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RESPONSES OF CLUSTERBEAN TO SOIL SALINITY

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ABSTRACT

Suitability of growing rainfed clusterbean in lands under summer fallow (after growing wheat with saline ground water) was evaluated through a study of alterations in the performance, N-P-K uptake and metabolism at 0, 2, 4, 6, 8 and 10 mmhos cm^{-1} of soil salinity. Final plant growth and seed yield significantly reduced only at 6 mmhos cm^{-1} and above. However, the adverse effects of salinity on the levels of leaf metabolites at the pre-flowering stage were discernible at a lower salinity level (4 mmhos cm^{-1} and above). Activities of different enzymes (i.e. nitrate reductase, protease, peroxidase, acid and alkaline pyrophosphatases) displayed variable sensitivity to salt concentration (2 to 6 mmhos cm^{-1}). The causes of disparate influence of salt concentrations on growth, yield and metabolic parameters have been discussed. Increasing salinity progressively increased the Na concentration and uptake in the shoot tissue without causing significant changes in the N, P and K concentrations. But their uptakes were reduced due to the decline in dry matter production. Taking all facts into consideration, crop has been deemed suitable for cultivation in salt affected areas under summer fallow.

INTRODUCTION

In many parts of arid and semi-arid Rajasthan where irrigated winter crops are raised with saline ground waters, the land is normally kept fallow for one or two rainy seasons for leaching of the salts from the soil profile before the irrigated winter crop is grown (Gupta and Abichandani, 1970, Lal and Singh, 1973, Dhir, 1977). In this cyclic system of management, land productivity declines due to the absence of any rainfed crop and the cropping intensity hardly ever exceeds 33 to 50 per cent. Introduction of a salt tolerant summer crop into this system of land use may augment the productivity, improve infiltration and reduce evaporation from soil due to crop canopy. In this regard it has been reported (Garg and Lahiri, 1986) that among clusterbean, mung bean and moth bean, the principal grain legumes of this region, clusterbean is more salt tolerant than the others. Therefore, an attempt has been made here to study the alterations in performance, nutrient uptake and metabolism of clusterbean under varying levels of soil salinity, in order to assess its suitability for the aforesaid condition.

Table 4. Influence of increasing salinity (mmhos cm^{-1}) on the leaf and stem growth of clusterbean at periodic intervals

Salinity levels	Leaf dry wt (g $plant^{-1}$) (days after sowing)					Stem dry wt (g $plant^{-1}$) (days after sowing)				
	15	30	45	60	75	15	30	45	60	75
0	0.068	0.40	0.92	1.70	2.97	0.024	0.14	0.42	1.38	4.40
2	0.063	0.36	0.77	1.61	2.71	0.020	0.13	0.39	1.23	3.91
4	0.050	0.32	0.60	1.50	1.98	0.016	0.11	0.35	1.07	3.42
6	0.043	0.26	0.46	1.28	1.81	0.015	0.10	0.28	0.80	2.97
8	0.037	0.18	0.33	0.97	1.74	0.014	0.08	0.21	0.60	2.60
10	0.030	0.13	0.27	0.70	1.62	0.013	0.06	0.17	0.42	2.10
LSD 5%	0.015	0.09	0.27	0.36	0.71	0.007	0.04	0.17	0.37	1.09

Table 5 indicates that a significant reduction with respect to control, was uniformly brought about at 6 mmhos cm^{-1} and beyond, in case of final plant height, dry weight of pods and seed yield. However, the reduction in seed yield was not associated with a significant decline in 100 seed weight. Thus it seems that salinity influenced the yield primarily through growth reduction while the photosynthate transport per se remained relatively unaffected. As per the norms set by Mahas and Hoffman (1977) with respect to yield of legumes under salinity, this crop may be considered to be fairly salt tolerant.

