SEARCHING ABILITY AND FEEDING POTENTIAL OF LARVAE, 7-SPOTTED BEETLE COCCINELLA SEPTEMPUNCTATA LINN. UNDER LABORATORY AND FIELD CONDITIONS

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ABSTRACT
A field study was carried out to investigate the searching behaviour and feeding potential of 7-spotted beetle on mustard aphid was conducted at Department of Entomology, Sindh Agriculture University, Tandojam during 2005. It was observed that aphid consumption of the 1st, 2nd, 3rd and 4th instar grubs of 7-spotted beetle, Coccinella septempunctata, was affected significantly (P<0.05) by host density. The aphid consumed under host density of 10 was 1.1 ±0.10, 1.65 ±0.96, 1.95 ± 0.09 and 2.8 ± 0.14 in lab and 0.92 ±0.09, 1.35 ± 0.09, 1.75 ± 0.09 and 2.55 ± 0.15/ beetle under field conditions by 1st, 2nd, 3rd and 4th instar grubs of 7-spotted ladybird beetle, respectively. Aphid consumption increased significantly with increasing host density and it was 1.65 ± 0.05, 2.0 ± 0.11, 2.65 ± 0.18 and 3.95 ± 0.20/beetle under lab conditions and 1.4± 0.00, 1.95 ± 0.23, 1.3 ± 0.19, 3.67 ± 0.30/beetle under field conditions by 1st, 2nd, 3rd and 4th instar grubs under the host density of 30 aphids, respectively. Searching distance covered by the 1st, 2nd, 3rd and 4th instar grubs under host density of 10 was 15.56 ±1.54, 21.69 ± 1.05, 28.35 ± 0.98 and 37.91 ±1.96 cm in lab and 24.56 ± 1.33, 31.64 ± 1.34, 38.68 ± 1.11 and 46.39 ± 1.19 cm under field conditions, respectively. Searching distance decreased with increasing host density and under host density of 30 searching distance was 10.26 ± 0.80, 16.92 ±1.04, 22.43 ± 0.99 and 33.41 ± 1.84 cm in lab and 19.91 ± 1.37, 27.02 ± 1.24, 33.58 ± 1.40 and 41.51 ± 1.67 cm/beetle in the field by 1st, 2nd, 3rd and 4th instar grubs, respectively. Searching distance of ladybird beetles under field conditions was significantly greater as compared to those under laboratory conditions, because the beetles had unlimited area in field to move and searched freely for their food and hence covered more distance as compared to laboratory conditions.

INTRODUCTION
Insect pests have always been a threat to agriculture productivity in Pakistan, in result the crop productivity per unit area is still far less than the potential exists or when comparison is made with the achievements of advanced agricultural countries of the world. Thus for controlling these harmful insects, different chemicals (pesticides) are applied against different insect pests (Pearson, 2004). The farmers spray toxic chemicals (pesticides) on cotton, vegetables, oilseeds and fruit crops in order to avoid the pest infestation. Due to the intensive and indiscriminate use of many pesticides poison, people suffer from many diseases, and some of these are chronic for human beings. Use of pesticides has resulted in the environmental pollution on large scale. Besides contaminating food and food products, pesticides have been accumulating in the soil, air and water to a critical stage. This calls for a safe and cheap control method. This can only be achieved by the practice of Integrated Pest Management (IPM); a pest control management which ensures environmental safety (Solangi, 2004).

7-spotted ladybird beetle, Coccinella septempunctata L., is one of the most common predators, which can consume its weight in 40 aphids daily as a mature grub (larva) and as many as 53 aphids daily as an adult. Ladybird beetles have been imported to control outbreaks of aphids and scale insects. They have hardened front wings that do not beat up and down. They provide lift that helps the lady bug stay in the air. Before it can fly, a lady bug opens its front wings and unfold its back wings. The front wings swing outwards, and when the back wings are beating fast enough, the lady beetles takes off. The bright colours of ladybird beetles warn enemies that they have a bitter taste. The spots of each species are arranged in a different pattern.

They are of very great importance in reducing the number of injurious species. The carnivorous characterized by the mandibles having simple or bifid apices and each jaw being armed with a basal tooth. These are most important of all predators. They are active in both the larval and the adult condition and have a considerable range of prey, which includes some of the most destructive groups of insects, notably the aphids and the scale insects. 7-spotted ladybird beetles are predaceous on aphids, mealy bugs, sugarcane aleyrodid, citrus psyllid, mites and sorghum stem borer, Chilo partellus. The larvae of aphid fly, Syrpus baleatus (Degean) are also important predators of aphids. These predators have high potential of predation both in the immature as well as adult stage (Shepard, 1998).

