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ORIGINAL ARTICLE

Bioconversion Efficacy and Reproductive Performance of *Coccinella septempunctata* Linnaeus (Coleoptera: Coccinellidae) on Different Aphid Species

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ABSTRACT

The observations on reproductive performance showed that seven potted ladybird beetle, *Coccinella septempunctata* L. consumed significantly ($F_{4, 14}$ = 2.23; p < 0.01) maximum number of *L. erysimi* (1117.33±12.98 aphids) followed by *H. coriendri* (934.00±3.46 aphids), *A. craccivora* (872.67±7.51 aphids), *R. nymphae* (838.33±3.76 aphids) and *M. rosae* (825.00±4.36 aphids). The potential fecundity of *C. septempunctata* was also recorded highest on *L. erysimi* (162.67±1.45 eggs) followed by *H. coriendri* (129.33±1.76 eggs), *R. nymphae* (114.33±2.33 eggs), *A. craccivora* (103.33±1.20 eggs) and *M. rosae* (96.67±2.91 eggs). In addition, progeny loss was recorded significantly ($F_{4, 14}$ = 4.91; p < 0.01) low on *L. erysimi* (3.28±0.18 %) and high on *M. rosae* (22.04±0.70 %). A marked variation in pre-reproductive ($F_{4, 14}$ = 1.00; p < 0.01), reproductive ($F_{4, 14}$ = 3.86; p < 0.01) and post-reproductive ($F_{4, 14}$ = 0.00; p < 0.01) period was observed with respect to different aphid species. The longest reproductive period were recorded on *L. erysimi* (18.00±0.58 days) and shortest on *M. rosae* (12.00±0.58 days), respectively. The reproductive time ratio also observed significantly ($F_{4, 14}$ = 5.09; p < 0.01) high on *L. erysimi* (0.45±0.00) and low on *M. rosae* (0.36±0.02). Moreover, reproductive rate of *Coccinella septempunctata* was recorded significantly ($F_{4, 14}$ = 1.97; p < 0.01) maximum on *L. erysimi* (9.05±0.21) and minimum on *A. craccivora* (6.90±0.21), respectively. Among different aphid species, highest bioconversion efficacy was recorded with respect to *L. erysimi* (14.56±0.06) followed by *H. coriendri* (13.85±0.14), *R. nymphae* (13.64±0.36), *A. craccivora* (11.84±0.15) and *M. rosae* (11.72±0.41), respectively. The variation in the bioconversion efficacy is due to either choice of food either of seven spotted ladybird beetle or variation in nutritional value aphid species.

Key Words: *Aphis craccivora, Hyadaphis coriendri, Lipaphis erysimi, Macrosiphum rosae, R. nymphae*

INTRODUCTION

Coccinella septempunctata is the most common ladybird in India and Europe. It has red colour elytra with three black spots on each side of elytra and one spot on the junction of elytra and therefore, making a total of seven spots, which reflects its name seven spotted ladybird beetle. It has a broad ecological range including fields, parkland, gardens, forests etc. Generally feed on aphids and termed as aphidophagous beetle but it can also feed on thrips, whiteflies, on the larvae of psyllids and leafhoppers, and sometime on the eggs and larvae of some beetles and butterflies. Moreover, due to target specificity it became dominating natural enemy or top predator of aphid and other plant lice. Therefore, in present time, *C. septempunctata* has been successfully introduced as biological control agents of many soft bodied insects.

The extensive studies on essential food require for the development and reproduction and some nonessential food which serves only as an energy source to the coccinellids have also been done by various workers (Hodek, 1960; Hodek and Honek, 1996; Omkar and Pervez, 2000; Lundgren and Wiedenmann, 2004; Berkvens *et al.*, 2008; Lundgren, 2009; Seago *et al.*, 2011; Guedes and Almeida, 2013; Skouras and Stathas, 2015; Castro *et al.*, 2016). Moreover, several successful studies on food suitability and reproductive performance have been carried out by Blackman (1967), Agarwala *et al.*, (1988), Hazzard and Ferro (1991), Rogers *et al.*, (1994), Omkar and Srivastava (2003), Omkar and Bind (2004), Omkar and James (2004), Pervez and Omkar (2004), Ali and Rizvi, (2007), Solano *et al.*, (2016) and Castro *et al.*, (2016). But present study is designed on bioconversion efficacy of different aphid species for egg production and also to observe the high reproductive performance of *C. septempunctata.*

