Effect of different nitrogen doses on sucking pests and yield in *Bt* cotton under unprotected and protected conditions

S Anusha, GMV Prasada Rao and DV Sai Ram Kumar

Abstract
An experiment was conducted to know effect of different nitrogen doses (0, 120, 150, 180, 225, 280, 350, 440 kg ha\(^{-1}\)) on sucking pests and yield in Jaadu BG-II cotton hybrid under protected and unprotected conditions at RARS, Lam, Guntur. The mean aphid population was increased from 14.12 to 42.54 and 9.67 to 26.20 per three leaves under unprotected and protected conditions respectively. Similarly, the mean leafhopper population was increased from 3.54 to 6.52 and 2.51 to 4.99 per three leaves under unprotected and protected conditions respectively. Significant positive correlations were observed with pest population. The highest seed cotton yield was obtained from plots applied with 150 kg N ha\(^{-1}\) both under unprotected (1967 kg ha\(^{-1}\)) and protected (2272 kg ha\(^{-1}\)) conditions. However, thereafter decrease in yield was observed with increased nitrogen level.

Keywords: *Bt* cotton sucking pests, nitrogen levels, yield, unprotected and protected

1. Introduction
Cotton (*Gossypium hirsutum* L.), the “White gold” is one of the most important commercial and industrial crops and plays a key role in economical and social affairs of the world and it is considered as “King of fibres”. The major factor responsible for the low productivity and quality deterioration of cotton in the state as well as in the country is the severe attack of insects / pests on cotton crop from sowing to harvesting. Adoption of *Bt* cotton has not only changed the cultivation profile, but also the pest scenario. While there is a decline in the pest status of bollworms; the sap feeders, viz. aphids, jassids, mirids and mealy bugs are emerging as serious pests \([1]\). Thus, insect pests remain a main determinant factor in sustainable cotton production. *Bt* cotton hybrids and their scope for extensive coverage in the coming years, necessitated for change in the nutrient management of *Bt* cotton hybrids. Fertilizer application plays an important role in raising cotton production. Nitrogen is utilized in cotton plant to greater extent and is generally considered the most important nutrient for maximizing the cotton yield. In recent years there has been tendency among cotton growers to increase maximum yield potentials by applying higher amount than that recommended nitrogen rates. *Bt* cotton at higher densities responding to higher nitrogen levels (25% more than recommended dose of N) and producing significantly higher yields \([2]\). The nitrogen as feeding regulator can positively or negatively affect the feeding amounts of herbivores on host-plants with high nitrogen content in two ways. Given choices, many insect herbivores can distinguish host plants of high nutritional quality from those of low quality. Highest mean population of leaf hopper, whitefly and thrips per leaf were found at plants receiving higher doses of nitrogen \([3]\). Higher nitrogen levels provide congenial substratum for growth and development of sucking pests throughout the crop growth period. Such conditions need protection against sucking pests compared to Non-*Bt* era. Hence, knowledge on effect of different nitrogen doses on sucking pests and yield under unprotected and protected conditions in *Bt* cotton is needed. Keeping this in view, field studies were conducted at RARS, Lam, Guntur to evaluate the impact of nitrogen on incidence of sucking insect pests in BG II cotton.

2. Materials and Methods
2.1 Layout and Treatments: Field experiment was conducted at Regional Agricultural Research Station, Lam, Guntur during Kharif 2013 in a randomised block design with eight treatments of different nitrogen levels *i.e.* 120, 150, 180, 225, 280, 350, 440 & 0 kg N ha\(^{-1}\) and
The mean aphid population was increased from 14.12 per three leaves to 42.54 per three leaves as nitrogen doses increased from 0 kg ha$^{-1}$ to 440 kg ha$^{-1}$ (Table 1) and there was a significant positive correlation between mean aphid population and nitrogen treatments ($r = 0.82, P<0.05$) (Figs. 1) under unprotected conditions. Similarly, in protected conditions, mean aphid population increased from 9.67 per three leaves to 26.20 per three leaves with increase in nitrogen doses from 0 kg ha$^{-1}$ to 440 kg ha$^{-1}$ (Table 1) and there was a significant positive correlation between mean aphid population and nitrogen treatments ($r = 0.93, P<0.05$) (Figs. 3) but, there is reduction of population in protected condition than in unprotected condition.

