Influence of microbial bioinoculants on growth and yield attributes of sugarcane

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Abstract
The study was conducted to evaluate the response of sugarcane variety CoC 24 to the application of bioinoculants viz., Gluconoacetobacter diazotrophicus, AM fungi and Azophos (Azospirillum and phosphobacteria), under different levels of N, P, and K inorganic fertilizer in plant and ratoon crop. The results revealed that the application of mycorrhizae, G. diazotrophicus, Azospirillum and phosphobacteria significantly produced higher cane yield in plant crop. The application of Gluconoacetobacter diazotrophicus @ 10 kg + AM fungi + Azophos @ 10 kg + 75 % NPK recorded the maximum germination and tiller population and also maximum mean millable cane population of 1.32 lakhs /ha, cane yield (137.45 t/ha) and sugar yield (16.96 t/ha). Similar results were recorded with the ratoon crop. The applied bacterial sources helps in nitrogen fixation and also in continuous mobilizing and solubilizing of nutrients and their persistence and colonization in soil is an added advantage and also enhances the soil fertility. The usage of these bioinoculants inturn reduces the inorganic fertilizer input and thereby reduces the cost of cultivation.

Keywords: sugarcane: nitrogen fixing bacteria: phosphorous solubilizing: mobilizing: phosphobacteria: am fungi: yield parameters

Introduction
Sugarcane is a very demanding crop as for a cane yield of 100 t/ha it removes about 205 kg N, 55 kg P, 275 kg K and a large amount of micronutrients from soil (Yaduvanshi and Yadav, 1990) [16]. Since its fertilizer consumption is higher than that of other crops it has negative effect on soil health in the long term. In order to sustain productivity major nutrients are provided each year at the recommended application rates of 150 kg/ha of N and 60 kg each of P and K for sugarcane. The efficiency of sugarcane to utilize N range between 16 and 45% as large quantities of applied N leach down through soil layer due to irrigation (Yadav and Prasad, 1992) [15]. Deterioration in the physico-chemical and biological properties of soil is considered to be the prime reason for declining sugarcane yield and productivity. The biofertilizer application increases crop growth through combination of BNF, growth promoting hormonal substances, increased availability of soil nutrients and disease resistance. The importance of biofertilizer lies in the ability to supplement/ mobilize soil nutrients with minimal use of non-renewable resources. Johri (2006) [5] reported that some of the sugarcane varieties have been found to derive up to 70% of their nitrogen requirement through biological nitrogen fixation. Since then various kinds of bacteria such as Gluconoacetobacter diazotrophicus, Herbaspirillum spp., Azospirillum amazonense, Burkholderia spp., capable of fixing nitrogen have been reported to colonize the epidermis of sugarcane stem and roots of which Gluconoacetobacter seems to contribute substantially to nitrogen nutrition of the plant (Dobereiner et al., 1995). G. diazotrophicus a nitrogen fixing endophyte is found in high number in all part of sugarcane (10^5 – 10^6 per g fresh weight) and its better colonization in sugarcane is probably due to this capability to grow in the presence of high sugar and low pH. Besides sugarcane it colonizes many other sugar and non-sugar crops also. Production of plant growth hormones is the other beneficial trait associated with G. diazotrophicus (Sevilla et al., 1998) [13]. Field trials conducted in sugarcane with Gluconoacetobacter diazotrophicus with other diazotrophs can match yield level equal to 275kg N/ha application (Sevilla et al., 2001; Muthukumaraswamy et al., 2002; Oliveria et al., 2002) [12, 8,10].

In India where sugarcane occupies over 4 million /ha, interest in exploitation of such microbes has increased due to an increase in prices of chemical fertilizers following withdrawal of subsidy on them. Concerning the above problems the current study was focused on the use of bioinoculants to enhance the sugarcane growth and also to assess the functional potentials in relation to plant growth promoting activities like IAA, phosphate solubilisation and nitrogenase activity with the following objectives of standardizing the efficient combination of bioinoculants for maximizing sugarcane productivity and exploring the possibility of reduction in inorganic fertilizer input through bioinoculant application.

Materials and Methods
The experiment was conducted for a period of 2 year (2010-2012) at Sugarcane Research Station, Cuddalore with ten treatments with three replications in Randomised Block Design in plant and ratoon crop. The sugarcane variety taken for the study was CoC24. The mean maximum and minimum temperature of the location was 31.7 °C and 24.1 °C respectively. The mean annual rainfall was 1200 mm. The soil of the experimental field was sandy clay loam, with low available N (186.84 kg ha^{-1}), medium in available ‘P’ (16.5 kg ha^{-1}) and medium in available potash (265 kg ha^{-1}). The pH of the soil is 7.2. The bioinoculants viz., G. diazotrophicus, AM fungi and Azophos (Azospirillum and phosphobacteria) was used along with inorganic fertilizer.
Treatment details

