In vitro comparative toxicity of different insecticides against adults of seven spotted beetle, Coccinella septempunctata L. (Coleoptera: Coccinellidae)

Talha Karamat Mughal, Zia Ullah, Muhammad Altaf Sabri, Saboor Ahmad and Dilbar Hussain

Abstract

Under the laboratory conditions (28 °C±1, 70 ± 5% relative humidity) a trial was conducted in the laboratory of Department of Entomology, University of Agriculture Faisalabad during 2012-13 to evaluate the effect of comparative toxicity of different insecticides against adults of the ladybird beetle (Coccinella septempunctata L.). In this experiment seven treatments used namely Ememectin Benzoate (Track® 10 EC), Indoxacarb (Steward® 150 EC), Imidachloprid (Crown® 70 WS), Chlorpyrifos (Helmat® 40 EC), Spinosad (Tracer® 480 SC), Leufenoron (Track® 10 EC) and Acetamaprid (Astarp® 250 WP). The experiment was laid out with five replications under Completely Randomized Design (CRD). Leaf dip bioassay method was used for Coccinella septempunctata L. Probit analysis was applied for statistical analysis. Our Results showed that the most toxic chemical was Chlorpyrifos that caused 100% mortality of adults of ladybird beetle after 72 hours and imidachloprid was the safest insecticide which can be included in integrated pest management practices. The order of toxicity on the basis of mortality was Chlorpyrifos > Indoxacarb > Spinosad > Acetamaprid > Ememectin Benzoate > Leufenoron > Imidachloprid.

Keywords: ladybird beetle, insecticides, toxicity, mortality

1. Introduction

Ladybird beetles are one of the most colorful insects in many parts of the world from a human perspective. Ladybird beetles are well known for their particular role in biological ecosystems [1]. These have valuable parts in our environment and have been used in different regions of the world to control pests such as thrips aphids, mealy bugs and mites. Therefore, this bio-agent has received much attention of researchers. Many efforts are being made to protect this predator from exposure of hazardous chemicals as this insect has become an important part of modern agriculture [2]. It is usually believed that there is an important role of natural enemies in regulating the pest populations. The most severe constraint to realizing the potential of natural enemies in field crops is disruption through the widespread use of insecticides with broad toxicity to both pest and their natural enemies [3]. The Coccinellidae predators can tolerate many insecticides which is an advantage over other predators. It is the most valuable bio control agent for the cotton pests, with its immature and mature stages. It is a voracious feeder of all the species of aphids [4, 5]. The extensive use of insecticides has deleterious influence on biological control agents in many crop systems, for example these insecticides have a direct or indirect effect on the population of parasitoids and predators. Sometime, the indiscriminate use of the insecticides adversely affect the population of these biological control agents and most of them killed by them. As a result of this, the natural pressure of these natural enemies on insect pests is decreased and outbreaks of the insect pests occur in many agricultural lands and sometime secondary insect pests abruptly become serious primary pests that cause economic losses to agricultural crops [6]. The use of insecticides accompanied with indigenous or exotic bio-control agents are considered as a rapid and effective control method for different insect pests with more interest [7, 8]. Problems such as insecticides resistance, pest resurgence and residues on crops are the result of the over use of Insecticides. This directed to the implementation of alternative pest management strategies, such as biological control.
Bio-control agents, such as predators and parasitoids, are considered as key tools in integrated insect pest management. The present project was undertaken to investigate the chemical effect of some insecticides on C. septempunctata L. in the laboratory conditions. So we had selected an insecticide which caused the minimum lethal effect on ladybird beetles among the insecticides selected for this purpose. It is hoped that in the future the outcome of present studies during integrated pest management (IPM) practices will be kept in consideration.

2. Materials and Methods
2.1 Adult beetles Collection: The adults of 7-spotted beetle (Coccinella septempunctata L.) were collected from the field and identified in the laboratory. These adults were placed in cages and aphids were given as food for them.

