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Research Note

Biological attributes and feeding potential of three dominant predators of *Lipaphis erysimi* (Kaltenbach)

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ABSTRACT: Basic biological attributes and feeding potential of three major predators *viz*., the seven spotted lady bird beetle *Coccinella septempunctata* Linnaeus and two syrphids *Episyrphus viridaureus* (Wiedemann) and *Betasyrphus isaaci* (Bhatia), of mustard aphid, *Lipaphis erysimi* were studied under laboratory conditions. The predators were multiplied on mustard aphids reared on mustard plants. *C. septempunctata*, *E. viridaureus* and *B. isaaci* completed their life cycle in 68.5± 6.5 days, 47±2 and 41±2, respectively. *Coccinella septumpunctata* completed the larval growth with four larval instars, while both the syrphids terminated the larval growth with three instars. Final instars of all the three predators were found to have highest predatory potential than the younger instars. *C. septumpunctata* was found to be the most dominant predator of mustard aphid with average lifetime consumption of 4312±537.74 aphids, followed by *E. viridaureus* (416.67±6.76 aphids) and *B. isaaci* (338±7.89 aphids). All the three predators have the potential to reduce the mustard aphids; however, *C. septumpunctata* has a maximum predatory potential with a longer life, which makes this species as an excellent bio-agent of *L. erysimi* and further research on their utilization on a large scale should be undertaken.

KEY WORDS: *Betasyrphus isaaci, Coccinella septempunctata, Episyrphus viridaureus, Lipaphis erysimi,* Meghalaya

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Indian mustard (*Brassica juncea* L.) is an agriculturally important oilseed crop and contributes as a major source of edible oil in the country. In terms of area and production, it ranks second among the oilseed crop next to the groundnut (Singh and Singh, 2013). India produces about 11.3% of the world's rapeseed and mustard (Pramanik and Dey, 2012). However, the average yield of mustard is relatively low in India compared to the other countries (Rao *et al.,* 2013). Insect-pests are one of the important factors for low productivity of mustard that cause significant reduction in yield. Amongst the insect pests, the mustard aphid, *Lipaphis erysimi* Kaltenbach (Hemiptera: Aphididae) is one of the most destructive insects and a major limiting factor for successful cultivation of mustard. Mustard aphid is a widely distributed pest, causes damage from seedlings till the harvesting stage and which alone can cause up to 73.3% reduction in yield (Gupta *et al.,* 2003). The yield losses varied from 30-40 %, depending upon the season and localities (Sultana *et al.,* 2009). Although synthetic chemical pesticides are widely used to manage the mustard aphid, they harm the ecosystem in several ways. As more emphasis is being given on natural and organic farming, it is important to find out the eco-friendly approaches for pest management, for maintaining ecosystem health and human nutrition through balanced food chain in agro-ecosystems.

Due to a distinct climatic conditions, the northeastern hilly region of India is exceptionally rich in terms of flora and fauna (Azad Thakur *et al.,* 2012; Firake *et al.,* 2013a). The brassicaceous ecosystems of Meghalaya harbour several natural enemies, many of them have a potential to reduce the pest damage (Firake *et al.,* 2012a; Lytan and Firake, 2012; Firake *et al.,* 2012b; Thubru *et al.,* 2016). Among predators, the ladybird beetle, *Coccinella septumpunctata* Linnaeus (Coleoptera: coccinellidae) and syrphid flies, *Episyrphus viridaureus* (Wiedemann) and *Betasyrphus isaaci* (Bhatia) (Diptera: Syrphidae) are the major predators of mustard aphid in mid altitude hills of Meghalaya. These potential natural enemies can be utilized to develop an effective bio-intensive pest management modules against target pests. Basic biological attributes and functional response of major natural enemies are very much essential to utilize them judiciously. However, this information is limited, particularly in case of syrphid flies. Consequently, the biological attributes and feeding potential of *C. septempunctata* and syrphid flies (*E. viridaureus* and *B.*

isaaci) were studied under *in vitro* conditions, to know their efficiency, potential and further benefits in the management of mustard aphid.

The experiments were conducted in Entomology Section, Division of Crop Protection, ICAR Research Complex for NEH region, Umiam, Meghalaya. The mustard variety 'M-27' was grown on the entomology farm of the institute. All three natural enemies *viz., E. viridaureus, B. isaaci* and *C. septempunctata* and mustard aphid, *L. erysimi* were collected from the field and further used for the experiments.