A study reported that aphid density in cotton plants fertilized with 72 kg ha$^{-1}$ N (84.2±22.7 aphids/plant) was significantly higher than fertilized with 0 and 108 kg ha$^{-1}$ N (36.7±4.0 and 47.8±18.7 aphids/plant)$^{[4]}$, similarly another study also reported that significantly more aphids were found on plants fertilized with 375 ppm N (230.50 ± 78.07) than on plants fertilized with 0, 19 and 38 ppm N (9.54 ± 2.62, 20.08 ± 5.58 and 62.83 ± 29.07 respectively)$^{[5]}$.

### 3.2 Influence of Nitrogen on Leaf hopper

It was evident from the data that more leafhopper incidence levels were observed at high nitrogen doses compared to the without nitrogen treatment. The mean leafhopper population increased from 3.54 per three leaves to 6.52 per three leaves under unprotected conditions and 2.51 per three leaves to 4.99 per three leaves as nitrogen dose increased from 0 kg ha$^{-1}$ to 440 kg ha$^{-1}$ (Table 1) and significant positive correlation between mean leafhopper population and nitrogen treatments ($r = 0.70, 0.84 P<0.05$) was observed both under unprotected and protected conditions (Figs. 2, 4) but, there is reduction of population in protected condition than in unprotected condition.

These results are in conformity with a study that the maximum dose of nitrogen 200 kg ha$^{-1}$ resulted in higher mean of 0.44 leafhoppers per leaf as compared to minimum dose of 50 kg N ha$^{-1}$ recorded 0.22 leafhoppers per leaf$^{[3]}$ and also the application of 120 kg N ha$^{-1}$ and 160 kg N ha$^{-1}$ recorded lower leafhopper population over incremental level of 200 kg N ha$^{-1}$.$^{[6]}$.
Non-significant positive correlation was observed between seed cotton yield and nitrogen treatments under both unprotected and protected conditions ($r = 0.32, 0.32; P<0.05$) (Figs. 5, 6).

There is an increase in yield in protected than in unprotected conditions (Figs.7), may be due to management of insect pests. These results are in conformity with a work revealing that the seed cotton yield obtained from sprayed plots was significantly higher compared to unsprayed plots. The yield was 16.24, 12.32, 12.80, 17.16, 11.84, 12.28, 20.80, 16 q ha$^{-1}$ under protected conditions where as under unprotected conditions, it was 10.48 q ha$^{-1}$ [8].

### 3.3.3 Cost Benefit Ratio

Cost-benefit ratios of different treatments were calculated for both protected and unprotected trials (Table 2). Under unprotected conditions, the highest cost-benefit ratio of 1:1.45 was recorded in 150 kg N ha$^{-1}$ applied treatment. Under protected conditions, the highest ratio of 1: 1.61 was recorded in 150 kg N ha$^{-1}$ applied treatment.

