Evaluation of liquid formulations of Bt against gram pod borer, *Helicoverpa armiger*a (Hubner) and spotted pod borer, *Maruca vitrata* (Geyer) in pigeonpea

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Abstract

A field experiment was conducted during 2012-13, 2013-14 and 2014-15 at Agricultural Research Station, Darsi, Prakasam district, Andhra Pradesh to evaluate Bt liquid formulations and other biopesticides against gram pod borer, *Helicoverpa armiger*a and spotted pod borer, *Maruca vitrata* in pigeonpea. There were 10 treatments (2 strains of Bt liquid formulation each at two doses, powdered Bt formulation, two doses of *Beauveria bassiana*, neem formulation, chemical check) including untreated control. Pooled analysis of three years data revealed that two sprays of chlorpyriphos 0.25% at fortnightly interval was significantly superior over other treatments in suppressing the larval population of *H. armiger*a (av. 0.81 larvae/plant) and *M. vitrata* (av. 0.80 larvae/in florescence) on pigeon pea and recorded minimum pod (5.07%) and seed (3.24 %) damage with maximum 16.9 q/ha yield. It was however, at par with the Bt strain NBAII-BtG4 @ 2% in respect of pod damage (5.30%), seed damage (3.91%) and yield (15.3 q/ha). The Bt strain NBAII-BtG4 @ 2% ranked next best to the insecticidal spray in recording surviving larval population of *H. armiger*a (av. 1.01 larvae / plant) and *M. vitrata* (av. 1.10 larvae / inflorescence). Moreover, the treatment PDBC-BT1 @ 2% was also found to be equally effective to superior ones. It is therefore biopesticides should be encouraged as eco-friendly insecticides.

INTRODUCTION

Pigeonpea, *Cajanus cajan* (L.) Millsp. is an important grain legume crop of the semi-arid tropics. India is the largest producer of pigeonpea contributing to more than 90 per cent of the world’s production (3.17 million tonnes) and 817 kg ha	extsuperscript{-1} of productivity [1]. In Andhra Pradesh, it has been grown in an area of about 0.509 million hectares with a production of 0.251 million tonnes and with a productivity of 524 kg ha	extsuperscript{-1}. More than 300 species of insect species have been reported infesting the crop [2] of which those attack pods like spotted pod borer (*Maruca vitrata* (Geyer)) and gram pod borer (*Helicoverpa armiger*a (Hubner)) cause considerable yield losses to the pigeon pea growing farmers. Sometimes their infestation level is so high that farmers do not get return even whatever they expended on seed. The pod damage due to *H. armiger*a and *M. vitrata* in pigeonpea could vary from 55 to 100% [3, 4, and 5]. In order to reduce the menace by these pests large number of insecticides is being used by ignorant farmers excessively and indiscriminately which leads to development of resistance against insecticides by these pests, adversely affect the crop ecosystem and increase the total cost of production. In recent past more emphasis has been given on safer and eco-friendly management of pests. The relative specificity, potential activity, environmental safety and immunity to insecticides have made microbial pesticides a favored component of Integrated Pest Management (IPM) strategies. Several microbial insecticides like *Bacillus thuringiensis* (Bt), *Beauveria* and Nuclear Polyhedrosis Virus (NPV) were already developed as commercial formulations and utilized on *H. armiger*a [6, 7, 8 and 9]. Pathogens have been reported to be most important as population regulating factors of *M. vitrata* in the field. The usefulness and effectiveness of *Bt* has been reported on *M. vitrata* [10] in regulating its populations under field conditions. However, work is continuing to develop new *Bt* isolates by different institutes and they may be explored for integrated management of the pod borers.

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Thus attempts were made in present investigation to study the efficacy of Bt liquid formulations and other biopesticides in comparison with traditional insecticides against H. armigera and M. vitrata in pigeonpea.

