EFFICACY AND ECONOMICS OF PEST MANAGEMENT MODULES AGAINST BRINJAL SHOOT AND FRUIT BORER (LEUCINODES ORBONALIS)

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ABSTRACT
Field experiments were carried out during Rabi season of 2009 - 10 and 2010 - 11 to evaluate the efficacy of pest management modules against brinjal shoot and fruit borer (Leucinodes orbonalis). The result on efficacy of modules revealed that minimum shoot and fruit damage (9.32 and 14.83 per cent, respectively) was observed in module having shoot clipping with alternate spraying of Multineem (1500 ppm) and Triazophos (35%) plus deltamethrin (1%). Maximum yield (210.5 q/ha) was also recorded in the same module. Minimum shoot and fruit damage was recorded in 3rd week of December.

KEY WORDS
Brinjal shoot
Fruit borer
Insecticides

INTRODUCTION
Brinjal (Solanum melongena L.) is one of the most popular and economically important vegetables among small scale farmers of the country. The average productivity of brinjal in India has been estimated to be only 130.08 q/ha (Anonymous, 2002). Out of several factors to cause low productivity, the insect pest attack to the crop is one of the vital constraints. The brinjal shoot and fruit borer, Leucinodes orbonalis Guen. is the most destructive pest of brinjal. In severe infestation it causes up to 70 per cent yield loss of fruit in south and southeast Asia (Srinivasan, 2009). Generally the farmers rely on chemicals for the control of this pest. However, due to overuse and misuse of these chemical insecticides, natural balance has been disturbed leading to enormous problems such as resistance, residues, resurgence, destruction of natural enemies etc. It is therefore necessary to develop and follow a rational approach with greater reliance on IPM to promote sustainability and to reduce the number of application of hazardous chemicals. In this regards, the present investigation was planned to evaluate some pest management modules including chemicals, microbials, botanical and cultural practices for the management of L. orbonalis in brinjal.

MATERIALS AND METHODS
The field experiments were conducted during the Rabi season of 2009 - 10 and 2010 -11 at 10 farmers’ fields by Gramin Vikas Trust - Krishi Vikyan Kendra, Godda (Jharkhand) to find out the efficacy of 05 pest management modules (Table 1) against brinjal shoot and fruit borer under on farm testing (OFT) activity of the KVK. The trials were laid out in RBD with 05 pest management modules including control (M1: Clipping of infested shoot at fortnightly interval, alternate spray of Multineem (1500 ppm azadirachtin) and Triazophos (35%) plus deltamethrin (1%); M2: Alternate spray of Bt 5 WP and Cartap hydrochloride 50 SP; M3: Carbofuran 3G@ 3g/plant at 35 DAT, alternate spray of Spinosad 2.5 EC and Profenofos 50 EC; M4: Farmers’ practice i.e. 2 -3 times Phorate 10G and 5 – 6 spraying of Cypermethrin 10 EC/ Endosulfan 35 EC; M5: Untreated control) and 10 replications (farmers) during both the season. Twenty eight days old seedlings of brinjal (Var. – Mukta Keshi) were transplanted in the 3rd week of September with the spacing 60 x 60 cm in the plot size of 6 x 6 m. All other agronomical practices were carried out to raise a good and healthy crop.

The observations were recorded on shoot damage by L. orbonalis from 25 randomly selected and tagged plants in each plot (M1, M2, M3, M4 and M5). Similarly to record the damaged fruits, the fruits were plucked from tagged 25 plants and then the number of total fruits, number of healthy fruits and number of damaged fruits were counted in each plot. The shoot and fruit damaged were converted into percentage infestation. Data regarding shoot damage were recorded from 30 DAT and continued upto 105 DAT at fortnightly interval. Whereas counting of fruit infestation was started from 70 DAT and closed at 145 DAT at the interval of same duration. The harvest of only healthy fruits were considered for recording the yield from all the pickings and economics was computed.
RESULTS AND DISCUSSION

The results of field experiments conducted by Gramin Vikas Trust – Krishi Vikas Kendra, Godda revealed that mean shoot damage of two years in different modules varied from 9.32 to 16.1 per cent (Table 2). It was further revealed from the same table that the pest management modules differed significantly in reducing the shoot damage by *L. orbonalis*. The per cent mean shoot infestation was observed minimum (9.32) in *M*<sub>1</sub> (shoot clipping with application of Multineem and Triazophos plus Deltamethrin) and it was significantly different from other modules.

Data pertaining to mean fruit infestation presented in Table 3 indicated that mean per cent fruit infestation was found in between 14.83 and 22.63. Pest management module (*M*<sub>1</sub>) (shoot clipping with application of Multineem and Triazophos plus Deltamethrin) was most effective to reduce fruit infestation to the lowest level (14.83).

