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SHORT COMMUNICATION

STUDIES ON PHOTOSYNTHETIC PIGMENTS, SODIUM AND POTASSIUM CONTENTS IN SEEDLINGS OF LENTIL GENOTYPES UNDER SIMULATED SALINITY STRESS

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The effect of salinity stress on photosynthetic pigments and ion accumulation was studied in four lentil (*Lens culinaris* Medic) genotypes. Dry weight of shoot, total chlorophyll and carotenoids contents decreased with the rise in levels of salt stress. The decrease in dry weight of shoot, total chlorophyll and carotenoids contents was more in susceptible genotypes (PL 406 & Arun) as compared to tolerant genotypes (L 145-4 and L 187-3). The tolerant genotypes have lower sodium and higher potassium in shoots as compared to susceptible genotypes.

***Key words*: Lentil, photosynthetic pigments, potassium, sodium.**

Soil salinity is a major environmental stress affecting plant growth and agricultural productivity. Among the various abiotic stresses, soil salinity is a major constraint for growth and yield of chickpea (Rheenen *et al*. 1990) and other crops. Salinity generally affects the plant growth adversely and these adverse effects may be attributed to non-availability of water, nutrients deficiency and ion toxicity. Extra expenditure of energy for osmotic adjustment or in repair mechanisms under salinity stress causes growth reductions (Pasternak 1987). The mechanisms which imparts salt tolerance to plants have not been fully resolved (Cheeseman 1988). Information regarding salinity effects on photosynthetic pigments and nutritional imbalances in lentil is meagre. Analysis of plant tissue for Na^+ and K^+ contents under salt stress conditions has been suggested as one of the useful parameters to measure the varietal salt tolerance (Qadar 1991). The identification of tolerant genotypes with their ionic uptake and transport characters may be useful for breeding salt tolerant crops (Keating 1986). The present investigation was undertaken to study the effect of salinity stress on photosynthetic pigments along with sodium and potassium content to assess the relative tolerance of lentil genotypes.

Two salt tolerant (L 145-4 and L 187-3) and two sensitive (PL 406 and Arun) lentil genotypes were selected for this study. Seeds were surface sterilized with 1% mercuric chloride solution for two minutes and thoroughly washed with distilled water. The stock solution of salt was prepared by dissolving 100 g salt mixture of NaCl, Ca Cl_2 and Na_2 So_4 in the ratio 7:2:1 in 500 ml water. From above stock solution, two salt solutions 8dS m^{-1} and 12dSm^{-1} were prepared by adding distilled water to the salt solution and measuring electrical conductivity using conductivity meter (Systronics Model 303). The seeds of all four genotypes were germinated at different salinity levels viz. 0.35 (control), 8.0 and 12.0 dSm^{-1} in sterilized germination boxes lined with filter papers and kept at 25±2ºC in a B.O.D. incubator. After 7 days seedlings were transplanted in pots containing acid washed sand and nutrient solution with above salinity levels and kept at ambient temperature. On 20th day, experiments were terminated and plants were harvested for recording observations. The shoot dry weight was measured by drying the plants in hot air oven set at 100ºC for 10 minutes and later at 70ºC to a constant weight. The amount of chlorophyll and carotenoids were measured in fresh shoots following the methods of Anderson and

Table 1. Effect of different levels of salinity on physiological and nutritional parameters.

Salt Stress (dSm^{-1})	Genotypes L 145-4 (T)	L 187-3 (T)	PL 406 (S)	Arun (S)	Mean
			Shoot dry weight (mg $plant^{-1}$)		
0.35	12.21	12.93	10.20	10.55	11.47
8.0	11.48	12.20	7.33	6.96	9.49
12.0	10.45	11.28	4.48	3.92	7.53
Mean	11.38	12.13	7.33	7.14	
C.D. (P=0.05)	Stress (S) 0.19	Genotypes (G) 0.22	G × S 0.39		
			Total Chlorophyll (mg g^{-1} fresh weight)		
0.35	0.507	0.530	0.250	0.262	0.387
8.0	0.425	0.459	0.125	0.127	0.284
12.0	0.240	0.249	0.073	0.077	0.159
Mean	0.390	0.412	0.149	0.155	
C.D. (P=0.05)	Stress (S) 0.001	Genotypes (G) 0.002	G × S 0.003		
			Carotenoids content (mg g^{-1} fresh weight)		
0.35	0.210	0.208	0.036	0.026	0.120
8.0	0.182	0.185	0.030	0.021	0.109
12.0	0.171	0.168	0.021	0.014	0.099
Mean	0.187	0.198	0.031	0.022	
C.D. (P=0.05)	Stress (S) 0.001	Genotypes (G) 0.002	G × S 0.003		
			Sodium content in shoots (mg g^{-1} dry weight)		
0.35	7.74	5.73	8.01	8.71	7.55
8.0	15.20	11.04	18.06	18.60	15.72
12.0	19.76	14.92	24.08	23.72	20.62
Mean	14.23	10.56	16.72	17.01	
C.D. (P=0.05)	Stress (S) 0.062	Genotypes (G) 0.072	G × S 0.125		
			Sodium content in roots (mg g^{-1} dry weight)		
0.35	18.41	20.01	25.27	29.85	23.38
8.0	21.85	23.43	33.24	38.97	29.37
12.0	27.53	30.38	42.10	48.79	37.20
Mean	22.59	24.60	33.53	39.20	
C.D. (P=0.05)	Stress (S) 0.054	Genotypes (G) 0.063	G × S 0.109		
			Potassium content in shoots (mg g^{-1} dry weight)		
0.35	29.80	30.46	27.06	29.46	28.69
8.0	25.40	26.33	22.66	23.10	24.37
12.0	19.30	20.43	16.53	16.07	18.08
Mean	24.83	25.74	22.08	22.21	
C.D. (P=0.05)	Stress (S) 0.189	Genotypes (G) 0.218	G × S 0.378		
			Potassium content in roots (mg g^{-1} dry weight)		
0.35	10.00	13.96	8.73	10.26	10.95
8.0	9.43	12.40	7.06	8.20	7.77
12.0	8.66	11.06	6.33	7.30	6.34
Mean	9.64	12.47	7.37	8.58	
C.D. (P=0.05)	Stress (S) 0.248	Genotypes (G) 0.286	G × S 0.496		

