Impact of Integrated Plant Nutrients on Yield, Quality of Seed and on Soil Health with Soybean

Neena V. Arora

Assistant Professor, Department of Chemistry, Sri Sathya Sai College For Women, Bhopal, INDIA (PIN-462024)
E-mail: ne.arora@rediffmail.com

Abstract

Increasing population & ever growing consumption have made to over exploit natural resources. Continuous application of chemical fertilizers has resulted many hazardous effects. Fertilizer over the year not only reduced the average farm yield but also made crop more susceptible to pest and disease. Looking to the seriousness of these problems there is an urgent need to develop sustainable agriculture, which not only maintain the rate growth along with keeping the soil fertile and productive but also improve quality of product.

In the present investigation an experiment was conducted to study the effect of integrated plant nutrients (inorganic mineral fertilizer along with Biofertilizer) on (a) yield (b) quality of seed and (c) soil health.

Result of these studies indicates that continuous use of chemical fertilizer alone deteriorated the soil health while use of Rhizobium biofertilizer rejuvenates the soil. Judicious application of chemical fertilizer along with the biofertilizer increases the fertility of soil.

Integration of chemical fertilizer along with biofertilizer proved beneficial and economical as it saves about 50% of chemical fertilizer to be used otherwise besides maintenance of soil health.

Key Words: Chemical fertilizer, Rhizobium biofertilizer, soybean, soil health, seed quality.

Introduction

Food security, nutritional security, sustainability and profitability are the main focus of the present and future agriculture development. The world population explosion of 20th century presents human world with one of its most complex challenge - "food" and this challenge is greater in low income countries of the world.
Modern agriculture the outcome of "Green Revolution" has no doubt introduced new technologies and increased productivity but the harmful impact on our environment can’t be neglected. There are indications that the highly productive fertilizer and seed technologies introduced over the past three decades may reach a point of diminishing return (Cassman et al 1999). In spite of the continuous development of the new and improved modern technologies and greater use of chemical fertilizer, yield growth began to slow in the later part of the century (Nambiar and Abrol -1989).

Possible reason of diminishing return from increased chemical fertilizer application in Asia includes-

1. More fertilizers are being used on land with poorer soil or uncertain water supply.
2. There is imbalance in supply of N, P and K.
3. Deficiencies of secondary nutrients and micronutrients are beginning to appear.
4. An overall decrease in soil degradation (Singh and Biswas, 2000).

Looking to the seriousness of these problems there is an urgent need to develop sustainable agriculture, which not only maintain the rate growth along with keeping the soil fertile and productive but also improve quality of the product. The conservation, improvement and management of soil are one of the key to meet the challenges of 21st century.

Integrated plant nutrient management system (IPNMS) could be considered as an important strategy for sustainable agriculture. The scientific integration of mineral fertilizer with organic source of plant nutrients along with biofertilizer is important to sustain yield and soil health (Patil, 2005). An experiment was therefore conducted to study the effect of integrated plant nutrients i.e. Chemical fertilizer (urea) and Rhizobium biofertilizer on (a) yield (b) quality of seed and (c) soil health with Soybean.

**Material and Method**

Experiments were conducted on a commercial field during Kharif season for consecutive four years between 2002-2005 in village Ratibarh of district Bhopal (M.P., India). The soil was clay loam having pH 6.8, organic carbon 0.63%, EC-0.178 mmhos/cum; available nitrogen 52.5 ppm, phosphorous 1.08 ppm and potassium 187 ppm. (Jackson, 1973).

The experiment was laid out in 7.5 X 2.4 m (0.0018 ha) in randomized block design with four replications. Soil cultivation, sowing, weed management, which are not part of the experimental design were identical among all treatments and were performed on similar dates and in a similar manner.

Experiment was designed to compare the effect of biofertilizer in unamended soil and in soil fertilized with different level of chemical fertilizer on yield, quality of seed and on soil health with Soybean (Somasegaran and Hoben 1994).

Following treatments were applied to the experimental plots:-

1. Soil only –Control (No NPK; No Rhizobium biofertilizer)
Impact of Integrated Plant Nutrients on Yield

(2) Soil + Recommended dose of nitrogen fertilizer (N\textsubscript{100})
(3) Soil + N\textsubscript{100} + Rhizobium biofertilizer (N\textsubscript{100} + Rhizobium)
(4) Soil + N\textsubscript{75} + Rhizobium biofertilizer (N\textsubscript{75} + Rhizobium)
(5) Soil + N\textsubscript{50} + Rhizobium biofertilizer (N\textsubscript{50} + Rhizobium)
(6) Soil + N\textsubscript{25} + Rhizobium biofertilizer (N\textsubscript{25} + Rhizobium)
(7) Soil + N\textsubscript{0} + Rhizobium biofertilizer (N\textsubscript{0} + Rhizobium)

Moist seeds of variety JS-335 were mixed with 2 gm thiram per kg. of seeds. These seeds were then inoculated with effective strain of Rhizobium biofertilizer which was earlier tested for pH & salinity tolerance. Recommended dose 25:50:30 kg/ha of N: P: K was used. Seed were planted at approximately 35 seeds per meter of row in a depth of 2.5-3.0 cm. Thinning was done evenly to 27 plants per meter. After 90 days of sowing harvesting was done & soil samples were collected from each plot and analyzed for organic carbon content and available nitrogen (Jackson, 1973). Seeds were collected form the pods after 1 week of harvesting and their yield was noted. The quality of seeds was tested by their total % oil content and total % protein content by AOAC standard method of analysis. Results of the present investigations are summarized in table 1.1, 1.2, 1.3 for yield, quality of seeds and soil health respectively.

