Field efficacy of selected insecticides against cowpea aphid, *Aphis craccivora* (Koch)

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Abstract

Field evaluation of new insecticide molecules for the management of Cowpea aphid and flea beetle was carried out in Student’s farm, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad during 2014-2015. The study revealed that the overall efficacy in reduction of aphid and flea beetle population over control clearly indicated that imidacloprid 17.5 SL @ 50 g a.i./ha (56.62%) and dimethoate 30 EC @ 300 g a.i./ha (55.60%) were superior than other molecules. The incremental cost: benefit ratio (ICBR) analysis of pesticidal treatments in cowpea showed that imidacloprid treated plot recorded highest average green fodder yield (10.47 t/ha) followed by dimethoate (9.73 t/ha), thiamethoxam (9.55 t/ha) and acetamiprid (9.55 t/ha). The other treatments recorded average green fodder yield of 8.81 t/ha (diazinon), 8.26 t/ha (spiromesifen), 8.17 t/ha (chlorfenapyr) and 7.52 t/ha (untreated control). The highest cost: benefit ratio was recorded by acetamiprid (1:1.59) followed by dimethoate (1:1.48) and imidacloprid (1:1.41). Thiamethoxam showed the next best ratio (1:1.33). Whereas, diafenthiuron, chlorfenapyr and spiromesifen had ICBR ratios of 1:1.17, 1:1.15 and 1:1.14, respectively.

Keywords: Field efficacy, newer molecules, percent reduction, ICBR

1. Introduction

Cowpea [*Vigna unguiculata* (L) Walp.] is a warm season annual leguminous fodder crop mainly grown in Northern and Central India [1,2]. Besides causing direct damage to the host by sucking the sap from various plant parts, they also lower the yield, quality and market ability of crops by transmitting plant viruses which result in early death of plants and the production of an excess of honey dew.

To protect the crops from aphids, insecticides are considered essential for their management. A large number of insecticides have been evaluated and recommended from time to time for their control [3]. In recent years, selective insecticides were introduced into the market instead of traditional insecticides because insect pests became resistant to conventional insecticides and are increasingly replacing the organophosphates and methyl carbamates [4].

The mode of action of neonicotinoid insecticides is modelled after the natural insecticide, nicotine. They act on the central nervous system of insects. Their action causes excitation of the nerves and eventual paralysis, which leads to death. Because they bind at a specific site (the postsynaptic nicotinic acetylcholine receptor), they are not cross-resistant to the carbamate, organophosphate, or synthetic pyrethroid insecticides, which was an impetus for their development. As a group, they are effective against sucking insects [5]. Diazinon, a thiourea derivative acts specifically on sucking pests such as mites, whiteflies and aphids [6-8]. Spiromesifen belongs to new class of chemicals called ketoenols and is a spirocyclic phenyl substituted tetronic acid derivative which acts on whiteflies, mites and other sucking pests. Chlorfenapyr, a member of the pyrrole group, is a pro-insecticide which uncouples oxidative phosphorylation at the mitochondria resulting in disruption of production of ATP, cellular death and ultimately mortality of the organism. In view of the resistance development to conventional insecticides and introduction of selective insecticides into the market, the present study is aimed to elucidate the effect of certain selected insecticides on *A. craccivora* under field conditions.

2. Material and methods

2.1 Field Studies

The present experiment was laid out in a randomized complete block design in the Student’s farm, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad during 2014-2015.
Cowpea variety KBC-2 was sown on October 31st 2014 as folded replication. The net plot size for each treatment was 5x4m and was replicated thrice. There were twelve rows in each plot, 30cm apart, while plant-to-plant distance was 10 cm. Fertilizers were applied at recommended doses (20:40:40NPK) as basal application and 25 DAS. The crop was irrigated at weekly intervals.

There were eight treatments including a control. Seven insecticides namely imidacloprid, thiamethoxam, acetamiprid, diafenthiuron, chlorfenapyr, spiromesifen and dimethoate were sprayed at recommended doses at 25 and 40 DAS. The population of aphids and flea beetles were counted from twenty plants, selected randomly in each treatment. The pre and post counts were taken as number of insects/ plant at 1,3 and 5 days after spraying in various treatments. At 55 DAS, the cowpea (green fodder) was harvested from each plot and yield in kg/plot for each of the treatments in the three replications was recorded.

