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Research Article
Aphid Species Affect Foraging Behavior of *Coccinella septempunctata* (Coccinellidae: Coleoptera)

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Abstract

Background: Flowers are admirable in scenic good looks and artistic beautification. These are also playing necessary roles in therapeutic preparations. Aphid is an important sucking pest of various flowers in ornamental territories and it is generally controlled by predators, so it was necessary to evaluate which aphid species affect the predator more or less. **Materials and Methods:** Biocontrol agent *Coccinella septempunctata* was used against cosmos aphid (*Aphis spiraecola*, rose aphid (*Macrosiphum rosea*), gul e ashrafi aphid (*Aphis fabae*), kaner aphid (*Aphis neri*), chandni aphid (*Sitobion avenae*), dahlia aphid (*Myzus persicae*) and annual chrysanthemum aphid (*Macrosiphoniella sanborni*). **Results:** The grub of *C. septempunctata* consumed 283.8±9.04 *M. rosea*, 487.7±12.6 *M. sanborni*, 432.75±16.02 *A. spiraecola*, 478.2±8.07 *A. fabae*, 552.3±9.04 *M. persicae*, 142±1.32 *A. nerii* and 498.5±13.09 *S. avenae* in its whole larval life. The *M. persicae* and *M. rosea* consuming grubs showed 100% adult emergence while, *M. sanborni*, *A. spiraecola*, *A. fabae* and *S. avenae* showed 96.58, 89.02, 94.78 and 75.45% adult emergence, respectively. **Conclusion:** The *C. septempunctata* has significant predatory potential against *A. spiraecola*, *M. rosea*, *A. fabae*, *S. avenae*, *M. persicae* and *M. sanborni* except *A. nerii*. Thus, further studies are needed to find out alternate predator to control *A. nerii* on ornamentals.

Key words: *Aphis nerii*, *Coccinella septempunctata*, predatory behavior, adult emergence, adult development

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The aphids (Aphididae: Homoptera) are commonly called as plant lice, green flies, ant cow and are important sucking pest of various flowers in house gardens and office lawns. Their population has been going to increase for last decade and had considered as a regular pest in Pakistan[1].

Flowers are so much trendy in scenic good looks. For ornamentation, medicinal preparations as well as aesthetic purposes flowers are essential and have great significance. These are also eye-catching and charming for insects because these are supportive for their nutrition and propagation. No doubt, usually insects cannot kill the plants but having serious threats. They can reduce the flowers quality, growth as well as disturb the other aspects of plant life.

Aphids both nymph and adult physically attack the flower plants, rupture the plant parts and start to suck cell sap vigorously. Severe aphid infestation lessens the market value, as well as reduces the flowering capacity of plants, ultimately 20-40% losses[2]. Aphid populations may boost up very quickly under natural circumstances because these are reproducing parthenogenetically. Conversely in coccinellid beetles' presence, aphids do not grow as hurriedly as these are eaten up[3].

Coccinellids (Coccinellidae: Coleoptera) generally called lady bird beetles[4] are constantly described as prospective and proficient predators against different aphids from various agroecosystems in the world, particularly Europe and Asia[5-10]. Aphids inhibit reproduction and development of *C. septempunctata*[11]. Type of prey directly affects the development and growth of the predator[12]. The prey aphids, natural as well as artificial diets affect the fecundity and longevity of the predator[13-15].

The objective of the study was to evaluate the effect of these aphid species on the foraging behavior of *C. septempunctata*. Before launching and recommending the biological control program for house or office lawns by this potential predator, it was necessary to evaluate which aphid species affect the predator more or less, what type of variations occurs from grub emergence to maturation of the predator and how much this humanity friend predate as well as sustainability of the program.

MATERIALS AND METHODS

The present study was carried out at Entomological Research Institute, AARI, Faisalabad, Pakistan during the year 2016. The experiment was performed at 27±1°C temperature and 65±3% relative humidity.

Materials: During the experiment rearing cage, camel hair brush, filter papers, beakers, petri dishes, thermometer, cotton bolls, scissors, rubber bands transparent polythene sheets and water were used.

Methods

Amassing and mass culturing: Adults of *Coccinella septempunctata* were collected from field area of Ayub Agriculture Research Institute (AARI) and reared in Biocontrol Laboratory. The field collected specimens were sorted out and pairs were chosen for oviposition and later on all developmental stages were reared and kept under study. The pairs were placed in separate petri dishes to obtain the batches of eggs for cohort progeny to reduce the variations in the experiments. The adult beetles were reared on *Brevicoryne brassicae*[13]. The eggs were stored in refrigerator at 6-7.5°C to establish aphid populations on flowers. After prey establishment, the eggs were allowed to hatch, the grubs of *Coccinella septempunctata* placed in beakers singly covered with transparent polythene sheet. The grubs were reared on different flowers aphids.

