Pearlmillet is an indispensable rainfed cereal crop of arid and semi-arid regions. The major constraint in crops production is lack in adoption of improved cultivation techniques by majority of farmers (Rajiv, 2014). The chemical fertilizers are quite expensive and the small and marginal farmers are unable to use these fertilizers in required quantities in these moisture deficit areas. Therefore, it is important to explore an alternative to chemical fertilizers that can be used by farmers. It is reported that pearlmillet has a variety of nitrogen fixing bacteria in its rhizosphere, which may release growth promising substances like indole acetic acid, gibberellin and cytokinin. These substances help in increasing root biomass. Wani et al. (1985) reported increase in grain yield and dry matter of pearlmillet and improving the soil fertility due to inoculation. In the light of these observations, an experiment was laid out to know the effect of bio-fertilizers, FYM and nitrogen on pearlmillet growth and yield.

Materials and Methods

A field experiment was conducted during the rainy season (kharif) 2018 and 2019 at Oilseed Research Farm, Kalyanpur, C. S. A. University of Agriculture and Technology, Kanpur, U. P., India.
Treatment comprising two FYM levels (0 and 5t/ha), three nitrogen levels (0, 30 and 60kg/ha) and three bio-fertilizer modes (control, Azospirillum + PSB and Azotobacter + PSB) in randomized block design with three replications. The pearl millet hybrid “Pusa 605” was sown in rows 50 cm apart at 5kg/ha on 06 July in 2018 and 20 July in 2019. The recommended dose of phosphorus (30kg/ha) was applied basally through single super phosphate having 16% P2O5. The nitrogen dose through urea was applied at the time of sowing, as per treatment. The soil of experimental site was sandy loam, having bulk density 1.17 mg/m2, field capacity 9.7% and permanent wilting point 1.65% in surface soil layer (0-15 cm) and pH of soil was 7.2. Data were recorded and analyzed economics as suggested by (Rajiv and Singh, 2014, Rajiv and Singh, 2016).

Results and Discussion

Effect of FYM

Application of FYM significantly increased the plant population, plant height and test weight (table 1). The treatment involving FYM @ 5t/ha proved significantly superior to the control. Manuring the crop with FYM resulted in significantly higher grain and fodder yields of pearl millet than no FYM up to 17.13 and 17.77%, respectively and resulted into higher net returns and benefit: cost ratio of Rs. 12504/ha and 2.13. It may be due to improvement in soil health and build up of soil fertility with the continuous use of FYM thereby better root growth and development and better uptake of the nutrient by the crop plant. These results are in conformity with the findings of (Rajiv and Dabas, 2011, Rajiv and Rathi, 2012; Rajiv and Prakash, 2014b; Rajiv, 2014a; Rajiv et al., 2018) on different crops. Khan et al. (2000) also reported increased efficiency of fertilizer in combination with FYM.

The application of FYM resulted in higher nutrient content of grain and stover coupled with higher yield and more nutrient uptake over control (table 2). These results are in close conformity with those of (Singh and Verma, 1996). The application of FYM had significant effect on the available NPK status of the soil after pearl millet harvest. The increased availability of these nutrients in soil might be due to their subsequent release from FYM. The N, P and K status of the soil after pearl millet harvest was significantly increased 14.5, 20.7 and 12.0% over initial status and 8.7, 22.6 and 5.1% over no FYM treatment. The organic carbon also significantly increased over initial and without FYM application. Rajiv (2014c), Rajiv and Singh (2018) and Singh et al. (2009) also reported similar findings on different crops.

Effect of Nitrogen

Nitrogen treatment significantly affected all the growth and yield attributes and grain yield of pearl millet (table 1). Each successive increase in N levels from the control to the highest dose, recorded significant improvement in yield attributes and grain and fodder yields of pearl millet. The highest N level 60kg/ha recorded significantly highest grain yield (24.2 q/ha), being 41.32% and fodder yield (57.6 q/ha), being 35.76% higher than the control. Increased yields of pearl millet with increasing nitrogen levels might be attributed to significant improvement in the yield attributes. The higher level of 60 kg N/ha recorded the maximum net returns and benefit: cost ratio of Rs. 13470/ha and 2.07 followed by 30 kg N/ha of Rs. 10588/ha and 1.90 and control of Rs. 5808/ha and 1.57. Singh and Agrawal (2004), Rajiv and Kawar (2016), Singh and Rajiv (2008) also observed similar results.