2.2 Statistical Analysis
The data was subjected to angular transformation wherever necessary. Randomized block design analysis [9] was followed using OPSTAT. The values of percent reduction were transformed to angular values and subjected to analysis of variance to test the significance between treatments. Average yield (kg/plot) of green fodder for each of the treatments was calculated and converted to t/ha. The Incremental Cost: Benefit Ratio (ICBR) was also calculated.

3. Results and Discussion
3.1 Field efficacy of selected insecticides against insect pests of cowpea
3.1.1 Cowpea Aphid
Data on field efficacy of selected insecticides against cowpea aphid is presented in Table 1. The population of aphids before I and II spray ranged between 2.633 to 3.843 and 2.968 to 4.105 aphids/plant respectively. The results indicated that all treatments reduced pest population over untreated control at 1, 3 and 5 days after application. The reduction in population over control in different treatments ranged between 46.66% to 54.40%, 47.36% to 55.26% and 49.73% to 57.93% at 1, 3 and 5 days after first spray, respectively. The mean% reduction in population over control was highest in imidacloprid (55.33%). It was on par with dimethoate (54.60%) but significantly differed from the rest of the insecticides. Acetamiprid (50.81%), thiamethoxam (49.92%) and chlorfenapyr (49.54%) were statistically on par with each other and differed significantly from diafenthiuron (48.83%) and spiromesifen (47.89%).

After the second spray the reduction in population over control in different treatments ranged between 49.94% to 57.48%, 50.42% to 58.49% and 51.14% to 59.05% at 1, 3 and 5 days after application, respectively. The mean% reduction in population over control was highest with imidacloprid (57.91%). It was on par with dimethoate (56.60%) but significantly differed from the rest of the insecticides. Acetamiprid (53.24%), thiamethoxam (53.64%) and chlorfenapyr (53.44%) were statistically on par with each other and differed significantly from diafenthiuron (50.69%) and spiromesifen (50.51%).

The overall efficacy in % reduction of aphid population over control clearly indicated that imidacloprid 17.5 SL @ 50 g a.i./ha (56.62%) and dimethoate 30 EC @ 300 g a.i./ha (55.60%) were superior than acetamiprid 20 SP @ 15 g a.i./ha (52.02%), thiamethoxam 25 WG @ 50 g a.i./ha (51.78%) and chlorfenapyr 10 SC @100 g a.i./ha (51.49%), which in turn showed greater efficacy than diafenthiuron 50 WP @ 50 g a.i./ha (49.76%) and spiromesifen 22.9 SC @ 120 g a.i./ha (49.20%). These results corroborate the findings of earlier workers.

Khade et al. [10] reported highest percent reduction in population of sucking pests in cowpea by imidacloprid 17.8 SL @ 0.005% i.e. aphids – 76.83%, thrips - 76.37% and jassids – 73.44% and lowest in diafenthiuron 50 WP 1.2 g -1 i.e. aphids 73.95%, thrips -72.63% and jassids –70.08%. Mohamed and Aziza [11] also reported that thiamethoxam was the most effective followed by diafenthiuron (thiourea compounds), carbosulfan (carbamate) and fenvalerate (pyrethroid) against the different field strains of A. craccivora. Jehan et al. [12] reported that treatments with imidacloprid and thiamethoxam as foliar applications were highly effective against aphids up to 14 days in the case of jassids, while the effect was moderate on the whitefly population (mature and immature stages). Imidacloprid had more initial and residual effect than thiamethoxam against jassids on cotton crop. Preetha et al. [13] opined that imidacloprid 17.8 SL was quite promising in reducing the population of aphids and leafhoppers on cotton crop. Muhammad Afzal [14] showed that imidacloprid and diafenthiuron gave maximum mortality against sucking pests of cotton during first spray (92.42 and 88.56%) and second spray (90.87 and 85.67%) after 72 h of application. Fenpropatrin showed superior efficacy in bringing down all the sucking pest population of transgenic cotton followed by dimethoate, imidacloprid and the standard check, acetamiprid. Dimethoate and imidacloprid were most effective against aphids [15]. On the contrary, Patel [16] reported that diafenthiuron 50 SC @ 400 g a.i./ha was found to be the most effective and recorded maximum reduction in population of cotton aphid, with maximum increase in yield over control. However, thiamethoxam 25 WG 75 g a.i. /ha and imidacloprid 200 SL @ 100 g a.i. /ha were next effective chemicals.

