EFFECT OF SALT STRESS ON NODULATION FIXED NITROGEN PARTITIONING AND YIELD ATTRIBUTES IN CHICKPEA (CICER ARIETINUM L.)

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SUMMARY

In sand culture, varying levels of chloride and sulphate salinity delayed nodule initiation, decreased nodule weight and leghaemoglobin content of fresh nodules in chickpea. Reduction in pod number and weight, seed yield, 100 seed weight and biological yield was observed. Harvest index increased at lower but decreased at higher salinity levels. Salinity also restricted the movement of fixed nitrogen out of the nodules and resulted in greater accumulation of nitrogen into leaves and podshells. Seed nitrogen drastically reduced under both types of salinity.

INTRODUCTION

Salinity is one of the important factors limiting crop production in tropical and sub-tropical regions. Presence of excessive salts in the soil adversely affects vegetative and reproductive growth of plants through osmotic as well as specific ion effects (Bernstein and Hayward, 1958, Strogonova, 1964 and Levitt, 1980).

Legume productivity under saline soils mainly depends upon their tolerance and nitrogen fixing efficiency. Such studies in chickpea under saline conditions are meagre. Hence, an attempt was made to elucidate the adverse effects of chloride and sulphate types of salinity on nodulation, fixed nitrogen partitioning and yield components in chickpea.

MATERIALS AND METHODS

The experiment was carried out in earthen pots (10” dia.) in sand culture. Each pot was lined with polythene bag and filled with 5 kg acid washed river sand. Salinity levels of 5, 7.5 and 10 dS/m were created by adding the required amount

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of salts in nitrogen free nutrient solution (Wilson and Reisenauer, 1963). Sodium chloride and sodium sulphate were used for creating chloride and sulphate salinity respectively. Nitrogen-free nutrient solution served as control. Sufficient quantities of salt solutions were applied in pots under each treatment for complete saturation. One day after creation of salinity ten seeds of chickpea variety H 208 inoculated with *Rhizobium leguminosarum* were sown in each pot. Three healthy plants in each pot were maintained after seedling establishment. Salinity levels were maintained by replenishing the sufficient quantity of respective salt solutions at an interval of 10-15 days after thoroughly flushing the pots with non-saline canal water. The quantity of irrigation water applied was determined gravimetrically for each treatment. Plants were dried in hot air oven at 70° ± 1°C for 36-40 hours for determining dry weight. Yield and the yield attributes were recorded after the harvest. Estimation of nitrogen in different plant parts and leghaemoglobin content in fresh nodules were done by the methods of Lindner (1944) and Hartree (1957) respectively.

RESULT AND DISCUSSIONS

Increasing salinity progressively delayed the nodulation in all the treatments (Table I). The initiation was delayed by 8-9 days at the highest salinity level of both the salt. Oven dry weight of nodules also decreased markedly by varying levels of chloride and sulphate salinity. The reduction was significant over control even at 5 d S/m salinity. With the advancement of age, nodule weight increased up to 150 DAS except with 10 d S/m salinity where it decreased after 125 DAS. Increase in nodule weight up to 150 DAS in control as well as under moderate salinity could be due to the development of late formed nodules and non-decaying of existing nodules.

Table I: Effect of Salt Stress on nodule initiation and dry weight of nodules of Chickpea

<table>
<thead>
<tr>
<th>Days after sowing (DAS)</th>
<th>Control</th>
<th>Salinity ds/m</th>
<th>C.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NaCl</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>at</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>7.5</td>
<td>10</td>
</tr>
<tr>
<td><strong>Nodule initiation (DAS)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>49</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>75</td>
<td>393</td>
<td>39</td>
<td>22</td>
</tr>
<tr>
<td>125</td>
<td>761</td>
<td>254</td>
<td>193</td>
</tr>
<tr>
<td>150</td>
<td>791</td>
<td>587</td>
<td>430</td>
</tr>
<tr>
<td></td>
<td></td>
<td>588</td>
<td>575</td>
</tr>
</tbody>
</table>

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under sand culture conditions. This fact was also supported by the finding of Siddiqui et al. (1985). Salinity reduced nodulation by effecting the survival, growth and infection ability of even the efficient Rhizobia. Yadav and Vyas (1971) showed variable adverse responses of salts on different Rhizobium species.

Balasubramanian and Sinha (1976, a & 1976, b) also observed that salinity interfered with the nodule initiation in chickpea, cowpea and mungbeans and also caused a reduction in number, weight as well as nitrogen fixing efficiency of nodules.

Salinity also caused a significant decrease in leghaemoglobin content as compared with control upto 125 DAS beyond which the reduction was marginal (Figure 1). Maximum leghaemoglobin content was observed at 75 DAS which

Fig. 1. Effect of NaCl and Na2SO4 on leghaemoglobin content of nodules of Chickpea at different growth stages
decreased with the ageing of nodules probably because of irreversible oxidation of leghaemoglobin (Swaraj and Garg 1977). Sulphate salinity showed slightly higher leghaemoglobin in nodules than chloride, during early stage at lower levels of stress. Siddiqui et al. (1985) also observed an adverse effects of salinity on leghaemoglobin content and nitrogen fixing efficiency of pea nodules.

