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Research Note

Behavioural response of *Cheilomenes sexmaculata* (Fabricius) to natural enemy and pest mediated semiochemicals

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ABSTRACT: The role of semiochemicals originating from the aphid and predators were studied using a four arm olfactometer. At higher densities, aphids produce more alarm pheromone which would serve as kairomonal cues to the coccinellids so that it attracts more predators compared to lower density of aphid infestation. *Cheilomenes sexmaculata* (Fabricius) showed more attraction towards high aphid population densities (150) of *Aphis craccivora* Koch and *C. sexamculata* showed a negative response towards the eggs of these predators in aphid colonies in the olfactometer.

KEY WORDS: *Aphis craccivora*, *Cheilomenes sexmaculata*, Semiochemicals, Kairomones

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Cheilomenes sexmaculata (Fabricius) is an aphidophagous coccinellid, abundant in the agricultural fields of India. *C. sexmaculata* is exhaustively studied coccinellid in the subcontinent as they are highly voracious and fecund, and have a wide prey range, which includes, aphids, coccids, diaspids, aleyrodids, etc. (Agarwala and Yasuda, 2000; Omkar and Bind, 2004; Omkar and Pervez, 2004a). Cluster-laying of eggs in ladybirds is a more effective means of defense from inter-specific predation than dispersed eggs (Agarwala and Dixon, 1993). Ninkovic *et al.* (2001) demonstrated that the seven spotted-lady bird *Coccinella. septempunctatau* responded positively towards volatiles from the aphid *Rhopalosiphum padi,* and to the infested plants of *Hordeum vulgare* and also reported that the response to plant odour was more specific in searching for the identification of targets such as attacked plants, pollen sources etc. Ware and Majerus, (2007) discussed the role of surface deterrents on eggs of the European species *Calvia quatuardecimguttata* (L) (Coleoptera: Coccinellidae) as a defence against intraguild predation by *Harmonia axyridis*. They also found that on the surface of the eggs of *Harmonia axyridis* larval tracks were present that acted as ovipostion deterring semiochemicals for other ladybirds, thus reducing egg cannibalism and intraguild predation. The *C. sexmaculata* is major predator of Cowpea aphid *Aphis craccivora* in the field condition during the experiment, hence *C. sexmaculata* was selected for study in the lab experiments. In order to study the behavioural response of *C. sexmaculata* to volatile emissions from the different densities of aphids and natural enemy mediated semiochemicals emission from aphid population with predator eggs were studied using a four-way olfactometer.

Laboratory experiments were carried out in the Department of Entomology, College of Horticulture, Vellanikkara during 2007-08. To study the effect of semiochemicals originating from the aphid on con specific of predators was studied by using four arm olfactometer, Non-absorbent, transparent acrylic sheet of 2 mm thickness was used for constructing the olfactometer. The design consisted of a central rectangular chamber (20 x 20 cm base and 30 cm height) with four arms extending from the four sides. A 20 x 20 cm acrylic sheet formed the base plate. From the centre of each face of the chamber, at 50 mm height, a 50 mm square hole was cut. Into this, a 50 x 50 x 500 mm rectangular acrylic tube, which formed the odour arm, was inserted. A small acrylic rim at the connecting end provided support to keep the tube in position. This also prevented the tube from being pushed inside. The distal end of the odour arm was closed with a removable acrylic sliding door. In the experimental studies, moth scales, moth scale extracts,

plant materials, or other semiochemical emanating substances were placed at the distal end through this window. The opening was closed using a sliding door, netting, or cloth to suit the specific needs. At the distal end an acrylic support was provided to keep the rectangular tube in position. The top of the central chamber was closed with an acrylic lid (20 x 20 mm) having a retaining rim. The removable lid had a central 5 mm hole to allow air movement. Trichocards were placed at the bottom of the chamber in a Petri-plate. During the setup, vaseline was smeared at the connecting inlets of each arm to prevent air entry from outside.

A small axial flow fan (DC 12V, 3.5 cm diameter) was installed at each of the four distal openings of the arms to provide uniform airflow. The axial fan was screwed on to an acrylic sheet and housed on a wooden base in such a way to direct the airflow towards the inside of olfactometer. The odour resource was kept at the distal end of each arm. This setup allowed the insects to receive airflow bathing the olfactory cues from the odour source and travel upwind in response to the volatiles. To avoid contaminants in the air plume, the unit was inserted into a laminar flow chamber (Ranjith, 2007).