Economic effectiveness of various pest management modules were also evaluated as presented in Table 4. It was observed that *M*<sub>1</sub> was highest with respect to cost benefit ratio (1 : 8.38)

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**Table 1: Pest management modules Details**

<table>
<thead>
<tr>
<th>Pest management modules</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M</em>&lt;sub&gt;1&lt;/sub&gt;</td>
<td>* Clipping of infested shoot at fortnightly interval before insecticidal application* Alternate spray of Multineem (1500 ppm azadirachtin) and combination product (Spark) of triazophos (35%) + deltamethrin (1%) at fortnightly interval started from 35 DAT* (total 6 sprays)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;2&lt;/sub&gt;</td>
<td>* Alternate spray of <em>Bt</em> based formulation (Halt 5 WP) and cartap hydrochloride 50 SP at fortnightly interval started from 35 DAT (total 6 sprays)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;3&lt;/sub&gt;</td>
<td>* Carbofuran 3G@ 3g/plant at 35 DAT* Alternate spray of spinosad 2.5 EC and profenofos 50 EC at fortnightly interval started from 50 DAT (total 5 sprays)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;4&lt;/sub&gt;</td>
<td>*Farmers’ practice ( 2 -3 times phorate 10G and 5 – 6 spraying of cypermethrin10 EC/ endosulfan35 EC)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;5&lt;/sub&gt;</td>
<td>* Untreated control</td>
</tr>
</tbody>
</table>

*DAT = Days after transplanting

**Table 2: Effect of different pest management modules on the brinjal shoot damage (mean of two years, 2009 – 10 and 2010 – 11)**

<table>
<thead>
<tr>
<th>Pest management modules (M)</th>
<th>Periods of observation</th>
<th>Shoot damage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 DAT</td>
<td>45 DAT</td>
</tr>
<tr>
<td></td>
<td>60 DAT</td>
<td>75 DAT</td>
</tr>
<tr>
<td></td>
<td>90 DAT</td>
<td>105 DAT</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;1&lt;/sub&gt;</td>
<td>11.4(19.54)</td>
<td>9.6(17.91)</td>
</tr>
<tr>
<td></td>
<td>11.8(19.74)</td>
<td>8.4(16.70)</td>
</tr>
<tr>
<td></td>
<td>6.8(14.67)</td>
<td>7.9(16.32)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;2&lt;/sub&gt;</td>
<td>12.8(20.41)</td>
<td>11.4(19.30)</td>
</tr>
<tr>
<td></td>
<td>7.2(15.40)</td>
<td>10.4(18.11)</td>
</tr>
<tr>
<td></td>
<td>9.6(17.30)</td>
<td>8.8(16.42)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;3&lt;/sub&gt;</td>
<td>11.2(18.90)</td>
<td>12.2(19.62)</td>
</tr>
<tr>
<td></td>
<td>8.8(16.88)</td>
<td>10.8(18.62)</td>
</tr>
<tr>
<td></td>
<td>9.4(17.61)</td>
<td>10.8(18.42)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;4&lt;/sub&gt;</td>
<td>21.0(26.84)</td>
<td>12.2(20.35)</td>
</tr>
<tr>
<td></td>
<td>15.0(22.51)</td>
<td>10.0(17.56)</td>
</tr>
<tr>
<td></td>
<td>10.0(18.10)</td>
<td>8.8(16.92)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;5&lt;/sub&gt;</td>
<td>19.6(26.09)</td>
<td>18.2(25.11)</td>
</tr>
<tr>
<td></td>
<td>17.4(24.48)</td>
<td>17.4(24.53)</td>
</tr>
<tr>
<td></td>
<td>11.6(19.46)</td>
<td>12.4(20.12)</td>
</tr>
<tr>
<td>Average</td>
<td>15.2(22.36)</td>
<td>12.72(20.45)</td>
</tr>
<tr>
<td></td>
<td>12.04(19.80)</td>
<td>11.4(19.10)</td>
</tr>
<tr>
<td></td>
<td>9.4(17.43)</td>
<td>9.74(17.64)</td>
</tr>
</tbody>
</table>

CD between modules (p = 0.05) = 0.20, CD between periods of observation (p = 0.05) = 0.24; Figures in parentheses are arc sine transformed values

**Table 3: Effect of different pest management modules on the brinjal fruit damage (mean of two years, 2009 – 10 and 2010 – 11)**

