Influence of NPK, N Fixing Bacteria and Antioxidants on Growth, Seed and Guaran Yield and Chemical Composition of Guar Plants

Farouk S.B. Badran, Omar A. Omar, Ragaa A. Taha and Nora M. Kamal

Abstract: This trial was carried out during the two successive seasons 2010 and 2011 at the experimental farm, Faculty of Agriculture, Minia University to explore the response of guar (Cyamopsis tetragonoloba) plants to mineral NPK, N fixing bacteria and antioxidant treatments. The partial replacement of mineral NPK, at different degrees, by N fixing bacteria, gave reasonable vegetative growth traits (plant height, branch number and herb dry weight), number of pods/ plant and seed yield per plant and fed, guaran yield per plant and fed, photosynthetic pigments and N, P and K % in the herb, especially the treatment of 75% NPK+ N-fixing bacteria. Concerning antioxidants, salicylic acid followed by ascorbic acid each at 200 ppm caused remarkable enhancement in all of the previous studied characters. However, the use of 25% NPK+ N fixing bacteria in combination with ascorbic acid at 200 ppm or salicylic acid at 200 ppm gave equal or better growth and yield of seeds and guaran values than those given by the recommended mineral NPK fertilization.

Key words: Cyamopsis tetragonoloba • Guar • NPK • Bradyrhizobium japonicum • Antioxidant

INTRODUCTION

Guar (Cyamopsis tetragonoloba, L. Taub.) is a drought resistant annual herb. It is considered as an agricultural crop in India and Pakistan, where it has been used for food and animal fodder. It is adapted well to arid and semi-arid climates and considered as one of the most important sources of mucilage, which makes special type of gum, used in industry and pharmaceutical preparations. Guar seeds contain about 34% protein, 23 % gum and 40 % fixed oil.

In Egypt, chemical fertilizers are heavily used to maintain soil fertility and ensure high crop productivity; however, recent documentation of adverse effects of chemical fertilizers emphasizes the importance of developing new production methods that are sustainable agriculturally, economically and environmentally.

So, the present study was planned to substitute some amounts of NPK chemical fertilizers by N-fixing bacteria and some antioxidant treatments in producing safer and less expensive vegetative growth and seed and guaran yield of guar plants under the environmental conditions of Minia Governorate.

Many authors observed that growth, seed yield, guaran production and/ or chemical composition of guar plants were enhanced due to NPK fertilization [1-8]. Meanwhile, the effectiveness of N-fixing bacteria products was revealed on guar [2, 3, 7, 9]; fennel [10, 11]; caraway [12] and Nigella sativa [13]. In addition, the efficiency of antioxidants was found by Deore and Bharud [14] and Mohamed and Naguib [15] on fenugreek, Tanious [16] on fennel, Helmy [17] on Nigella sativa and Badran et al. [17, 18] on coriander.

MATERIALS AND METHODS

The present study was carried out during two successive seasons 2010 and 2011 at the experimental farm and the laboratory of Faculty of Agriculture, Minia University to explore the influence of chemical and bio-fertilizers, as well as, antioxidant treatments on growth, yield, guaran and chemical composition of guar (Cyamopsis tetragonoloba, L. Taub.) plants.

The seeds were sown on April 12th and April 15th for the two successive seasons in 3x2 m plots. Each plot contained 3 rows, 60 cm apart, with 6 hills (50 cm apart)
### Table 1: Physical and chemical analysis of the soil

