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Salinity Induced Responses to NRA and Nodulation in Kidney Bean (*PHASEOLUS VULGARIS Linn.)*

B. K. Verma[1], K. A. Varshney[2]

Plant Physiology and Biochemistry Section Post Graduate Department of Botany, Bareilly College, Bareilly (U.P.)

Abstract: ***A field experiment was conducted with two varieties of kidney bean viz. Pant bean-2 and PDR-14 to study the effect of salinity on nitrate reductase and root nodulation. Salinity is detrimental to growth of leguminous plants as it affects nodulation and NRA. In a salt tolerant variety of kidney bean viz., Pant bean-2 the minimum NRA was noticed, while in highly tolerant var. PDR-14 higher NRA was observed with the increasing salt concentration from 4 to 8 mScrn^{-1}. The formation of root nodules, size, number, fresh weight of single nodule and haemoglobin contents were found suppressed significantly in both the varieties of kidney bean indicating thereby that with an increasing salt concentrations kidney bean plant might tend to overcome the adverse effect of salinity on nodulation by increasing NR activity in highly salt tolerant variety PDR-14 in comparision of var. Pant bean-1. It may be inferred that reduced NRA might be due to the specific effects of Cl; Na^+ and Ca^{++} ions on uptake and transport of NO_3^- ions.***

1. Introduction

A great understanding has been gained on nitrate and nitrite reductase activity through the work of Davis (1953), Hageman and Flesher (1960), Evans and Nasan (1970), Srivatava (1980), Khan (1989) and Kumari (1991). NRA can rapidly change in response to several environmental factor including salinity stress (Kanjebaeva and Rakova, 1995). However reports on the effect of salinity are scanty and rather contradictory as both inhibition (Martinez and Cerda, 1989; Gouia et al., 1994) and stimulation of NR activity (Mishra and Dwivedi, 1990) are concerned.

Salinity not only delayed development of leghaemoglobin pigment, but also results into and earlier and enhanced senescence of the nodules and the development of newly found nodules (Kumar and Garg, 1980).

An attempt has been made in the present investigation to understand the rate of nitrate reductase activity in nitrogen metabolism as it is considered to be a limiting factor for growth and development of nodule and also in development of leghaemoglobin pigment in the nodules.

2. Materials and Methods

Seeds of kidney bean varieties Pant bean-2 and PDR-14 were surface sterilize with 0.1% $HgCl_2$ and were sown in the ordinary garden soil as per the technique of Karadge and Chavan (1977) and Varsheny and Baijal (1977). Salinity treatments (4, 6 and 8 mSem^{-1}) of NaCl and $CaCl_2$ (1:1) were applied at fortnightly intervals. Plants from each plot were harvested randomly at seedling stage (4 DAS) and flagging stage (20 DAS). Plants were washed in tap water and samples were blotted immediately.
For the determination of NR activity nodulation number and size of nodule were recorded at seedling and flagging stages. Leghaemoglobin contents in nodules was determine.

3. Results and Discussion

Nitrate reductase (NR) has been one of the most important regulatory enzymes associated with process of nitrate assimilation, plants growth, development and protein production, therefore nitrogen metabolism must be one of the primary determinant for the growth of plants and saline and sodic conditions. Mishra et al. (1996), has stated in special relevance to legumes that NR enzyme is highly sensitive to all types of stresses including salinity stress in different crop plants (Garg et al., 1993; Lahiri et al., 1996).

In the present study, the activity of nitrate reductase in both kidney bean varieties viz. Pant bean-2 and PDR-14 got inhibited and the inhibitory effect of NRA found gradual towards increasing EC levels of salts. As is obvious from the data given in Table 1 and Fig. 1 that there was 14.28% and 2.66% reduction in NRA under 4 ECe whereas 60.97% and 11.55% reduction over control under 8 ECe treated seedlings of variety Pant bean-2 and PDR-14 respectively. While the seedlings of former variety did so by 33.44% under same ECe level.

