Evaluation of efficacy of predators against green apple aphid (*Aphis pomi*) in apple orchards and cabbage aphid (*Brevicoryne brassicae*) in cabbage field of Kashmir

Akhtar Ali Khan, Shazia Riyaz and Ajaz Ahmad Kundoo

**Abstract**

The experiment was conducted to evaluate the efficacy of natural enemies against green apple aphid, *Aphis pomi*, and cabbage aphid, *Brevicoryne brassicae*, in cabbage field. 2nd and 3rd instar larvae of three species of coccinellids viz., *Coccinella septempunctata*, *Adalia trivittata* and *Hippodamia convergens* and one species of chrysopids (*Chrysoperla carnea*) were released @ 30/tree (4 weekly release) in apple orchards of Pattan of district Baramulla and 5/plant in cabbage of farmer field Narkara of district Budgam with a treated check (Imidacloprid 17.8SL @ 0.28ml/Liter of water) and with an untreated check (use water only) for experiments in both the cases during 2014. Both the stages were monitored for their efficacy on apple aphid and cabbage aphid on the ‘Red delicious’ varieties and ‘Golden Acre’ variety of cabbage respectively. The 3rd instar stage of *Coccinella septempunctata* exhibited best performance on the basis of reduction of green apple aphid (62.00%) and cabbage aphid (63.98%) with highest recovery of 52.00% and 54.4%, respectively. Hence, *Coccinella septempunctata* may be considered as a potential bio-control agent against green apple aphid and cabbage aphid in respective ecosystems of Kashmir.

**Keywords:** Biological Control, efficacy, predators, *Aphis pomi*, *Brevicoryne brassicae*, Apple orchards, cabbage field

**Introduction**

Aphids are an extremely successful group that occurs throughout the world [1]. So far 800 species of aphids have been described from India [2]. The green apple aphid, *Aphis pomi* De Geer (Hemiptera: Aphididae), is a holocyclic and monoeiotic aphid species that is widespread in Kashmir region [3]. It is one of the most important pests in apple orchards with infestation occurring regularly each year [4]. Continuous feeding by aphid causes yellowing, wilting and stunting of plant [5]. Sever infestation may curl leaves [6], reduce tree growth and non-structural carbohydrate concentration in young apple tree over the period of May–June [7] and decrease fruit production [8]. Cabbage aphid, *Brevicoryne brassicae* L. (Hemiptera: Aphididae) is an important pest in cabbage fields in Kashmir [3]. Cabbage aphids feed on the underside of the leaves and on the centre of the cabbage head [9]. They prefer feeding on young leaves and flowers and go deep into the heads [10]. Colonies of the cabbage aphid can be seen on upper and lower leaf surfaces, in leaf folds, along the leafstalk, near leaf axils [11]. In cabbage aphid *B. brassicae*, there are two small pipes called cornicles or siphunculi (tailpipe-like appendages) at the posterior end that can be seen if one looks with a hand lens. These short cornicles and the waxy coating found on cabbage aphids help differentiate cabbage aphids from other aphids that may attack the same host plant [12, 13]. Aphids feed by sucking sap causes yellowing, wilting and stunting of plants. Severely infested plants become covered with a mass of small sticky aphids (due to honeydew secretions), which can eventually lead to leaf death and decay.

The green apple aphid, *A. pomi* and the cabbage aphid, *B. brassicae* are two important pests of temperate fruits and cruciferous vegetables, respectively [3]. Damage in agricultural and horticultural crops caused by aphids is very dreaded problem because one aphid is enough to transmit the viral diseases [13]. They are especially harmful in nurseries and young orchards [14, 15, 16]. The apple aphid, *Aphis pomi* is an economically important pest of apple throughout the world [17] along with the cabbage aphid. Apple and cabbage are economically two important crops of Kashmir.
The farmers depend on insecticides for their eradication. Their resistance is now increasing progressively in concurrence with regular use on vegetables and fruits [18]. So presence of predators and parasitoids in orchids and vegetable fields has been a subject for many studies for reducing the insecticide usage and thereby environmental pollution [19, 20]. Usually the role played by the natural enemies minimize the need of application of insecticides and increase the density of natural enemies which results in increased rate of reduction of aphids. Thus conservation biological control aims at enhancing natural enemy densities within the orchard system through attraction and/ or retention [21, 22] and the natural enemy complex of Aphis species has been extensively studied by Oatman and Legner [23], Holdworth [24], Carroll and Hoyt [25], Hagley and Allen [14], Haley and Hogue [26].