<table>
<thead>
<tr>
<th></th>
<th>Sand (%)</th>
<th>Silt (%)</th>
<th>Clay (%)</th>
<th>Soil type</th>
<th>Org. matter (%)</th>
<th>CaCO₃ (%)</th>
<th>pH (1:2.5)</th>
<th>E.C. (mmhos/cm)</th>
<th>DTPA Ext. (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>28.20</td>
<td>30.70</td>
<td>41.10</td>
<td>Clay loam</td>
<td>1.62</td>
<td>2.09</td>
<td>7.82</td>
<td>1.04</td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td>0.08</td>
<td>0.21</td>
<td>0.17</td>
<td></td>
<td>1.11</td>
<td>1.24</td>
<td>0.34</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>P (%)</td>
<td>15.12</td>
<td>14.12</td>
<td>13.12</td>
<td></td>
<td>1.11</td>
<td>1.24</td>
<td>0.34</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>8.54</td>
<td>8.54</td>
<td>8.54</td>
<td></td>
<td>1.11</td>
<td>1.24</td>
<td>0.34</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td>2.06</td>
<td>2.06</td>
<td>2.06</td>
<td></td>
<td>1.11</td>
<td>1.24</td>
<td>0.34</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Zn</td>
<td>2.75</td>
<td>2.75</td>
<td>2.75</td>
<td></td>
<td>1.11</td>
<td>1.24</td>
<td>0.34</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Mn</td>
<td>8.26</td>
<td>8.26</td>
<td>8.26</td>
<td></td>
<td>1.11</td>
<td>1.24</td>
<td>0.34</td>
<td>0.43</td>
<td></td>
</tr>
</tbody>
</table>

### RESULTS AND DISCUSSION

**Vegetative Growth:** Table 2 showed that the three studied vegetative growth traits, plant height, branch number/ plant and herb dry weight/ plant, were significantly augmented, in both seasons due to all five NPK and/or N- fixing bacteria treatments in comparison with control treatment. Gradual reduction in the values of these traits was obtained due to the gradual decrease in the NPK amount from 100% to zero%. However, no significant differences were existed between 100% NPK and 75% NPK + N- fixing bacteria. The role of NPK in promoting vegetative growth of guar plants was revealed by previous studies [3, 6-8]. While the role of N- fixing bacteria in enhancing the vegetative growth was emphasized by previous studies on guar [3, 7] and on *Nigella sativa* [13].

The use of the two antioxidants, ascorbic acid and salicylic acid at both 100 and 200 ppm, caused significant increase in plant height and branch number and herb dry weight/plant, in the two seasons over those of control treatment (Table 2). The best results were obtained from 200 ppm salicylic or ascorbic acids. These results were in agreement with those reported by other studies on fenugreek [14, 15]; fennel [16] and on coriander [18].

The interaction between NPK, N fixing bacteria and antioxidant treatments was significant for plant height and herb dry weight/plant with the best results being given by 100% NPK or 75% NPK + N fixing bacteria treatment, while the lowest values were those of N fixing bacteria only. Other researches on guar were in accordance with these results concerning NPK [3, 4, 6, 7] and regarding N biofertilization those of Hussein [3] on guar, Badran and Safwat [11] on fennel and Ahmed [13] on *Nigella sativa*.
Concerning antioxidant treatments, both ascorbic acid and salicylic acid at 100 and 200 ppm resulted, significantly in both seasons, in better results than control treatment. However, the high concentration of ascorbic or salicylic acid gave as much as double seed yield per plant and per feddan as that of control treatment as illustrated in Table 3. These results were insured by other researches [12, 15, 16, 19]. The interaction between fertilization and antioxidant treatments was significant, in both seasons, for seed yield per plant and feddan, with the heaviest yield being given due to the combined treatments 100% NPK or 75% NPK plus N fixing bacteria with salicylic acid at 200 ppm (Table 4).

The interaction between fertilization and antioxidant treatments was significant in the two seasons for guaran yield per plant and feddan with the best results being given due to supplying guar plants with 100% NPK with the supplement of salicylic acid at 200 ppm (Table 4).

Chemical Composition: Tables 5 and 6 declared that the three photosynthetic pigments, chlorophyll a and b and carotenoids contents, as well as, nitrogen, phosphorus and potassium percentage were greatly augmented due to the use of all tested NPK and/or N- fixing bacteria in both seasons. However, the 100 % NPK and 75% NPK plus *Bradyrhizobium japonicum* gave significantly the highest overall values over all other treatments including control for the

### Table 2: Effect of mineral NPK, N fixing bacteria and antioxidant treatments on vegetative growth of guar plants during 2010 and 2011 seasons

