Avoidable yield loss in greengram due to major insect pests through insecticide spray schedules under field conditions

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Abstract
A field experiment was conducted at RARS, Lam Farm, Guntur to evaluate the spray schedules of insecticides in reducing the yield losses in greengram for two consecutive seasons i.e. during Rabi 2013-14 and 2014-15. Adoption of seed treatment with imidacloprid 600 FS @ 5.0 g/kg seed followed by one spray with either thiamethoxam 25 WG @ 0.2 g/lt or acetamiprid 20 SP @ 0.2 g/lt at 25 DAS and flubeniamide 39.35 % SC @ 0.2 g/lt or indoxacarb 14.5 % SC @ 1.0 ml/lt at 40 DAS gave higher seed yield due to less incidence of YMV coupled with low pod damage due to spotted pod borer in greengram. The avoidable yield loss was highest with flubeniamide 39.35 % SC @ 0.2 g/lt followed by indoxacarb 14.5 % SC @ 1.0 ml/lt and spinosad 45 SC @ 0.3 ml/lt when sprayed at 40 DAS thus helps in attaining high seed yield in greengram.

Keywords: insecticide spray schedule, avoidable yield loss, greengram

1. Introduction
Greengram (Vigna radiata (L.) Wilczek, otherwise known as mungbean is an important legume crop widely grown in many Asian countries. In India, it occupies third place after chickpea and pigeonpea. It is one of the most important short duration pulse crop grown in India and occupies an area of about 3 m.ha with a production of 0.25 m.t and 425 kg ha-1 productivity. Andhra Pradesh is the fourth major state in India contributing 15.5 per cent of the national production of greengram with 351 kg/ha average productivity [1]. In Andhra Pradesh, it is grown throughout the year, i.e as kharif crop, rabi crop both in uplands and rice fallows and also as summer crop. Due to its more luxuriant vegetative growth, number of insects attack from seedling to harvesting stage which is detrimental factor for production and causing severe yield losses [2]. Among the different biotic stresses, thrips and whiteflies at vegetative stage and spotted pod borer during flowering to pod formation stage are the major insect pests causing considerable yield loss in greengram in Andhra Pradesh. Both the thrips and whiteflies acts as vectors for viral diseases such as leaf curl and yellow mosaic virus disease (YMV), respectively. Hence, it is important to avoid the incidence of both the sucking pests rather than control to escape from the viral diseases and to obtain higher seed yield. Further, the larval incidence of Maruca occurs from 40 days after sowing in single flowers and cause considerable damage [3]. But farmers are realising the Maruca pod borer larval incidence only after noticing the webbings in floral parts. By that time significant damage already occurs and causing yield losses. Though the farmers are using new insecticides, they are unable to avoid yield loss due to the above insect pests because of several reasons. Timing of insecticidal application as foliar sprays is the most important basic requirement for effective control of insect pests in greengram [4]. Hence, in the present study, insecticidal schedule was evaluated besides evaluation of best combination of insecticides for scheduling the foliar sprays against major insect pests in greengram to avoid yield loss.

2. Materials and Methods
The present study field trials on evaluation of insecticides schedule were conducted at RARS, Lam Farm, Guntur for two consecutive seasons, i.e. during Rabi 2013-14 and 2014-15. The most popularly grown variety in Andhra Pradesh, LGG 460 was selected as test variety and the seed was sown in plots each measuring 20 sq.m at 30 x 10 cm spacing. The crop was sown during last week of October and harvested during third week of...
January during both the seasons. A total of 14 insecticide schedule treatments were evaluated including untreated control and each treatment was replicated thrice. The seed treatment with imidacloprid 600 FS @ 5.0 ml/kg seed was done commonly for all the treatments excluding untreated control. Two popularly used neonicotinoids i.e. thiamethoxam 25 WG and acetamiprid 20 SP were selected against sucking pests and six different molecules with different modes of action were selected against spotted pod borer for the present study. The conventional insecticides such as triazophos 40 EC and chlorpyriphos 50 EC were selected as standard insecticide checks against sucking pests and pod borer, respectively along with one untreated check. One spray was given at 25 DAS against sucking pests followed by second spray at 40 DAS against spotted pod borer using water volume of 500 liters per hectare. Observations were taken at one day before spraying as pre treatment count, as well as at 3 and 7 days after each application from five randomly selected plants per plot. The sucking pests such as thrips and whiteflies were counted from three trifoliate leaves each one from top, middle and bottom canopies, while the larvae and pod damage were counted on whole plant basis. The incidence of yellow mosaic virus (YMV) disease was recorded at 60 days after sowing from all the treatments. The seed yield was recorded from net plot and then converted to hectare basis. The data thus obtained from both the seasons regardless the pest incidence, disease incidence and yield was pooled and statistically analysed and presented hereunder.