Stockpiling of aphid species: The grub aphid consumption of *C. septempunctata* was recorded on daily basis. They were maintained all the time on the following aphid species mentioned in Table 1. In this experiment fresh and a counted numbers of aphids were provided to get instar wise feeding. During experiment aphids consumed by each grub through out their larval stage was observed. Five replications of each were tested. The dead individuals were replaced with the same aged individuals during the whole experiment.

Statistical analysis: The experiment was carried out under laboratory conditions and designed according to Complete Randomized Design (CRD) with five replications and seven treatments. Means of treatments were analyzed.

RESULTS

Aphid consumption by larval instars: The average aphid feeding by larval instars of *Coccinella septempunctata* is given on different aphid species. Number of aphids fed by each instar is shown in Table 2. The grub of *C. septempunctata* consumed 283.8±09.4 rose aphid (*M. rosea*), 487.7±12.6 annual chrysanthemum aphid (*M. sanborni*), 432.75±16.02 cosmos aphid (*A. spiraecola*), 478.2±08.07 gul-e-ashrafi aphid

Table 1: Aphid species and their host flowering plants

Ornamental plants (Host)	Aphid species (Pest)
Cosmos (*Cosmos bipinnatus*)	Cosmos aphid (*Aphis spiraecola*)[16]
Rose (*Rosa indica*)	Rose aphid (*Macrosiphum rosea*)[17]
Gul-e-ashrafi (*Calendula officinalis*)	Gul-e-ashrafi aphid (*Aphis fabae*)[18]
Kaner (*Nerium indicum*)	Kaner aphid (*Aphis nerii*)[19]
Chandni (*Tabernaemontana divaricata*)	Chandni aphid (*Sitobion avenae*)[20]
Dahlia (*Dahlia pinnata*) Cav.	Dahlia aphid (*Myzus persicae*)[21]
Annual chrysanthemum (*Chrysanthemum indicum*)	Annual chrysanthemum aphid (*Macrosiphoniella sanborni*)[22]

Table 2: Comparison of average or mean aphid consumption by larval instars of *Coccinella septempunctata* on different aphid species

	Larval instars				
Aphid species	1st	2nd	3rd	4th	Means±SE
Macrosiphum rosea	17.6	45.50	111.0	109.7	283.80±9.40
Macrosiphoniella sanborni	30.4	90.00	227.9	139.4	487.70±12.60
Aphis spiraecola	19.4	83.35	157.2	330.0	432.75±16.02
Aphis fabae	22.7	76.00	321.7	57.8	478.20±8.07
Myzus persicae	61.0	139.00	289.0	63.3	552.30±9.04
Aphis nerii	8.0	43.00	77.0	14.0	142.00±1.32
Sitobion avenae	41.7	102.50	260.0	94.3	498.50±13.09

Table 3: Pupae duration of *Coccinella septempunctata* against different aphid species

Aphid species	Minimum (Days)	Maximum (Days)
Macrosiphum rosea	3	6
Macrosiphoniella sanborni	2	4
Aphis spiraecola	3	4
Aphis fabae	1	3
Myzus persicae	2	3
Sitobion avenae	2	4
Aphis nerii	0	0

Table 4: Adult emergence (age%) of *Coccinella septempunctata* against different aphid species

Aphid species	Adult emergence (age%)
Macrosiphum rosea	100.00
Macrosiphoniella sanborni	96.58
Aphis spiraecola	89.02
Aphis fabae	94.78
Myzus persicae	100.00
Sitobion avenae	75.45

Table 5: Aphid consumption of *C. septempunctata* adult immediate after emergence for 3 days against different aphid species

Aphid species	1st day	2nd day	3rd day	Total	Means
Macrosiphum rosea	45	56	80	181	60.30
Macrosiphoniella sanborni	60	88	100	248	82.66
Aphis spiraecola	40	93	103	236	78.66
Aphis fabae	45	87	91	223	74.33
Myzus persicae	43	85	96	224	74.66
Sitobion avenae	70	70	80	220	73.33

(*A. fabae*), 552.3±09.04 dahlia aphid (*M. persicae*), 142±01.32 kaner aphid (*A. neri*) and 498.5±13.09 chandni aphid (*S. avenae*) in its whole larval life.

