Effect of saline and saline-sodic soils on soil *Rhizobium* population and yield of soybean

BHAKTI Y. SHEWALE, SWATI D. SHINDE, P.P. KADU AND V.A. JADHAV

**SUMMARY**

A pot culture experiment was conducted to study the effect of saline and saline-sodic soils on *Rhizobium* population and its influence on growth and yield of soybean during Kharif-2008, in the Department of Soil Science and Agricultural Chemistry at Mahatma Phule Krishi Vidyapeeth, Rahuri. The maximum rhizobial population and root nodulation was observed in normal soil with low pH and lower salt concentration. The pH of this soil was observed to be favourable for the microbial growth. The soil rhizobial population was lower in saline soil than the normal soil due to increased pH and high salt concentration. A significant increase in yield was also observed by *Bradyrhizobium* seed inoculation in saline-sodic soils over the uninoculated treatment.


**KEY WORDS:** Salinity, *Bradyrhizobium* inoculation, Soybean, Saline-sodic soil, Salt concentration

Soybean [*Glycine max* (L.) Merrill] is one of the most versatile crop yielding oil and protein across a wide range of the environmental conditions.

In India area under soybean was 7.17 million ha, with production and productivity of 8.27 MT and 1073 kg ha\(^{-1}\), respectively. In Maharashtra area under soybean was 2.34 million ha with production and productivity of 2.52 MT and 1077 kg ha\(^{-1}\), respectively (Anonymous, 2006).

The role of legumes in improving soil fertility was known much earlier, however, the main responsible bacteria for N fixation *Rhizobium* was isolated and identified later. Presently there are more than seven known cross inoculation groups, based on host specification. The taxonomy of root and stem nodulation bacteria is now in a state of transition. The latest system of classification (Jordan, 1984) divides root nodule bacteria into two genera *Rhizobium* and *Bradyrhizobium*, based on mole per cent G + C values in DNA, numerical taxonomy, serological relationships and other characteristics.

The soil properties largely influence the rhizobial population, root nodulation, which significantly reduce the soybean yields.

**EXPERIMENTAL METHODS**

A pot culture experiment was conducted with three different soils having varying soil reactions. Soybean was grown as a test crop in pot culture experiment and the effect of varying soil properties on *Rhizobium* population were studied under green house condition during Kharif 2008 at the Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri.

Three different soils namely normal soil of order Vertic Haplustept, saline soil of order Lithic Haplaquent and saline-sodic soil of order Vertic Halaquept were collected for pot culture experiment.

The experiment was conducted in a Factorial Completely Randomized Block Design with four replications. Each replication consisted of three soil types. Each soil type consisted of two sub-treatments *i.e.*
Soybean seed was coated with moist Rhizobium biofertilizer and dried for one hour in shed and was used for sowing. One pot of each soil was sown with Bradyrhizobium treated seed and one pot of each soil was sown with Bradyrhizobium untreated seed. Separate pots in each treatment were kept for periodical sampling at 30 DAS and 45 DAS for nodule count. Soil rhizobial population was enumerated by serial dilution technique (Chhonkar et al., 2007). The initial soil rhizobial count was 5 x 10^3/g of soil, 3 x 10^4/g of soil, 2 x 10^4/g of soil in normal, saline and saline-sodic soil, respectively. The grain yield was recorded after harvest.

**EXPERIMENTAL FINDINGS AND ANALYSIS**

The results obtained from the present investigation as well as relevant discussion have been presented under following heads:

**Rhizobial population at 30 DAS:**

The soil rhizobial population was observed to be 9.75 x 10^4/g of soil in the normal soil with Bradyrhizobium seed inoculation treatment, which was higher than the uninoculated treatment in normal soil 6.00 x 10^4/g of soil and was also higher than seed inoculated treatment in saline and saline-sodic soils. An increased in soil rhizobial population up to the tune of 62.5 per cent in Bradyrhizobium seed inoculation treatment over uninoculated treatment (Table 1).

**Rhizobial population at 45 DAS:**

The highest soil rhizobial population was observed in the normal soil with Bradyrhizobium seed inoculation treatment (14.50 x 10^4/g of soil) than the uninoculated treatment in normal soil (8.75 x 10^4/g of soil). The per cent increased over uninoculated was observed to be 65.71 per cent in Bradyrhizobium inoculated treatment. In saline soil with Bradyrhizobium seed inoculation treatments, the rhizobial population was observed to be more (9.50 x 10^4/g of soil) than uninoculated treatment in saline soil (6.50 x 10^4/g of soil). An increased in soil rhizobial population up to a tune of 46.1 per cent in Bradyrhizobium inoculated treatment over uninoculated treatment was observed. In saline-sodic soil the soil rhizobial population was found to be lower than saline soil and the normal soil in both inoculated and uninoculated treatments. However, the rhizobial population was higher (5.50 x 10^4/g of soil) in seed inoculated treatment than the uninoculated treatment than the uninoculated treatment (4.00 x 10^4/g of soil). The per cent increase over uninoculated treatment was observed to be 37.5 per cent in Bradyrhizobium inoculated treatment (Table 1).

It is clear that the soil rhizobial count was observed to be highest (14.50 x 10^4/g of soil) in normal soil, followed by 9.50 x 10^4/g of soil in saline soil and 5.50 x 10^4/g of soil in saline-sodic soil in Bradyrhizobium seed inoculation treatments. Herridge et al. (1984) also observed a substantial soil rhizosphere rhizobial population at 14 DAS of soybean inoculated with Bradyrhizobium treatment and recorded maximum soil rhizobial population at 45 DAS growth stage i.e. flowering stage. The soil rhizobial population in this study was also observed to be highest at 45 DAS growth stage.