The percentage reduction in the population of thrips, whiteflies and spotted pod borer larvae over untreated check in different treatments was computed using the modified Abbot’s formula \[\text{Percent population reduction} = \frac{(\text{Post treatment population in treatment}) - (\text{Pre treatment population in treatment})}{(\text{Post treatment population in the untreated check})} \times 100\]

The pod damage was recorded at the time of harvesting from 10 randomly selected plants and per cent pod damage was calculated as given below.

\[
\text{Per cent pod damage} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100
\]

The per cent avoidable yield loss due to insecticide schedule was calculated by using the formula given below \[\text{Avoidable yield loss} = \frac{(\text{Yield of Protected crop} - \text{Yield of Unprotected crop})}{\text{Total number of pods}} \times 100\]

The data thus obtained were analyzed statistically by ANOVA after converting it to suitable transformed values.

3. Results

3.1 Incidence of sucking pests

The data revealed that the per cent reduction in thrips population was slightly high with thiamethoxam 25 WG @ 0.2 g/lit (around 88 %) when compared to acetamiprid 20 SP @ 0.2 g/lit (around 86 %), but both were statistically on a par with each other. The trend was vice versa with whiteflies, since, the per cent reduction in whitefly population was comparatively high with acetamiprid 20 SP (more than 88 %) than with thiamethoxam 25 WG (around 86 %). However, both the insecticides were found significantly superior over the conventional insecticide check, triazophos 40 EC @ 1.0 ml/lit (around 73 %) and untreated check in reducing the population of both the thrips and whiteflies. The two insecticides tested against sucking pests i.e. thiamethoxam 25 WG and acetamiprid 20 SP were found effective against both the thrips and whiteflies in greengram (Table.1).

3.2 Incidence of YMV

The incidence of YMV was numerically low in acetamiprid 20 SP @ 0.2 g/lit treated plots (below 15 per cent) compared to thiamethoxam 25 WG @ 0.2 g/lit (18 - 22 per cent), but statistically there were no significant differences between both the treatments. Among the different insecticide schedule treatments, the incidence of YMV was highest (35.0 %) from conventional check, i.e. triazophos 40 EC @ 1.0 ml/lit at 25 DAS fb chlorpyriphos 50 EC @ 2.0 ml/lit at 40 DAS treated plots which was found statistically at a par with the untreated check which recorded 41.66 per cent incidence of YMV at 60 DAS (Table.1).

3.3 Incidence of Spotted pod borer and pod damage

Among the different molecules used in schedule, the per cent reduction in larval population of spotted pod borer over untreated control was high with flubendiamide 39.35 % SC @ 0.2 g/lit and it was found significantly superior with more than 80 per cent reduction in larval population over the remaining treatments. The next best treatments in the descending order of efficacy were indoxacarb 14.5 SC @ 1.0 ml/lit, novaluron 10 EC @ 1.0 ml/lit and spinosad 45 SC @ 0.3 ml/lit with more than 60 per cent reduction in larval population over untreated control and were found on par with each other. The other conventional insecticide, acephate 75 SP @ 1.0 g/lit recorded more than 50 per cent reduction in larval population over untreated control. However, all the treatments were found significantly superior over the insecticidal check, chlorpyriphos 50 EC @ 2.0 ml/lit (less than 45 %) and untreated check in reducing the larval population of spotted pod borer in greengram (Table.1).

