline will act as a potential biochemical marker for assessing the salinity tolerance both in tolerant as well as sensitive cultivars. Still more detail study is required to reveal the actual mechanism which imparts stress situations. Similar results were reported by Stewart and Lee (1974) and Dubey and Rani (1989).From this research it is understood that proline might serve as nitrogen source for growth and survival under saline conditions, thereby inducing salinity resistance to rice cultivars. Salt tolerant cultivars maintain higher level of free proline than the salt sensitive cultivars when grown in a saline medium.

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