2.2 Insecticides Application: Adults ladybird beetles were used in our experiment for insecticides treatment. Seven insecticides viz., Emamectin Benzoate (Timer® 1.9 EC), Indoxacarb (Steward® 150 EC), Imidacloprid (Crown® 70 WS), Chlorpyrifos (Helmat® 40 EC), Spinosad (Tracer® 480 SC), Leufenoron (Track® 10 EC) and Acetamiprid (Astarp® 250 WP) were applied on 7-spotted ladybird beetle C. septempunctata L. by leaf dip bioassay method. Different field concentrations of the insecticides were used in this experiment which are given in the Table 1.

2.3 Data Analysis: After 24, 48 and 72 hours of treatment the leaves were observed for mortality of the adult beetles. Abbott’s formula was used for corrected mortality on untreated leaves. Data was analyzed by using probit Analysis.

3. Results
Our results showed that Imidacloprid gave minimum mortality at all the exposure times so it was the safest insecticide followed by Leufenuron which also gave less mortality and considered as safe a insecticide as compare to others. Imidacloprid showed 26.70%, 33.30% and 40% mortality of Coccinella septempunctata L. adults after 24, 48 and 72 hours of treatment respectively. While leufenuron caused 40%, 43.33% and 50% mortality after 24, 48 and 72 hours respectively. Emamectin benzoate caused 46.7%, 53.3% and 60% mortality of adults of C. septempunctata L. after 24, 48 and 72 hours respectively. Acetamiprid showed the 50%, 56.7% and 66.7% mortality after 24, 48 and 72 hours respectively, while spinosad caused 57%, 66.7% and 77% mortality of C. septempunctata L. adults after 24, 48 and 72 hours respectively. Indoxacarb caused 67%, 78% and 89% mortality C. septempunctata L. adults after 24, 48 and 72 hours respectively. Chlorpyrifos caused 82%, 89% and 100% mortality after 24, 48 and 72 hours respectively. Chlorpyrifos caused highest mortality of C. septempunctata L. adults as compared to the other insecticides used in our experiment after all times exposures. The order of toxicity on the basis of% mortality of Coccinella septempunctata L. was Chlorpyrifos > Indoxacarb > Spinosad > Acetamiprid > Emamectin benzoate > Leufenoron > Imidacloprid.

Mortality of all seven chemicals is shown below in (Table 2) and (figure 1).

<table>
<thead>
<tr>
<th>Chemical name</th>
<th>Trade Name</th>
<th>Formulations</th>
<th>Concentrations (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emamectin benzoate</td>
<td>Timer®</td>
<td>1.9 EC</td>
<td>152, 76, 38, 19, 9.5</td>
</tr>
<tr>
<td>Indoxacarb</td>
<td>Steward®</td>
<td>150 EC</td>
<td>1600, 800, 400, 200, 100</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>Crown®</td>
<td>70 WS</td>
<td>7000, 3500, 1750, 875, 437.5</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>Helmat®</td>
<td>40 EC</td>
<td>16000, 8000, 4000, 2000, 1000</td>
</tr>
<tr>
<td>Spinosad</td>
<td>Tracer®</td>
<td>480 SC</td>
<td>15360, 7680, 3840, 1920, 960</td>
</tr>
<tr>
<td>Leufenoron</td>
<td>Track®</td>
<td>10 EC</td>
<td>10000, 5000, 2500, 1250, 625</td>
</tr>
<tr>
<td>Acetamiprid</td>
<td>Astarp®</td>
<td>250 WP</td>
<td>152, 76, 38, 19, 9.5</td>
</tr>
</tbody>
</table>