The lowest pod damage was recorded from flubendiamide 39.35 % SC @ 0.2 g/lit treated plots (less than 6 %) which was due to highest per cent reduction in larval population of spotted pod borer and it was found significantly superior over the remaining treatments. The next best treatment was indoxacarb 14.5 SC (less than 10 %) followed by spinosad 45 SC @ 0.3 ml/lit (10-11.5 %) and novaluron 10 EC @ 1.0 ml/lit (around 16 %). The other treatment, acephate 75 SP @ 1.0 g/lit recorded around 20 per cent pod damage. However, all
the treatments were found significantly superior over the insecticidal check, chlorpyriphos 50 EC @ 2.0 ml/l (more than 25 %) and untreated check in reducing the pod damage by spotted pod borer in green gram (Table 1).

3.4 Seed Yield

The seed yield was ranged from 2.99 to 7.77 q/ha in different treatments. The seed yield was numerically highest from the plots treated with acetamiprid 20 SP @ 0.2 g/lit at 25 DAS fb flubendiamide 39.35 % SC @ 0.2 g/lit at 40 DAS but it was found statistically at a par with indoxacarb 14.5 SC @ 1.0 ml/l and spinosad 45 SC @ 0.3 ml/lit at 40 DAS. The seed yield was lowest (5.15 q/ha) from conventional check, i.e. triazophos 40 EC @ 1.0 ml/lit at 25 DAS fb chlorpyriphos 50 EC @ 2.0 ml/lit at 40 DAS treated plots. However, it was found significantly superior over the untreated check which recorded only 2.99 q/ha seed yield (Table 1).

3.5 Avoidable Yield loss (AYL %)

The avoidable yield loss was highest with acetamiprid 20 SP @ 0.2 g/lit at 25 DAS fb flubendiamide 39.35 % SC @ 0.2 g/lit at 40 DAS followed by thiamethoxam 25 WG @ 0.2 g/lit at 25 DAS fb flubendiamide 39.35 % SC @ 0.2 g/lit at 40 DAS. The avoidable yield loss was low (72.2 %) from conventional check, i.e. triazophos 40 EC @ 1.0 ml/lit at 25 DAS fb chlorpyriphos 50 EC @ 2.0 ml/lit at 40 DAS treated plots (Table 1).

