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Predation efficiency of five coccinellid beetles on *Aphis craccivora* Koch infesting cowpea

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ABSTRACT: The predation efficiency of five species of coccinellids, namely, *Coelophora biplagiata* (Swartz), *Coccinella transversalis* F., *Menochilus sexmaculatus* (F.), *Cryptolaemus montrouzieri* Mulsant, and *Chilocorus nigrita* (F.), against cowpea aphid, *Aphis craccivora* Koch, was evaluated in the laboratory. Maximum consumption of *A. craccivora* (65.20 ± 0.59 to 214.60 ± 2.60) was observed in *C. biplagiata* released under various predator densities, whereas *C. montrouzieri* consumed the minimum numbers (19.40 ± 0.36 to 84.60 ± 0.73). *C. biplagiata* was closely followed by *M. sexmaculatus* and *C. transversalis*. It was also observed that *C. biplagiata*, *M. sexmaculata* and *C. transversalis* exhibited higher predation efficiency with a mean aphid consumption of 43.60 ± 0.46 to 485.80 ± 5.18, 41.20 ± 0.33 to 377.00 ± 3.35 and 40.60 ± 0.96 to 370.00 ± 3.74, respectively, under different prey densities of 45 to 720. When *C. biplagiata* was released, significantly lowest aphid population (23.06) was recorded, followed by *M. sexmaculatus* (35.26), *C. transversalis* (43.00) and *C. nigrita* (49.13) as against unreleased control (191.86). The highest aphid population (54.26) was recorded in the treatment where *C. montrouzieri* released.

KEY WORDS: *Aphis craccivora*, cowpea, feeding efficiency, predaceous coccinellids.

INTRODUCTION

Cowpea, *Vigna sinensis* Savi, is one of the most important and widely cultivated summer pulse crops in Manipur for its green pods. Insect pests are one of the major threats to commercial and sustainable cowpea production, of which the black aphid, *Aphis craccivora* Koch, plays a key role in reduction of yield causing great damage both to vegetative and podding stage of the crop. Predaceous coccinellids are considered as good agents for aphid control. Various species of coccinellids have been reported to feed on aphids in India. Five species, *viz*. *Coccinella septempunctata* Linnaeus, *Chilocorus nigrita* (Fabricius), *Cryptolaemus montrouzieri* Mulsant, *Menochilus sexmaculatus* (Fabricius) and *Coccinella transversalis* Fabricius are locally available in crop fields (Omkar and Bind, 1993). Functional response is a good measure of an efficient predator (Hussell, 1992) and should form the basis of comparative efficiency of ladybird beetles (Houck and Strauss, 1985). Keeping the above consideration in view, this investigation was undertaken to compare the feeding efficiency of five coccinellids, *viz*. *C. transversalis*, *C. nigrita*, *M. sexmaculatus, C. montrouzieri,* and *Coelophora biplagiata* (Swartz) on *A. craccivora* in cowpea.

MATERIALS AND METHODS

For the investigation, three sets of laboratory experiments were designed in randomized block design (RBD) and replicated five times during March-August, 2004 in the Biological Control Laboratory of Entomology Department, College of Agriculture, Central Agricultural University, Imphal. During experimentation, the laboratory temperature and relative humidity (RH) were 28.59°C ± 2.00°C and 75.50 ± 5.00%, respectively. The aphid (*Aphis craccivora* Koch) and predators (*C. biplagiata*, *C. nigrita*, *C. montrouzieri*, *M. sexmaculatus* and *C. transversalis*) were reared under the net house condition as per the methods described by Shenhmar and Brar (1995) and Gautam (1990).

Effect of various predator densities on prey consumption

For the experiment, three-day-old predaceous coccinellids were kept in glass jars (17.0 x 10.5cm) following starvation for 12h. Three hundred third instars of *A. craccivora* were placed on twigs of cowpea in separate glass jars. Five densities, *viz*. one, two, four, eight and sixteen (three-day-old adults of any one of the coccinellids) were placed in different glass jars. The open ends of the jars were covered with muslin cloth and secured with rubber bands. The experiment was conducted for twenty-four

Table 1. Prey consumed by different densities of five coccinellid species at constant prey density of *A. craccivora* (300 nos.) on cowpea