### Table 1: Influence of Nitrogen doses on sucking pests and yield in Jaadu BG-II cotton hybrid

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Aphids/three leaves</th>
<th>Leafhoppers/three leaves</th>
<th>Yield (kg ha$^{-1}$)</th>
<th>Aphids/three leaves</th>
<th>Leafhoppers/three leaves</th>
<th>Yield (kg ha$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: 120 kg N ha$^{-1}$ (Recommended)</td>
<td>28.32 (5.42) b</td>
<td>4.74 (2.40) ab</td>
<td>1826 b</td>
<td>13.47 (3.80) b</td>
<td>3.48 (2.12) b</td>
<td>2076 b</td>
</tr>
<tr>
<td>T2: 150 kg N ha$^{-1}$</td>
<td>32.19 (5.76) bc</td>
<td>5.17 (2.48) bc</td>
<td>1967 b</td>
<td>15.25 (4.03)b</td>
<td>3.73 (2.17) bc</td>
<td>2272 b</td>
</tr>
<tr>
<td>T3: 180 kg N ha$^{-1}$</td>
<td>33.29 (5.86) c</td>
<td>5.55 (2.56) bc</td>
<td>1848 b</td>
<td>15.71 (4.09)b</td>
<td>3.98 (2.23) bc</td>
<td>2065b</td>
</tr>
<tr>
<td>T4: 225 kg N ha$^{-1}$</td>
<td>34.47 (5.96) cd</td>
<td>5.76 (2.60) bc</td>
<td>1874 b</td>
<td>17.04 (4.25)bc</td>
<td>4.21 (2.28) bc</td>
<td>2042 b</td>
</tr>
<tr>
<td>T5: 280 kg N ha$^{-1}$</td>
<td>36.56 (6.13) cd</td>
<td>5.86 (2.62) bc</td>
<td>1785 b</td>
<td>20.62 (4.65)cd</td>
<td>4.48 (2.34) cd</td>
<td>2053 b</td>
</tr>
<tr>
<td>T6: 350 kg N ha$^{-1}$</td>
<td>39.33 (6.35) de</td>
<td>6.16 (2.68) bc</td>
<td>1744 b</td>
<td>21.92 (4.79) d</td>
<td>4.74 (2.40) de</td>
<td>2040 b</td>
</tr>
<tr>
<td>T7: 440 kg N ha$^{-1}$</td>
<td>42.54 (6.60) e</td>
<td>6.52 (2.74) c</td>
<td>1904 b</td>
<td>26.20 (5.22) f</td>
<td>4.99 (2.45) e</td>
<td>2048 b</td>
</tr>
<tr>
<td>T8: 0 kg N ha$^{-1}$</td>
<td>14.12 (3.89) a</td>
<td>3.54 (2.13) a</td>
<td>1440 a</td>
<td>9.67 (3.27) a</td>
<td>2.51 (1.87) a</td>
<td>1591 a</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>0.38</td>
<td>0.31</td>
<td>282.13</td>
<td>0.48</td>
<td>0.20</td>
<td>345.66</td>
</tr>
<tr>
<td>CV%</td>
<td>3.81</td>
<td>7.02</td>
<td>8.94</td>
<td>6.40</td>
<td>5.19</td>
<td>9.75</td>
</tr>
<tr>
<td>Correlation (r) (P&lt;0.05)</td>
<td>0.82</td>
<td>0.70</td>
<td>0.32 (NS)</td>
<td>0.93</td>
<td>0.84</td>
<td>0.32 (NS)</td>
</tr>
</tbody>
</table>

Figures in parentheses are values. Numbers with same superscript are not statistically different