Anjumoni et al. [17] showed that the lowest incidence and the highest population reduction of the mustard aphid population with imidacloprid at 30 g a.i./ha and the highest mean yield from the experimental trial treated with imidacloprid 30 g a.i./ha (7.32 q/ha). Gopal et al. [19] revealed that imidacloprid was most effective in control of mustard aphids followed by β-cyfluthrin, the residues being more in imidacloprid compared to β-cyfluthrin.

The insecticides Provado 1.6F (imidacloprid) and Actara 25WG (thiamethoxam) significantly suppressed the M. persicae population by 74.92 and 67.79%, respectively on two potato varieties [19]. Sarwar et al. [20] reported that imidacloprid, thiamethoxam and acetamiprid were superior in reducing the population of canola aphids. However, chlorpyrifos (16.2%) and dimethoate (17.5%) were also found to be effective in maintaining the aphid population at lower levels on canola (B. napus) crop.

3.1.2 Flea Beetle
Cowpea was infested with flea beetles (Brown flea beetle: Chaetocnema confinis, and Striped flea beetle: Phyllotreta striolata). The data recorded on the efficacy of selected insecticides against flea beetles is presented in table 2. The population of flea beetles before the I and II sprayings ranged between 0.222 to 0.513 and 0.300 to 0.565 beetles/plant respectively. The results indicated that all treatments reduced pest population over untreated control at
The reduction in population over control in different treatments ranged between 40.97% to 44.69%, 42.63% to 46.36%, 44.30% to 48.36% at 1, 3 and 5 days after first spray, respectively. The mean% reduction in population over control was highest in dimethoate (46.47%) followed by imidacloprid (44.59%) and acetamiprid (44.58%) but significantly differed from the rest of the insecticides. Dacifenthion (43.96%), spiroimesifen (43.95%) and chlorfenapyr (43.80%) were statistically on par with each other and differed significantly from thiamethoxam (42.63%). After the second spray the reduction in population over control in different treatments ranged between 42.77% to 46.17%, 43.63% to 47.73%, 45.00% to 49.27% at 1, 3 and 5 days after application, respectively. The mean% reduction in population over control was highest in dimethoate (47.72%) followed by imidacloprid (46.00%) and acetamiprid (45.83%) but significantly differed from the rest of the insecticides. Spiromesifen (45.02%), dacifenthion (44.90%) and chlorfenapyr (44.84%) were statistically on par with each other and differed significantly from thiamethoxam (43.17%). The overall efficacy in% reduction of flea beetle population over control clearly indicated that dimethoate 30 EC @ 300 g a.i./ha (47.09%), imidacloprid 17.5 SL @ 50 g a.i./ha (45.29%) and acetamiprid 20 SP @ 15 g a.i./ha (45.20%) were superior than spiroimesifen 22.9 SC @ 120 g a.i./ha (44.48%), dacifenthion 50 WP @ 50 g a.i./ha (44.43%) and chlorfenapyr 10 SC @ 100 g a.i./ha (44.32%) and thiamethoxam 25 WG @ 50 g a.i./ha (43.17%). Khuara et al. [21] reported that seed treatments with imidacloprid and thiamethoxam reduced flea beetle (Chaetocnema pulicaria Melsheimer) feeding injury to leaves in all the three varieties of sweet corn and reduced Stewart's bacterial wilt disease incidence in the susceptible variety ‘Sprint’.

### 3.2 Incremental Cost: Benefit Ratio (ICBR) analysis of insecticidal treatments in cowpea

The incremental cost: benefit ratio (ICBR) analysis of insecticidal treatments in cowpea is presented in table 3.