As for as the effects on salinity of NRA in the plants of flagging stage are concerned the NRA was found inhibited with increasing salinity levels in both the varieties investigated. In variety Pant bean-2, the effect was recorded 49.32%, 69.37% and 68.83% over control. While in var. PDR-14 it was noted to be 1.91%, 8.62% and 8.64% over control respectively. It was interestingly noted that later var. depicted relatively lesser effect than the former one thereby showing higher salinity tolerant nature. Salinity was found to effect adversely the size, number and fresh and dry weight of nodules in both the varieties of kidney bean investigated in the present study. The results presented in Table 2 and Fig. 2 indicate that the size of nodules got reduced by increasing levels of salinity and the range of percentage reduction over control was observed to be 11.11% to 33.33% in var. Pant bean-2 and 16.66% 43.33% in var. PDR-14 indicating salinity favoured nodule development relatively more in var. Pant bean-2. Salinity also reduced the number of nodules per plant and the reduction range over control was observed to be 28.00% - 33.03% in var. Pant bean-2 and 18.33% - 20.83% in var. PDR-14. As against the size, nodular frequency got reduced more in former var. than in later one. Fresh weight of nodule was also found to reduce by 23.87% - 48.38% in var. Pant bean-2 and 24.32% - 51.35% in var. PDR-14. Dry weight of nodules was found to

be reduced by 7.77% to 46.66% in var. Pant bean-2 and 8.00% 42.22% in var. PDR-14.

Table 1: Effect of salinity on NRA (μmol NO_2 g^{-1} fresh wt hr^{-1}.) in seedlings and leaves of two kidney bean varieties

Growth Stages	(Values are mean of three replicates)							
	Var Pant bean-2				Var PDR-14			
	Salinity ($mScm^{-1}$ EC)				Salinity ($mScm^{-1}$ EC)			
	C	4	6	8	C	4	6	8
Seedling stage (Pertiplate culture)	28.7	24.6	19.1	11.2	22.5	21.9	20.7	19.9
Flagging stage (Field culture)	36.9	18.7	11.3	11.5	31.3	30.7	28.6	28.5

SEm ± and C.D. values						
	Seedlig stage			Flagging stage		
For NRA	V	T	V x T	V	T	V x T
SEm±	0.23234	0.32857	0.46468	0.22821	0.32274	0.45643
C.D. at 5%	0.70466	0.99654	1.40932	0.659215	0.97886	1.38431