<table>
<thead>
<tr>
<th>Antioxidant treatments (ppm)</th>
<th>Plant height (cm)</th>
<th>Number of branches / plant</th>
<th>Herb dry weight / plant (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fertilization Treat. A</strong></td>
<td><strong>Cont.</strong></td>
<td><strong>Asc. 100</strong></td>
<td><strong>Asc. 200</strong></td>
</tr>
<tr>
<td>Control</td>
<td>81</td>
<td>86</td>
<td>94</td>
</tr>
<tr>
<td>100 NPK</td>
<td>102</td>
<td>112</td>
<td>129</td>
</tr>
<tr>
<td>75 NPK + N Fix.</td>
<td>96</td>
<td>112</td>
<td>130</td>
</tr>
<tr>
<td>50 NPK + N Fix.</td>
<td>74</td>
<td>112</td>
<td>129</td>
</tr>
<tr>
<td>25 NPK + N Fix.</td>
<td>92</td>
<td>112</td>
<td>130</td>
</tr>
<tr>
<td>0 NPK + N Fix.</td>
<td>70</td>
<td>112</td>
<td>129</td>
</tr>
<tr>
<td>Mean</td>
<td>92</td>
<td>101</td>
<td>114</td>
</tr>
<tr>
<td>LSD 5 %</td>
<td>A: 5</td>
<td>B: 2</td>
<td>A+B: 5</td>
</tr>
</tbody>
</table>

**Guaran percentage and Yield:** Table 4 showed clearly that guaran % and yield were greatly and significantly augmented, in both seasons, due to the use of any NPK and/or N- biofertilizer treatment. However, the 100% NPK followed by 75% NPK plus *Bradyrhizobium japonicum* treatment overcome all other treatments. The obtained results are on the line with prior studies [1, 2, 4, 9].
### Table 3: Effect of mineral NPK, N fixing bacteria and antioxidant treatments on the yield of guar plants during 2010 and 2011 seasons

<table>
<thead>
<tr>
<th>Antioxidant treatments (ppm)</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of pods/plant</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilization Treat. A</td>
<td>Cont. Asc. 100 Asc. 200 Sal. 100 Sal. 200 Mean Cont. Asc. 100 Asc. 200 Sal. 100 Sal. 200 Mean</td>
</tr>
<tr>
<td>Control</td>
<td>59 82 101 98 109 90 63 86 63 106 101 110 93</td>
</tr>
<tr>
<td>100 NPK</td>
<td>188 207 216 211 218 208 187 211 220 214 214 222 211</td>
</tr>
<tr>
<td>75 NPK + N Fix.</td>
<td>180 204 214 207 216 204 175 204 211 210 201 221 204</td>
</tr>
<tr>
<td>50 NPK + N Fix.</td>
<td>173 191 197 192 197 190 161 194 200 200 203 203 192</td>
</tr>
<tr>
<td>25 NPK + N Fix.</td>
<td>164 172 185 177 187 177 142 176 185 179 191 175</td>
</tr>
<tr>
<td>0 NPK + N Fix.</td>
<td>114 123 138 132 146 131 111 126 143 135 149 133</td>
</tr>
<tr>
<td>Mean</td>
<td>146 163 175 170 179 140 166 178 173 183 183</td>
</tr>
<tr>
<td>LSD 5 %</td>
<td>A: 7 B: 5 A=B: N.S. A: 5 B: 7 A=B: N.S</td>
</tr>
<tr>
<td></td>
<td>Seed weight/ plant(g)</td>
</tr>
<tr>
<td>Control</td>
<td>3.5 6.1 9.9 8.5 11.5 7.9 4.5 7.0 11.5 7.8 11.8 8.5</td>
</tr>
<tr>
<td>100 NPK</td>
<td>36.1 48.6 73.9 57.4 93.2 61.8 40.0 62.5 92.5 68.3 103.4 73.3</td>
</tr>
<tr>
<td>75 NPK + N Fix.</td>
<td>31.0 41.5 67.4 50.0 88.1 55.6 33.8 55.5 75.2 61.8 97.4 64.7</td>
</tr>
<tr>
<td>50 NPK + N Fix.</td>
<td>26.3 36.1 55.2 41.3 59.6 43.7 27.0 46.7 65.3 53.4 77.5 54.0</td>
</tr>
<tr>
<td>25 NPK + N Fix.</td>
<td>15.9 22.7 40.0 26.3 45.8 30.1 14.1 22.3 38.3 24.8 43.1 28.5</td>
</tr>
<tr>
<td>0 NPK + N Fix.</td>
<td>7.9 10.0 17.0 12.4 18.9 13.2 9.5 12.4 19.4 14.3 23.7 15.8</td>
</tr>
<tr>
<td>Mean</td>
<td>20.1 27.5 43.9 32.6 52.8 21.5 34.4 50.3 38.4 59.5 59.5</td>
</tr>
<tr>
<td>LSD 5 %</td>
<td>A: 3.3 B: 2.1 A=B: 5.1 A: 5.2 B: 3.5 A=B: 8.6</td>
</tr>
<tr>
<td></td>
<td>Seed yield/ fed( kg )</td>
</tr>
<tr>
<td>Control</td>
<td>42 73 122 102 138 95 52 84 138 108 155 107</td>
</tr>
<tr>
<td>100 NPK</td>
<td>433 583 887 689 1118 743 480 750 902 852 1276 852</td>
</tr>
<tr>
<td>75 NPK + N Fix.</td>
<td>372 498 718 600 1053 648 406 666 866 742 1168 770</td>
</tr>
<tr>
<td>50 NPK + N Fix.</td>
<td>316 434 662 514 863 558 340 561 784 640 969 659</td>
</tr>
<tr>
<td>25 NPK + N Fix.</td>
<td>190 272 480 316 573 366 169 267 460 294 517 341</td>
</tr>
<tr>
<td>0 NPK + N Fix.</td>
<td>95 120 199 148 235 159 111 150 241 172 281 191</td>
</tr>
<tr>
<td>Mean</td>
<td>241 330 511 395 663 260 413 565 468 728 728</td>
</tr>
<tr>
<td>LSD 5 %</td>
<td>A: 38 B: 32 A=B: 79 A: 39 B: 61 A=B: 149</td>
</tr>
</tbody>
</table>