Predator density	[1]Mean number of aphid consumption after 24 hours				
	Coelophora biplagiata	*Coccinella transversalis*	*Chilocorus nigrita*	*Menochilus sexmaculatus*	*Cryptolaemus montrouzieri*
1	65.20 ± 0.59	60.00 ± 0.68	56.00 ± 1.62	62.60 ± 0.78	19.40 ± 0.36
2	94.40 ± 0.36	90.00 ± 0.63	86.60 ± 1.76	93.80 ± 0.82	31.40 ± 0.88
4	142.80 ± 0.66	131.80 ± 0.87	119.20 ± 2.80	139.20 ± 1.11	37.60 ± 0.81
8	185.60 ± 2.05	169.60 ± 1.54	157.20 ± 2.46	179.60 ± 1.00	72.80 ± 1.04
16	214.60 ± 2.60	197.80 ± 3.62	183.40 ± 3.08	211.40 ± 2.68	84.60 ± 0.73

[1]Mean aphid consumption of five replications

hours. After completion of the experiment, the predators were removed from the jars. The prey consumption per predator was worked out after recording the unconsumed prey number at various predator densities.

Predation efficiency of coccinellid beetles on *A. craccivora* at different prey densities

Three-day-old adult beetles were kept individually in glass jars (178.0 x 10.5cm) and starved for 12h in order to standardize the level of hunger. Third instar nymphs of *A. craccivora* on cowpea twigs were kept at five densities, *viz*. 45, 90, 189, 360 and 720 in glass jars, in which one pre-starved adult was released. The open ends of the jars were covered with muslin cloth and secured with rubber bands. The experiment was carried out for 48h. The predators were removed from the jars after the completion of the experiment and unconsumed aphids were recorded to compute the number of prey consumed by the predators.

Feeding efficiency of coccinellids on *A. craccivora* at constant ratio of prey-predator

For the experiment, the adult beetles of the five coccinellids were collected from the stock culture and starved for 12h. One adult of each predator was introduced in a petri plate (100 x 7mm) containing 200 individuals of *A. craccivora* on a twig of cowpea. Petri plates were covered and fastened with rubber bands and placed under room conditions (28.50°C ± 2.00°C temperature and 75.50 ± 5.00% relative humidity). Observations on the unconsumed surviving aphid population was recorded in all the treatments of each replication every 24h for up to 72h.

The data obtained from the various experiments were subjected to statistical analysis after suitable transformation as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of various predator densities on prey consumption

The total aphid consumption by the predators increased with increase in predator density (Table 1). However, among the five predators tested, *C. biplagiata* consumed the maximum prey (65.20 ± 0.59 to 214.60 ± 2.60) at different prey densities followed by *M. sexmaculatus* (62.00 ± 0.78 to 211.40 ± 2.68), *C. transversalis* (60.00 ± 0.68 to 197.80

Table 2. Effect of different densities of *A. craccivora* on prey consumption by coccinellid species at constant density (one) on cowpea

Predator density	[1]Mean number of aphid consumption after 24 hours				
	Coelophora biplagiata	*Coccinella transversalis*	*Chilocorus nigrita*	*Menochilus sexmaculatus*	*Cryptolaemus montrouzieri*
45	45.60 ± 0.46	40.60 ± 0.96	38.60 ± 0.46	41.20 ± 0.33	28.20 ± 0.87
90	68.20 ± 1.99	62.20 ± 0.59	61.00 ± 0.45	62.80 ± 0.77	39.80 ± 1.93
180	155.00 ± 4.45	154.0 ± 2.54	90.20 ± 2.32	98.40 ± 1.93	61.00 ± 1.52
360	305.20 ± 4.45	243.20 ± 2.28	224.00 ± 3.84	246.00 ± 2.26	157.00 ± 3.03
720	485.80 ± 5.18	370.00 ± 3.74	358.80 ± 2.52	377.00 ± 3.35	209.20 ± 2.47

[1]Mean aphid consumption of five replications.

± 3.62) and *C. nigrita* (56.00 ± 1.62 to 183.40 ± 3.08). The lowest prey consumption (19.40 ± 0.36 to 84.60 ± 0.73) at different predator densities (1–16) was recorded in the case of *C. montrouzieri*.