The application of 60 kg N/ha recorded the highest N, P and K uptake of 128.1, 21.7 and 130.0 kg/ha followed by 30 kg N/ha and control (table 2). These findings corroborate the results of (Meena and Gautam, 2005). Available nitrogen of 127.6 kg/ha in soil after 2 years increased significantly due to application of 60 kg N/ha over without nitrogen (108 kg/ha) and initial values. Soil organic carbon and available phosphorus and potassium status remained statistically unaffected by N fertilization, though an increasing trend was observed.

Effect of Bio-fertilizer

Plant population, plant height and test weight significantly increased when combined form of Azospirillum + PSB was inoculated compared with un-inoculated and application of Azotobacter + PSB (table 1). This might be partly owing to their additive effect of nitrogen fixed from the atmosphere and partly owing to synthesis to biologically active substances like vitamins, auxins and gibberellins etc., which in turn might have stimulated the plant growth parameters.
These results are akin to the findings of (Kumar and Gautam, 1992; Rajiv et al., 2014; Rajiv and Prakash, 2014a; Rajiv and Singh, 2017). The grain and fodder yields of pearl millet increased significantly with inoculation of bio-fertilizers and maximum grain yield was recorded with the combined inoculation of Azospirillum + PSB in comparison to un-inoculated and application of Azotobacter + PSB (Table 1). The increase was 19.82% over un-inoculated. The increase in yield might have resulted from the growth regulating substances produced by combined application of bio-fertilizers besides fixation of additional nitrogen from atmosphere, thereby, increasing the nitrogen availability in the soil throughout the crop growth. Meena and Gautam (2005) also reported the similar findings. Net returns (Rs. 8984/ha) and benefit: cost ratios (1.88) were lowest in control treatment (Table 1). Application of Azospirillum + PSB increased the net returns (Rs. 16604/ha) and benefit: cost ratio (2.59) considerably and were highest followed by Azotobacter + PSB treatment of net returns (Rs. 12384/ha) and benefit: cost ratio (1.92). Rajiv and Dabbas (2012), Rajiv (2014b) and Rajiv (2015) have reported almost similar results on different crops earlier.

