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Predatory potential of *Coccinella undecimpunctata* L. (Coleoptera, Coccinellidae) on *Aphis craccivora* Koch. (Hemiptera, Aphididae) in Ladakh, India

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ABSTRACT: Predatory potential of all instar larvae and adults of *Coccinella undecimpunctata* (Coleoptera, Coccinellidae), using *Aphis craccivora* Koch (Hemiptera, Aphididae) was assessed in laboratory settings. The study, conducted with varying aphid densities in rearing jars, showed a significant increase in prey consumption as aphid density rose. Furthermore, prey consumption heightened with larval development, with 4th instars devouring more aphids compared to earlier instars. Female adults exhibited greater aphid consumption than males. Deploying both 4th instar larvae and adults could enhance pest suppression.

KEYWORDS: Prey consumption, fourth instar, densities

Faba bean (*Vicia faba* L.) is a highly nutritious leguminous crop known for its tolerance to cooler temperatures and a wide range of soil environments (Anil *et al.,* 2013). Faba beans, have a long history of versatile and valuable applications in both feed and food (Crepon *et al*., 2010); (Xiao *et al*., 2021). Among the significant aphid species affecting this crop, the cowpea aphid, *Aphis craccivora* Koch (Hemiptera, Aphididae) is a serious threat (Soffan and Aldawood, 2014). The economic threshold of *A. craccivora* to the bean is 8.6 aphids per plant, (Abdou *et al*., 2012). If effective management methods are not implemented during the primary infection, result in flower and leaf damage as well as a reduction in seed yield (Annan *et al.,* 2000). Regardless of the age of the pod, all levels of infection significantly reduced seed output (Ofuya, 1989).

Plants, upon infestation, emit specific volatiles that can affect the foraging behavior of insect predators targeting herbivores (Fouad, 2021). Aphid populations have the potential to proliferate significantly over time and space (Borges *et al.,* 2006; Ramzan and Khursheed 2023). Fouad (2021) discovered that adult *Coccinella undecimpunctata* utilizes plant volatiles induced by *A. craccivora* infestation, suggesting that these volatiles could serve as reliable indicators for locating prey. These responses can include changes in predation rate, prey selection (Cabral *et al*., 2013). *C. undecimpunctata* L. is an aphid predator (Smyth *et al*., 2013), and recognized as euriphagous predators (Cabral *et al*., 2009); with potential to serve as an effective biological control agent against aphids (Soares *et al*., 2003; Abd-Rabou, 2008;

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(Fouad, 2021). This study aims to study predatory potential of various life stages of *C. undecimpunctata* on *A. craccivora* under laboratory conditions.

The experiment was conducted at LOGIC (Ladakh Organic and Green Initiative Consultancy) Agri-Farm in Kanoor, Ladakh, at an altitude of 9800ft. The faba bean seeds were initially sown in the field and later transplanted into plastic pots, and cultivated under polyhouse conditions. Nymphs and adults of *A. craccivora* were collected directly from faba bean in the field, released onto the cultivated host plants, and the culture was maintained for subsequent use. *C. undecimpunctata* adults were collected from the field and reared in plastic jars (15cm x 15cm) supplied with cowpea aphids and a faba bean twig endowed with soaked cotton. Aphids were replenished every 24 hours, and oviposition sites were provided with crumpled paper. Eggs were collected gently with the help of a camel hair brush, transferred to a new insect breeding dish (100×40mm), and allowed to hatch. Newly emerged larvae and adults were utilized for the experiments, and the culture was maintained in the laboratory until the completion of experiment (Farooq *et al*., 2018, Abbas *et al*., 2020, Marri *et al*., 2021).

The experiments consisted of an insect breeding dish/jar (100×40mm) with a moist layer of cotton and filter paper to prevent direct contact between aphids and cotton. Leaves from healthy faba bean plants were placed abaxial surface facing up on the filter paper. *A. craccivora* of various densities (10-130 aphids) were transferred onto leaves and left undisturbed for 30 minutes. 3-4 hours pre-starved *C. undecimpunctata* of different life stages were introduced in each insect-breading jar, and prey mortality was recorded every 24 hours for six replicates per treatment. Each treatment, representing a specific life stage of the predator and prey number combination. Control treatments without predators were conducted to assess natural prey mortality (Ramzan and Khursheed, 2023). For each prey density, maintained six replications. Control treatments were conducted with the abovementioned prey densities in the absence of predators to evaluate natural prey mortality unrelated to predator activity. No predator mortality was observed throughout the experiment, and similarly, no prey mortality was observed in the control treatment.

