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ORIGINAL ARTICLE

Effect of Different Soil Salinity Levels on Certain Biochemical Parameters of Kidney Bean Plants

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A pot experiment was designed to find out the effect of various salinity levels (0 – 12 $mScm^{-1}$) on total chlorophyll contents, nitrate reductase activity, betaine contents and Na^+ and K^+ contents of Kidney bean plants (*Phaseolus vulgaris* L.). Results revealed that increasing soil salinity brought about marked reduction in total chlorophyll contents, nitrate reductase activity and K^+ ion contents. However, Na^+ ion contents and betaine contents got increased. Both the genotypes perform well up to 4 $mScm^{-1}$. At 8 and 12 $mScm^{-1}$ electrical conductivity levels the behaviour of them was observed significantly antagonistic demonstrating their susceptibility towards saline conditions.

Key words: salinity, chlorophyll, nitrate reductase, betaine, Phaseolus vulgaris

Soil salinity affects almost every aspect of the physiology and biochemistry of plants and significantly reduces yield. Great efforts have been devoted to understand physiological facets of tolerance to salinity in plants. Although there are comparatively salt tolerant cultivars of kidney bean, it has proved difficult to enrich elite lines with genes from wild species that confer tolerance. The paucity of success achieved by past attempts to generate salt tolerant cultivars both through conventional breeding programmes and through some biotechnological approaches has fuelled hopes that the problems might be solved through cultural techniques allowing plants to with stand the deleterious effects of salts better.

The present research work was undertaken to estimate the biochemical attributes like total chlorophyll, nitrate reductase activity, Na^+ and K^+ contents and betaine contents of two kidney bean varieties under different salinity levels.

MATERIALS AND METHODS

A pot culture experiment was carried out in Department of Botany, Bareilly College, Bareilly of which each pot (9" earthenware) contained 7.0 kg of normal garden soil having EC 1.2 $mScm^{-1}$. The artificial salinization was induced by using NaCl and $CaCl_2$ in 1: 1 ratio at 4, 8 and 12 $mScm^{-1}$ at 25°C. A polythene lining was provided inside the pots. The salinity treatments were given at fortnightly intervals. EC of soil was checked regularly by Conductivity Bridge (Systronics make) following the method of Varshney and Baijal, 1977). After collecting the fresh leaves and other green tissues, 1 gm sample was weighed and chlorophyll contents were determined by using Arnon's formulae in acetone extracts. Nitrate reductase activity was determined from the leaf samples following the method of Steward and Orebamjo (1979).

Calculation:

NRA = CF (Correction factor) x DF (Dilution factor) x OD (Optical density) x Time

The Na^+ and K^+ contents in dry leaf samples were determined by Atomic Absorption Spectrophotometer (Model- Perkin-Elmer, 2380) directly and expressed in $meqg^{-1}$ dry weight. Betaine contents were determined by the method of Hitz *et al*. (1982).

The data were statistically analyzed by analysis of variance method

RESULTS AND DISCUSSION

Total chlorophyll contents

The effect of salinity on chlorophyll formation was significant (Table 1). The chlorophyll contents decreased gradually with increasing levels of soil salinity (4-12 $mScm^{-1}$) as compared to control (1.2 $mScm^{-1}$). Chl. a suffered relatively more than chl, b in both the varieties of kidney bean. Our results are in agreement with those of Panda and Khan (2003); Mandel and Singh (2001). Total chlorophyll contents maintained comparatively more in leaves than in other green tissues even upto 12 $mScm^{-1}$. The exhibition of retention of the contents was found more or less same in both the varieties. However, var. PDR-14 of kidney bean performed relatively well.

Nitrate reductase activity

The effect of soil salinity regimes on NRA was found significant (Fig. 1). Increasing soil salinity was found to decrease NRA as compared to control. Our findings are more or less similar to those of Pandey and Srivastava (1989); Gill and Singh (1992). So far as the decreasing trend is concerned, it was recorded better in var. Pant bean-2 than var. PDR-14. Maximum NRA was noted in former variety of kidney bean. Highest reduction in NRA was found in var. Pant bean-2 showing its susceptible nature.

Betaine and total QACs

The data portrayed in Fig. 2 and 3 was found significant and reveal that soil salinity brought about a marked accumulation of betaine and total quaternary ammonium compounds in both the varieties of kidney bean in leaves as well as seedlings.