### Table 4: Effect of mineral NPK, N fix. bacteria and antioxidant treatments on guaran determinations of guar plants during 2010 and 2011 seasons

<table>
<thead>
<tr>
<th>Antioxidant treatments (ppm)</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Guaran (%)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilization Treat. A</td>
<td>Cont. Asc. 100 Asc. 200 Sal. 100 Sal. 200 Mean Cont. Asc. 100 Asc. 200 Sal. 100 Sal. 200 Mean</td>
</tr>
<tr>
<td>Control</td>
<td>20.3 24.3 26.7 26.0 28.7 25.7 22.3 26.6 28.6 28.0 31.0 27.3</td>
</tr>
<tr>
<td>100 NPK</td>
<td>34.0 39.3 42.0 41.0 45.0 40.3 36.0 41.3 44.0 43.0 46.6 42.2</td>
</tr>
<tr>
<td>75 NPK + N Fix.</td>
<td>32.7 38.3 41.1 40.0 43.0 39.0 34.6 40.3 43.0 42.0 45.0 41.0</td>
</tr>
<tr>
<td>50 NPK + N Fix.</td>
<td>30.0 35.7 39.0 37.3 40.7 36.5 32.0 37.6 41.0 39.3 42.6 38.5</td>
</tr>
<tr>
<td>25 NPK + N Fix.</td>
<td>26.0 32.3 35.3 33.7 36.3 32.7 31.3 34.3 37.3 35.3 38.3 35.3</td>
</tr>
<tr>
<td>0 NPK + N Fix.</td>
<td>22.3 28.3 31.3 29.7 32.3 28.2 24.3 30.3 33.3 31.6 33.6 30.6</td>
</tr>
<tr>
<td>Mean</td>
<td>27.6 33.1 35.9 34.6 37.7 30.1 35.1 37.8 36.5 39.5 39.5</td>
</tr>
<tr>
<td>LSD 5 %</td>
<td>A: 2.2 B: 2.6 A=B: N.S A: 2.8 B: 2.5 A=B: N.S</td>
</tr>
<tr>
<td></td>
<td>Guaran yield/ plant(g)</td>
</tr>
<tr>
<td>Control</td>
<td>.7 1.5 2.7 2.2 3.3 2.1 6.1 1.9 3.9 2.7 4.1 2.6</td>
</tr>
<tr>
<td>100 NPK</td>
<td>12.3 19.0 31.2 23.6 41.8 25.6 14.4 29.2 44.5 30.6 49.3 33.6</td>
</tr>
<tr>
<td>75 NPK + N Fix.</td>
<td>10.0 15.9 24.5 19.9 37.8 21.6 14.2 22.2 39.1 25.8 43.8 29.0</td>
</tr>
<tr>
<td>50 NPK + N Fix.</td>
<td>8.0 13.0 21.5 16.0 29.0 17.5 7.6 17.5 30.1 20.9 34.4 22.1</td>
</tr>
<tr>
<td>25 NPK + N Fix.</td>
<td>4.1 7.3 14.1 9.2 17.3 10.4 4.0 7.7 14.2 11.7 16.4 10.8</td>
</tr>
<tr>
<td>0 NPK + N Fix.</td>
<td>1.8 2.8 5.2 3.7 6.4 4.0 3.3 4.5 7.2 6.7 8.6 6.1</td>
</tr>
<tr>
<td>Mean</td>
<td>6.2 9.9 16.5 12.4 22.6 7.4 13.8 23.2 16.4 26.1 26.1</td>
</tr>
<tr>
<td>LSD 5 %</td>
<td>A: 1.3 B: 1.4 A=B: 3.4 A: 2.5 B: 1.0 A=B: 2.5</td>
</tr>
</tbody>
</table>
### Table 4: Continue