**Result & Discussion**

**Yield**

Data in table 1.1 reveals that

The decrease in yield from year 2002 to 2005 was found in treatment having recommended dose of chemical fertilizer alone. This may be due to decrease in microbial activity of soil & more depletion in micronutrient (Kumar. and Yadav-2005). Maximum increase in average yield over control was found in treatment N\textsubscript{50} + Rhizobium followed by N\textsubscript{75} + Rhizobium and N\textsubscript{100} + Rhizobium. This may be due to efficient nitrogen fixation between legume- Rhizobium symbiosis. It has been reported that both mineral nitrogen and fixed nitrogen are essential for maximizing nitrogen accumulation and yield in legumes. (Harper, 1974; George and Singleton, 1992; Yinbo et al 1997). The significant improvement in growth and yield attributes of treatment having integrated plant nutrient may be due to slow and prolonged availability of plant nutrient (Singh et al -2002).
**Table 1.1:** Effect of different combination of Urea & Biofertilizer on grain yield of JS-335 during Kharif season from 2002-2005.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Treatment</th>
<th>Yield (q/ha)</th>
<th>Average (q/ha)</th>
<th>% increase over control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2002</td>
<td>2003</td>
<td>2004</td>
</tr>
<tr>
<td>T1</td>
<td>Control</td>
<td>10.18</td>
<td>9.67</td>
<td>9.23</td>
</tr>
<tr>
<td>T2</td>
<td>N&lt;sub&gt;100&lt;/sub&gt;</td>
<td>14.88</td>
<td>14.13</td>
<td>13.54</td>
</tr>
<tr>
<td>T3</td>
<td>N&lt;sub&gt;100&lt;/sub&gt;+Rhizobium</td>
<td>15.23</td>
<td>14.62</td>
<td>13.76</td>
</tr>
<tr>
<td>T4</td>
<td>N&lt;sub&gt;75&lt;/sub&gt;+Rhizobium</td>
<td>15.16</td>
<td>14.75</td>
<td>13.90</td>
</tr>
<tr>
<td>T5</td>
<td>N&lt;sub&gt;50&lt;/sub&gt;+Rhizobium</td>
<td>15.44</td>
<td>14.98</td>
<td>15.11</td>
</tr>
<tr>
<td>T6</td>
<td>N&lt;sub&gt;25&lt;/sub&gt;+Rhizobium</td>
<td>13.52</td>
<td>12.65</td>
<td>12.14</td>
</tr>
<tr>
<td>T7</td>
<td>N&lt;sub&gt;0&lt;/sub&gt;+Rhizobium</td>
<td>12.23</td>
<td>11.63</td>
<td>10.14</td>
</tr>
</tbody>
</table>

Data are mean of four replicates.
Recommended dose of N-25 kg/ha.

---

**Figure 1**

*Effect of different combination of Urea & Biofertilizer on grain yield of Soybean JS-335 during Kharif season 2002-2005.*
Quality of Seed
Table 1.2 reveals that quality of seeds was improved due to the application of integrated plant nutrients. 6.3% to 16.91% increase in total oil content and 10.20% to 15.66% increase in total protein content over control was observed due to the application of different combination of fertilizers. Maximum increase in total percent oil content and total percent protein content was found with N50 + Rhizobium treatment due to proper nutrient supply and effective symbiosis. It has been reported that application of Rhizobium increased the number of nodule/plant, plant height, number of pods/plant, seed yield, seed weight, oil and protein content (Yazdi & zali-1978) which is confirmed with the present findings. Amruthavali and Reddy (2000), Pragathi et al (2004) also reported increase in oil content of sunflower due to application of biofertilizer.

Table 1.2: Effect of different combination of inorganic chemical fertilizer & Rhizobium biofertilizer on % protein content & % Oil content in seeds in year 2005.