2. MATERIALS AND METHODS

The field experiment was conducted for three consecutive years (2012-13, 2013-14 and 2014-15) at Agricultural Research Station, Darsi, Prakasam district, Andhra Pradesh. The trial was laid out in randomized block design with ten treatments and three replications. The pigeonpea variety LRG 41 was grown with all suitable package of agronomical practices at 180 x 20 cm spacing in 9 x 5 m plots comprising a total plot size of 1890 sq. mt. The treatments comprised spraying of liquid formulations of Bt strains PDBC-BT1 @ 1 and 2%, NBAII-BTG4 @ 1 and 2%, Beauveria bassiana @ 1.5 and 2.0 kg/ha, commercial Bt formulation (Halt) @ 0.2%, commercial neem formulation Nivaar 1500 ppm @ 0.2%, chlorpyriphos 20EC @ 0.25% as standard chemical check and untreated control. Two sprays of treatments were given- first spray of treatments was given at pod initiation stage and subsequent spray at fortnightly interval. Observations on the larval population of H. armigera and M. vitrata were recorded from five randomly selected plants from each treatment a day before treatment application as pre-count and post counts at 3 and 7 days after each spray. Pod damage per cent was estimated by counting the total number of pods and affected ones on five randomly plants in each treatment. At harvest, the pods from individual plots were threshed separately and the yield was recorded from the net plot area. Yield data was converted into quintal per ha. The data recorded on each parameter was subjected to statistical scrutiny by the analysis of variance (ANOVA) technique as described by Panse and Sukhatme (11). The treatment means were compared using the critical difference values calculated at 5 per cent level of significance.

3. RESULTS & DISCUSSION

Pooled analysis of three years data (Tables 1 and 2) revealed that all the treatments significantly reduced larval population of pod borers over untreated check after 3 and 7 days after spraying. Two sprays of chlorpyriphos @ 0.25% at fortnightly interval was significantly superior over other treatments in suppressing the larval population of H. armigera (av. 0.81 larvae / plant) and M. vitrata (av. 0.80 larvae / inflorescence) on pigeon pea. Among the biological options tested for their efficacy in bio suppression of pod borers, NBAII BtG4 @ 2% maintained its supremacy in pod borers management by recording least no. of H. armigera (av. 1.01 larvae / plant) and M. vitrata (av. 1.10 larvae / inflorescence) and ranked next best to the insecticidal spray. This is followed by PDBC Bt1 @ 2% (1.11 H. armigera larvae / plant and 1.22 M. vitrata larvae / inflorescence) which was at par with NBAII BtG4 @ 1% (1.18 H. armigera larvae / plant and 1.30 M. vitrata larvae / inflorescence) and PDBC Bt1 @ 1% (1.28 H. armigera larvae / plant and 1.33 M. vitrata larvae / inflorescence ).

It is evident from pooled data presented in Table 3 that the biopesticides evaluated remained statistically at par to each other in harboring natural enemy population. All the biopesticide treatments were eco-friendly to predatory population of spiders (1.93 – 2.73 / plant) and coccinellids (1.33 – 1.80 / plant) and significantly superior to insecticidal check plots (0.80 and 0.23 / plant, respectively) in harboring their populations both after first and second round of imposition of treatments.

Table 1: Effect of Bt liquid formulations against Helicoverpa armigera in pigeon pea (Pooled data for 2012-13, 2013-14 and 2014-15).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>No. of H. armigera larvae / plant on pigeonpea after</th>
<th>Cumul. Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laundry 1</td>
<td>Laundry 7</td>
</tr>
<tr>
<td>PDBC Bt1 @ 1%</td>
<td>0.73</td>
<td>0.47</td>
</tr>
<tr>
<td>PDBC Bt1 @ 2%</td>
<td>0.80</td>
<td>0.43</td>
</tr>
<tr>
<td>NBAII BTG4 @ 1%</td>
<td>0.67</td>
<td>0.40</td>
</tr>
<tr>
<td>NBAII BTG4 @ 2%</td>
<td>0.73</td>
<td>0.37</td>
</tr>
<tr>
<td>Beauveria bassiana (Toxin WP 1.15%) @ 1.5 Kg/ha</td>
<td>0.87</td>
<td>0.60</td>
</tr>
<tr>
<td>Beauveria bassiana (Toxin WP 1.15%) @ 2.0 Kg/ha</td>
<td>0.73</td>
<td>0.67</td>
</tr>
<tr>
<td>Bt k (Halt 5% WP) @ 0.2%</td>
<td>0.93</td>
<td>0.47</td>
</tr>
<tr>
<td>Nivaar 1500 ppm @ 0.2%</td>
<td>0.87</td>
<td>0.67</td>
</tr>
<tr>
<td>Chlorpyriphos 20EC @ 0.25%</td>
<td>1.07</td>
<td>0.33</td>
</tr>
<tr>
<td>Untreated control</td>
<td>0.80</td>
<td>0.87</td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>NS</td>
<td>0.30</td>
</tr>
</tbody>
</table>