Table 1: Mean efficacy of different insecticidal spray schedules against incidence of major pests, pod damage and yield (Pooled data of 2013-14 and 2014-15)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Insecticide</th>
<th>% Reduction over control Thriss</th>
<th>% Reduction over control WF</th>
<th>% Reduction over control YMV</th>
<th>% Pod Damage</th>
<th>Yield (Q/ha)</th>
<th>AYL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Thiamethoxam 25 WG @ 0.2 g/lit at 25 DAS fb</td>
<td>90.18 (71.78)</td>
<td>85.43 (67.59)</td>
<td>18.33 (24.74)</td>
<td>64.33 (53.35)</td>
<td>10.54 (18.95)</td>
<td>6.44 (115.4)</td>
</tr>
<tr>
<td>T2</td>
<td>Thiamethoxam 25 WG @ 0.2 g/lit at 25 DAS fb</td>
<td>88.81 (70.49)</td>
<td>84.69 (67.00)</td>
<td>18.33 (26.58)</td>
<td>69.95 (56.78)</td>
<td>9.78 (18.23)</td>
<td>6.69 (123.7)</td>
</tr>
<tr>
<td>T3</td>
<td>Thiamethoxam 25 WG @ 0.2 g/lit at 25 DAS fb</td>
<td>88.02 (69.78)</td>
<td>85.63 (67.76)</td>
<td>18.33 (25.36)</td>
<td>61.61 (64.64)</td>
<td>5.84 (13.99)</td>
<td>7.44 (148.8)</td>
</tr>
<tr>
<td>T4</td>
<td>Thiamethoxam 25 WG @ 0.2 g/lit at 25 DAS fb</td>
<td>88.17 (69.92)</td>
<td>83.59 (66.14)</td>
<td>20.00 (26.58)</td>
<td>67.41 (35.22)</td>
<td>16.51 (23.98)</td>
<td>6.04 (102.0)</td>
</tr>
<tr>
<td>T5</td>
<td>Thiamethoxam 25 WG @ 0.2 g/lit at 25 DAS fb</td>
<td>89.75 (71.36)</td>
<td>84.53 (66.94)</td>
<td>21.67 (27.76)</td>
<td>52.23 (46.30)</td>
<td>18.25 (25.30)</td>
<td>5.62 (88.0)</td>
</tr>
<tr>
<td>T6</td>
<td>Chlorpyriphos 50 EC @ 2.0 ml/lit at 40 DAS</td>
<td>88.11 (68.33)</td>
<td>86.32 (68.33)</td>
<td>20.00 (26.58)</td>
<td>43.62 (41.36)</td>
<td>26.63 (31.08)</td>
<td>5.29 (76.9)</td>
</tr>
<tr>
<td>T7</td>
<td>Acetamiprid 20 SP @ 0.2 g/lit at 25 DAS fb</td>
<td>86.27 (68.29)</td>
<td>89.39 (71.02)</td>
<td>11.67 (18.44)</td>
<td>63.69 (52.97)</td>
<td>11.49 (19.82)</td>
<td>6.56 (119.4)</td>
</tr>
<tr>
<td>T8</td>
<td>Acetamiprid 20 SP @ 0.2 g/lit at 25 DAS fb</td>
<td>86.06 (68.11)</td>
<td>88.92 (70.60)</td>
<td>13.33 (20.72)</td>
<td>70.76 (57.29)</td>
<td>9.87 (18.31)</td>
<td>6.92 (131.4)</td>
</tr>
<tr>
<td>T9</td>
<td>Acetamiprid 20 SP @ 0.2 g/lit at 25 DAS fb</td>
<td>85.77 (67.87)</td>
<td>88.68 (70.38)</td>
<td>13.33 (19.98)</td>
<td>81.70 (64.71)</td>
<td>5.18 (13.16)</td>
<td>7.77 (159.9)</td>
</tr>
<tr>
<td>T10</td>
<td>Acetamiprid 20 SP @ 0.2 g/lit at 25 DAS fb</td>
<td>85.71 (67.82)</td>
<td>89.08 (70.74)</td>
<td>13.33 (20.72)</td>
<td>65.56 (54.09)</td>
<td>15.95 (23.55)</td>
<td>6.25 (109.0)</td>
</tr>
<tr>
<td>T11</td>
<td>Acetamiprid 20 SP @ 0.2 g/lit at 25 DAS fb</td>
<td>85.63 (67.76)</td>
<td>92.05 (73.66)</td>
<td>11.67 (18.44)</td>
<td>53.62 (47.10)</td>
<td>19.03 (25.87)</td>
<td>5.81 (94.3)</td>
</tr>
<tr>
<td>T12</td>
<td>Acetamiprid 20 SP @ 0.2 g/lit at 25 DAS fb</td>
<td>86.83 (68.76)</td>
<td>91.80 (73.40)</td>
<td>13.33 (19.98)</td>
<td>45.68 (42.54)</td>
<td>25.89 (30.60)</td>
<td>5.54 (85.3)</td>
</tr>
<tr>
<td>T13</td>
<td>Triazophos 40 EC @ 1.0 ml/lit at 40 DAS</td>
<td>72.69 (58.52)</td>
<td>73.15 (58.82)</td>
<td>35.00 (36.29)</td>
<td>42.88 (40.93)</td>
<td>27.82 (31.85)</td>
<td>5.15 (72.2)</td>
</tr>
<tr>
<td>T14</td>
<td>Untreated control</td>
<td>0.00 (0.00)</td>
<td>0.00 (0.00)</td>
<td>41.67 (40.22)</td>
<td>0.00 (0.00)</td>
<td>43.68 (41.39)</td>
<td>2.99</td>
</tr>
<tr>
<td>CD (p=0.05)</td>
<td>9.55</td>
<td>7.69</td>
<td>7.10</td>
<td>2.73</td>
<td>2.25</td>
<td>1.50</td>
<td></td>
</tr>
<tr>
<td>CV %</td>
<td>8.90</td>
<td>7.15</td>
<td>16.20</td>
<td>7.10</td>
<td>6.20</td>
<td>13.00</td>
<td></td>
</tr>
</tbody>
</table>