| Table 2: % mortality of Coccinella septempunctata L. adults after 24, 48, 72 hours |
|---------------------------------|-----------------|-----------------|-----------------|
| Sr. No.                        | Insecticides    | %Mortality after 24 hours | %Mortality after 48 hours | %Mortality after 72 hours |
| 1                               | Imidacloprid    | 26.70%           | 33.30%           | 40%             |
| 2                               | Leufenoron      | 40%              | 43.33%           | 50%             |
| 3                               | Emamectin benzoate | 46.7%          | 53.3%           | 60%             |
| 4                               | Acetamiprid     | 50%              | 56.7%           | 66.7%           |
| 5                               | Spinosad        | 57%              | 66.7%           | 77%             |
| 6                               | Indoxacarb      | 67%              | 78%            | 89%             |
| 7                               | Chlorpyrifos    | 82%              | 89%            | 100%            |
In terms of LC$_{50}$ values Imadachloprid showed that the LC$_{50}$ values were 50235.1, 33078.6, 17098.7 ppm after 24, 48, and 72 hours against adults of C. septempunctata L. adults respectively. LC$_{50}$ values of Leufenoron were 25524.2, 19820.8, 11132.1 ppm after 24, 48, and 72 hours against C. septempunctata L. adults respectively. LC$_{50}$ values of Emamectin benzoate were 205.805, 128.342, 73.7211 ppm against adults of C. septempunctata L. adults after 24, 48, and 72 hours respectively. LC$_{50}$ values of Acetamiprid were 129.120, 64.9323, 29.1127 ppm against C. septempunctata L. adults after 24, 48, and 72 hours respectively. LC$_{50}$ values of Spinosad against C. septempunctata L. adults were 1715408, 754510 and 173160 ppm after 24, 48, and 72 hours respectively against C. septempunctata L. adults. LC$_{50}$ values of Spinosad against C. septempunctata L. adults were 7420.01, 3076.20, 1440.34 ppm respectively. LC$_{50}$ values of Indoxacarb against C. septempunctata L. adults after 24, 48, and 72 hours were 320.438, 147.533, 42.3656 ppm respectively. LC$_{50}$ values of Chlorpyrifos were 1292.46, 413.929, 257.357 ppm after 24, 48, and 72 hours against adults of C. septempunctata L. respectively. LC$_{50}$ values, fiducial limits and slope ± S.E are shown in (Table 3).

Table 3: LC$_{50}$ values of Insecticide after 24, 48 and 72 hours against adults of 7-spotted lady bird beetle (Coccinella septempunctata L.)

<table>
<thead>
<tr>
<th>Insecticides</th>
<th>Time (Hours)</th>
<th>LC$_{50}$ Values (ppm)</th>
<th>F.L (95%)</th>
<th>Slop ± S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imadachloprid</td>
<td>24</td>
<td>50235.1</td>
<td>0.319±0.1043</td>
<td></td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>33078.6</td>
<td>0.307±0.966</td>
<td></td>
</tr>
<tr>
<td></td>
<td>72</td>
<td>17098.7</td>
<td>0.314±0.909</td>
<td></td>
</tr>
<tr>
<td>Leufenoron 10 EC</td>
<td>24</td>
<td>25524.2</td>
<td>0.318±0.9357</td>
<td></td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>19820.8</td>
<td>0.293±0.9176</td>
<td></td>
</tr>
<tr>
<td></td>
<td>72</td>
<td>11132.1</td>
<td>0.314±0.8929</td>
<td></td>
</tr>
<tr>
<td>Emamectin benzoate 1.9 EC</td>
<td>24</td>
<td>205.805</td>
<td>0.314±0.4451</td>
<td></td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>128.342</td>
<td>0.260±0.4199</td>
<td></td>
</tr>
<tr>
<td></td>
<td>72</td>
<td>73.7211</td>
<td>0.265±0.4129</td>
<td></td>
</tr>
<tr>
<td>Acetamiprid 250 WP</td>
<td>24</td>
<td>129.120</td>
<td>0.292±0.4260</td>
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<tr>
<td></td>
<td>48</td>
<td>64.9323</td>
<td>0.263±0.4117</td>
<td></td>
</tr>
<tr>
<td></td>
<td>72</td>
<td>29.1127</td>
<td>0.249±0.4059</td>
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</tr>
<tr>
<td>Spinosad 480 SC</td>
<td>24</td>
<td>7420.01</td>
<td>0.319±0.8893</td>
<td></td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>3076.20</td>
<td>0.232±0.8816</td>
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</tr>
<tr>
<td></td>
<td>72</td>
<td>1440.34</td>
<td>0.267±0.8940</td>
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</tr>
<tr>
<td>Indoxacarb 150 EC</td>
<td>24</td>
<td>320.438</td>
<td>0.232±0.6436</td>
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<tr>
<td></td>
<td>48</td>
<td>147.533</td>
<td>0.282±0.6533</td>
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<td></td>
<td>72</td>
<td>42.3656</td>
<td>0.309±0.695</td>
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<tr>
<td>Chlorpyrifos 40 EC</td>
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<td>1292.46</td>
<td>0.316±0.9126</td>
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<td>48</td>
<td>413.929</td>
<td>0.349±0.9962</td>
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<td></td>
<td>72</td>
<td>257.357</td>
<td>0.473±1.2711</td>
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</tbody>
</table>