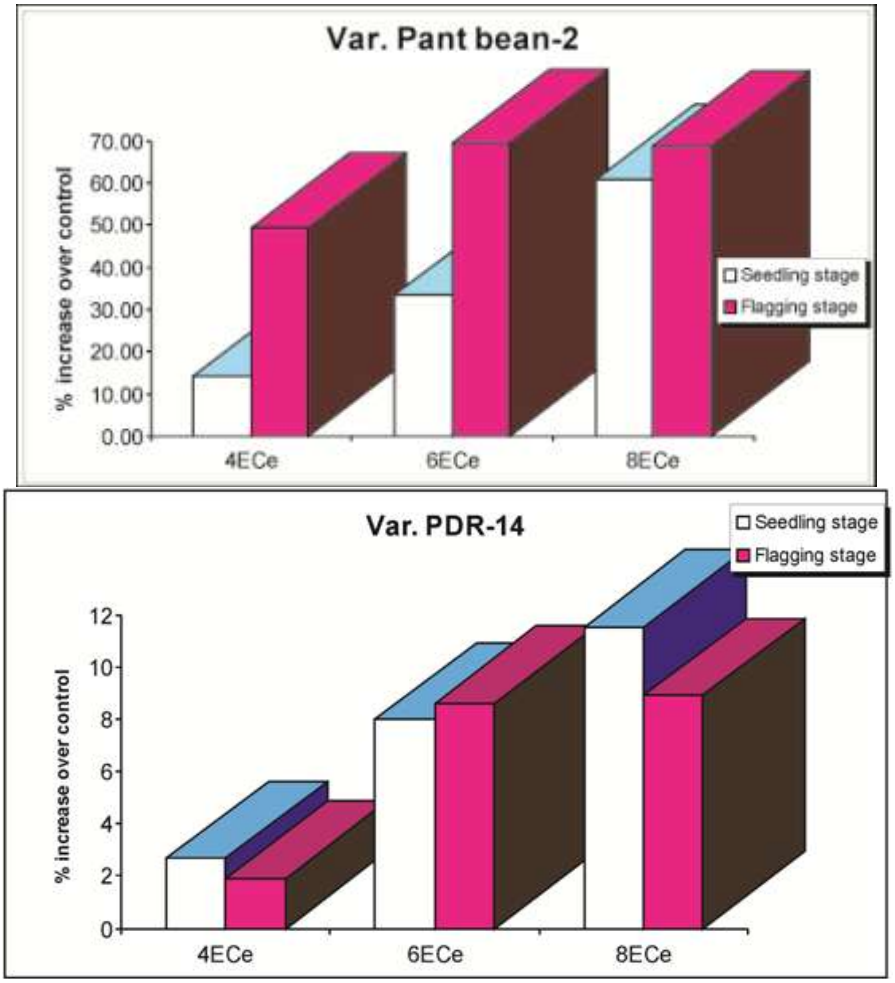

Figure 1: Effect of salinity on NRA in seedlings and leaves of two kidney bean varieties

Table 2: Effect of soil salinity on nodulation and leghaegmoglobin contents in two varieties of kidney bean (*Phaseolus vulgaris L.*)

Parameters	(Values are means of four replicates)		
	Treatments ($mScm^{-1}$)	Plants of leafy stage	
		Var. Pant bean-2	Var. PDR-14
Size of nodules (cms)	Control	1.8	1.8
	4 ECe	1.6	1.5
	6 ECe	1.5	0.86
	8 ECe	1.2	0.78
Number of nodules	Control	15.0	12.0
	4 ECe	10.8	9.8
	6 ECe	12.0	10.0
	8 ECe	10.0	9.5
Fresh weight of nodules (mgs)	Control	155.0	148.0
	4 ECe	118.0	112.0
	6 ECe	105.0	95.0
	8 ECe	80.0	72.0
Dry weight of nodules (mgs)	Control	50.0	37.0
	4 ECe	45.0	32.0
	6 ECe	40.0	30.0
	8 ECe	30.0	22.0
Loghaemoiglobin contents (1g/gm. Fresh weight)	Control	90.0	75.0
	4 ECe	83.0	69.0
	6 ECe	73.0	59.0
	8 ECe	48.0	43.0

SEm ± C.D. Values			
	V	T	V x T
For size of nodules			
SEm±	0.32659	0.46187	0.65318
C.D. at 5% P	0.99052	0.1408	0.19810
For number of nodules			
SEm±	0.21702	0.30691	0.4304
C.D. at 5% P	0.65820	0.93084	1.31640
For fresh wt. of nodules			
SEm±	1.75424	2.48087	3.50849
C.D. at 5% P	5.32043	7.52422	10.6408
For dry wt. of nodules			
SEm±	0.66256	0.93700	1.3251
C.D. at 5% P	2.00947	2.84182	4.01895
For leghaemoglogin contents			
SEm±	0.99925	1.41316	1.99851
C.D. at 5% P	3.03063	4.28595	6.06125