MATERIALS, METHODS AND RESULTS

Different aphid species *Lipaphis erysimi* Kaltenbach, *Aphis craccivora* Koch, *Hyadaphis coriandri* Das, *Rhopalosiphum nymphae* Linnaeus and *Macrosiphum rosae* Linnaeus, were collected from natural infested crops of Indian mustard (*Brassica juncea* L.), common bean (*Phaseolus vulgaris* L.), coriander (*Coriandrum sativum* L.), ornamental plants, verbena (*Verbena laciniata* L.) and rose (*Rosa indica*) plants. From the infested field grub and beetles of seven spotted ladybird (*Coccinella septempunctata*) were also collected to begin the experiment in the laboratory.

The collected specimens placed in BOD incubator maintained at 25 ±1 ºC, 65 ± 5 % relative humidity and 12 L: 12 D photoperiod. On account of emergence, beetles were reared in pairs on the five different aphid species separately in Petri dishes (90 x 10 mm). Eggs laid by female were collected and transferred to other Petri dishes for commencement of observations. After hatching, a total of ten newly hatched (zero day old) grubs of *C. septempunctata* were reared individually in plastic vials (4.0 x 6.0 cm) on the five different aphid species, each replicated thrice. A total of 30-40 nymphs of the different aphid species were supplied to the grubs as food. This number increase with subsequent moult and reach up to 100 nymphs daily. All the procedure for rearing of *C. septempunctata* was followed as per Omkar *et al.*, (2005) and Ali *et al.*, (2009).

To observe bioconversion efficiency and reproductive performance of *C. septempunctata*, the number of eggs produced throughout a female's lifetime (fecundity), percent progeny loss (number of unviable eggs x 100/ fecundity), pre-reproductive period, reproductive (oviposition) period, post-reproductive period, reproductive rate (fecundity/ duration of oviposition period), reproductive time ratio (ratio of female reproductive to non-reproductive period), predation efficiency (number of aphids consumed in life times) and bioconversion efficiency (number of eggs x 100/ number of aphids consumed) were calculated with respect to all aphid species (Omkar *et al.*, 2005 and Ali *et al.*, 2009). The data collected were analyzed by one-way ANOVA through MINITAB 11 for WINDOW software. The statistical difference was also determined by comparing mean values through Duncan's multiple range tests at 1 % level of significance for two successive generations.

RESULTS AND DISCUSSION

The predation efficiency of *C. septempunctata* showed that it consume significantly ($F_{4, 14} = 2.23$; $p < 0.01$) maximum aphids of *L. erysimi* (1117.33±12.98) followed by *H. coriandri* (934.00±3.46), *A. craccivora* (872.67±7.51), *R. nymphae* (838.33±3.76) and minimum of *M. rosae* (825.00±4.36) (Table 1). In previous study, Omkar *et al.*, (2005) observed maximum feeding potential of *C. septempunctata* than other ladybird beetles on cowpea aphids. On the other hand, Ahmadov and Hasanova (2016) studied that Coccinella beetles suppress the good number of aphids specially *Aphis craccivora* and *Aphis gossypii* and given strengthen to present findings.

The egg laying capacity or potential fecundity of even spotted ladybird beetles was recorded highest on *L. erysimi* (162.67±1.45 eggs) followed by *H. coriendri* (129.33±1.76 eggs), *R. nymphae* (114.33±2.33 eggs), *A. craccivora* (103.33±1.20 eggs) and *M. rosae* (96.67±2.91 eggs) (Table 1). Some authors believe that the variation in predation is due to choice of *C. septempunctata* (Michaud, 2005). In present study, the potential fecundity is proportional to the amount of food and the variation in fecundity and progeny loss may be possible due to nutritional value of aphid species provided as food (Michaud, 2005; Hodek *et al.*, 2012; Castro *et al.*, 2016). The progeny loss was also recorded significantly ($F_{4, 14} = 4.91$; $p < 0.01$) low on *L. erysimi* (3.28±0.18 %) and high on *M. rosae* (22.04±0.70 %) (Table 1). Possibly, it is due to poor quality of food on which aphid feed during its development (Omkar *et al.*, 2005; Hodek and Honek, 1996). However, Khan *et al.*, (2015) advised that temperature also played important role for the development of ladybird beetles.