Response of *Cheilomenes sexmaculata* to different density of aphid population

Ten adults of *C. sexmaculata* were placed in the centre of olfactometer chamber. Cowpea leaf infested with different density of apterous *A. craccivora viz.,* 10, 50,100 and 150 were placed in four different arms. The number of *C. sexmaculata* attracted to different treatments were counted at one hour interval and the retention time was also recorded. The whole experiment was carried out for three hours and replicated five times. The experiments were conducted in laboratory at 27±2%C, and 45–65% relative humidity. The olfactometer was covered from inside with black paper in order to avoid phototactic responses.

Response of *C. sexmaculata* towards predator egg of *C. sexmaculata*

Ten adult beetles of *C. sexmaculata* were kept in the centre of olfactometer chamber. The four treatments *viz*., cowpea leaf infested with 10 alate aphids, cowpea leaf with 10 apterous aphids, cowpea leaf with 10 predator eggs and cowpea leaf with 10 predator eggs and 10 aphids were tested against *C. sexmaculata* separate olfactometer experiment. The experiments were conducted in laboratory at 27±2% C, and 45–65% relative humidity.

A non parametric statistical analysis was carried out by **Kendall's *W*** (also known as **Kendall's coefficient of concordance**). It is a normalization of the statistic of the Friedman test, and can be used for assessing agreement among raters.

It was found that highest number of *C. sexmaculata* was attracted towards cowpea leaf infested with 150 aphids (4.4) followed 100 aphids (1.0), 50 aphids (0.6) and 10 aphids (0.4). The maximum retention was 120 seconds in cowpea leaf infested with 150 aphids and minimum was 30 seconds in cowpea leaves infested with 10 aphids (Table 1). The more retention was also seen at higher population density of aphids. Similar observation was also made by Omkar and Pervaz (2005). At higher densities, aphids produce more alarm pheromone which would serve as kairomonal cues to the coccinellids so that it attracts more predators compared to lower density of aphid infestation. Suja (2003), reported that searching speed of adults and grubs of *C. sexmaculata* and *C. transversalis* was found to increase with increased prey density.

Eggs of *C. sexmaculata* was found to have negative effect on the attraction of the predators to aphid infested cowpea leaf (Table 2). *C. sexmaculata* was attracted more (5.4) towards cowpea leaf infested with apterous aphids followed by cowpea leaf infested with alates (2.6) and un-infested cowpea leaf with predator eggs (2.0). *C. sexmaculata* did not show any response to aphid infested

Table 1. Response of *Cheilomenes sexmaculata* to different densities of aphid population

Aphid population	Responded		Retention	
	Number	Mean rank score	Time (seconds)	Mean rank score
10	0.4	1.67	30	1.20
50	0.6	1.83	45	2.20
100	1	2.5	60	2.60
150	4.4	4.00	120	4.00

∗ Ranking based on Kendall's test

cowpea leaf with egg mass of the predators. The maximum retention time was recorded in cowpea leaf with predator eggs (180 seconds) for *C. sexmaculata*. The presence of predator eggs on aphid infested cowpea failed to attract the predators *C. sexmaculata*. This might be due to the presence of marker pheromone / spacing pheromone like chemicals, which are released from the egg mass deposited in aphid colonies. Pasteeles, (1982) showed that the eggs of coccinellid predators produced defense chemicals like coccineline and adaline that occurred in *Coccinella septempunctata* and *Adalia bipunctata* respectively. However, the coccinellid adults responded well to the egg mass of the predators on cowpea leaves in the absence of aphids. Agarwala (1991) showed that the egg cannibalism strongly enhanced the survival of adult females and enabled them to search longer for aphid food. The starved adult beetles must have resorted to interspecific predation in the absence of aphid prey as reported by Agarwala *et al.,* (1998) for *C. sexmaculata* and *C. transversalis.*

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Table 2. Response of *Cheilomenes sexmaculata* towards cowpea with predator eggs

Aphid population	Responded		Retention	
	Number	Mean rank score	Time (seconds)	Mean rank score
Cowpea leaf + alate	2.6	3.50	60	2.00
Cowpea leaf + predator egg	2.0	2.67	180	3.70
Cowpea leaf + apterous	5.4	2.83	120	3.30
Cowpea leaf + aphid + predator egg	0.0	0.00	0	1.00

∗ Ranking based on Kendall's test