* fb – followed by; AYL: Avoidable yield loss; DAS – Days after sowing
* Figures in parenthesis are arcsine transformed values

4. Discussion

The results obtained from the present study revealed that the seed treatment with imidacloprid 600 FS @ 5.0 ml/kg followed by foliar spraying with either of the neonicotinoids such as thiamethoxam 25 WG or acetamiprid 20 SP were found effective against both the thrips and whiteflies in greengram and able to reduce the incidence of YMV, if sprayed at appropriate time i.e at 20-25 days after sowing. The present findings are in accordance with many of the earlier reports. Foliar spray with thiamethoxam @ 0.2 g/lit was highly effective against whitefly in mungbean by recording minimum population (11.4/10 plants) at 15 days after spraying [7]. Foliar application of thiamethoxam 25 WG at 100 g a.i./ha resulted in more than 90 per cent reduction in the population of aphids, leafhoppers and whiteflies in cotton[8]. Foliar spray with acetamiprid 20 SP @ 40 g a.i./ha recorded highest reduction in whitefly population over untreated control in bhendi and least incidence of YYMV disease [9]. Thiamethoxam 25 WS @ 0.005 % was highly effective against whiteflies with the lowest population of 2.60 whiteflies/ plant and low MYMV incidence (10.7 %) in mungbean [10]. In Mesta, acetamiprid @ 0.2 g/lit and thiamethoxam @ 0.2 g/lit were found highly effective in reducing both the whitefly population and YMV disease [11]. In the present study, the conventional check, triazophos 40 EC @ 1.0 ml/lit was found less effective against both thrips and whiteflies when compared to the neonicotinoids which might be due to development resistance against triazophos. Guntur population of B. tabaci has developed 1.41 folds resistance to triazophos when compared with baseline data [12]. Among the different insecticides tested against spotted pod borer in the schedule, flubendiamide 39.35 % SC @ 0.2 g/lit was found significantly superior over the rests of the
treatments against pod borer and in reducing the pod damage. The next best treatments were indoxacarb 14.5 SC @ 1.0 ml/l, spinosad 45 SC @ 0.3 ml/l and novaluron 10 EC @ 1.0 ml/l with more than 60 per cent reduction in larval population of spotted pod borer. The efficacy of flubendiamide 39.35 % SC against different lepidopteron pests in different crops was reported by many of the earlier research workers [13, 14, 15]. The efficacy of spinosad 45 EC and indoxacarb 14.5 EC was proved against spotted pod borer in pigeon pea [16, 17]. The avoidable yield loss was slightly high with combination of acetamiprid 20 SP at 25 DAS irrespective of insecticide spray at 40 DAS. This can be attributed to the higher efficacy of acetamiprid 20 SP against whiteflies which flew numerically lower incidence of YMV when compared to thiamethoxam 25 WG treated plots. The effect of acetamiprid 20 SP is due to its systemic transaminar action and results in the destruction of hidden pests and assures the protection of young rapidly growing shoots. The present findings were in agreement with [18] who reported that, the ovicidal activity of foliar applications of acetamiprid 20 SP was 10-18 fold more potent than imidacloprid 200 SL under controlled conditions on cotton seedlings. The avoidable yield loss was highest with flubendiamide 39.35 % SC @ 0.2 g/l at 40 DAS either with acetamiprid 20 SP @ 0.2 g/l or thiamethoxam 25 WG @ 0.2 g/l at 25 DAS when compared to indoxacarb 14.5 SC @ 1.0 ml/l, spinosad 45 SC @ 0.3 ml/l and novaluron 10 EC @ 1.0 ml/l due to added suppression of spotted pod borer larvae and less pod damage.

5. Conclusion
Adoption of seed treatment with imidacloprid 600 FS followed by one spray with either thiamethoxam 25 WG or acetamiprid 20 SP at 25 DAS and flubendiamide 39.35 % SC or indoxacarb 14.5 % SC at 40 DAS provides the higher seed yield because of highest avoidable yield loss due to less incidence of YMV coupled with less pod damage by the spotted pod borer in greengram.

6. Acknowledgement
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7. References
1. AICRP on MULLARP Report. All India Co-ordinated Research Project on MULLaRP. Project Coordinator’s Report, 2014.