The management of sap sucking insect pests through bioagents renders it important to record the diversity of natural enemies of aphids, both generalist and specific, commonly occurring in any crop ecosystem to exploit them in favour. The aphidophagous arthropod guild can be divided broadly into specialists that include Baconidae and Aphidiinae parasitoids, predatory coccinellids [27, 28], Lacewings [29, 30] and Hoversflies [4] or generalist that include euryphagous predators like ground beetles and spiders [31]. Intra-guild competition is often reported among aphidophagous natural enemies due to their foraging activity when they frequently encounter hetero-specific aphid predators [32], which may disrupt biological control efforts against aphids where more than one predator species is present; hence, this necessitates carefully choosing a combination of predators for success in biological control of aphids [33].

The aim of present study was to investigate the potential aphicidal efficacy of three species of coccinellids viz., Coccinella septempunctata, Adalia tetraspilota, and Hippodamia verigata and one species of chrysopid viz., Chrysoperla z. sillemi against the green apple aphid (Aphis pomi) in apple orchards of Pattan (Baramulla) and cabbage aphids (Brevicoryne brassicae) in cabbage field of Narkara (Budgam) of Kashmir.

2. Materials and Methods

2.1 Experimental Design

The cultures of predatory natural enemies (Coccinellids and Chrysoperla), green apple aphid (Aphis pomi) and cabbage aphid (Brevicoryne brassicae) were maintained at 25± 2°C temperature 60±10 % relative humidity and a photoperiod of 14 hours light: 10 hours darkness. Three species of coccinellids viz., Coccinella septempunctata (Cs), Adalia tetraspilota (At) and Hippodamia verigata (Hv) and one species of chrysopid, Chrysoperla z. sillemi against the green apple aphid (Aphis pomi) in apple orchards of Pattan (Baramulla) and cabbage aphids (Brevicoryne brassicae) in cabbage field of Narkara (Budgam) of Kashmir.

2.2 Statistical analysis

The trails were laid out in randomized block design in both apple orchards as well as Cabbage fields. In case of apple orchards the trail was laid on apple trees of “Red delicious” variety of 15-20 years of uniform age and “Golden acre” variety of cabbage in cabbage fields. Percent reduction was worked out by computing the differences between pre and post treatment population of green apple aphid and cabbage aphid by applying Abbot’s formula [34]. The data was subjected to analyze of variance and critical differences at 5% level of significance was work out.

3. Results and Discussion

3.1 Efficacy of predators against Aphis pomi

In the present study the biological control of Aphis pomi and Brevicoryne brassicae was evaluated. After first weekly release the highest mean mortality (55.75%) of green apple aphidwas recorded against 3rd instar grub of Coccinella septempunctata @30/ tree which was significantly high than other predatory treatments as compared to treated check (Imdaclorpid 17.8SL @ 0.28ml/L) and was 76.66%. The other treatments were worked out by computing the differences between pre and post treatment population of green apple aphid and cabbage aphid by applying Abbot’s formula [34]. The data was subjected to our findings.

After, 2nd weekly release the maximum reduction of 59.62% of green apple aphid population was recorded against 3rd instar grub of Cs@ 30/tree which was statistically on par with all the predatory treatments and in treated check (Imdaclorpid 17.8SL @ 0.28ml/L) and was 78.39%. Other treatments, showed increasing trend as compared to the data of after 1st weekly release. The green apple aphid population were reduced as 49.36%, 45.86%, 50.88%, 46.18%, 47.70 and 51.07% in case of 2nd instar grub of Cs, 2nd instar larva of Czs, 3rd instar larva of Cs, 3rd instar grub of At, 2nd instar grub of Hv, respectively @ 30/tree and 3rd instar grub of Hv @ 30/tree after first weekly release (Table 1). The feasibility of using predatory insects for biological control of aphids in protected crops was investigated by Scopes [35] using Crysoperla corena L. and by Gurney & Hussey [36] for 4 Coccinellid sp. were used for our findings.