Boardman (1964). Sodium and potassium content in dry shoots and roots were estimated by the method of Jackson (1973).

A considerable decrease in dry weight of shoot was observed with rise in salinity from 0.35 (control) to 12 dSm^{-1} in 20 days old lentil seedlings (Table 1). The decrease was maximum in susceptible genotypes as compared to tolerant ones. Our results are in consonance with the report of Rao (1965) who has reported that decrease in dry weight of shoot under salts stress may be due to inhibition of hydrolysis of reserve/synthesizing food or and its translocation to the growing axis. The deleterious effect of salinity might be due to its adverse effect on translocation and partitioning of assimilates towards sink and other metabolic processes (Narayana and Rao 1987).

Increasing salinity levels progressively decreased the total chlorophyll content. The reduction was least (52.66%) in tolerant genotypes L 145-4 but was as high as 70.80% in PL 406 at salinity level of 12 dsm^{-1} (Table 1). Earlier studies have indicated larger decline in total chlorophyll content due to salinity stress in susceptible than tolerant genotypes of different crops (Lahiri *et al*. 1996). Salinity was found to enhance the chlorophyllase activity which results in lowering the chlorophyll content (Rao and Rao 1981) and it may also be partly due to interference of salt ions with the *de novo* synthesis of proteins, the structural component of chloroplast.

As regards carotenoids content under salt stress, both tolerant and susceptible genotypes recorded a significant decrease with increasing level of salinity. The percentage reduction was less in tolerant than that of susceptible genotypes (Table 1). Carotenoids, an accessory photosynthetic pigment in the chloroplast helps in trapping the solar radiation during photosynthesis. Decrease in carotenoids content is in agreement with the reports of Rao and Rao (1981) and Sudhaker *et al*. (1991). The more reduction in carotenoids contents in susceptible genotypes might reduce the photosynthetic efficiency of the plants.

Sodium content in shoots and roots increased with rise in salt stress in all lentil genotypes. The value of sodium content in shoots and roots were significantly higher in susceptible genotypes (PL 406 and Arun) as compared to tolerant genotypes (L 145-4 and L 187-3) (Table 1). The value of sodium content in roots was higher as compared to shoots in all the lentil genotypes. The higher uptake of Na^+ and Cl^- by roots might probably be due to the loss of control over uptake processes and roots become leaky and the ions appeared to be the major factors causing salt injury (Sharma 1997). Sharma (1995) and Datta *et al*. (1996) have reported a positive relationship between soil salinity and uptake of Na^+. Shoots of tolerant genotypes of lentil (L 145-4 and L 187-3) accumulated less Na^+, it could thus sustain a lesser Na^+/K^+ ratio, thereby leading to its more tolerance under salt stress.

Potassium content in shoots and roots decreased with increasing salt stress levels. The content of potassium content in shoots and roots of tolerant genotypes (L 145-4 and L 187-3) were significantly higher than that of susceptible genotypes (PL 406 and Arun). In various crops like soybean (Abel and Mackenzie 1964), and clusterbean (Lahiri *et al*. 1996) genotypes susceptible to salt stress had high concentrations of Na^+ and low concentration of K. A similar trend was observed in the present study under salinity stress. Sodium accumulation coinciding with loss or restriction of potassium uptake during salinity has been reported in several other plant species (Qadar 1991, Sharma, 1995). The differences in accumulation of Na^+ and K^+ between tolerant and susceptible genotypes have been reported by Joshi *et al*. (1985). Sharma (1995) and Datta *et al*. (1996) reported a negative relationship between soil salinity and uptake of K^+. Potassium is not only involved in osmotic adjustment under saline condition but also in turgor maintenance responses like stomatal and leaf movements (Seeman and Critchley 1985). It is thus concluded that genotypes under test showed tolerance because it could avoid the uptake of Na^+ ions and retained its substantial portion in roots. However, genotypes L 145-4 and L 187-3 displayed better salinity tolerance as compared to cv. PL 406 and Arun.

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