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Predatory potential Of *Chrysoperla zestrowi* Sillemittenry and *Cryptolaemus montrouzieri* (Mulsant) on papaya mealybug, *Paracoccus marginatus* (Williams And Granara De Willink)

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ABSTRACT: Predatory potential of *Chrysoperla zestrowi* Sillemittenry and C*ryptolaemus montrouzieri* (Mulsant) was investigated in the laboratory. Both predators were found feeding on all the nymphal instars of *Paracoccus marginatus* (Williams and Granara de Willink). Third instar larvae of *C. zestrowi* were the most voracious feeder and consumed significantly higher number of ovisacs, first, second and third instar nymphs of mealybug as compared with first and second instar larvae of the predator. Similarly fourth instar grub of *C. montrouzieri* consumed higher number of ovisacs, first, second and third instar nymphs of mealybug. The results indicate the potential of *C. zestrowi* and *C. montrouzieri* in the the biological control of *P. marginatus.*
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Key words:predatory potential, *Chrysoperla zestrowi*, *Cryptolaemus montrouzieri*, papaya mealybug, *Paracoccus marginatus* .

INTRODUCTION

Papaya is a popular fruit crop extensively grown in India. Mealybug, *Paracoccus marginatus* (Williams and Granara de Willink) is causing economic damage many agricultural and horticultural crops in India. Papaya mealybug is a native of Mexico and/ or Central America and was first described by Williams and Granara de Willink (1992). It is a highly polyphagous pest of 133 plant species belonging to 48 families (Sakthivel *et al.,* 2012). Due to growing environmental and economic concerns involved in the use of synthetic chemicals, there is a dire need to develop alternate measures for the suitable management of *P. marginatus.* In this context biological control need to be explored for controlling mealybug. The coccinellid predator,

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C. montrouzieri is one of the most commonly used bio-control agent in various parts of the world. It has played a major role in the natural control of different sucking pests especially mealybugs (Mani and Krishnamoorthy, 2008; Shylesa *et al.*, 2011). Green lacewing, *C. zestrowi* commonly known as aphid-lion is a general predator of a wide range of pest species such as mealybugs, aphids, thrips, whiteflies and mites (Yadav and Pathak, 2010).

Detailed studies on the use of *C. montrouzieri* and *C. zestrowi* for the biological control of *P. marginatus* are lacking and hence detailed studies were undertaken under laboratory conditions.

MATERIALS AND METHODS

Potatoes are used as an alternative food source for rearing of mealybugs (Serrano and Laponite, 2002). Seed potatoes with eyes were brought from local markets, washed and disinfected in 5% Sodium hypochlorite solution. After cleaning, the potatoes were treated with gibberlic acid 100 ppm solution for half an hour and placed under dark condition in wet gunny bags for four to five days to induce early sprouting. The tubers were then sown in plastic basins filled with moist sand. Before filling, the sand was sterilized in hot air oven at 1000^{o}C to prevent infestation by any pathogen which might induce rotting of tubers. Crawlers collected from the field were introduced on the green sprouts when they reached a height of 15-20 cm using a camel hair brush and mass cultured continuously for several generations under laboratory condition.

The two predators *C. montrouzieri* and *C. zestrowi* were reared using the stock supplied by the National Bureau of Agriculturally Important Insects, Banglore. The adults of *C. montrouzieri* were mass reared on *Maconellicoccus hirsutus* (Green) infesting pumpkins (*Cucurbita moschata* Duchense) treated with carbendazim (1gL^{-1}) to avoid fungal attack and the wounds were treated with wax. The methodology as described by Babu and Azam (1987) was followed for mass culturing of the predator.

For assessing the feeding potential of the predators two experiments were conducted.

i) No choice feeding -

The feeding potential of the larval instars of *C. zestrowi* (3 nos.) and *C. montrouzieri* (4 nos.) were individually collected from the mass cultures maintained separately in the laboratory. One each of these larva was transferred to Petri dish (9 cm diameter). From the culture of mealybug known number of ovisac, first, second and third instars collected separately and provided in petridish separately for the first, second and third nymphal instars of both predators. Each treatment was replicated eight times. The number of prey insects consumed was recorded daily. Fresh ovisacs and mealybugs were provided to the predators until they reached the next instar. In this way, the number of prey insects consumed during each larval instar was recorded. The experiment was laid out in Completely Randomized Design with four replications

ii) Free choice feeding -

In this experiment, single larva of each instars of the predators was introduced into petridish (9 cm diameter) with the help of camel hair brush along with known number of mealybugs of 1-3 nymphal instars for feeding. Free choice feeding of each predator instar on each instar of *P. marginatus* was recorded daily till the completion of each instar of the predator. The experiment was laid out in Completely Randomized Design with four replications.

The data were subjected to statistical analysis.

RESULTS AND DISCUSSION

Predation of *C. zestrowi*

No choice condition-

Feeding efficacy of different larval stages and adult of the predator was studied (Table 1). The third instar larvae of *C. zestrowi* consumed higher number of 3.25 ovisacs, 330.75 first instar, 120.63 second instar and 87.25 third instar nymphs of *P. marginatus* which differed significantly from 1.38 ovisacs, 109.25 first instar, 37.88 second instar and 12.63 third instar consumed by first instar *C.* carnea. The second instar *C. zestrowi* consumed 1.88 ovisacs, 206.13 first instars, 69.88 second instars and 37.75 third instar nymphs of *P. marginatus.* Third instar predator proved to be the most voracious feeder of all the nymphal instars of *P. marginatus* compared to first and second instars. The reason for higher feeding potential of third instar might be due to its large size than other developmental stages of the predator.