Increasing salinity led to a significant reduction in number as well as weight of pods/plant over unstresed control. Sulphate salinity at 5 d S/m though produced 16.8 per cent more pods per plant than that of chloride counterpart but the difference was non-significant (Table II). Raising salinity from 5 d S/m to 10 d S/m registered a reduction of 48.8 and 45.3 per cent in pod weight under chloride and sulphate salinity respectively.

Seed and biological yields decreased significantly with increase in the levels of salinity. Seed yield reduction of 83.7 and 82.6 per cent over control was observed with 10 d S/m of sodium chloride and sodium sulphate respectively. Unlike seed yield, podshell weight was progressively higher under salinity treatments. This clearly indicated that salinity restricted the mobilization of dry matter to seeds. This fact was further substantiated by the lower 100 seed weight observed under saline treatments in the present study.

Reduction in growth, dry matter production and yield under saline conditions was also reported by a number of workers (Imamba, 1973, Balasubramanian and

Table II: Effect of Salt Stress on yield and yield attributes of Chickpea at harvest

<table>
<thead>
<tr>
<th>Plant Characters (Per plant basis)</th>
<th>Control</th>
<th>Salinity d S/m</th>
<th>C.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NaCl 5 7.5 10</td>
<td>NaSO₄ 5 7.5 10</td>
</tr>
<tr>
<td>Number of pods</td>
<td>64.5</td>
<td>35.8 34.0 34.0</td>
<td>34.8 34.8</td>
</tr>
<tr>
<td>Dry weight of pods-g.</td>
<td>6.03</td>
<td>5.23 4.40 2.68</td>
<td>4.95 4.28 2.71</td>
</tr>
<tr>
<td>Seed yield-g.</td>
<td>5.63</td>
<td>4.29 2.55 0.92</td>
<td>4.39 2.60 0.98</td>
</tr>
<tr>
<td>Podshell weight-g.</td>
<td>0.40</td>
<td>0.94 1.85 1.76</td>
<td>0.56 1.68 1.73</td>
</tr>
<tr>
<td>100 seed weight-g.</td>
<td>14.05</td>
<td>13.66 12.31 10.10</td>
<td>13.86 13.48 11.07</td>
</tr>
<tr>
<td>Biological yield-g.</td>
<td>16.85</td>
<td>10.89 8.52 5.02</td>
<td>10.52 8.02 5.22</td>
</tr>
<tr>
<td>Harvest index-%</td>
<td>33.4</td>
<td>39.4 29.9 18.3</td>
<td>41.7 32.4 18.8</td>
</tr>
</tbody>
</table>
Sinha, 1976a and Siddiqui and Kumar, 1985). Salt stress at 5 d S/m resulted in higher harvest index as compared to control. This is because of relatively greater reduction in biological yield as compared to seed yield as affected by substrate salinity (Table II). However, at higher stress levels a progressive decrease in harvest index was noticed under both types of salinity.

Salinity created by either of the salts also decreased total plant nitrogen. This decrease was more drastic at 10 d S/m (Figure-2). Partitioning of total plant nitrogen into different plant parts at maturity, indicated that major fractions of the nitrogen accumulated mainly into seeds and leaves irrespective of salt treatments (Figure-2).

Fig. 2. Effect of NaCl and Na₂SO₄ salinity on percent partitioning of total plant nitrogen in different plant parts of chickpea
Per cent nitrogen in leaves showed a slight decrease up to 7.5 d S/m whereas an increased accumulation was observed at 10 d S/m. Of the total nitrogen fixed by the nodules, nearly 37-50 per cent was partitioned into pods (Seed + Podshell) under various treatments. With increase in salinity beyond 5 d S/m a progressive decline in the partitioning of pod nitrogen into seeds was observed leaving more and more nitrogen into the podshells itself. It clearly indicates for a poor demands of nitrogen by the developing seeds probably because of their restricted development at higher levels of salinity (Table II). This also substantiates the observed accumulation of nitrogen in leaves at 10 d S/m salinity level.

Salt stress also induced accumulation of nitrogen into nodules indicating some probable impedance in normal outward movement of fixed nitrogen from the nodule. Such restrictions were also noticed to some extent in roots but not in stem. Minimum nitrogen partitioning was recorded in stem under all the salt treatments (Figure 2.).

Salinity induced disturbed nitrogen fixation and its poor partitioning into seeds alongwith other possible metabolites probably led to a significant reduction in chickpea yield under salt stress conditions. The overall response of both types of salinity was almost at par suggesting that their harmful effects were primarily due to the excess of sodium rather than the variability in accompanying anions at least in chickpea. However, salinity responses are much more complicated which needs further innovations.

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