Table 5. Influence of increasing soil salinity (mmhos cm^{-1})on growth and yield of clusterbean

Salinity levels	Final plant height (cm)	Dry wt (g $plant^{-1}$)		100-seed weight (g)
		Pods	Seed	
0	54.6	7.60	4.50	3.44
2	53.6	7 20	4.26	3.38
4	49.9	6.36	3.90	3 35
6	47 6	6 00	3.66	3 34
8	45.1	5.56	3.50	3.35
10	43 6	4.70	3.00	3.32
LSD 5%	4.8	1.50	0 73	NS

Figure 1 clearly indicates that the uptake of nitrogen, phosphorus and potassium declined with the increasing level of salinity at all the developmental stages although ageing as such, in all cases, increased the uptake. The salinity induced reduction in uptake of N, P and K could no doubt adversely influence the growth and yield. But the Fig. 1 also indicates that the concentrations of N and P in the tissue at different levels of salinity showed hardly any variation at any stage of growth, and K displayed only a marginal decline. Therefore, it is more likely that the reduction in the total uptake of these nutrients was a result of lowering of dry matter production with increasing salinity. In this regard Levitt (1980) has indicated that nutrient deficiency may sometimes contribute to salt injury, but is seldom, if ever, the sole cause of growth inhibition.

The sodium concentration in the shoot tissue progressively increased with the increasing salinity at all stages (Table 6) but the level declined with the advancement of plant age. This could be due to increased plant growth on the one hand and a decline in soil salinity level on the other. Table 6 further indicates that during early growth the sodium uptake progressively increased with increase of salinity level. However, at later stage the sodium uptake did not display any concentration dependent increase. At higher salinities the growth was very much restricted. Therefore, the absolute sodium content did not show any increase despite the increase in its concentration in the tissue with increasing salinity level. However, the higher concentration of sodium alongwith the

Dislocations in nitrogen metabolism are furthermore obvious from salt induced decline in nitrate reductase activity and increase in protease activity (Table 8). A reduction in nitrate reductase activity in this crop, under saline water irrigation, was also noted earlier (Garg et al., 1986). Salt induced increase in protease activity has also been reported in mung bean (Sheoran and Garg, 1978). It seems that in clusterbean, these enzymes are highly sensitive to salt stress, as their activities markedly declined even at 2 mmhos cm^{-1} but the threshold of salinity response varied widely in different enzymes. For instance, the activites of alkaline pyrophosphatase and peroxidase were affected at about 6 mmhos cm^{-1} while that of acid pyrophosphatase was influenced at 2 mmhos cm^{-1}. But in any case it is obvious that salinity had an all prevading effect where, among other things, it also influenced energy regulating mechanism and oxidative processes. Thus it seems that salt induced derangements at a biochemical plane resulted in growth and yield reduction. However, it seems that significant reductions in growth and yield could arise at a higher concentration than the level(s) at which the individual metabolic parameters are influenced. This could possibly arise from the cumulative effects of metabolic derangements over time and space on the growth and yield.

Table 8. Influence of increasing soil salinity (mmhos cm^{-1})on the activities of certain leaf enzymes of clusterbean at pre-flowering stage (35 days after sowing)

Salinity levels	Protease (Δ OD mg^{-1} protein h^{-1})	Nitrate reductase (μg NO_2 formed g^{-1} dry wt h^{-1})	Peroxidase (mg g^{-1} dry wt)	Acid pyrophosphatase (mg Pi Lib. g^{-1} dry wt h^{-1})	Alkaline pyrophosphatase (mg Pi Lib. g^{-1} dry wt h^{-1})
0	0.076	772.3	1 07	176.2	375.4
2	0.083	495.5	1 23	212.4	448.8
4	0.122	402.8	0.98	226.4	364.3
6	0.105	403.6	1.36	198.3	473.0
8	0.121	404.3	1.46	243.6	494.7
10	0.176	444.6	1.64	322.0	564.0

However, informations derived in totality regarding clusterbean suggest that crop may be grown during summer in lands presently kept fallow after wheat cultivation under saline water irrigation. Although field study is needed to confirm this fact, yet the present pot culture study provides promising indications in this regard as the decline of yield of the order of only 18.7 and 22.2 per cent has been found at 6 and 8 mmhos cm^{-1} respectively. It has earlier been reported (Garg et al., 1984) that clusterbean can maintain a higher N_2-ase activity as compared to moth bean up to 10 mmhos cm^{-1} salinity caused by chloride, sulphate and bicarbonate of sodium. Additional advantage emerges from the finding (Kathju et al., 1987) that normally clusterbean improves the soil nitrogen status more than moth bean and mung bean and thus contributes more towards the yield improvement of a succeeding crop.

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