After, 2nd weekly release the maximum reduction of 59.62% of green apple aphid population was recorded against 3rd instar grub of Cs@ 30/tree which was statistically on par with all the predatory treatments and in treated check (Imdaclorpid 17.8SL @ 0.28ml/L) and was 78.39%. Other treatments, showed increasing trend as compared to the data of after 1st weekly release. The green apple aphid population were reduced as 49.36%, 45.86%, 50.88%, 46.18%, 47.70 and 51.07% in case of 2nd instar grub of Cs, 2nd instar larva of Czs, 3rd instar larva of Cs, 3rd instar grub of At, 2nd instar grub of Hv, respectively @ 30/tree and 3rd instar grub of Hv @ 30/tree after 2nd release of green apple aphid predators. Least reduction of green apple aphid was recorded 44.37% against 2nd instar grub of At @ 30/tree after 2nd release. The reductions of green apple aphid increased after 3rd and 4th weekly release of predators and under the treatment of treated check (Imdaclorpid 17.8SL @ 0.28ml/L) were decreased. The highest reduction after 3rd and 4th release were recorded as 64.37% and 68.36% against 3rd instar grub of Cs @ 30/tree and least were recorded 49.02% and 55.59% against 2nd instar grub of At @ 30/tree in apple orchards of Kashmir.
The highest mean reduction of green apple aphid was recorded 62.00% against 3\textsuperscript{rd} instar grub of Cs @ 30/tree followed by 3\textsuperscript{rd} instar grub of Czs@ 30/tree was 55.11% and least mortality (36.34%) was recorded against 2\textsuperscript{nd} instar grub of At @ 30/tree. In other treatment, the reduction of green apple aphid were 51.81%, 48.37%, 50.21%, 52.14% and 54.37% in case of 2\textsuperscript{nd} instar grub of Cs, 2\textsuperscript{nd} instar larva of Czs, 3\textsuperscript{rd} instar grub of At and 2\textsuperscript{nd} instar grub of Hv and 3\textsuperscript{rd} instar grub of Hv, respectively. Under treated check the meanreduction of green apple aphid population was 74.86% as compared quite high then that of the other predatory treatments. The recovery of predatory fauna was also recorded after 30days of 4\textsuperscript{th} weekly release and highest recovery (52.00%) were recorded in case of 3\textsuperscript{rd} instar larvae of Coccinella septempunctata treated plot followed by 3\textsuperscript{rd} instar larvae of Chrysoperla z. sillemi (40.00%) as compared to the treated check (Imdaclorpid 17.8SL @ 0.28ml/L) showing reduction of 56.25%. Least recovery of 21.05% was recorded against 2\textsuperscript{nd} instar grub of Hippodamia verigata @ 30/tree. Rest of treatment showed as 37.50%, 38.46%, 25.00%, 35.71% and 33.33% recovery of predatory fauna against 2\textsuperscript{nd} instar grub of Cs, 2\textsuperscript{nd} instar larvae of Czs, 2\textsuperscript{nd} instar grub of At, 3\textsuperscript{rd} instar grub of At and 3\textsuperscript{rd} instar grub of Hv, respectively. Little informations are available on release of predators by Tauber et al., (2000) [13] proved that releases of the second-instar larvae of C. carnea have proven to be very successful for the control of the green peach aphid [14].

3.2 Efficacy of predators against Brevicoryne brassicae

The percent reduction of cabbage aphid (Brevicoryne brassicae) (57.36%) against 3\textsuperscript{rd} instar grub of Coccinella septempunctata @ 5/plant after first weekly release was recorded highest than other treatment as compared to treated check (Imdaclorpid17.8 SL @ 0.28ml/L of water) that was 78.32%. In other treatment the reduction of cabbage aphid population observed were 47.28% against 2\textsuperscript{nd} instar grub of Cs @ 5/plant (3releases), 39.02% against 2\textsuperscript{nd} instar larva of Czs @ 5/plant, 42.59% against 3\textsuperscript{rd} instar grub of Czs@ 5/plant, 44.36% against 2\textsuperscript{nd} instar larvae of At @ 5/plant, 33.74% against 3\textsuperscript{rd} instar larvae of At @ 5/plant, 35.69% against 2\textsuperscript{nd} instar larvae of Hv @ 5/plant and 46.88% against 3\textsuperscript{rd} instar larvae of Hv@ 5/plant at first days after first weekly release (Table 2). After, 2\textsuperscript{nd} weekly release, the maximum reduction of 62.19% of cabbage aphid was recordagain3\textsuperscript{rd} instar larva of Cs @ 5/plant which was statistically on par with all the predatory treatments and in treated check (Imdaclorpid17.8 SL @ 0.28ml/L) it was 74.12%. The reduction of cabbage aphid showed increasing trend as compared to the data of after weekly release. The cabbage aphid population were reduced as 49.53%, 48.67%,40.20%,39.84%,49.75% and 48.63% against 2\textsuperscript{nd} instar grub of Cs@ 5/plant, 2\textsuperscript{nd} instar grub of Czs@ 5/plant, 3\textsuperscript{rd} instar grub of Cs@ 5/plant, 2\textsuperscript{nd} instar grub of At@ 5/plant, 3\textsuperscript{rd} instar grub of At@ 5/plant and 3\textsuperscript{rd} instar grub of Hv@ 5/plant and 3\textsuperscript{rd} instar grub of Hv@ 5/plant after second weekly release, respectively as compared to treated check Imdaclorpidl(17.8 SL @ 0.28ml/L).