<table>
<thead>
<tr>
<th>Fertilization Treat. A</th>
<th>Cont.</th>
<th>Asc. 100</th>
<th>Asc. 200</th>
<th>Sal. 100</th>
<th>Sal. 200</th>
<th>Mean</th>
<th>Cont.</th>
<th>Asc. 100</th>
<th>Asc. 200</th>
<th>Sal. 100</th>
<th>Sal. 200</th>
<th>Mean</th>
</tr>
</thead>
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<tr>
<td>Control</td>
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<td>23</td>
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<td>32</td>
<td>49</td>
<td>32</td>
</tr>
<tr>
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<td>228</td>
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<td>283</td>
<td>502</td>
<td>307</td>
<td>173</td>
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<td>534</td>
<td>367</td>
<td>592</td>
<td>403</td>
</tr>
<tr>
<td>75 NPK + N Fix.</td>
<td>120</td>
<td>191</td>
<td>294</td>
<td>239</td>
<td>454</td>
<td>258</td>
<td>170</td>
<td>266</td>
<td>469</td>
<td>310</td>
<td>526</td>
<td>348</td>
</tr>
<tr>
<td>50 NPK + N Fix.</td>
<td>96</td>
<td>156</td>
<td>258</td>
<td>192</td>
<td>348</td>
<td>210</td>
<td>91</td>
<td>210</td>
<td>361</td>
<td>251</td>
<td>413</td>
<td>265</td>
</tr>
<tr>
<td>25 NPK + N Fix.</td>
<td>49</td>
<td>88</td>
<td>169</td>
<td>110</td>
<td>208</td>
<td>125</td>
<td>48</td>
<td>92</td>
<td>170</td>
<td>140</td>
<td>197</td>
<td>129</td>
</tr>
<tr>
<td>0 NPK + N Fix.</td>
<td>22</td>
<td>34</td>
<td>62</td>
<td>44</td>
<td>77</td>
<td>48</td>
<td>40</td>
<td>54</td>
<td>86</td>
<td>80</td>
<td>103</td>
<td>73</td>
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<tr>
<td>Mean</td>
<td>74</td>
<td>119</td>
<td>198</td>
<td>149</td>
<td>272</td>
<td>88</td>
<td>166</td>
<td>248</td>
<td>197</td>
<td>313</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSD 5 %</td>
<td>A:</td>
<td>18</td>
<td>B:</td>
<td>18</td>
<td>A×B:</td>
<td>43</td>
<td>A:</td>
<td>15</td>
<td>B:</td>
<td>18</td>
<td>A×B:</td>
<td>43</td>
</tr>
</tbody>
</table>

### Table 5: Effect of mineral NPK, N fixing bacteria and antioxidant treatments on photosynthetic pigments of guar plants during 2010 and 2011 seasons