The stock cultures of natural enemies were maintained (at 20±1°C Temperature, 75% Relative humidity, 10:14, L: D Light hours) on the aphid infested mustard plants in the laboratory. For that, mustard seeds (variety 'M-27') was planted in small plastic jar and raised inside the net house. Initial culture of aphid, *L. erysimi* was collected from the entomology farm of the institute. At 35 days of planting, mature aphids were gently released on mustard plants @10 aphid per plant with the help of camel hair brush. The infested plants were brought into the laboratory after 15-25 days of release. The larvae of natural enemies viz. *E. viridaureus, B. isaaci* and *C. septempunctata* were collected from the entomology farm and released inside the wooden rearing cages (45x45x45cm) containing infested mustard plants. The host plants were produced regularly during experimental period and the natural enemies were multiplied on aphid, *L. erysimi* developing on mustard plants.

For the experiment, mated females of ladybird beetle (n = 30) and syrphid flies (n = 20) were released in a plastic jar containing mustard aphid. Eggs laid on the leaves or periphery of the plastic jar were collected gently with a soft camel hair brush and kept in petri-plates. The newly hatched larvae of different predators were allowed to feed upon the aphids inside the plastic jar till attaining their adult stage. Fresh food was provided regularly until completion of their growth and development. Observations on incubation period, larval (instar wise) and pupal period were recorded regularly. Adults of all three predators (n = 10 pairs) were separated immediately after the emergence and kept in specially developed oviposition chamber for eggs laying. Fresh twigs of mustard plants containing sufficient numbers of aphids and honey solution (50%) were provided to adults till their death. Observations on adult longevity and fecundity were recorded regularly.

To study the predatory potential of coccinellids and syrphid flies, ten newly hatched larvae of different predators were released in a separate Petri dishes. The mustard aphids were provided regularly @ 100 live mature aphids per larva. After 24 hours, observation on consumption of aphids was recorded from each plate regularly and provided with fresh aphids in Petri dishes. The process was repeated until the complete growth of the predators. Observations on different life stages were also recorded regularly to know the most efficient stage of the predators. Adult syrphid flies are free living and therefore the observations on syrphid predators were only recorded up to final larval instars. In case of *C. septumpunctata*, the feeding potential was also recorded in the adult stage. In addition to aphids (@100 aphids/day), honey solution (50%) was also provided regularly to the adult beetles until their death. Average values and standard error of the mean were calculated with Microsoft office Excel 2007 Windows 7.0.

Biological attributes of the predators under laboratory conditions

Coccinella septempunctata

The adult female, laid yellow coloured eggs in cluster of around 26-45 in numbers. The incubation period was found to be 3.5±0.5 days. The grub of *C. septempunctata* underwent four larval instars. The size of the grub increased with each consecutive moulting. The total larval period was observed to be 26±3 days. The pupa of *C. septempunctata* was grey to black in colour with orange marking on the outside. The size of the pupa was approximately as same size of the adult. The pupal period was found to be 7.5±1.5 days. The adult female lived for 31.5±1.5 days and laid 357.45±22.41 eggs in her lifetime. The earlier reports on biology of *C. septempunctata* (Xu 1985; Rauf *et al.,* 2013; Sattar *et al.,* 2008) are in conformity with our results and slight variation in developmental period could be due to different factors including prey species and host plants.

Episyrphus viridaureus

Singly laid eggs of *E. viridaureus* were observed near or within aphid colonies. The eggs were whitish in colour and oblong in shape. The incubation period was found to be 3±0.5 days. *E. viridaureus* underwent three larval instars to complete larval growth. Interestingly, the maggot of *E. viridaureus* had a transparent body, enables the clear visibility of the internal organs. The larval period was observed to be 22±1.5 days. The pupa of *E. viridaureus* was creamy coloured and pear shaped, tapering at the end. The pupal period was found to be 7±1 day. Adult female lived for 14±1.5 days and laid 45.0±16.8 eggs in her lifetime. The fly completes its life cycle in 47 to 49 days. While studying biology of *E. balteatus*, Hong and Hung (2010) found 21.2 days life cycle of *E. balteatus* with larval period of 7.6 days.

Betasyrphus isaaci

The adult female of *B. isaaci* laid egg singly near aphid colonies. The eggs were faint grey in colour and oblong shaped. The incubation period was found to be 3±1 day. The total larval period was observed to be 21±1.5 days and larva underwent three larval instars. The pupal period was found to be 8±1 day. The adult female lived for 13 ±1 days and laid 31.2±13.6 in her lifetime.

