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SALT TOLERANCE STUDIES ON *SESBANIA ACULEATA*

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Salt tolerance of dhancha (*Sesbania aculeata*), a leguminous green manuring crop, was studied using gravel culture technique. Results indicate that germination of dhancha was relatively less affected while the death rate of seedlings was greatly increased at higher levels of salinity. The average dry weight of the aerial parts of the plant decreased from 117 g to 41 g (corresponding to 65% reduction in yield) when electrical conductivity of solution in the root zone was increased from 3 mmhos cm^{-1} to 15 mmhos cm^{-1}. The calculated EC value of the substrate that would cause 50% reduction in yield was 13.7 mmhos cm^{-1}. Ash content increased progressively in stems and abruptly in leaves when EC of the substrate was increased beyond 15 mmhos cm^{-1}.

INTRODUCTION

Dhancha (*Sesbania aculeata*) produces large amount of green matter per unit area, has a short growth period and is leguminous in nature. By virtue of these very characteristics it has become one of the most important green manuring crops of the irrigated areas of the Punjab. The plant is capable of fixing atmospheric nitrogen thus improving the fertility status of the soil; has a profuse root system which improves the soil aggregation; excretes acidic juices, and is easily decomposed by cellulolytic fungi when added to saline-sodic soils (Malik and Haider, 1977). This plant thus has a pivotal role to play in the proposed biological reclamation programme of saline-sodic soils (Sandhu and Malik, 1975). The plant is not as salt tolerant as some other important plant species (e.g. *Diplachne fusca*) and cannot be used as a primary colonizer of the highly salt-affected soils. Nevertheless, accurate measurements regarding its salt tolerance limits have never been made. Some of the previous studies were carried out using somewhat doubtful technique of soil culture (Ali, 1975; Ahmad, 1975) and probably over estimated the salt tolerance limits of dhancha. Results of a recent study on salt tolerance of this plant using gravel culture technique (Qureshi *et al.*, 1977) are described here.

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MATERIALS AND METHODS

Gravel Culture

Gravel (2–5 mm dia.) separated from Lawrencepur sand was washed successively with dil. HCl, canal water and distilled water and used as support for growing plants. Calculated amounts of Na_2SO_4, $CaCl_2$, $MgCl_2$ and NaCl in the ratio of 10:5:1:4 on equivalent basis were dissolved in Arnon and Hoagland nutrient solution (Hewitt, 1952) to produce required salinity levels. To maintain a constant salinity level the pots were drained and replenished with the solution daily after correcting the salinity level by the addition of water or salts as required.

Studies on Emergence/Survival Rate of Seedlings

Six different salinity levels i.e. EC 3, 5, 10, 15, 20 and 22.5 mmhos cm^{-1} were prepared and the solutions (350 ml) poured into the plastic beakers containing 1 kg gravel. Ten selected seeds of dhancha were sown in each beaker and number of seedlings emerged/died recorded daily. The plants were harvested after 4 weeks and the number of nodules on the roots recorded. The treatments were repeated three times.

Post-Seedling Studies

In this case 12 kg gravel in glazed pots with a side hole was used instead of 1 kg gravel in plastic beakers while rest of the procedure was the same as described above. The plants after germination were subjected to higher salinity levels by step-wise increase in EC of 5 mmhos cm^{-1} every five days. The plant height was recorded and plants harvested after 60 days of growth. Fresh weight yields of aerial parts (leaves and stems) and roots were recorded separately. The dry matter yields were noted by drying the plants for 7 days at 70°C. Total ash content of leaves and stems was determined using dry ashing procedure mentioned by Jackson (1962).

RESULTS AND DISCUSSION

(A) Effect of Root Zone Salinity on Germination and Survival Rate of Seedlings.

Results presented in Table 1 indicate that the germination percentage of dhancha was slightly decreased at higher salinity levels (a delay in germination was also noticed). At an EC level of 15 mmhos cm^{-1} germination was 90% as against 97% in case of control. The germination decreased further to 80% when EC level in the root zone was increased to 22.5 mmhos cm^{-1}.

These results are contrary to those of Ahmad (1975) and Ali (1975) who reported more pronounced effect of higher salinity levels on the germination of dhancha. They reported 85% and 53% decrease in germination of dhancha at EC levels of 20 and 16 mmhos cm^{-1}, respectively. The figures mentioned by these authors are exceedingly low and perhaps pertain to the number of seedlings that survived rather than those that emerged. In very carefully conducted experiments we noticed that, at high salinity levels, most of the seeds germinated but the seedlings died after 1-2 days. The percentage of surviving seedlings decreased from 86.6 to 23.3 as the EC level increased from 3 mmhos cm^{-1} to 22.5 mmhos cm^{-1}. The 50% decrease in the percentage of seedlings that survived was at an EC level of 15 mmhos cm^{-1}. It is thus apparent that germination of dhancha was relatively less affected while the plant was highly sensitive to salinity at seedling stage.