Pupation period: After completing larval period the grubs go into their pupation period that is shown in Table 3. The maximum and minimum number of days required to emerge out an adult from pupae against each aphid species. Maximum pupation period was observed against *M. rosea*, while minimum pupation time period was observed against *A. fabae*. Grubs that feed on *A. nerii* showed delayed pupation period even no adult emergence from pupae.

Adult emergence: Adult emergence (age%) of *Coccinella septempunctata* against different aphid species is shown in Table 4. The *M. persicae* and *M. rosea* consuming grubs showed 100% adult emergence. Grubs feeding *M. sanborni*, *A. spiraecola*, *A. fabae* and *S. avenae* showed 96.58, 89.02, 94.78 and 75.45% adult emergence, respectively.

Aphid consumption by *Coccinella septempunctata* adult: *Coccinella septempunctata* adult aphid consumption immediate after emergence against each species for 3 days is shown in Table 5. The maximum and minimum consumption ranges against each aphid species are shown.

DISCUSSION

Present study has clearly demonstrated that *C. septempunctata* grubs as well as adults are overall good biological control agent. This study also showed different predacious behaviors of *C. septempunctata* against each considered aphid species. These grubs successfully consumed *M. rosea* and flourished well on this species of aphid. The minimum pupation period observed was 3 days and the maximum was 6 days. These results are in line with Sarmad *et al.*[17]. They reported that incubation period in *C. septempunctata* was 4.3±0.81 days and mean duration of 1st, 2nd, 3rd and 4th larval instars were 2, 2, 3 and 5 days, respectively and pupal duration was 6 days.

The *M. sanborni* is a common pest of chrysanthemum which was successfully controlled by *C. septempunctata*. As the total larval duration feeding was 487.7 aphids by each grub. These results are in agreement with Behera *et al.*[23]. They showed that the feeding potential of 1st, 2nd, 3rd and 4th larval instar and adult was 9.17±1.5, 20.8±3.3, 34.1±3.5, 37.5±4.7 and 55.3±6.7 aphids day^{-1}, respectively.

Deliverance of a newly hatched *C. septempunctata* grubs to control *A. fabae* onto faba bean crop plants significantly reduced aphid density. It was also observed that *A. fabae* enhanced the development rate, fecundity and proved as a suitable food source in laboratory experiments. Consumption of aphids significantly increased the female fecundity and fertility of *C. septempunctata* also. The present study is in

conformity with Shannag and Obeidat[24]. As the predation range for *A. fabae* adult was 45-91 day^{-1} which showed the suitability of prey for the predator.

A key pest of citrus clementines is *A. spiraecola* and it was controlled by early predator and should be measured to expand new intrusion thresholds suggested by Gomez-Marco *et al*.[25]. *Sitobion avenae* are appropriate food as the females of *C. septempunctata* fed with *S. avenae* laid more eggs as compared to those fed with *A. fabae*[26].

Cabral *et al*.[27] recommended that *A. fabae* and *M. persicae* should be considered as essential prey. Aphid species has been shown different degrees of fitness: *M. persicae* notably lowers the pre-oviposition period and improved adult longevity, fecundity and fertility compared to *A. fabae*. Moreover, *A. fabae* represent a suitable diet for larval development but is not a suitable food source for adult reproduction.

The *C. septempunctata* pre-adult development on *Aphis nerii* was much longer as compared to other aphid species under consideration. This statement is aligned with Omkar and Srivastava[28], found that pre-adult development was long on *A. nerii*.

Though we could not find any report of pupation and adult emergence against *A. nerii* as the grub consume more and more aphids per day and died in their larval duration. This experiment was repeated 3 times to confirm the pre-adult mortality. Especially *C. septempunctata* was not found on *Nerium indicum* plant during *A. nerii* collection from field. This also showed that *C. septempunctata* may not provide successful control for *A. nerii* and may be skipped for biological control program.

CONCLUSION

This study has practical implication. For launching and recommending the biological control program for house or office lawns *C. septempunctata* provide successful control for all considered aphid species except *A. nerii*. Thus, further studies are needed to find out alternate predator to control *A. nerii* in house or office lawns.

SIGNIFICANT STATEMENT

The present study could not find any report for *C. septempunctata* pupation and adult emergence against *A. nerii* as the grub consume more and more aphids per day and died in their larval duration. It may be due to toxins present in kaner (*Nerium indicum*). Especially *C. septempunctata* was not found on *Nerium indicum* plant during *A. nerii* collection from field. This also showed that *C. septempunctata* may not provide successful control for *A. nerii* and may be skipped for biological control program. Thus, further studies are needed to find out alternate predator.

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