A marked variation in pre-reproductive ($F_{4, 14} = 1.00$; $p < 0.01$), reproductive ($F_{4, 14} = 3.86$; $p < 0.01$) and post-reproductive ($F_{4, 14} = 0.00$; $p < 0.01$) period was observed with respect to different aphid species (Table 1). The longest reproductive period were recorded on *L. erysimi* (18.00±0.58 days) and shortest on *M. rosae* (12.00±0.58 days), respectively. The reproductive time ratio also observed significantly ($F_{4, 14} = 5.09$; $p < 0.01$) high on *L. erysimi* (0.45±0.00) and low on *M. rosae* (0.36±0.02). Moreover, reproductive rate of *C. septempunctata* was recorded significantly ($F_{4, 14} = 1.97$; $p < 0.01$) maximum on *L. erysimi* (9.05±0.21) and minimum on *A. craccivora* (6.90±0.21), respectively (Table 1). All reproductive parameters showed significant and favorable observations with respect to *L. erysimi* than other aphid species. The other corroborative observations are Dixon (2000), Omkar and Srivastava (2003), Kalushkov and Hodek (2004), Omkar and James (2004), Pervez and Omkar (2004), Berkvens *et al.*, (2008) Lundgren (2009), Guedes and Almeida (2013), Skouras and Stathas (2015) and Castro *et al.* (2016).

Table 1: Bioconversion efficiency and reproductive performance of *C. septempunctata* on different aphid species

Aphid species	Predation efficiency	Potential fecundity	Progeny loss	Pre-reproductive period	Reproductive period	Post-reproductive period	Reproductive time ratio	Reproductive rate	Bioconversion efficiency
L. erysimi	1117.33 ±12.98d	162.67 ±1.45e	3.28 ±0.18a	35.00 ±0.58d	18.00 ±0.58e	5.33 ±0.33b	0.45 ±0.01d	9.05 ±0.21d	14.56 ±0.06c
A. craccivora	872.67 ±7.51c	103.33 ±1.20b	17.41 ±0.37d	32.33 ±0.33c	15.00 ±0.58c	3.33 ±0.33a	0.42 ±0.01c	6.90 ±0.21c	11.84 ±0.15a
H. coriandri	934.00 ±3.46b	129.33 ±1.76d	9.27 ±0.38b	37.00 ±0.58e	15.67 ±0.33d	3.33 ±0.33a	0.38 ±0.01b	8.27 ±0.27ab	13.85 ±0.14b
R. nymphae	838.33 ±3.76b	114.33 ±2.33c	14.89 ±0.67c	29.00 ±0.58a	13.33 ±0.33b	6.67 ±0.33c	0.37 ±0.01ab	8.60 ±0.37b	13.64 ±0.36b
M. rosae	825.00 ±4.36a	96.67 ±2.91a	22.04 ±0.70e	30.00 ±0.58b	12.00 ±0.58a	3.33 ±0.33a	0.36 ±0.02a	8.11 ±0.59a	11.72 ±0.41a
F and P value	2.23 4, 14 P ≤ 0.01	0.08 4, 14 P ≤ 0.01	4.91 4, 14 P ≤ 0.01	1.00 4, 14 P ≤ 0.01	3.86 4, 14 P ≤ 0.01	0.00 4, 14 P ≤ 0.01	5.09 4, 14 P ≤ 0.01	1.97 4, 14 P ≤ 0.01	0.29 4, 14 P ≤ 0.01
LSD Value	9.31	3.17	0.53	0.76	0.56	0.53	0.01	0.47	0.36

The overall observation revealed that bioconversion efficacy of aphids was recorded highest on the feeding of *L. erysimi* (14.56±0.06) by *Coccinella septempunctata* followed by *H. coriendri* (13.85±0.14), *R. nymphae* (13.64±0.36), *A. craccivora* (11.84±0.15) and minimum *M. rosae* (11.72±0.41), respectively. This variation in the bioconversion efficacy is possibly due to choice of food either of seven spotted ladybird beetle or in variation of nutritional value aphid species.

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