In leaves and seedlings both, the mode of accumulation was recorded more or less same. However, var. Pant bean-2 performed better for betaine and QACs both. Similar results have also been reported by Hitz *et al*. (1982); Steward and Lee (1974); Wyn Jones and Storey (1977).

It may be suggested that beetaine like QACs are localized in the cytoplasm where they act as benigs osmotica to balance decreased vacuolar water potential or as products of ammonia detoxification. Irrespective of the physiological role of these compounds, their accumulation in considerable amount can be crucial to the nitrogen economy of plants (Pan *et al.*, 1981).

Na^+ and K^+ contents

The effect of soil salinity on Na^+ and K^+ contents was significant (Table 2). Present findings revealed that Na^+ contents increased and K^+ contents decreased with increasing episodes of salinity. These observations successfully corroborate the findings of Sultana *et al.* (2002). The excessively accumulated Na^+ contents restricted the uptake of K^+ ions by Kidney bean plants. Our results are supported by Islam *et al.* (1995) and Dionision and Tobita (2000).

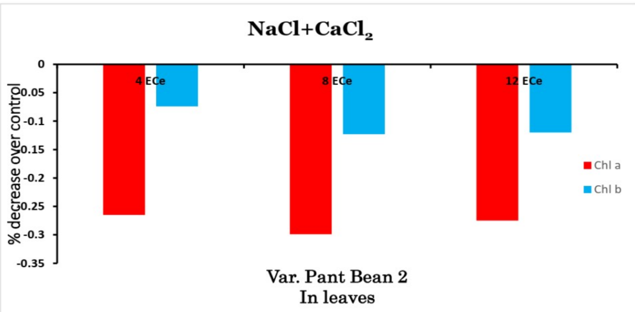
Table 1. Chlorophyll contents (µgg^{-1} fresh wt.) in plants of kidney bean (*Phaseolus vulgaris* L.) var. Pant bean 2 and var. PDR-14 under saline conditions

Treatment	ECe (mScm^{-1})	In leaves				In other green tissues			
		Chl-a	Chl-b	a:b ratio	Total Chl	Chl-a	Chl-b	a:b ratio	Total Chl
var. Pant bean 2									
$NaCl+CaCl_2$	Control	0.301	0.581	0.818	0.882	0.123	0.283	0.434	0.406
	4	0.221	0.538	0.410	0.459	0.093	0.238	0.390	0.331
	8	0.211	0.509	0.351	0.811	0.092	0.221	0.416	0.313
	12	0.218	0.511	0.356	0.826	0.091	0.168	0.341	0.259
var. PDR-14									
$NaCl+CaCl_2$	Control	0.388	0.589	0.658	0.977	0.222	0.349	0.686	0.571
	4	0.254	0.419	0.606	0.673	0.212	0.305	0.675	0.517
	8	0.238	0.370	0.608	0.608	0.124	0.212	0.584	0.336
	12	0.228	0.398	0.572	0.626	0.079	0.168	0.470	0.247

Values are mean of three replicates

Table 2. Na^+ and K^+ contents in plants of kidney bean (*Phaseolus vulgaris* L.) var. Pant bean 2 and var. PDR-14 under saline conditions

Varieties	Na^+ Contents (meq/g^{-1})				K^+ Contents (meq/g^{-1})			
	Control	4	8	12	Control	4	8	12
var. Pant bean 2								
a. In seedlings	0.011	0.09	0.41	0.45	0.023	0.011	0.003	0.003
b. In leaves	0.16	0.22	0.32	0.41	0.083	0.061	0.050	0.01
var. PDR-14								
a. In seedlings	0.32	0.34	0.41	0.40	0.17	0.16	0.11	0.09
b. In leaves	0.91	0.98	1.03	1.00	0.64	0.52	0.48	0.14



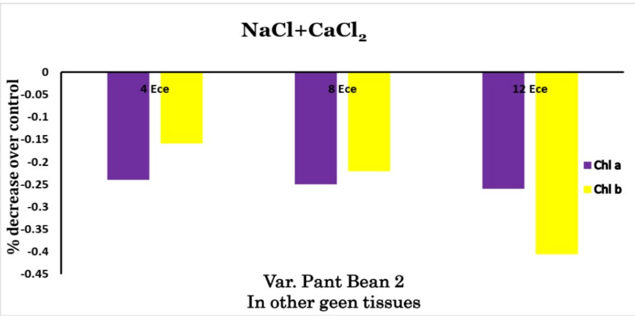


Figure 1. Chlorophyll contents (µgg^{-1} fresh wt.) in plants of kidney bean (*Phaseolus vulgaris* L.) var. Pant bean 2 and var. PDR-14 under saline conditions.