Predation efficiency of coccinellid beetles on *A. craccivora* at various densities of prey

The aphid consumption by different species of adult beetles decreased with increase in prey density (45–720) (Table 2). *C. biplagiata* consumed the maximum aphid population (43.60 ± 0.46 at a density of 45 aphids and 485.80 ± 5.18 at a density of 720 aphids). It was closely followed by *M. sexmaculatus* (41.20 ± 0.33 to 377.00 ± 3.35), *C. transversalis* (40.60 ± 0.96 to 370.00 ± 3.74) and *C. nigrita* (38.60 ± 0.46 to 358.80 ± 2.52) at prey densities ranging from 45 to 720. The least prey consumption was by *C. montrouzieri* (28.20 ± 0.87 to 209.20 ± 2.47).

Feeding efficiency of coccinellids on *A. craccivora* at constant ratio of prey-predator

The population of aphids in the released treatments was significantly lower than that of unreleased control at all the time intervals under observation (Table 3). The mean population of aphids in the treatment where *C. biplagiata* released was significantly lower than that recorded in the other four treatments at all the observation periods. The treatment with *C. biplagiata* recorded minimum aphid population (23.06) as against 191.86 aphids in unreleased control. The maximum aphid population (54.26) was recorded with *C. montrouzieri*. *Menochilus sexmaculatus* and *C. transversalis* registered lower mean surviving aphid population of 35.26 and 43.00, respectively, but they were significantly different from each other (Table 3).

In general, *C. montrouzieri* and *C. nigrita* provided satisfactory prey consumption of *A. craccivora*, but proved inferior to *C. biplagiata*, *M. sexmaculatus* and *C. transversalis*. Further, the results showed that increased prey consumption in all the coccinellids with increase in their densities might be due to many factors, *viz*. greater interaction of prey and predators, decreased, handling time, limited area of searching and the level of starvation. However, when predator density doubled, prey consumption by the predator remained less than double. Decreased consumption might be ascribed to the limited time of predation and restricted area of searching. When time of predation was limited, the predators had to face hindrance from increased number of prey, thus resulting in decreased prey consumption. Satiation can also be a major factor in limiting the predation at increased prey density. The number of prey consumed by a predator depends upon one of the following reasons: i) the nutritive value of the prey for a predator, and ii) the relative ease with which the prey is handled and caught (Omkar and Srivastava, 2003).

The feeding preference of *C. biplagiata*, *M. sexmaculatus* and *C. transversalis* on *A. craccivora* could be a result of its suitability in terms of nutritive value and moderate size to the predators. The present results on increased preference of *M. sexmaculatus* and *C. transversalis* for *A. craccivora* are in accordance with the reports of Singh *et al*. (1994) and Joshi *et al*. (1999) who observed that *A. craccivora* was the most preferred host for these two predatory coccinellids recording higher rate of consumption and maximum fecundity.

Results of the present investigation indicate that it is desirable to conserve and utilize effectively the three species of coccinellids, *viz*. *C. biplagiata*, *M. sexmaculatus* and *C. transversalis,* which are able to reduce aphid population below the economic threshold. Thus, these locally occurring biocontrol agents may be exploited for developing integrated *A. craccivora* management strategy in cowpea in ecosystem of Manipur to minimize the detrimental effects to the environment and the health hazards caused by excessive and repeated use of broad spectrum conventional insecticides.

Table 3. Predation efficiency of adult coccinellids at constant ratio of prey-predator on *A. craccivora* infesting cowpea under laboratory conditions

Predatory coccinellid	[1]Average number of unconsumed aphid population after release of predator			Mean
	24 hours	48 hours	72 hours	
Coelophora biplagiata	10.00 (3.23)	21.80 (4.72)	37.40 (6.15)	23.06 (4.70)
Coccinella transversalis	19.80 (4.50)	41.80 (6.50)	67.40 (8.23)	43.00 (6.41)
Chilocorus nigrita	21.40 (4.67)	41.80 (6.57)	84.20 (9.20)	49.13 (6.81)
Cheilomenes sexmaculata	15.80 (4.08)	36.60 (6.09)	53.40 (7.39)	35.26 (5.83)
Cryptolaemus montrouzieri	23.20 (19.80)	45.00 (6.74)	94.60 (9.79)	54.26 (7.11)
Unreleased control	148.80 (14.12)	196.60 (14.03)	180.20 (13.43)	191.86 (13.9)
CD (P = 0.05)	0.22	0.26	0.08	0.24

Figures in parentheses are $\sqrt{X + 0.5}$ transformed values; [1]Average unconsumed aphid population of five replications

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