<table>
<thead>
<tr>
<th>Fertilization Treat. A</th>
<th>Cont.</th>
<th>Asc. 100</th>
<th>Asc. 200</th>
<th>Sal. 100</th>
<th>Sal. 200</th>
<th>Mean</th>
<th>Cont.</th>
<th>Asc. 100</th>
<th>Asc. 200</th>
<th>Sal. 100</th>
<th>Sal. 200</th>
<th>Mean</th>
</tr>
</thead>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.50</td>
<td>1.53</td>
<td>1.59</td>
<td>1.55</td>
<td>1.61</td>
<td>1.56</td>
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<td>1.54</td>
<td>1.59</td>
<td>1.56</td>
<td>1.62</td>
<td>1.56</td>
</tr>
<tr>
<td>100 NPK</td>
<td>1.76</td>
<td>1.87</td>
<td>1.94</td>
<td>1.89</td>
<td>1.96</td>
<td>1.88</td>
<td>1.77</td>
<td>1.87</td>
<td>1.95</td>
<td>1.89</td>
<td>1.97</td>
<td>1.89</td>
</tr>
<tr>
<td>75 NPK + N Fix.</td>
<td>1.75</td>
<td>1.87</td>
<td>1.94</td>
<td>1.90</td>
<td>1.96</td>
<td>1.88</td>
<td>1.76</td>
<td>1.87</td>
<td>1.94</td>
<td>1.90</td>
<td>1.96</td>
<td>1.89</td>
</tr>
<tr>
<td>50 NPK + N Fix.</td>
<td>1.62</td>
<td>1.77</td>
<td>1.80</td>
<td>1.78</td>
<td>1.83</td>
<td>1.76</td>
<td>1.62</td>
<td>1.77</td>
<td>1.81</td>
<td>1.78</td>
<td>1.84</td>
<td>1.76</td>
</tr>
<tr>
<td>25 NPK + N Fix.</td>
<td>1.59</td>
<td>1.62</td>
<td>1.67</td>
<td>1.64</td>
<td>1.67</td>
<td>1.64</td>
<td>1.59</td>
<td>1.62</td>
<td>1.67</td>
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<td>1.68</td>
<td>1.64</td>
</tr>
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<td>1.59</td>
<td>1.64</td>
<td>1.58</td>
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<td>A:</td>
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<td>B:</td>
<td>0.01</td>
<td>A×B:</td>
<td>0.02</td>
<td>A:</td>
<td>0.02</td>
<td>B:</td>
<td>0.01</td>
<td>A×B:</td>
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### Table 6: Effect of mineral NPK, N fixing bacteria and antioxidant treatments on N, P and K% of guar plants during 2010 and 2011 seasons

<table>
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<tr>
<th>Fertilization Treat. A</th>
<th>Cont.</th>
<th>Asc. 100</th>
<th>Asc. 200</th>
<th>Sal. 100</th>
<th>Sal. 200</th>
<th>Mean</th>
<th>Cont.</th>
<th>Asc. 100</th>
<th>Asc. 200</th>
<th>Sal. 100</th>
<th>Sal. 200</th>
<th>Mean</th>
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<td></td>
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<tr>
<td>Control</td>
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<td>1.75</td>
<td>1.75</td>
<td>1.55</td>
<td>1.45</td>
<td>1.60</td>
<td>1.66</td>
<td>1.64</td>
<td>1.72</td>
<td>1.61</td>
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<tr>
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<td>3.14</td>
<td>3.84</td>
<td>3.65</td>
<td>3.82</td>
<td>3.82</td>
<td>3.62</td>
<td>3.19</td>
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<td>3.80</td>
<td>3.73</td>
<td>3.92</td>
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<tr>
<td>75 NPK + N Fix.</td>
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<td>3.76</td>
<td>3.76</td>
<td>3.48</td>
<td>2.97</td>
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<td>3.62</td>
<td>3.72</td>
<td>3.81</td>
<td>3.53</td>
</tr>
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<td>2.82</td>
<td>3.30</td>
<td>3.44</td>
<td>3.34</td>
<td>3.54</td>
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<td>3.42</td>
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<td>3.31</td>
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<td>2.83</td>
<td>2.61</td>
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<td>2.62</td>
<td>2.45</td>
<td>2.77</td>
<td>2.93</td>
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<td>2.41</td>
<td>2.55</td>
<td>2.65</td>
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<tr>
<td>Mean</td>
<td>2.39</td>
<td>2.74</td>
<td>2.95</td>
<td>2.80</td>
<td>3.02</td>
<td>2.48</td>
<td>2.85</td>
<td>2.97</td>
<td>2.73</td>
<td>3.14</td>
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<td></td>
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<tr>
<td>LSD 5 %</td>
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<td>B:</td>
<td>0.06</td>
<td>A×B:</td>
<td>0.14</td>
<td>A:</td>
<td>0.08</td>
<td>B:</td>
<td>0.04</td>
<td>A×B:</td>
<td>0.09</td>
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Table 6: Continue