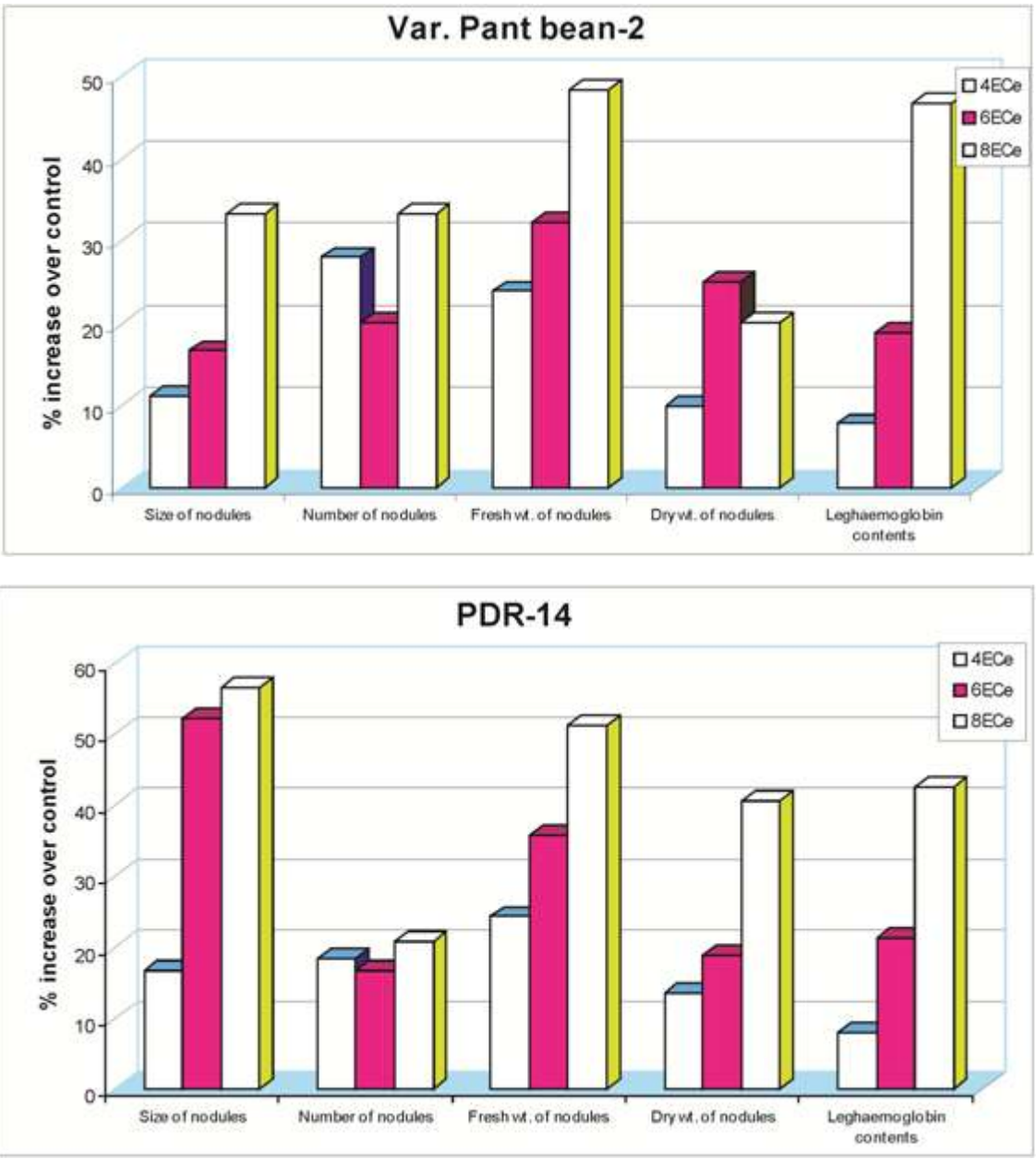

Figure 2: Effect of soil salinity on Nodulation and leghaemoglobin contents in kidney bean varieties

Salinity affects the leghaemoglobin contents in both the varieties of kidney bean adversely the percentage reduction in haemoglobin over control in var. Pant bean-2 was observed to be 7.7%, 8.8% and 46.6% under 4, 6 and 8 ECe, respectively, while those of var. PDR-14 showed correspondingly reduced percentage 8.00%, 21.33% and

46.66%. The role of nitrogenase seemed to increase with the induction of salinity in root nodules of both the varieties of kidney bean. As a result, lower concentration of nitrogen seemed probably to lead into a concomittant promotion in nitrogenase enzyme activity as has also been recorded by Rigaud (1981).

Our results demonstrated marked depletion in number size, fresh weight and dry weight of nodules of both of the varieties of kidney bean investigated. This may be ascribed to the reduced activity of nitrate reductase activity under saline conditions. Our results are in agreement to those of Garg and Garg (1980) reported in pea; Singh and Jain (1982) in chickpea; Gill and Dutt (1987) in soybean.

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