<table>
<thead>
<tr>
<th>No.</th>
<th>Treatment</th>
<th>Total Protein Content (%)</th>
<th>% increase over control</th>
<th>Total Oil content (%)</th>
<th>% increase over content</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Control</td>
<td>38.42</td>
<td>-</td>
<td>18.62</td>
<td>-</td>
</tr>
<tr>
<td>T2</td>
<td>N100</td>
<td>42.34</td>
<td>10.20</td>
<td>19.82</td>
<td>6.44</td>
</tr>
<tr>
<td>T3</td>
<td>N100+Rhizobium</td>
<td>43.16</td>
<td>12.33</td>
<td>20.75</td>
<td>11.43</td>
</tr>
<tr>
<td>T4</td>
<td>N75+Rhizobium</td>
<td>43.90</td>
<td>14.26</td>
<td>21.48</td>
<td>15.35</td>
</tr>
<tr>
<td>T5</td>
<td>N50+Rhizobium</td>
<td>44.44</td>
<td>15.66</td>
<td>21.77</td>
<td>16.91</td>
</tr>
<tr>
<td>T6</td>
<td>N25+Rhizobium</td>
<td>43.81</td>
<td>14.01</td>
<td>21.22</td>
<td>13.96</td>
</tr>
<tr>
<td>T7</td>
<td>N0+Rhizobium</td>
<td>42.63</td>
<td>10.95</td>
<td>20.86</td>
<td>12.03</td>
</tr>
</tbody>
</table>

Data are mean of four replicates

Figure 2
Soil health
The perusal of table 1.3 reveals that the highest percentage of organic carbon content was observed with treatment N$_{50}$+ Rhizobium where as the lowest was recorded in control plot. The increase could be attributed to the addition of organic matter and also due to better root growth and more plant residue after harvest of the crop, which indirectly influences the physico-chemical characteristics of soil (Bhandari et al-1992; D.Selvi et al-2003).

![Figure 3](image)

Table 1.3: Soil % organic Carbon content & Available nitrogen after harvesting of JS-335 with IPNS in year 2005.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Treatment</th>
<th>% Organic Carbon content</th>
<th>% increase over Control</th>
<th>Available Nitrogen in soil Mg/100 gm soil</th>
<th>% increase over control</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-1</td>
<td>Control</td>
<td>0.59</td>
<td>-</td>
<td>7.23</td>
<td>-</td>
</tr>
<tr>
<td>T-2</td>
<td>N$_{100}$</td>
<td>0.65</td>
<td>10.16</td>
<td>8.58</td>
<td>18.67</td>
</tr>
<tr>
<td>T-3</td>
<td>N$_{100}$+Rhizobium</td>
<td>0.69</td>
<td>16.94</td>
<td>9.08</td>
<td>25.58</td>
</tr>
<tr>
<td>T-4</td>
<td>N$_{75}$+Rhizobium</td>
<td>0.74</td>
<td>23.72</td>
<td>8.92</td>
<td>23.37</td>
</tr>
<tr>
<td>T-5</td>
<td>N$_{50}$+Rhizobium</td>
<td>0.81</td>
<td>37.28</td>
<td>9.21</td>
<td>27.38</td>
</tr>
<tr>
<td>T-6</td>
<td>N$_{25}$+Rhizobium</td>
<td>0.66</td>
<td>14.86</td>
<td>8.45</td>
<td>16.37</td>
</tr>
<tr>
<td>T-7</td>
<td>N$_{0}$+Rhizobium</td>
<td>0.63</td>
<td>6.77</td>
<td>8.22</td>
<td>13.69</td>
</tr>
</tbody>
</table>

Data are mean of four replicates.
Available nitrogen content was also found maximum with treatment N$_{50}$+ Rhizobium. Efficient nitrogen fixation in legume has been shown to depend upon favourable environment condition of the legume-Rhizobium symbiosis (Childt-1981). It is reported that nitrate supply may either inhibit or stimulate nodule formation and N$_2$ fixation depending on concentration, nitrogen source and stage of development (Streeter -1988; Gan et al -2002). Thus the interaction among mineral nitrogen supply, N$_2$ fixation and plant growth determine the total amount of N$_2$ fixed.

**Conclusion**

On the basis of the results of the present investigations it is concluded that -

1. Continuous application of recommended dose of chemical fertilizer alone deteriorates the soil health.
2. Judicious application of chemical fertilizer along with biofertilizer increases the fertility of soil.
3. Soil deteriorated by continuous application of recommended dose of inorganic nitrogen fertilizer alone can be rejuvenated by the application of integrated plant nutrient.
4. Optimum condition for Soybean - N$_{50}$+ Rhizobium biofertilizer
5. Integration of chemical fertilizer along with biofertilizer proved beneficial and economical as it saves about 50% of chemical fertilizer to be used otherwise besides maintenance of soil health.
6. Soil testing and integrated plant nutrient supply is need of time for food security, nutritional security, profitability and for sustainable agriculture.

**Acknowledgement**

Author is grateful to University grant commission, New-Delhi, India, for the partial financial support to conduct this project & owner of the agriculture farm Mr. O.P. Jhanda for kind help and support.

**References**


[19] Yinbo G., Stuten L., Keulen H.V. and Kuiper P.J.C.,2004, Low concentration of nitrate and ammonium stimulate nodulation and N2 fixation while inhibiting specific nodulation ( nodule DWg -1 root dry weight) and specific N2 fixaton (N2 fixed g-1 root dry weight) in soybean, PI. and soi, 258:281-292.