<table>
<thead>
<tr>
<th>Pest management modules (M)</th>
<th>Periods of observation</th>
<th>Fruit damage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>70 DAT</td>
<td>85 DAT</td>
</tr>
<tr>
<td></td>
<td>100 DAT</td>
<td>115 DAT</td>
</tr>
<tr>
<td></td>
<td>130 DAT</td>
<td>145 DAT</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;1&lt;/sub&gt;</td>
<td>14.55(22.30)</td>
<td>9.25(17.55)</td>
</tr>
<tr>
<td></td>
<td>12.36(20.45)</td>
<td>16.9(24.24)</td>
</tr>
<tr>
<td></td>
<td>17.27(24.47)</td>
<td>18.64(25.47)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;2&lt;/sub&gt;</td>
<td>16.27(23.67)</td>
<td>10.63(18.82)</td>
</tr>
<tr>
<td></td>
<td>14.16(21.99)</td>
<td>18.38(25.24)</td>
</tr>
<tr>
<td></td>
<td>19.22(25.85)</td>
<td>21.17(27.28)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;3&lt;/sub&gt;</td>
<td>17.22(24.36)</td>
<td>11.88(19.89)</td>
</tr>
<tr>
<td></td>
<td>15.21(22.88)</td>
<td>19.43(25.88)</td>
</tr>
<tr>
<td></td>
<td>20.94(27.09)</td>
<td>24.17(29.29)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;4&lt;/sub&gt;</td>
<td>18.61(25.30)</td>
<td>12.88(20.49)</td>
</tr>
<tr>
<td></td>
<td>16.59(23.92)</td>
<td>21.66(27.62)</td>
</tr>
<tr>
<td></td>
<td>23.60(28.85)</td>
<td>27.82(31.76)</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;5&lt;/sub&gt;</td>
<td>20.61(26.93)</td>
<td>15.13(22.74)</td>
</tr>
<tr>
<td></td>
<td>18.68(25.55)</td>
<td>24.09(29.32)</td>
</tr>
<tr>
<td></td>
<td>26.23(30.74)</td>
<td>31.05(33.83)</td>
</tr>
<tr>
<td>Average</td>
<td>17.45(24.51)</td>
<td>11.95(19.89)</td>
</tr>
<tr>
<td></td>
<td>12.04(19.80)</td>
<td>11.4(19.10)</td>
</tr>
<tr>
<td></td>
<td>9.4(17.43)</td>
<td>9.74(17.64)</td>
</tr>
</tbody>
</table>

CD between modules (p = 0.05) = 0.14, CD between periods of observation (p = 0.05) = 0.24; Figures in parentheses are arc sine transformed values

**Table 4: Economic analysis of pest management modules for *L. orbonalis***

<table>
<thead>
<tr>
<th>Pest management modules (M)</th>
<th>Average yield (q/ha) (2009 – 10 and 2010 – 11)</th>
<th>Cost of insecticides (including labour cost)/(Rs./ha)</th>
<th>Net gain over control (q/ha)</th>
<th>Realisation over control (Rs./ha)</th>
<th>C : B ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M</em>&lt;sub&gt;1&lt;/sub&gt;</td>
<td>210.5</td>
<td>5175</td>
<td>44.5</td>
<td>35600</td>
<td>1 : 8.38</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;2&lt;/sub&gt;</td>
<td>193.5</td>
<td>4767</td>
<td>27.5</td>
<td>22000</td>
<td>1 : 4.31</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;3&lt;/sub&gt;</td>
<td>183.0</td>
<td>7481</td>
<td>17.0</td>
<td>13600</td>
<td>1 : 1.73</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;4&lt;/sub&gt;</td>
<td>172.5</td>
<td>8400</td>
<td>6.5</td>
<td>5200</td>
<td>1 : 0.62</td>
</tr>
<tr>
<td><em>M</em>&lt;sub&gt;5&lt;/sub&gt;</td>
<td>166.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. D. (p = 0.05)</td>
<td>8.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
due to comparatively low spraying cost and highest fruit yield followed by $M_2 (1:4.31), M_3 (1:1.73)$ and $M_4 (1:0.62)$. The yield recorded in different modules differed significantly. Due to economic loss in farmers practice, farmers of the area are avoiding the cultivation of brinjal in commercial scale because of the insect pest infestation and complain about the increasing trend of damage in spite of several rounds of insecticidal applications.

In the present investigation clipping of infested shoot with application of Multineem and Triazophos plus Deltamethrin ($M_1$) gave maximum protection to the brinjal crop in terms of lowest shoot and fruit damage and highest fruit yield. Removal of infested shoot and application of neem based pesticides/ Bt. have also been reported effective against shoot and fruit borer in brinjal by several workers (Mandal et al., 2008; Singh et al., 2008). Efficacy of different chemical insecticides against $L. orbonalis$ have also been reported by Jena et al. (2006), Anil and Sharma (2010), etc. Singh et al. (2008) recorded maximum net profit with spraying of quinalphos in brinjal crop.

The shoot and fruit damage of brinjal crop was recorded at fortnightly interval. Minimum (9.48%) and maximum (15.2 %) shoot damage was recorded at 90 DAT (3rd week of December) and at 30 DAT (3rd week of October), respectively (Table 2). Brinjal fruit damage was noticed minimum (11.95%) and maximum (24.57%) at 85 DAT (3rd week of December) and at 145 DAT (3rd week of February, Table 3), respectively. The shoot and fruit damage infestation at fortnightly interval differed significantly with few exceptions in case of shoot damage. The maximum fruit damage in 3rd week of February is may be due to moderate temperature (average temperature of both the years was min. 13.2ºC and max. 27.02ºC during February). This is in conformity with the findings of Dhamdhere et al. (1995) who observed that moderate temperature and high humidity favoured the population build up of brinjal shoot and fruit borer.

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