(B) Effect of Root-zone Salinity on the Growth of Dhancha

(i) *Plant Height and Nodulation.* Results presented in Table 2 indicate that average plant height decreased progressively from 139 cm to 111 cm when the root zone salinity was increased from an EC of 3 mmhos cm^{-1} to 10 mmhos cm^{1-} and beyond that the decrease was more pronounced and average plant height at 22.5 mmhos cm^{-1} was 25 cm only. These results are in contradiction to those reported by Ahmad (1975) who noticed an increase in the average plant height at an EC of 8 mmhos cm^{-1}. This difference in trend could be due to inherent differences in the techniques employed for the salt tolerance studies in the two cases.

The nodulation of dhancha appears to be drastically affected by the salinity in the root zone (Table 1). No nodules were found on the roots when the salinity was increased beyond 10 mmhos cm^{-1}. Although data on the salt tolerance of Rhizobia of dhancha are scanty, this observation warrants further studies to evaluate the performance of leguminous crops grown in salt-affected soils.

(ii) *Yield of Aerial Parts and Roots.* Results indicate that an increase in the root zone salinity decreased the dry matter yield of aerial parts as well as roots, the effect being much more pronounced in case of roots (Table 2). The statistical analysis of the results indicates a significant negative correlation between the root zone salinity and the crop yield ($r = -0.9854$). The calculations from the regression equation ($y = 129.6554 - 5.8953x$) indicate that 50% decrease in the dry matter yield of the aerial parts of the plant would be at about 13.7 mmhos cm^{-1}. These results are in contradiction to the earlier studies (Ahmad, 1975; Ali, 1975) where dhancha has been shown to tolerate much higher levels of salinity. Ahmad (1975) indicated an increase in yield of dhancha at an EC of 8 mmhos cm^{-1} and a slight decrease (11%) at an EC of 16 mmhos cm^{-1} as compared to control. The higher tolerance of dhancha to salinity observed by these authors seems to be the result of inherent drawbacks of the soil culture technique as discussed by Qureshi *et al.* (1977). In conclusion it may be mentioned that the salt tolerance limits observed in the present study appear to be more reliable as they are based on a gravel culture technique, which ensures constant root zone salinity levels.

(iii) *Ash Content.* The data on per cent ash content of dhancha leaves and stems presented in Table 2 indicate that leaves contained higher percentage of salts compared with stems. Ash percentage of dhancha stems increased progressively as the root zone salinity was increased above EC of 3 mmhos cm^{-1} (control) whereas, the leaves did not show any corresponding increase upto an EC of 10 mmhos cm^{-1}. Above EC of 10 mmhos cm^{-1}, leaves also started accumulating salts and at an EC of 20 mmhos cm^{-1} or above increases in ash contents of stems and leaves were comparable. Ahmad (1975) also reported a slight increase in the ash content of dhancha at higher salinity levels. The increased accumulation of salts in plants at higher root zone salinity levels was probably the result of increased absorption of salts by the plants to counteract higher external osmotic pressure. At the higher salinity levels (15 mmhos cm^{-1}) the forced (passive) absorption of ions through root membrane into the plant and ultimate accumulation in the aerial parts of the plant is also probable.

Progressive increase in the ash content of stems with increase in salinity points to the fact that dhancha is not a salt rejecting plant and some other mechanism is involved in its relatively high salt tolerance. Results indicate that at higher root zone salinity the absorbed ions were initially retained by the stems and thereby allowed the leaves to perform their normal physiological functions which may in part account for its tolerance to salts.

Table 1. *Effect of salinity levels on germination/survival rate and nodulation of dhancha (Sesbania aculeata).*

S. No.	EC of the solution in the root zone mmhos cm^{-1}	*Maximum germination* Number	%age	*Survival rate* Number	%age	No. of nodules produced pot^{-1}
1	3	29	97	26	86.6	43
2	5	28	93	21	70.0	33
3	10	27	90	15	50.0	14
4	15	27	90	13	43.3	0
5	20	25	83	11	36.6	0
6	22.5	24	80	7	23.3	0

Table 2. *Effect of salinity levels on the growth characteristics and ash content of dhancha (Sesbania aculeata).*

S.No.	EC of the solution in the root zone (mmhos cm^{-1})	Plant height (cm)	Dry wt. of leaves + stem (g pot^{-1})	Dry wt. of roots (g pot^{-1})	*Ash %age* Leaves	Stem
1.	3	139	117	94	9.07	5.57
2.	5	134	96	54	8.65	6.20
3.	10	111	74	29	8.36	6.49
4.	15	60	41	12.5	10.63	7.31
5.	20	33	6	1.9	16.14	9.99
6.	22.5	25	4	1.2	17.68	10.65

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