The predatory potential was calculated by using the following equation (Soares *et al.,* 2003):

$$Po = (A-a_{24})\ ra_{24}$$

Po= Number of aphids eaten; **A=** Number of aphids available; $\mathbf{a_{24}}$= Number of aphids alive after 24hrs; $\mathbf{ra_{24}}$= The ratio of aphids found alive after 24 hrs in the control treatment.

A one-way ANOVA was conducted to compare the predatory potential of all the predatory stages of *C. undecimpunctata* across different prey densities. The analysis was carried out using SPSS version 22.

Predatory potential: The findings from the current study demonstrated that with increasing prey density and developmental stages, the consumption rate of *C. undecimpunctata* rose, consistent with findings reported by Darwish (2019) and Ramzan and Khursheed (2023).

When prey density increases, the number of preys ingested by *C. undecimpunctata* larvae in their 1st, 2nd, 3rd, and 4th instars increases dramatically. Maximum values are reached at 50, 70, 70, and 90 preys given respectively, (i.e.,14±0.57, 19.33±0.33, 21.5±0.22, and 30±0.57 prey consumed, respectively). The 4th instar larvae show more voracity than those in their 1st, 2nd, and 3rd instars. This finding is consistent with other research conducted by Cabral *et al*. (2006), Moura *et al*. (2006), Cabral *et al*. (2009), and Ramzan and Khursheed (2023). Male and female voracity both rise sharply with an increase in prey density, but adult satiation occurs at greater densities as compared to larvae, i.e., when 110 prey are available (i.e., 36±0.25 and 38.66±0.42 prey consumed, respectively). It's crucial to remember that prey density determines satiation, therefore increasing prey densities does not significantly alter predatory potential. When compared to larval instars, both male and female adults of *C. undecimpunctata* showed increased predation. This increased predation in adults may be attributed to the higher

Table 1. Voracity (number of prey consumed ± SE) of *C. undecimpunctata* across its various developmental stages (1st to 4th instar larvae and adults, both females and males) when exposed to different densities of *A. craccivora* prey

Prey density	Voracity					
	1st Instar	2nd Instar	3rd Instar	4th Instar	Adult male	Adult female
10	1.66±0.21c	2.16±0.30d	4±0.25d	6.16±0.30e	8±0.36f	9±0.25f
30	6.66±0.42b	8.83±0.47c	11.16±0.30c	15.16±0.70d	16±0.25e	18±0.35e
50	14±0.57a	15.83±0.47b	17.83±0.60b	19.16±1.75c	23±0.57d	26.16±0.47d
70	14±0.44a	19.33±0.33a	21.5±0.22a	25.16±0.60b	26.66±0.55c	29.83±0.79c
90	-	19.33±0.42a	21.66±0.21a	30±0.57a	33±0.25b	35.16±0.30b
110	-	-	-	30±0.57a	36±0.25a	38.66±0.42a
130	-	-	-	-	36±0.25a	38.66±042a

In the column, values sharing the same letters are statistically non-significant at p = 0.05.

energy requirements associated with successful reproduction and mate searching. Conversely, the lower prey consumption by early larval instars may be due to their smaller size and lower energy requirements (Ramzan and Khursheed, 2023).

In the study, it was observed that female adults of *C. undecimpunctata* exhibited greater voracity compared to males, consistent with the findings of Bayoumy *et al*. (2015). This pattern aligns with the general observation in coccinellids, wherein adult females tend to be more voracious due to their larger size and increased nutrient requirements for egg production and oviposition (Omkar and Pervez, 2004). However, the results of the present study do not entirely align with the findings reported by Cabral *et al*., 2006: Moura *et al*., 2006: Cabral *et al*., 2009 and Imam 2015, who observed higher voracity in 4th instar larvae compared to adults. In this case, the discrepancy in results could be attributed to the utilization of different prey species and prey instars with varying body sizes, as previously hypothesized by Moura *et al*. (2006). The increased voracity of 4th instar larvae is a common observation in other coccinellid species as well, such as *C. transversalis* (Omkar and James, 2004), *Propylea dissecta* Mulsant (Omkar and Pervez, 2004), and *Harmonia axyridis* Pallas (Lee and Kang, 2004). This heightened voracity may be attributed to the greater energy requirements necessary for growth and achieving critical weight for pupation (Cabral *et al*., 2009).

The study demonstrated among all developmental stages, 4th instar larvae consumed the most, and adult females consumed more prey compared to adult males. Since aphidophagous ladybirds are known to lay their eggs just before the peak aphid infestation period (Hemptinne *et al*., 2000), releasing mature adults of *C. undecimpunctata* into the field early in the season may enhance as a biocontrol agent.

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