Table 1

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Millable cane population ('000/ha)</th>
<th>Cane yield ('000/ha)</th>
<th>CCS%</th>
<th>Sugar yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: G. diazotrophicus + 75 % NPK</td>
<td>120.0</td>
<td>126.12</td>
<td>9.92</td>
<td>12.51</td>
</tr>
<tr>
<td>T2: AM fungi + 75 % NPK</td>
<td>117.2</td>
<td>123.56</td>
<td>7.27</td>
<td>12.01</td>
</tr>
<tr>
<td>T3: Azophos + 75 % NPK</td>
<td>118.7</td>
<td>125.79</td>
<td>9.80</td>
<td>12.33</td>
</tr>
<tr>
<td>T4: G. diazotrophicus + AM fungi (colonized root bits) + 75 % NPK</td>
<td>124.8</td>
<td>131.25</td>
<td>10.34</td>
<td>13.57</td>
</tr>
<tr>
<td>T5: Azophos + G. diazotrophicus + 75 % NPK</td>
<td>123.5</td>
<td>130.55</td>
<td>10.22</td>
<td>13.34</td>
</tr>
<tr>
<td>T6: AM fungi (colonized root bits) + Azophos + 75 % NPK</td>
<td>121.2</td>
<td>129.84</td>
<td>9.95</td>
<td>12.92</td>
</tr>
<tr>
<td>T7: G. diazotrophicus + AM fungi (colonized root bits) + Azophos + 100 % NPK</td>
<td>132.4</td>
<td>137.45</td>
<td>10.70</td>
<td>14.96</td>
</tr>
<tr>
<td>T8: G. diazotrophicus + AM fungi (colonized root bits) + Azophos + 100 % NPK</td>
<td>125.2</td>
<td>133.62</td>
<td>10.50</td>
<td>14.03</td>
</tr>
<tr>
<td>T9: Recommended NPK (100%) alone</td>
<td>120.8</td>
<td>128.19</td>
<td>10.50</td>
<td>12.88</td>
</tr>
<tr>
<td>T10: 75% of recommended NPK alone</td>
<td>95.70</td>
<td>107.15</td>
<td>10.05</td>
<td>10.52</td>
</tr>
<tr>
<td>Mean</td>
<td>119.95</td>
<td>127.352</td>
<td>10.17</td>
<td>12.907</td>
</tr>
<tr>
<td>SEd</td>
<td>4.21</td>
<td>3.55</td>
<td>0.99</td>
<td>0.68</td>
</tr>
<tr>
<td>CD</td>
<td>8.47</td>
<td>7.14</td>
<td>NS</td>
<td>1.38</td>
</tr>
</tbody>
</table>

The CCS% and sugar yield also recorded maximum with 10.7% and 16.96 t/ha respectively with the application of G. diazotrophicus @ 10 kg/ha + AM fungi @ 25 kg/ha + Azophos @ 10 kg/ha + 75% of the recommended NPK (Table 1). As that of plant crop similar trend was observed with ratoon crop with maximum millable cane population of 1.22 lakhs/ha in plot treated with G. diazotrophicus @ 10 kg/ha + AM fungi @ 25 kg/ha + Azophos @ 10 kg/ha + 75% of the recommended NPK.

The increase in yield and enhanced quality parameters was due to the combined effect of the bioinoculants along with the inorganic fertilizers. The biofertilizers application enhanced the yield and quality parameters and also essential to maintain soil microflora population and protect soil fertility from deterioration.

Table 2: Effect of combined application of bio inoculants with NPK fertilizers on yield attributes, juice quality, cane and sugar yield in plant crop

Table 3: Effect of combined application of bio inoculants with NPK fertilizers on yield attributes, juice quality, cane and sugar yield in ratoon crop
5. **G. diazotrophicus** + Azophos + 75% NPK | 117.0 | 122.85 | 10.67 | 12.88
6. AM fungi + Azophos + 75% NPK | 115.8 | 122.14 | 10.4 | 12.46
7. **G. diazotrophicus**+ AM fungi + Azophos + 75% NPK | 122.4 | 129.75 | 11.15 | 14.5
8. **G. diazotrophicus**+ AM fungi + Azophos + 100% NPK | 118.2 | 125.92 | 10.95 | 13.57
9. Recommended NPK (100%) alone | 116.5 | 120.49 | 10.95 | 12.42
10. 75% of recommended NPK alone | 89.70 | 99.45 | 10.5 | 10.06

**Conclusion**

The inoculation of bioinoculants is beneficial for sugarcane growth for increasing the plant vigour at lower nitrogen levels, consequently the amount of fertilizer could be reduced. AM fungi and phosphobacteria are very much essential to convert the unavailable form of the phosphorous source to available source and providing to the plants. The usage of these bioinoculants in turn reduces the inorganic fertilizer input and thereby reduces the cost of cultivation. With this references these bioinoculants can be recommended for their use in nutrient management and enhanced sugarcane productivity.

**References**