**Table 1: Mean aphid population and % reduction on different days before and after spray**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Dose (g a.i./ha)</th>
<th>(No. of aphids/plant)</th>
<th>First spray</th>
<th>Mean</th>
<th>(No. of aphids/plant)</th>
<th>First spray</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 DAS</td>
<td>3 DAS</td>
<td>5 DAS</td>
<td>Mean</td>
<td>1 DAS</td>
</tr>
<tr>
<td>Imidacloprid 17.8 SL</td>
<td>300</td>
<td>3.000</td>
<td>54.40</td>
<td>55.26</td>
<td>56.34</td>
<td>55.33</td>
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</tr>
<tr>
<td>Acetamiprid 20 SP</td>
<td>50</td>
<td>3.033</td>
<td>49.70</td>
<td>50.10</td>
<td>52.64</td>
<td>50.81</td>
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<tr>
<td>Thiamethoxam 25WG</td>
<td>15</td>
<td>3.100</td>
<td>49.39</td>
<td>49.47</td>
<td>50.92</td>
<td>49.92</td>
<td>2.968</td>
</tr>
<tr>
<td>Dacifenthion 50 WP</td>
<td>50</td>
<td>2.967</td>
<td>49.11</td>
<td>47.63</td>
<td>49.76</td>
<td>48.83</td>
<td>4.087</td>
</tr>
<tr>
<td>Chlorfenapyr 10 SC</td>
<td>100</td>
<td>3.483</td>
<td>48.10</td>
<td>49.47</td>
<td>51.05</td>
<td>49.54</td>
<td>3.367</td>
</tr>
<tr>
<td>Spiromesifen 22 SC</td>
<td>120</td>
<td>2.633</td>
<td>46.66</td>
<td>47.36</td>
<td>47.93</td>
<td>47.89</td>
<td>3.367</td>
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<td>Dimethoate 30 EC</td>
<td>50</td>
<td>3.417</td>
<td>52.73</td>
<td>53.15</td>
<td>57.93</td>
<td>54.60</td>
<td>3.717</td>
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<tr>
<td>Control</td>
<td>-</td>
<td>3.843</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>4.105</td>
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<tr>
<td>SE±</td>
<td>-</td>
<td>0.115</td>
<td>0.251</td>
<td>0.049</td>
<td>0.327</td>
<td>-</td>
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<tr>
<td>CD</td>
<td>-</td>
<td>0.357</td>
<td>0.782</td>
<td>0.152</td>
<td>1.019</td>
<td>-</td>
<td>0.260</td>
</tr>
</tbody>
</table>

Figures in parenthesis are angular/arcsine transformed values; DAS=Days after spray; *Pooled mean of three replications; BS=Before spray

Imidacloprid treated plots recorded highest average yield of green fodder (10.47 t/ha) followed by dimethoate (9.73 t/ha), thiamethoxam (9.55 t/ha) and acetamiprid (9.00 t/ha). The other treatments recorded average yield of (8.81 t/ha) diafenthion, (8.26 t/ha) spiroimesifen and (8.17 t/ha) chlorfenapyr and lowest in untreated control (7.52 t/ha). The highest cost: benefit ratio was recorded by acetamiprid (1:1.59) followed by dimethoate (1:1.48) and imidacloprid (1:1.41). The highest ICBR ratio of acetamiprid may be because of the low cost of treatment compared to imidacloprid and dimethoate. Thiamethoxam showed the next best ratio (1:1.33) whereas dacifenthion, chlorfenapyr and spiroimesfen had ratios of 1:1.17, 1:1.15 and 1:1.14, respectively. Gaikwad et al. [22] showed that dimethoate 0.03% and imidacloprid 0.004% were the most effective for the control of safflower aphids. Highest yield of safflower was recorded in dimethoate 0.03% but highest incremental cost benefit ratio was recorded in the application of imidacloprid 0.004% followed by dimethoate 0.03%. These results are in tune with the present findings. Khade et al. [23] indicated that with respect to yield, imidacloprid (17.8 SL) obtained maximum yield of cowpea (45.27 q/ha) with 20.40 q/ha increased yield over control. It was significantly superior over rest of the treatments, followed by dimethoate 30EC (43.25 q/ha), diafenthion (50WP) (41.95 q/ha) and Neem oil 1% (38.59) with 18.38 q/ha, 17.08 q/ha and 13.72q/ha increased yield over control, respectively and they were at par among themselves. Abdul et al. [24] reported highest marketable potato yield (34.58 mt/ha) in the plot treated with Systoate 40 EC (dimethoate), followed by 34.05 mt/ha and 33.95 mt/ha in plots treated with Confidor 200 SL (imidacloprid) and Primor 50 DG (pyrimicarb), respectively. The lowest marketable potato yield (29.58 mt/ha) was obtained in plot treated with Pan-star 20 EC (Chlorpyriphos). These results showed that Confidor 200 SL, Systoate 40 EC and Primor 50 DG could be used effectively for aphid management to increase marketable potato yield.
Vigna unguiculata and other crops. Brighton—


dother crops. Brighton—
Pieris brassicae

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4. Conclusion
From the present studies, it can be concluded that imidacloprid and dimethoate were most toxic among the seven selected insecticides against Cowpea pests. And also imidacloprid and dimethoate treated plots recorded highest yields of green fodder.

5. Acknowledgments
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6. References


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