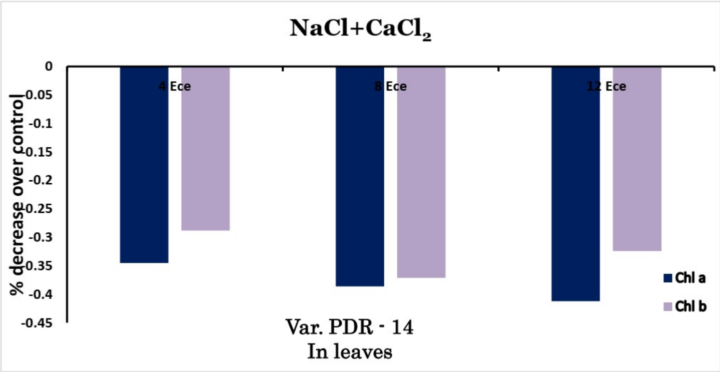
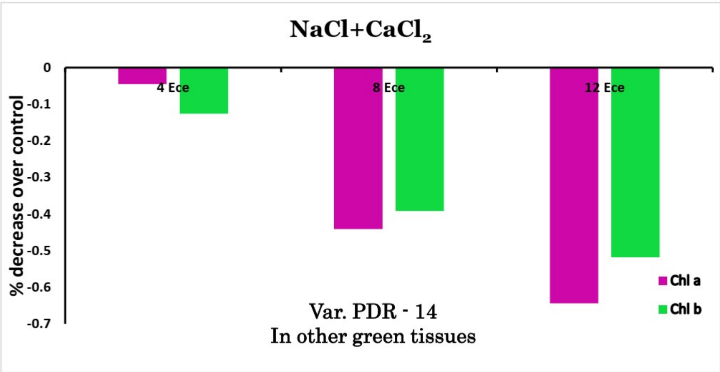


Figure 2. Na^+ and K^+ contents in plants of kidney bean (*Phaseolus vulgaris* L.) var. Pant bean 2 and var. PDR-14 under saline conditions



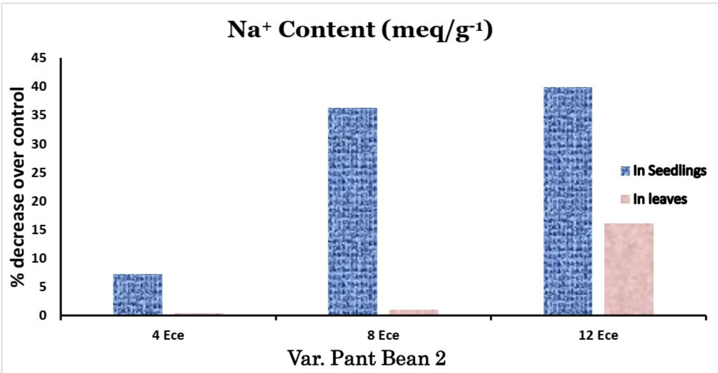
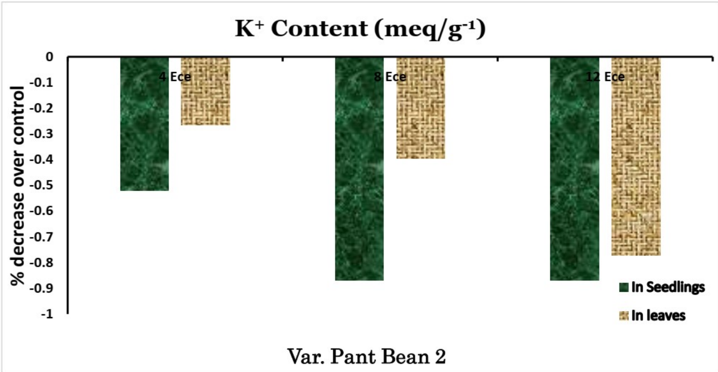


Figure 3. Betane and total QACs in both plants of kidney bean (*Phaseolus vulgaris* L.) var. Pant bean 2 and var, PDR-14 under saline conditions.



CONFLICTS OF INTEREST

The authors declare that they have no potential conflicts of interest.

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