Keeping in view the significance of predator (7-spotted ladybird beetle) for a safest control
of insect pest (mustard aphid), the present study was performed to investigate its searching behaviour for feeding on mustard aphid. The findings of the study will surely be helpful for the future research for planning the control of mustard aphid under field conditions under agro-ecological conditions of Tandojam.

MATERIALS AND METHODS

FEEDING POTENTIALS
The grubs of first, second, third and fourth instars of *C. septempunctata* were obtained from the culture maintained in the laboratory for experimentation. Each grub of respective instar was provided with 50 aphids, (*Lipaphis erysimi* Kalt.) in paired petridishes along with mustard leaves. The experiment in each case was replicated five times. The consumption of aphids was recorded daily (by counting unconsumed aphids) and continued till grub entered into the next development stage. The record of dead aphid (beetle injured) in each petridish was also maintained.

Searching Ability

Searching Efficiency of *C. septempunctata* in Laboratory
For the searching efficiency of 7-spotted beetle, *C. septempunctata* mustard plants were grown in pots and were kept in the cage in laboratory. For the researching efficiency, the adults male and female were brought in the laboratory for oviposition to get 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} instars of *C. septempunctata* for this experiments. The searching efficiency of 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} instar of *C. septempunctata* to aphid on mustard crop was recorded. For this experiment adults male and female and their grubs (1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} instar) were placed at the base of the stem of mustard plant and the number of aphids (10,15,25 and 30) were glued on the ventral side on the different leaves of mustard plant. The searching efficiency of grubs *C. septempunctata* were observed at 20 minute fixed time. During the experiment period, consumption which was glued also recorded.

Searching Efficiency of *C. septempunctata* in Field
For observing searching efficiency of 7-spotted beetle *C. septempunctata* the mustard crop was sown in the field of plant protection faculty. For taking the observation, twenty-five plants were randomly selected in mustard field. The selected plants were tagged for trial purpose laboratory reared grubs such as 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} instar and adults of *C. septempunctata* were released at the base of stem of those tagged plants separately. For the searching efficiency of larvae *C. septempunctata* were observed at 20 minute fixed time, and larvae distance covered and aphid consumption was also recorded.

Statistical Analysis of Data
The data thus collected on plant basis were arranged replication wise for working out analysis of variance to assess the significance of the differences in aphid consumption and searching distance covered by *C. septempunctata* upto 4\textsuperscript{th} instar of grubs and comparison was made both for aphid consumption and searching ability between male and female adults.

RESULT AND DISCUSSION

Aphid Consumption (Instar)
Aphid consumption of the 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} instar grubs of the 7-spotted beetle *C. septempunctata* was affected significantly (P<0.05) by host density (Table-1). The aphid consumed under host density of 10 was 1.10 ± 0.10, 1.65 ± 0.96, 1.95 ± 0.09, and 2.8 ± 0.14/beetle under laboratory conditions, while it was 0.92 ± 0.09, 1.35 ± 0.09, 1.75 ± 0.09 and 2.55 ± 0.15/beetle under field conditions by 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} instar grubs of 7-spotted ladybird beetle, respectively. Aphid consumption under host density of 15 was 1.25 ± 0.12, 1.70 ± 0.05, 1.95 ± 0.09 and 2.85 ± 0.15/beetle under laboratory conditions, while it was 0.95 ± 0.09, 1.45 ± 0.09, 1.75 ± 0.09 and 2.5 ± 0.10/beetle under field conditions by 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} instar ladybird grubs, respectively.

Aphid consumption under host density of 20 was 1.55 ± 0.12, 1.80 ± 0.00, 2.35 ± 0.09 and 3.30 ± 0.42/beetle under laboratory conditions, while it was 1.20 ± 0.82, 1.55 ± 0.05, 2.10 ± 0.05 and 3.05 ± 0.25/beetle under field conditions by 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} instar ladybird grubs, respectively. Similarly, under host density of 25, the consumption was 1.60 ± 0.82, 1.90± 0.05, 2.6 ± 0.14, 3.65 ± 0.26/beetle under laboratory conditions, while it was 1.35 ± 0.05, 1.70 ± 0.05, 2.20 ± 0.14, 3.40 ± 0.23/beetle under field conditions by 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} instar ladybird grubs, respectively.

The aphid consumption under 30 host density was 1.65 ± 0.05, 2.0 ± 0.11, 2.65 ± 0.18 and
3.95 ± 0.20/beetle under laboratory conditions and 1.40 ± 0.00, 1.95 ± 0.23, 1.30 ± 0.19, 3.67 ± 0.30/beetle under field conditions by 1st, 2nd, 3rd and 4th instar grubs, respectively. It was observed that aphid consumption was significantly (P<0.05) higher in case of 4th instar grubs of ladybirds as compared to 1st, 2nd, 3rd and 4th, might be due to advancement in age of insects. Moreover, the aphid consumption under laboratory conditions of the ladybirds was significantly (P<0.05) higher as compared to those under field conditions. This was happened due to the fact that under laboratory conditions, the beetles had less area to move and hence their activity was only to feed on aphids, while under field conditions, the beetles cover more distance and spent greater time in searching the aphid.