DAS – Days After Spraying, Beauveria bassiana – Toxin 1.15% WP, make- Varsha Bioscience & Technology, Bt k – Bacillus thuriengensis Serovar Kurstaki H

3a, 3b, 3c; 5% WP, Halt, 5X10³ spore/mg, make - Biostadt
It is suggestive that, biological products are relatively safe bio-pesticides to an array of beneficial organisms. Being safer than conventional insecticides the biopesticides will fit well in the management of pod borers of pigeon pea.

The pooled data analysis of three years (Table 4) indicated that pod and seed damage per cent was significantly reduced by all the treatments over untreated check. Minimum pod and seed damage of 5.07% and 3.24% was observed in insecticidal check treatment chlorpyriphos @ 0.25%. It was however, at par with the *Bt* strain NBAI-BG4 @ 2% in respect of pod damage (5.30%) and seed damage (3.91%) confirming their supremacy in management of pod borers in pigeon pea ecosystem. Moreover, lower concentration of NBAI-BG4 @ 1% was also found to be equally effective to superior ones in reducing pod damage (6.29%) and seed damage (4.77%) and remained at par to *Beauveria bassiana* @ 2 kg/ha (6.75%) and 4.94% pod and seed damage) and *Bt* k powdered formulation @ 0.2% (7.09%) and 5.34% pod and seed damage). The application of two sprays of PDBC Bt1 @ 2% (7.50% and 5.40%), PDBC Bt1 @ 1% (7.74% and 5.77%) and *Beauveria bassiana* @ 1.5 kg/ha (8.07% and 5.77%), respectively
showed non-significant variation to each other in their effectiveness in pod and seed damage reduction. These biological treatments were followed by Nivaar 1500 ppm @ 0.2% (9.42% pod damage) but significantly different from untreated control (12.94%). However, highest seed damage of 8.78% was recorded in untreated control and was at par with Nivaar 1500 ppm @ 0.2% (7.62%).

Consequent upon protection of pigeon pea crop with different biopesticides significant increase in yield over untreated control (Table 4) was noticed. Pooled analysis of pod yield was ranged from 9.2 to 16.9 q/ha across the treatments. Pod yield was significantly highest in chemical control (16.9 q/ha) and was followed by at par with both doses of NBAII-BtG4 (15.3 and 14.2 q/ha) and higher dose of PDBC Bt1 @ 2% (14.1 q/ha). These were followed by Bt k powdered formulation @ 0.2% (13.7 q/ha), PDBC Bt1 @ 2% (13.5 q/ha) and B. bassiana @ 2 kg/ha (12.7 q/ha) which were on par with each other. Lowest pod yield was recorded in B. bassiana @ 1 kg/ha (12.1 q/ha), Nivaar 1500 ppm @ 0.2% (11.5 q/ha) and were on par with untreated check (9.2 q/ha). Though insecticidal treatment recorded highest yield, it had serious repercussions since it reduced the general predators of the pod borers after application. Utilization of fungal pathogens at lower doses does not ensure satisfactory protection of pigeon pea from pod borers. This was evidenced by higher seed and pod damage and lower grain yield in Beauveria bassiana @ 1.5 kg/ha treatment. In support of these observations, Kulkarni [14] reported the superiority of Bt., next to toxic chemical, over fungal as well as viral pathogens in pigeonpea ecosystem. Superiority of Bt formulations against pod borers was also reported in recording highest larval reduction and lowest pod and grain damage and increasing profitability in pigeon pea [15].

4. CONCLUSION

Three years of experimentation on efficacy of Bt liquid formulations showed that NBAII BtG4 @ 2% was effective in reducing pod borer population with higher grain yield in pigeon pea ecosystem. Large scale demonstration of NBAII BtG4 may be conducted in comparison with farmers practice over a large area to confirm the effectiveness of NBAII BtG4. For judicious use of synthetic insecticides it is advocated to alter with biopesticides like Bt, Beauveria for prolonged action, economical, eco-friendly and sustainability of management system.

5. REFERENCES


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