<table>
<thead>
<tr>
<th>Fertilization Treat. A</th>
<th>Cont.</th>
<th>Asc. 100</th>
<th>Asc. 200</th>
<th>Sal. 100</th>
<th>Sal. 200</th>
<th>Mean</th>
<th>Cont.</th>
<th>Asc. 100</th>
<th>Asc. 200</th>
<th>Sal. 100</th>
<th>Sal. 200</th>
<th>Mean</th>
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<tr>
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<td>0.18</td>
<td>0.19</td>
<td>.19</td>
<td>.22</td>
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<td>0.17</td>
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<tr>
<td>100 NPK</td>
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<td>0.49</td>
<td>.48</td>
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<td>0.47</td>
<td>0.41</td>
<td>0.44</td>
<td>0.47</td>
<td>0.47</td>
<td>0.48</td>
<td>0.45</td>
</tr>
<tr>
<td>75 NPK + N Fix.</td>
<td>0.42</td>
<td>0.45</td>
<td>0.47</td>
<td>.45</td>
<td>0.47</td>
<td>0.45</td>
<td>0.39</td>
<td>0.42</td>
<td>0.45</td>
<td>0.45</td>
<td>0.47</td>
<td>0.44</td>
</tr>
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<td>0.37</td>
<td>0.41</td>
<td>0.42</td>
<td>.42</td>
<td>0.45</td>
<td>0.41</td>
<td>0.38</td>
<td>0.41</td>
<td>0.42</td>
<td>0.42</td>
<td>0.45</td>
<td>0.42</td>
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<tr>
<td>25 NPK + N Fix.</td>
<td>0.33</td>
<td>0.37</td>
<td>0.38</td>
<td>.38</td>
<td>0.41</td>
<td>0.37</td>
<td>0.33</td>
<td>0.36</td>
<td>0.37</td>
<td>0.37</td>
<td>0.38</td>
<td>0.36</td>
</tr>
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<td>0.23</td>
<td>0.24</td>
<td>.25</td>
<td>0.26</td>
<td>0.24</td>
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<tr>
<td>Mean</td>
<td>0.32</td>
<td>0.35</td>
<td>0.37</td>
<td>.36</td>
<td>0.38</td>
<td>0.31</td>
<td>0.33</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
<td>0.37</td>
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</tr>
<tr>
<td>LSD 5 %</td>
<td>A:</td>
<td>0.01</td>
<td>B:</td>
<td>0.01</td>
<td>A×B:</td>
<td>0.03</td>
<td>A:</td>
<td>0.01</td>
<td>B:</td>
<td>0.01</td>
<td>A×B:</td>
<td>0.02</td>
</tr>
</tbody>
</table>

| Herb potassium (%)    |      |         |         |         |         |      |      |         |         |         |         |      |
| Control               | 1.20 | 1.42    | 1.48    | 1.45    | 1.51    | 1.41 | 1.34 | 1.45    | 1.51    | 1.47    | 1.53    | 1.46 |
| 100 NPK               | 3.08 | 3.54    | 3.65    | 3.58    | 3.69    | 3.51 | 3.08 | 3.59    | 3.66    | 3.61    | 3.70    | 3.53 |
| 75 NPK + N Fix.       | 2.91 | 3.35    | 3.49    | 3.41    | 3.57    | 3.35 | 2.79 | 3.31    | 3.42    | 3.41    | 3.53    | 3.29 |
| 50 NPK + N Fix.       | 2.73 | 3.20    | 3.25    | 3.23    | 3.35    | 3.16 | 2.69 | 3.16    | 3.22    | 3.18    | 3.31    | 3.11 |
| 25 NPK + N Fix.       | 2.11 | 2.45    | 2.46    | 2.54    | 2.71    | 2.49 | 2.09 | 2.42    | 2.59    | 2.52    | 2.75    | 2.47 |
| 0 NPK + N Fix.        | 1.69 | 1.91    | 2.01    | 2.03    | 2.11    | 1.95 | 1.66 | 1.85    | 2.03    | 2.00    | 2.13    | 1.94 |
| Mean                  | 2.29 | 2.65    | 2.75    | 2.71    | 2.83    | 2.28 | 2.63 | 2.74    | 2.70    | 2.83    |          |      |
| LSD 5 %               | A:   | 0.08   | B:      | 0.04    | A×B:    | 0.10 | A:   | 0.05    | B:      | 0.04    | A×B:    | 0.10 |