Feeding potential of three predators of mustard aphid

Data on predatory potential of three major natural enemies are presented in Table 2. In case of all three predators, consumption of aphids was found to increase with each subsequent instars and final larval instar consumed maximum aphids than the younger ones. Predatory potential of immature stages of *C. septumpunctata* was found to be much higher than both the species of syrphid flies. A single adult *C. septumpunctata* consumed an average of 81.55±15.34 aphids per day and ultimately consumed 2691.00±533 aphids during adult stage. Since both immature and adult stage of *C. septumpunctata* are predatory and therefore it was found to be the most dominant predator of *L. erysimi*. A single *C. septumpunctata* consumed an average of 4312±537.74 aphids in a lifetime; which is much higher than *E. viridaureus* (416.67±6.76 aphids) and *B. isaaci* (338±7.89 aphids). Higher consumption during last larval instar could be attributed to the complete development of mouth parts and higher metabolism than early instars. Our results are supported by several findings on feeding potential of different syrphids and coccinellids (Baskaran *et al.,* 2009; Romabai Devi *et al.,* 2011; Verma *et al.,* 2005; Alfiler and Calilung, 1980; Bunker and Ameta, 2009; Singh and Singh, 2013, 2014). Singh and Singh (2013) reported that the first, second, third and fourth instar of *C. septumpunctata* consumed 21.43, 46.90, 72.61, and 102.60 aphids per day. The total consumption of *E. viridaureus* was reported to be 464 ± 21.65 aphids (Kotwal *et al.,* 1984). The prey consumption of *Episyrphus* spp. is known to increase gradually with the age of the developing instars (Romabai Devi*et al.,* 2011), as observed in this study. The information on feeding potential of *B. issaci* is not available in the existing literature, however, Verma *et al.* (2005) reported that the first, second and third instar of another closely related syrphid, *B. serarius* consumed 11.5, 44.75 and 232.5 aphids/day.

The present study concludes that all the three predators have the potential to reduce the mustard aphids. The *C. septumpunctata* has a maximum predatory potential with a longer life, which makes this species as an excellent bioagent of *L. erysimi* and further research on their utilization on large scale should be addressed.

Table 1. Biological attributes of three predators of mustard aphids under laboratory conditions

Parameter	Predators		
	Coccinella septempunctata	*Episyrphus viridaureus*	*Betasyrphus isaaci*
Incubation period	3.5±0.5 days	03±0.5 days	3±1 days
Larval period	26±3 days	22±1.5 days	21±1.5 days
First instar	3.5±0.5 days	12.9±1.0 days	13.10±0.5 days
Second instar	7.5±1.5 days	4.1±0.5 days	3.90±1.0 days
Third instar	6.5±0.5 days	5.0±1.0 days	4.0±0.5 days
Fourth instar	8.5±1.0 days	-	-
Pupal period	7.5±1.5 Days	7±1 days	8±1 days
Adult longevity	31.5±1.5 Days	14±1.5 days	13±1 days
Life cycle	68.5±6.5 Days	47±2 days	41±2 days
Fecundity	357.45±22.41. No/female	45.0 ± 16.8. No/female	31.2 ± 13.6. No/female

Table 2. Feeding potential of three major predators on *Lipaphis erysimi*

Stages	Daily consumption of aphids per day (Mean± SE)			Consumption per life stage (Mean± SE)		
	Coccinella septempunctata	*Episyrphus viridaureus*	*Betasyrphus isaaci*	*Coccinella septempunctata*	*Episyrphus viridaureus*	*Betasyrphus isaaci*
First instar	20.42±00.42	07.30±0.08	06.51±0.17	081.67±0.33	095.00 ± 1.51	084.67 ± 1.30
Second instar	35.00±00.99	23.58±0.22	23.75±0.29	315.00±1.34	094.00 ± 4.30	095.00 ± 4.80
Third instar	65.48±01.27	45.53±1.09	39.58±1.46	458.33±1.29	227.67 ± 0.95	158.33 ± 1.79
Fourth instar	85.11±01.39	-	-	766.00±1.78	-	-
Adult	81.55±15.34	Free living	Free living	2691.00±533	Free living	Free living
Total consumption				4312±537.74	416.67 ± 6.76	338.00 ± 7.89

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