### Table 2: Influence of nitrogen levels on seed cotton yield under unprotected and protected conditions

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (kg ha$^{-1}$)</th>
<th>Per cent increased yield over recommended dose of fertilizer</th>
<th>Cost-Benefit Ratio</th>
<th>Yield (kg ha$^{-1}$)</th>
<th>Per cent increased yield over recommended dose of fertilizer</th>
<th>Cost-Benefit Ratio</th>
<th>Yield difference between protected and unprotected (kg ha$^{-1}$)</th>
<th>Per cent increase in yield under protected over unprotected</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: 120 kg N ha$^{-1}$ (Recommended)</td>
<td>1826 b</td>
<td>1 : 1.35</td>
<td>2076 b</td>
<td>1 : 1.48</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2: 150 kg N ha$^{-1}$</td>
<td>1967 b</td>
<td>7.2</td>
<td>1 : 1.45</td>
<td>2272 b</td>
<td>8.6</td>
<td>1 : 1.61</td>
<td>304</td>
<td>17.9</td>
</tr>
<tr>
<td>T3: 180 kg N ha$^{-1}$</td>
<td>1848 b</td>
<td>1.2</td>
<td>1 : 1.35</td>
<td>2065 b</td>
<td>- 0.5</td>
<td>1 : 1.45</td>
<td>216</td>
<td>- 15.7</td>
</tr>
<tr>
<td>T4: 225 kg N ha$^{-1}$</td>
<td>1874 b</td>
<td>2.6</td>
<td>1 : 1.36</td>
<td>2042 b</td>
<td>- 1.6</td>
<td>1 : 1.42</td>
<td>168</td>
<td>- 49.1</td>
</tr>
<tr>
<td>T5: 280 kg N ha$^{-1}$</td>
<td>1785 b</td>
<td>- 2.3</td>
<td>1 : 1.28</td>
<td>2053 b</td>
<td>- 1.1</td>
<td>1 : 1.42</td>
<td>268</td>
<td>6.7</td>
</tr>
<tr>
<td>T6: 350 kg N ha$^{-1}$</td>
<td>1774 b</td>
<td>- 2.9</td>
<td>1 : 1.25</td>
<td>2043 b</td>
<td>- 1.6</td>
<td>1 : 1.39</td>
<td>269</td>
<td>7.0</td>
</tr>
<tr>
<td>T7: 440 kg N ha$^{-1}$</td>
<td>1904 b</td>
<td>4.1</td>
<td>1 : 1.32</td>
<td>2048 b</td>
<td>- 1.3</td>
<td>1 : 1.37</td>
<td>144</td>
<td>- 73.7</td>
</tr>
<tr>
<td>T8: 0 kg N ha$^{-1}$</td>
<td>1440 a</td>
<td>- 26.8</td>
<td>1 : 1.09</td>
<td>1591 a</td>
<td>- 30.4</td>
<td>1 : 1.16</td>
<td>151</td>
<td>- 65.7</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>282.13</td>
<td>345.66</td>
<td>9.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Figs 1: Effect of nitrogen on mean population of aphid in Bt cotton hybrid Jaadu (unprotected)

Fig 2: Effect of nitrogen on mean population of leafhopper in Bt cotton hybrid Jaadu (unprotected)

Fig 3: Effect of nitrogen on mean population of aphid in Bt cotton hybrid Jaadu (protected)

Fig 4: Effect of nitrogen on mean population of leafhopper in Bt cotton hybrid Jaadu (protected)

Fig 5: Effect of nitrogen on mean seed cotton yield in Bt cotton hybrid Jaadu (unprotected)

Fig 6: Effect of nitrogen on mean seed cotton yield in Bt cotton hybrid Jaadu (Protected)

Fig 7: Influence of nitrogen levels on seed cotton hybrid yield under unprotected and protected conditions

4. Discussion

Higher populations of sucking pests in plots receiving higher nitrogen doses is due to more vigorous growth of plants which are generally more palatable for herbivores than plants that exhibit slow growth. Nitrogen fertilization increase rates of new leaf flushing in indeterminate plants and affect leaf development rates. Many folivores typically prefer new leaf tissues because of their relatively high N content and low toughness, and changes in flushing phenology can substantially affect interactions between plants and insect herbivores.

The increased seed cotton yields obtained at 150 kg N ha⁻¹ and decreasing trend was observed from 150 to 440 kg N ha⁻¹ in both protected and unprotected conditions was mainly due to, with excessive nitrogen application, cotton plants may put forwarding excessive vegetative growth thus imbalancing
between source to sink and at higher nitrogen fertiliser rates, the soil and crop retain a smaller proportion of the nitrogen applied and a greater proportion is lost from the system through denitrification and leaching. If there is a high level of native nitrogen in the soil, cotton crops make limited use of nitrogen fertiliser, especially when applied at high rates. A study reported that, at 400 kg N ha⁻¹ fertiliser applied, only 128 kg N ha⁻¹ (32% of the 400 kg N ha⁻¹) are recovered by the crop. Soil has a finite capacity to retain fertiliser nitrogen and when this is exceeded, nitrogen is lost from the soil–plant system (42% of the 400 kg N ha⁻¹ applied)⁹ and favourable weather conditions prevailed during Kharif 2013 at RARS, Lam, Guntur resulted in the development of aphids, leafhoppers and other sucking pests at higher dose of nitrogen application. Further, management of aphid, leafhopper and other sucking pests under protected conditions also played a role in enhanced seed cotton yields over unsprayed conditions.

5. References