Table 1. Growth and yield attributes, yields and economics as affected by fertilizers management practices in pearl millet (pooled data over 2 years)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant Population</th>
<th>Plant Height (cm)</th>
<th>Test Weight (g)</th>
<th>Grain Yield (q/ha)</th>
<th>Fodder Yield (q/ha)</th>
<th>Net Returns (Rs/ha)</th>
<th>Benefit: Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>FYM (q/ha)</td>
<td></td>
<td></td>
<td></td>
<td>2018</td>
<td>2019</td>
<td>Pooled</td>
<td>2018</td>
</tr>
<tr>
<td>F0</td>
<td>132</td>
<td>172</td>
<td>9.1</td>
<td>10.5</td>
<td>25.3</td>
<td>17.9</td>
<td>23.9</td>
</tr>
<tr>
<td>F5</td>
<td>137</td>
<td>180</td>
<td>10.1</td>
<td>13.7</td>
<td>29.5</td>
<td>21.6</td>
<td>33.7</td>
</tr>
<tr>
<td>CD(P=0.05)</td>
<td>4.1</td>
<td>5.2</td>
<td>0.5</td>
<td>0.9</td>
<td>1.8</td>
<td>1.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Nitrogen Levels (kg/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N0</td>
<td>132</td>
<td>170</td>
<td>9.4</td>
<td>10.7</td>
<td>18.0</td>
<td>14.4</td>
<td>25.5</td>
</tr>
<tr>
<td>N30</td>
<td>135</td>
<td>177</td>
<td>9.7</td>
<td>12.1</td>
<td>29.1</td>
<td>20.6</td>
<td>28.6</td>
</tr>
<tr>
<td>N60</td>
<td>137</td>
<td>182</td>
<td>9.8</td>
<td>13.4</td>
<td>35.0</td>
<td>24.2</td>
<td>32.3</td>
</tr>
<tr>
<td>CD(P=0.05)</td>
<td>1.8</td>
<td>3.8</td>
<td>0.2</td>
<td>0.6</td>
<td>1.2</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td>Bio-fertilizers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B0</td>
<td>132</td>
<td>172</td>
<td>9.4</td>
<td>10.9</td>
<td>23.9</td>
<td>17.4</td>
<td>26.4</td>
</tr>
<tr>
<td>B1</td>
<td>137</td>
<td>179</td>
<td>9.7</td>
<td>13.1</td>
<td>30.2</td>
<td>21.7</td>
<td>28.7</td>
</tr>
<tr>
<td>B5</td>
<td>134</td>
<td>177</td>
<td>9.6</td>
<td>12.2</td>
<td>28.1</td>
<td>21.2</td>
<td>26.3</td>
</tr>
<tr>
<td>CD(P=0.05)</td>
<td>1.9</td>
<td>2.0</td>
<td>0.2</td>
<td>0.8</td>
<td>1.9</td>
<td>0.4</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Table 2. Effect of FYM, nitrogen and bio-fertilizer on nitrogen, phosphorus and potassium uptake, organic carbon and available nitrogen, phosphorus and potassium in soil after crop harvest in pearl millet (pooled data over 2 years)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total Uptake of N (kg/ha)</th>
<th>Total Uptake of P (kg/ha)</th>
<th>Total Uptake of K (kg/ha)</th>
<th>Organic Carbon (%)</th>
<th>Available N (kg/ha)</th>
<th>Available P (kg/ha)</th>
<th>Available K (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FYM (q/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F0</td>
<td>75.2</td>
<td>14.9</td>
<td>94.5</td>
<td>0.32</td>
<td>112.8</td>
<td>12.7</td>
<td>212.4</td>
</tr>
<tr>
<td>F5</td>
<td>108.2</td>
<td>17.0</td>
<td>122.3</td>
<td>0.39</td>
<td>123.6</td>
<td>16.4</td>
<td>223.8</td>
</tr>
<tr>
<td>CD(P=0.05)</td>
<td>6.4</td>
<td></td>
<td></td>
<td>0.05</td>
<td>6.7</td>
<td>1.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Nitrogen Levels (kg/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N0</td>
<td>73.1</td>
<td>13.6</td>
<td>93.6</td>
<td>0.32</td>
<td>108.0</td>
<td>13.4</td>
<td>199.2</td>
</tr>
<tr>
<td>N30</td>
<td>117.4</td>
<td>17.9</td>
<td>122.2</td>
<td>0.35</td>
<td>121.1</td>
<td>14.0</td>
<td>220.5</td>
</tr>
<tr>
<td>N60</td>
<td>128.1</td>
<td>21.7</td>
<td>130.0</td>
<td>0.37</td>
<td>127.6</td>
<td>14.1</td>
<td>220.7</td>
</tr>
<tr>
<td>CD(P=0.05)</td>
<td>7.3</td>
<td></td>
<td></td>
<td>0.33</td>
<td>4.3</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Bio-fertilizers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B0</td>
<td>74.7</td>
<td>14.0</td>
<td>95.6</td>
<td>0.31</td>
<td>102.6</td>
<td>11.4</td>
<td>195.8</td>
</tr>
<tr>
<td>B1</td>
<td>121.4</td>
<td>20.3</td>
<td>134.2</td>
<td>0.36</td>
<td>120.0</td>
<td>15.6</td>
<td>219.8</td>
</tr>
<tr>
<td>B5</td>
<td>123.7</td>
<td>21.3</td>
<td>135.5</td>
<td>0.35</td>
<td>122.0</td>
<td>16.2</td>
<td>222.4</td>
</tr>
<tr>
<td>CD(P=0.05)</td>
<td>2.5</td>
<td></td>
<td></td>
<td>0.02</td>
<td>2.8</td>
<td>0.9</td>
<td>3.5</td>
</tr>
</tbody>
</table>
Enhanced nutrient uptake (NPK) was observed with bio-fertilizers (table 2) and a higher N and P uptake under co-inoculation of bio-fertilizers (Azospirillum + PSB at par with Azotobacter + PSB) over un-inoculation (control) might be attributed to enhanced nitrogenase and nitrate-reductase enzyme activities in soil leading to more biological N fixation by Rhizobium and increased availability of P in soil due to greater solubilization. Similarly, K uptake was greatly improved under bio-fertilizers and indicated its need for higher vegetative growth and seed formation. The results are in agreement with the findings of (Rathore et al., 2006).

Bio-fertilizers markedly increased the soil available N, P and K and indicated the buildup of these nutrients in post-harvest soil. Combined inoculation of Azotobacter and phosphate solubilizing bacteria registered higher soil available N, P and K and the increase was 15.9, 29.8 and 12.0% whereas, in combination of Azospirillum and phosphate solubilizing bacteria increase was 14.5, 26.9 and 10.9% over control. There was no significant difference between Azotobacter + PSB and Azospirillum + PSB application. In case of organic carbon available in soil, the similar trend was also observed.

References


Rajiv and Rathi, P. K. (2012) Impact of improved technologies on the productivity and economics of sesame (Sesamum indicum) at farmer’s field in Fatehpur district of Uttar Pradesh, International Journal of Agricultural Sciences, 8(1): 147-149.