In terms of LC$_{90}$ values Imadachloprid showed LC$_{90}$ values 2779350, 2126436 and 1002834 ppm after 24, 48, and 72 hours against adults of C. septempunctata L. adults respectively. LC$_{90}$ values of Leufenoron were 1423405, 1571528 and 651923 ppm after 24, 48, and 72 hours respectively and LC$_{90}$ values of Emamectin benzoate were 12054.3, 17424.3 and 9215.0 ppm after 24, 48, and 72 hours respectively against C. septempunctata L. adults. LC$_{90}$ values of Acetamiprid were 10374.6, 8352.59 and 4947.09 ppm after 24, 48, and 72 hours respectively against C. septempunctata L. adults. LC$_{90}$ values of Spinosad were 1715408, 754510 and 173160 ppm after 24, 48, and 72 hours respectively against C. septempunctata L. adults. LC$_{90}$ values of Indoxacarb were 78594.8, 13882.9 and 2673.34 ppm after 24, 48, and 72 hours respectively against C. septempunctata L. adults. LC$_{90}$ values of Chlorpyrifos were 74349.8, 16126.3 and 3849.32 ppm after 24, 48, and 72 hours respectively against C. septempunctata L. adults. LC$_{90}$ values with fiducial limits and slope ± S.E are shown in (Table 4).
Table 4: LC50 values of Insecticide after 24, 48 and 72 hours against adults of 7-spotted lady bird beetle (Coccinella septempunctata L.)

<table>
<thead>
<tr>
<th>Insecticides</th>
<th>Time (Hours)</th>
<th>LC50 Values(ppm)</th>
<th>F.L (95%)</th>
<th>Slop ± S.E</th>
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<tr>
<td>Imidachloprid 70 WS</td>
<td>24</td>
<td>277930</td>
<td>105274-10810</td>
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<td>48</td>
<td>2120436</td>
<td>2126436-140002</td>
<td>0.307±0.966</td>
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<tr>
<td></td>
<td>72</td>
<td>1002834</td>
<td>68504.9-374456</td>
<td>0.314±0.909</td>
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<tr>
<td>Leufenoron 10 EC</td>
<td>24</td>
<td>1423405</td>
<td>98830.1-322823</td>
<td>0.318±0.9574</td>
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<td></td>
<td>48</td>
<td>1517528</td>
<td>95614.1-173479</td>
<td>0.293±0.9176</td>
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<td></td>
<td>72</td>
<td>651923</td>
<td>65230.9-190486</td>
<td>0.314±0.8929</td>
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<td>Emamectin benzoate 1.9 EC</td>
<td>24</td>
<td>120543</td>
<td>1086.08-172035</td>
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<td>48</td>
<td>174243.3</td>
<td>1055.41-480558</td>
<td>0.269±0.4199</td>
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<td>72</td>
<td>9215.03</td>
<td>9215.03-419676</td>
<td>0.265±0.4129</td>
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<tr>
<td>Acetamiprid 250 WP</td>
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<td>10374.6</td>
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<td>0.292±0.4260</td>
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<td>8352.59</td>
<td>714.616-386165</td>
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<td>4947.09</td>
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<td>Spinosad 480 SC</td>
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<td>0.319±0.8893</td>
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<td>57357.3-177707</td>
<td>0.232±0.8816</td>
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<td>72</td>
<td>173160</td>
<td>28546.1-498497</td>
<td>0.267±0.8940</td>
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<tr>
<td>Indoxacarb 150 EC</td>
<td>24</td>
<td>78594.8</td>
<td>5974.72-185111</td>
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<td></td>
<td>48</td>
<td>138829.2</td>
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<td>2673.34</td>
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<td>0.309±0.695</td>
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<td>Chlorpyrifos 40 EC</td>
<td>24</td>
<td>74349.8</td>
<td>19793.8-54343886</td>
<td>0.316±0.9126</td>
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<tr>
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<td>48</td>
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<td>7020.46-602361</td>
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<td>72</td>
<td>3849.32</td>
<td>2123.48-12846.9</td>
<td>0.473±1.2711</td>
</tr>
</tbody>
</table>