The reduction of cabbage aphid population were increase after 3\textsuperscript{rd} and 4\textsuperscript{th} weekly release of predators and under the treated check (Imdaclorpid17.8 SL @ 0.28ml/L) were decreased as 73.22% and 72.24%, respectively. The highest reduction after 3\textsuperscript{rd} and 4\textsuperscript{th} release were recorded as 66.35% and 70.07% against 3\textsuperscript{rd} instar grub of Cs @ 5/plant and least were recorded 46.25% and 53.05% against 2\textsuperscript{nd} instar grub of At @ 5/plant, respectively in cabbage field of Kashmir.

The highest mean reduction of cabbage aphid was recorded 66.98% against 3\textsuperscript{rd} instar grub of Cs @ 5/plant followed by 2\textsuperscript{nd} instar of Cs @ 5/plant was 53.51% and least reduction (43.25%) was recorded against 2\textsuperscript{nd} instar grub of At@ 5/plant. In other treatment, the reduction of cabbage aphid were 49.78%, 51.61%,52.18%, 44.01% and 52.46% against 2\textsuperscript{nd} instar grub of Czs@ 5/plant, 3\textsuperscript{rd} instar larvae of Cs@ 5/plant, 2\textsuperscript{nd} instar grub of At@ 5/plant, 3\textsuperscript{rd} instar grub of Hv@ 5/plant and 3\textsuperscript{rd} instar grub of Hv@ 5/plant, respectively. Under treated check of Imdaclorpid (17.8 SL) @ 0.28ml/L mean reduction of cabbage aphid was 74.52% as compared to predatory treatments.

The recovery of predatory fauna was also recorded 30days of 4\textsuperscript{th} weekly release and recorded highest recovery (57.10%) in case of 3\textsuperscript{rd} instar grub of Czs@ 5/plant followed by 54.54% in case of 3\textsuperscript{rd} instar grub of Cs@ 5/plant and both are statistically similar to each other as compared to treated check of Imdaclorpid (17.8 SL) @ 0.28ml/L andrecorded 50.00%. The least recovery of 33.33% was recorded against 2\textsuperscript{nd} instar grub of Hv@ 5/plant. Rest of the treatments, showed; 50.00%, 42.85%, 40.00%, 50.00% and 41.66% recovery against 2\textsuperscript{nd} instar grub of Cs, 2\textsuperscript{nd} instar larva of Czs, 2\textsuperscript{nd} instar grub of At, 3\textsuperscript{rd} instar grub of At and 3\textsuperscript{rd} instar larva of Hv@ 5/plant, respectively.

Our results showed that Coccinella septempunctata being more efficient on subduing and consuming prey, and consequently being more voracious was able to eat a large amount of aphid compared to Adalia tetraspilota, Hippodamia verigata and chrysopid (Chrysoperla z. sillemi). Also the number of aphids engrossed by 2\textsuperscript{nd} and 3\textsuperscript{rd} instar larvae showed significant difference. The third instar larvae are showed better predatory activity and faster response. The higher voracity of later instar larvae is possibly due to higher energy intake for growth and to attain critical weight for pupation [38]. The recovery of 3\textsuperscript{rd} instar grub wasalso more as compared to the grubs recovered by releasing the 2\textsuperscript{nd} instar. The number of prey items attacked also increase with the total time, prey density and attack rate [39]. The increase in number of aphid killed with the increasing density may be explained by the fact that at higher prey densities, encounter rates are more frequent and consequently predators consume considerably more than the minimum required [38, 40].