Searching Distance (Instars)

Distance covered (searching behaviour) by the 1st, 2nd, 3rd and 4th instar grubs of the 7-spotted beetle Coccinella septempunctata was affected significantly (P<0.05) by host density (Table-II). The distance covered by the ladybird beetle under host density of 10 was 15.56 ± 1.54, 21.69 ± 1.05, 28.35 ± 0.98 and 37.91 ± 1.96 cm under laboratory conditions, while it was 24.56 ± 1.33, 31.64 ± 1.34, 38.68 ± 1.11 and 46.39 ± 1.19 cm under field conditions by 1st, 2nd, 3rd and 4th instar grubs of 7-spotted ladybird beetle, respectively. searching distance under host density of 15 was 15.13 ± 1.08, 21.55 ± 1.97, 26.06 ± 1.04 and 37.13 ± 1.77 cm/beetle under laboratory conditions, while it was 23.81 ± 0.39, 30.74 ± 1.31, 37.46 ± 1.35 and 45.51 ± 1.38 cm/beetle under field conditions by 1st, 2nd, 3rd and 4th instar ladybird grubs, respectively.

The searching distance covered by ladybird beetles under host density of 20 was 13.17 ± 1.78, 19.14 ± 1.44, 26.02 ± 0.79 and 26.21 ± 1.80 cm/beetle under laboratory conditions, while it was 22.53 ± 0.15, 29.81 ± 1.32, 29.09 ± 1.43 and 44.47 ± 1.53 cm/beetles under field conditions by 1st, 2nd, 3rd and 4th instar ladybird grubs, respectively. Similarly, under host density of 25, searching distance was 11.42 ± 1.83, 19.36 ± 1.03, 23.30 ± 1.13 and 34.18 ± 1.66 cm/beetle under laboratory conditions, while it was 20.74 ± 1.83, 27.4 ± 1.81, 34.4 ± 1.32 and 39.90 ± 1.65 cm beetle under field conditions by 1st, 2nd, 3rd and 4th instar grubs, respectively. The searching distance covered by ladybird beetle under 30 host densities was 10.26 ± 0.80, 16.92 ± 1.04, 22.43 ± 0.99 and 33.41 ± 1.84 cm/beetle under laboratory conditions and 19.91 ± 1.37, 27.02 ± 1.24, 33.58 ± 1.40 and 41.51 ± 1.67 cm/beetle under field conditions by 1st, 2nd, 3rd and 4th instar grubs, respectively.

The searching distance covered by 7-spotted ladybird beetle was significantly (P<0.05) higher in case of 4th instar grubs as compared to 1st, 2nd and 3rd instars, and this increased searching distance was mainly associated with advancement in age of the beetles, required more food to consume and hence more distance was covered to fulfil their food requirement. Furthermore, the searching distance of ladybird beetles under field conditions was significantly (P<0.05) greater as compared to those under laboratory conditions. This was happened due to the fact that under field conditions, the beetles had unlimited area to move and searched freely for the insect pests for their food and hence more distance was covered. While, under laboratory conditions, the ladybird beetles were under a controlled area and they could not move freely and hence less distance was covered. The results further revealed that under higher host density, less distance was covered by the ladybirds as compared to those under lower host density. It was mainly due to the fact that due to relatively easy available aphids under higher host density, the beetles moved relatively lesser and managed their food. While, under low host density beetles were impelled to search greater and hence more searching distance was recorded.

The aphid consumption was significantly (P<0.05) higher in case of 4th instar grubs of ladybirds as compared to 1st, 2nd and 3rd instars, might be due to advancement in age of insects. Moreover, the aphid consumption under laboratory conditions of the ladybirds was significantly (P<0.05) higher as compared to those under field conditions. This was happened due to the fact that under laboratory conditions, the beetles had less area to move and hence their activity was only to feed on aphids, while under field conditions, the beetles cover more distance and spent greater time in searching the aphid. These results are further supported by Ali et al. (1994), Alamgeer et al. (1999), Gautam et al. (2002) and Omkar et al. (2003).