six studied chemical constituents. The role of NPK mineral fertilization in promoting such chemical constituents was revealed by other works [2, 5, 6-8, 12, 13].

Regarding antioxidant treatments, both ascorbic acid and salicylic acid at 100 and 200 ppm resulted in significant increase in the three photosynthetic pigments and N, P and K % in comparison with control treatment. However, 200 ppm salicylic acid followed by 200 ppm ascorbic acid gave the highest chemical constituent values as shown in Tables 5 and 6. In agreement with these results previous studies [12, 16 -19]. Concerning antioxidants, ascorbic acid occurs in all plant tissues, usually being higher in the chloroplasts, cytosol, vacuoles, mitochondria and cell wall. It protects the plants against damage resulting from aerobic metabolism and pollutants. It stimulates cell division and has significant resistant against many plant pathogens [26]. Meanwhile, salicylic acid has direct involvement in plant growth, thermogenesis, flower induction and uptake of ions. It affects ethylene biosynthesis, stomatal movement, reverses the effect of ABA on leaf abscission, enhances the photosynthetic rate and exhibits a rapid rate of root differentiation [27].

Concerning antioxidants, ascorbic acid occurs in all plant tissues, usually being higher in the chloroplasts, cytosol, vacuoles, mitochondria and cell wall. It protects the plants against damage resulting from aerobic metabolism and pollutants. It stimulates cell division and has significant resistant against many plant pathogens [26]. Meanwhile, salicylic acid has direct involvement in plant growth, thermogenesis, flower induction and uptake of ions. It affects ethylene biosynthesis, stomatal movement, reverses the effect of ABA on leaf abscission, enhances the photosynthetic rate and exhibits a rapid rate of root differentiation [27].

The effectiveness of mineral NPK and/ or N fixing bacteria (Bradyrhizobium japonicum) in augmenting different vegetative growth characters, seed yield, guar aspects and chemical constituents of guar plants could be explained in the light of their vital roles in plant growth and development. The superiority of mineral N, P and K fertilizers could be attributed to their unique physiological and biological roles. In the meantime, Bradyrhizobium japonicum as a N fixing bacteria may affect the host plant by one or more mechanism such as nitrogen fixation, production of growth promotion substances or organic acids, enhancing nutrients uptake or protection against plant pathogens [24, 25] added that such organism produced adequate amounts of IAA and cytokinins which increased the surface area per unit of root length and were responsible for hair branching with an eventual increase in the uptake of nutrients from the soil.

Concerning antioxidants, ascorbic acid occurs in all plant tissues, usually being higher in the chloroplasts, cytosol, vacuoles, mitochondria and cell wall. It protects the plants against damage resulting from aerobic metabolism and pollutants. It stimulates cell division and has significant resistant against many plant pathogens such as nematode, fungi, bacteria and parasitic plants [26]. Meanwhile, salicylic acid has direct involvement in plant growth, thermogenesis, flower induction and uptake of ions. It affects ethylene biosynthesis, stomatal movement, reverses the effect of ABA on leaf abscission, enhances the photosynthetic rate and exhibits a rapid rate of root differentiation [27].

It is obvious from the obtained data that supplying the plants with 25% NPK plus Bradyrhizobium japonicum in combination with ascorbic acid or salicylic acid at 200 ppm resulted in equal or better values of seed and guaran yield in comparison with the recommended NPK treatment.
REFERENCES