Table 1: Evaluation of efficacy of predators against green apple aphid Aphis pomi in apple orchard of Kashmir

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number of aphids/10cm of twigs before treatment</th>
<th>Number of aphids/10cm after treatment*</th>
<th>Recovery of Natural enemies**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1\textsuperscript{st} weekly release</td>
<td>2\textsuperscript{nd} weekly release</td>
<td>3\textsuperscript{rd} weekly release</td>
</tr>
<tr>
<td>2\textsuperscript{nd} instar grub of Cs@30/tree</td>
<td>78.2</td>
<td>41.24 (47.26)</td>
<td>39.60 (49.36)</td>
</tr>
<tr>
<td>3\textsuperscript{rd} instar grub of Cs@30/tree</td>
<td>74.8</td>
<td>43.10 (55.75)</td>
<td>30.20 (59.62)</td>
</tr>
<tr>
<td>2\textsuperscript{nd} instar larva of Czs@30/tree</td>
<td>80.4</td>
<td>46.62 (42.00)</td>
<td>43.53 (45.86)</td>
</tr>
</tbody>
</table>
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3rd instar larva of @ 30/ tree: 81.6
2nd instar grub of At@ 30/ tree: 76.6
3rd instar grub of At@ 30/ tree: 79.4
2nd instar grub of Hv@ 30/ tree: 80.2
3rd instar grub of Hv@ 30/ tree: 82.0

Treated check (Imdaclorpid Cts = 17.8SL @ 0.28ml/liter of water): 79.8
Untreated check (Use water only): 80.4

Replication: 5, Figure in parenthesis indicates mean % reduction of aphids, Cs = Coccinella septempunctata, Czs = Chrysoperla z.sillemi, At = Adalia tetraspilota, Hv = Hippodamia verigata. *Natural enemies count on the basis of 10 twigs.

**Figure in parenthesis indicates mean % Recovery of Natural enemies.

Table 2: Evaluation of efficacy of predators against cabbage aphid Brevicoryne brassicae in Cabbage field of Kashmir

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number of aphids/ leaf before treatment</th>
<th>Number of aphids/ leaf after treatment</th>
<th>Recovery of Natural enemies*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st weekly release</td>
<td>2nd weekly release</td>
<td>3rd weekly release</td>
</tr>
<tr>
<td>2nd instar grub of Cs@ 5/ Plant</td>
<td>80.25</td>
<td>42.30 (47.28)</td>
<td>40.50 (49.53)</td>
</tr>
<tr>
<td>3rd instar grub of Cs@ 5/ Plant</td>
<td>75.65</td>
<td>32.75 (57.36)</td>
<td>28.60 (62.19)</td>
</tr>
<tr>
<td>2nd instar larva of Cs@ 5/ Plant</td>
<td>92.25</td>
<td>35.35 (39.02)</td>
<td>47.35 (48.67)</td>
</tr>
<tr>
<td>3rd instar larva of Cs@ 5/ Plant</td>
<td>90.85</td>
<td>52.15 (42.59)</td>
<td>45.65 (49.75)</td>
</tr>
<tr>
<td>2nd instar grub of At@ 5/ Plant</td>
<td>94.25</td>
<td>62.45 (33.74)</td>
<td>56.70 (39.84)</td>
</tr>
<tr>
<td>3rd instar grub of At@ 5/ Plant</td>
<td>85.65</td>
<td>47.65 (44.36)</td>
<td>43.25 (49.50)</td>
</tr>
<tr>
<td>2nd instar grub of Hv@ 5/ Plant</td>
<td>90.65</td>
<td>58.25 (35.69)</td>
<td>54.20 (40.20)</td>
</tr>
<tr>
<td>3rd instar grub of Hv@ 5/ Plant</td>
<td>82.25</td>
<td>45.50 (44.68)</td>
<td>42.25 (48.63)</td>
</tr>
<tr>
<td>Treated check(Imdaclorpid Cts = 17.8SL @ 0.28ml/liter of water)</td>
<td>95.25</td>
<td>20.45 (78.32)</td>
<td>24.65 (74.12)</td>
</tr>
<tr>
<td>Untreated check (Use water only)</td>
<td>89.15</td>
<td>90.25 (90.23)</td>
<td>90.76 (18.11)</td>
</tr>
<tr>
<td>CD(P=0.05)</td>
<td>4.67</td>
<td>3.66</td>
<td>4.01</td>
</tr>
</tbody>
</table>

Replication: 5, Figure in parenthesis indicates mean % reduction of aphids, Cs = Coccinella septempunctata, Czs = Chrysoperla z.sillemi, At = Adalia tetraspilota, Hv = Hippodamia verigata.

*Figure in parenthesis indicates mean % Recovery of Natural enemies.

4. Acknowledgements

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