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more food to consume and hence more distance was covered to fulfil their food requirement. Furthermore, the searching distance of ladybird beetles under field conditions was significantly (P<0.05) greater as compared to those under laboratory conditions. This was happened due to the fact that under field conditions, the beetles had unlimited area to move and searched freely for the insect pests for their food and hence more distance was covered. While, under laboratory conditions, the ladybird beetles were under a controlled area and they could not move freely and hence less distance was covered. The results further revealed that under higher host density, less distance was covered by the ladybirds as compared to those under lower host density. It was mainly due to the fact that under higher host density, the beetles moved relatively lesser and consumed more aphids as food; while, under low host density beetles were impelled to search greater and hence more searching distance was recorded. Similar results have also been recorded by Carter et al. (1984), Gour and Pareek (2003) Omkar et al. (2003) and Takahashi (1993).

CONCLUSIONS
i. The aphid consumption was significantly higher in 4th instar grubs of ladybirds as compared to 1st, 2nd and 3rd instars.

ii. Searching distance covered by 7-spotted ladybird beetle was significantly higher in case of 4th instar grubs as compared to 1st, 2nd and 3rd instars.

iii. Searching distance of ladybird beetles under field conditions was significantly greater as compared to those under laboratory conditions, because the beetles had unlimited area in field to move and searched freely for their food and hence more distance as compared to laboratory conditions.

iv. Under higher host density, less distance was covered by the ladybirds as compared to those under lower host density.
Table-I  Effect of host density on feeding rate of different larval instars of Coccinella septempunctata reared on Lipaphis erysimi L. under laboratory and field conditions

<table>
<thead>
<tr>
<th>Host density</th>
<th>Level</th>
<th>Feeding rate/larva of C. septempunctata</th>
<th>Instars</th>
</tr>
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<tr>
<td></td>
<td></td>
<td>1\textsuperscript{st}</td>
<td>2\textsuperscript{nd}</td>
</tr>
<tr>
<td>10</td>
<td>Lab</td>
<td>1.10 ± 0.10</td>
<td>1.65 ± 0.96</td>
</tr>
<tr>
<td></td>
<td>Field</td>
<td>0.92 ± 0.09</td>
<td>1.35 ± 0.09</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>1.25 ± 0.12</td>
<td>1.70 ± 0.05</td>
</tr>
<tr>
<td>15</td>
<td>Field</td>
<td>0.95 ± 0.09</td>
<td>1.45 ± 0.09</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>1.55 ± 0.12</td>
<td>1.80 ± 0.00</td>
</tr>
<tr>
<td>20</td>
<td>Field</td>
<td>1.20 ± 0.82</td>
<td>1.55 ± 0.05</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>1.60 ± 0.82</td>
<td>1.90 ± 0.05</td>
</tr>
<tr>
<td>25</td>
<td>Field</td>
<td>1.35 ± 0.05</td>
<td>1.70 ± 0.05</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>1.65 ± 0.05</td>
<td>2.00 ± 0.11</td>
</tr>
<tr>
<td>30</td>
<td>Field</td>
<td>1.40 ± 0.00</td>
<td>1.95 ± 0.23</td>
</tr>
</tbody>
</table>

Interaction (Lab and Field) =P<0.01
Host density =P<0.01
Replications =P<0.01

L= Laboratory reared
F= Field reared
### Table-II

Effect of host density on searching behavior (distance covered) by different larval instars of *Coccinella septempunctata* under laboratory and field condition

<table>
<thead>
<tr>
<th>Host density</th>
<th>Level</th>
<th>Searching behaviour of larval instar <em>C. septempunctata</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Instars</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1(^{st})</td>
</tr>
<tr>
<td>10</td>
<td>Lab</td>
<td>15.56 ± 1.54</td>
</tr>
<tr>
<td></td>
<td>Field</td>
<td>24.56 ± 1.33</td>
</tr>
<tr>
<td>15</td>
<td>Lab</td>
<td>15.13 ± 1.08</td>
</tr>
<tr>
<td></td>
<td>Field</td>
<td>23.81 ± 0.39</td>
</tr>
<tr>
<td>20</td>
<td>Field</td>
<td>22.53 ± 0.15</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>11.42 ± 1.83</td>
</tr>
<tr>
<td>25</td>
<td>Field</td>
<td>20.74 ± 1.83</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>10.26 ± 0.80</td>
</tr>
<tr>
<td>30</td>
<td>Field</td>
<td>19.91 ± 1.37</td>
</tr>
</tbody>
</table>

Interaction (Lab and Field) = P<0.01  
Host density = P<0.01  
Replications = P<0.01

**REFERENCES**

- Alamgeer, S., A. Kumar, N. Kumar and C.P.M. Tripathi. 1999. Pre-predator relationship between *Lipaphis erysimi* Kalt. (Homoptera Aphididae) and *Coccinella septempunctata* Linn. (Coleoptera: Coccinellidae); Biolog. Agric. and Hort. 17 (1): 11-17.