4. Discussion
In our results imidacloprid was the safest insecticide which caused the less mortality. Bozsik observed the mortality of C. septempunctata by using some common insecticides including Imidacloprid and he observed that imidacloprid was seem to be safe for C. septempunctata adults according to different sorts of assessment.[13]. These results were similar as the results of our experiment. Ahmad et al.,[14] also conducted an experiment who evaluated that the imidacloprid was the nontoxic insecticide for ladybird beetles which caused the lowest mortality. While according to the results of Gour and Pareek[15] imidicloprid was in moderate group of toxicity to the ladybird beetles. Their difference with our results may be due to difference in concentrations or time for exposure. Asin and Pons resulted that the applications of emamectin benzoate were reasonably safe[16]. Emamectin benzoate was less toxic to ladybird beetles according to the results of Mollah et al.,[17]. In our results Emamectin benzoate was observed as moderate toxic insecticides. Our results were different with the above findings that may be due to the difference in concentrations, exposure time or exposure method. Moderate to high acute toxicity was shown in experiments of Tomlin by acetamiprid[18]. Acetamiprid showed least toxicity to the grubs (larvae of beetles). Acetamiprid gave significantly less mortality in the results of Tank et al.,[19]. While our results showed that acetamiprid was moderately toxic to the ladybird beetles. Our results varied which may be due to the concentrations difference, exposure time or stage of the tested insects. Solangi et al.,[20] used some insecticides in their experiments and they observed that tracer (spinosid) showed less toxicity while our results showed that tracer caused moderate mortality to the C. septempunctata. The difference in our results with solangi et al.,[20] may be due to differences in the stage of testing insect (he tested spinosid on the larval stage of 7-spotted ladybird beetle while in our experiment adults of Coccinella septempunctata L. were exposed to this chemical). Galvan et al.,[21] tested indoxacarb and some other chemicals against Harmonia axyridis (Coleoptera: Coccinellidae). He concluded that indoxacarb moderate toxic to the H. axyridis. In our results indoxacarb caused high mortality of Coccinella septempunctata L. Our results were different from the results of Galvan et al.,[21] may be due to the different species, exposure time and insecticides application methods. The effects of some natural and synthetic insecticides including lufenuron were evaluated by Tavares et al.,[22] to assess the mortality of Spodoptera frugiperda (Lepidoptera: Noctuidae) and its predator Eriopis connexa (Coleoptera: Coccinellidae). Lufenuron caused high mortality of S. frugiperda and E. connexa larvae. Our results were different to Tavares et al.,[22] may be due to the species difference, insect stage or may be due to the different concentrations of the chemical. According to Thomas and Phadke[23] Chlorpyrifos was more toxic to all the stages of the coccinellids as compared to the other chemicals used in this experiment. Bostanian et al.,[24] also observed that chlorpyrifos was very toxic to the adult beetles when compared with other insecticides. Our results also matched to the all above discussed results for chlorpyrifos. Pasqualini and Civolani[25] also observed the toxicity of chlorpyrifos was moderate to high but in our results chlorpyrifos showed high toxicity, this little difference in the results may be due to the difference in concentration or exposure time.

5. Conclusion
It is concluded that all chemicals caused mortality of Coccinella septempunctata L. adults but chlorpyrifos were the most toxic insecticides in our experiment and it caused highest mortality of the adults. In our experiment Imidacloprid was safest insecticide as caused lowest mortality of the C. septempunctata adults and this can be included in the integrated pest management (IPM) for the best control of insect pests.

6. Acknowledgment
Facilities provided by Ayub Agriculture Research Institute, Faisalabad, Pakistan and Entomology Department, University of Agriculture Faisalabad, Pakistan were highly acknowledged and thanks to our friends and laboratory staff for their valuable help during our research project.

7. References