**Soil rhizobial population at harvest:**

A decline in soil rhizobial population (Table 1), was observed at harvest stage i.e. 11.25, 7.50 and 5.25 x 10^4/g of soil in treated and 7.00, 5.00 and 3.25 x 10^4/g of soil in uninoculated treatment in normal, saline and saline – sodic soils, respectively. This decline in soil rhizobial population at harvest may be attributed to the shrinkage of the root nodules at harvest leading to death of soil rhizobia. Gaikwad (2008) observed an increasing trend in soil rhizobial population from 30 DAS and was highest at 45 DAS. He also observed a decline in soil rhizobial population at harvest. These observations corroborate with the findings of this investigation. Increased salinity was negatively correlated with soil rhizobial population (Mensah et al., 2006). He observed that bacteria preferred low salt concentrations for growth and grew

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatments</th>
<th>Rhizobial population (x 10^4/g soil)</th>
<th>Rhizobial population (x 10^4/g soil)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>30 DAS</td>
<td>45 DAS</td>
</tr>
<tr>
<td>1.</td>
<td>Normal soil (Bradyrhizobium untreated)</td>
<td>6.00</td>
<td>8.75</td>
</tr>
<tr>
<td>2.</td>
<td>Normal soil (Bradyrhizobium treated)</td>
<td>9.75 (62.5)</td>
<td>14.50 (65.7)</td>
</tr>
<tr>
<td>3.</td>
<td>Saline soil (Bradyrhizobium untreated)</td>
<td>4.75</td>
<td>6.50</td>
</tr>
<tr>
<td>4.</td>
<td>Saline soil (Bradyrhizobium treated)</td>
<td>6.75 (42.1)</td>
<td>9.50 (46.1)</td>
</tr>
<tr>
<td>5.</td>
<td>Saline-sodic soil (Bradyrhizobium untreated)</td>
<td>3.00</td>
<td>4.00</td>
</tr>
<tr>
<td>6.</td>
<td>Saline-sodic soil (Bradyrhizobium treated)</td>
<td>4.50 (50.0)</td>
<td>5.50 (37.5)</td>
</tr>
</tbody>
</table>

Figures in parenthesis denote per cent increase over uninoculated treatment.
heavily with a higher count. These results are in consonance with the observations recorded by Elsheikh and Wood (1989), Elsheikh (1998).

**Bradyrhizobium seed inoculation and soybean yield in different soil type:**

On perusal of the data (Table 2), it was observed that the grain and straw yields of soybean (6.98, 9.20 g plant\(^{-1}\), respectively) increased significantly in the *Bradyrhizobium* inoculated seed treatments in all the three soil types than uninoculated treatment (5.16, 6.78 g plant\(^{-1}\), respectively). An increase in grain yield in *Bradyrhizobium* inoculated treatment was observed to be 35.2 per cent over uninoculated treatment. Similarly, 35.7 per cent increase in straw yield was observed in *Bradyrhizobium* inoculated treatment over uninoculated treatment in all the three soil types.

The highest grain and straw yields (8.33 and 10.49 g plant\(^{-1}\), respectively) were observed in the normal soil (Table 2), followed by saline soil (6.41 and 9.29 g plant\(^{-1}\) grain and straw yield, respectively) and the lowest grain and straw yield were observed in the saline-sodic soil (i.e. 3.47 and 4.20 g plant\(^{-1}\), respectively).

The interaction between soil type and *Bradyrhizobium* seed treatment was statistically significant, indicating that *Bradyrhizobium* seed treatment increased the grain and straw yield irrespective of the soil types. However, the increase in yields were in the order of normal soil > saline soil > saline sodic soil. The increase in grain yield of the *Bradyrhizobium* treated and uninoculated treatments was also observed to be statistically significant. Gawade (2001) and Kalhapure (2003) also observed similar results which corroborate with the findings in this study.

**Saline, saline- sodic soil and soybean yield:**

Salinity usually has a negative impact on plant growth, photosynthesis and demand for nitrogen. Higher, salinity and sodicity deteriorate soil physical condition, which adversely affect the germination and root growth (Table 2). Thus, it resulted in decreased dry matter production. These findings are in close conformity with the findings of Tu (1981), Mensah *et al.* (2006) and Viradiya *et al.* (2008) who reported the grain yield and dry matter production of soybean were adversely affected by soil salinity.

**Table 2:** Grain yield and straw yield of soybean as affected by *Bradyrhizobium* seed inoculation in different soil type

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Soil type</th>
<th>Grain yield (g plant(^{-1}))</th>
<th>Straw yield (g plant(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal soil</td>
<td>Saline soil</td>
<td>Saline-sodic soil</td>
</tr>
<tr>
<td></td>
<td>Normal soil</td>
<td>Saline soil</td>
<td>Saline-sodic soil</td>
</tr>
<tr>
<td>Bradyrhizobium untreated</td>
<td>6.74</td>
<td>5.70</td>
<td>3.05</td>
</tr>
<tr>
<td>Bradyrhizobium treated</td>
<td>9.92</td>
<td>7.13</td>
<td>3.90</td>
</tr>
<tr>
<td>Mean</td>
<td>8.33</td>
<td>6.41</td>
<td>3.47</td>
</tr>
<tr>
<td>A</td>
<td>0.16</td>
<td>0.13</td>
<td>0.23</td>
</tr>
<tr>
<td>B</td>
<td>0.39</td>
<td>0.68</td>
<td>0.64</td>
</tr>
<tr>
<td>A x B</td>
<td>0.48</td>
<td>0.31</td>
<td>0.68</td>
</tr>
</tbody>
</table>

**LITERATURE CITED**