Free choice condition -

The different prey stages of mealybug were offered together to different larval instars of *C. zestrowi* (Table 2). The third and second instar larvae of *C. zestrowi* consumed 23.50 and

Table 1. Feeding potential of *C. zestrowi* on different instars of *P. marginatus* (No choice condition)

Different Instars of *C. carnea*	Total number of different stages of mealybug consumed* (mean ± SE)			
	Ovisac	1st instar nymph	2nd instar nymph	3rd instar nymph
1st	1.38 ± 0.18 c	109.25 ± 1.37 a	37.88 ± 0.76 a	12.63 ± 0.26 a
2nd	1.88 ± 0.13 a	206.13 ± 3.78 b	69.88 ± 1.04 b	37.75 ± 0.59 b
3rd	3.25 ± 0.16 b	330.75 ± 1.59 c	120.63± 0.98 c	87.25 ± 0.56 c
CD	0.47	7.34	2.75	1.45

* Mean of four replications

Table 2. Feeding potential of *C. zestrowi* on different instars of *P. marginatus* (Free choice condition)

Different Instars of *C. carnea*	Number of different instars of mealybug consumed* (mean ± SE)		
	I[st] instar nymph	II[nd] instar nymph	III[rd] instar nymph
1[st]	16.21 ± 0.40 [a]	7.00 ± 0.69 [a]	0.75 ± 0.12 [a]
2[nd]	23.04 ± 0.34 [b]	10.42 ± 0.75 [b]	3.75 ± 0.26 [b]
3[rd]	23.50 ± 0.48 [b]	11.58 ± 1.16 [c]	6.875 ± 0.22 [c]
CD	1.21	0.93	0.61

* Mean of four replications

23.04 of first instar mealybugs respectively were on par whereas, the first instar consumed minimum number of 16.21 first instar nymphs of *P. marginatus*. Higher number of second instar mealybug nymphs were consume by third instar larvae of *C. zestrowi* (11.58) followed by second instar (10.42) and first instar *C. zestrowi* (7.00) The third instar of *C. zestrowi* consumed significantly higher number of 6.88 third instar nymphs of mealybug whereas the second instar of predator consumed 3.75 third instar nymphs of *P. marginatus*. The first instar *C. zestrowi* consumed lowest number of 0.75 ± 0.69 third instar nymphs of mealybug. The higher response of the predator towards the first instar prey could be attributed to the absence of thin white waxy layer on the bodies of the first instar compared to second and third instar prey. Similar trend was also reported by Liu and Chen (2001) for *C. zestrowi* reared on *Lipaphis erysmi.*

Predation of *C. montrouzieri*

No choice condition -

The fourth instar grub of *C. montrouzieri* consumed significantly higher no. of 13.13 ovisacs, 337.50 first instar nymphs of *P. marginatus* followed by 218.00, 174.25 and 124.75 nymphs consumed by third, second and first instar grubs of *C. montrouzieri* respectively (Table 3). First instar grub of *C. montrouzieri* consumed minimum number of 67.00 second instar nymphs of *P. marginatus* whereas the fourth instar grub consumed maximum number of 209.25 nymphs. This was followed by the consumption of 169.25 and 97.00 second instar mealybug nymphs by third and second instar grub of *C. montrouzieri* respectively The fourth instar grub of *C. montrouzieri* consumed maximum number of 137.38 of third instar mealybug nymphs where as minimum consumption of 31.88 third instar mealybugs by first instar grub.The third instar grub of *C. montrouzieri* consumed maximum number of 83.25 third instar mealybug nymphs followed by minimum consumption of 54.13 third instar mealybug nymphs by second instar grub of *C. montrouzieri*. The highest feeding rate was observed in the fourth larval instar than other instars of *C. montrouzieri.*

Table 3. Feeding potential of C. montrouzieri on different instars of *P. marginatus* (No choice condition)

Different Instars of *C. montrouzieri*	Total number of different instars of mealybug consumed* (mean ± SE)			
	Ovisac	1st instar nymph	2nd instar nymph	3rd instar nymph
1st	4.38 ± 0.18 [a]	124.75 ± 0.94 [a]	67.00 ± 0.85 [a]	31.88 ± 0.77 [a]
2nd	7.13 ± 0.30 [b]	174.25 ± 1.06 [b]	97.00 ± 0.88 [b]	54.13 ± 1.23 [b]
3rd	9.63 ± 0.26 [c]	218.00 ± 1.98 [c]	169.25 ± 0.86 [c]	83.25 ± 1.13 [c]
4th	13.13 ± 0.40 [d]	337.50 ± 2.16 [d]	209.25 ± 0.94 [d]	137.38 ± 1.38 [d]
CD	1.04	4.72	2.59	3.32

* Mean of four replications

Free choice condition -

Significantly higher number of 84.46 first instar nymphs of mealybug was consumed by fourth instar grub of *C. montrouzieri* whereas first instar grub of *C. montrouzieri* consumed minimum of 24.50 first instar mealybug nymphs (Table 4). The third instar grub of *C. montrouzieri* consumed 60.17 first instar mealybug nymphs followed by second instar grub with 43.00 numbers of first instar mealybug nymphs. Maximum consumption of fourth instar *C. montrouzieri* was 52.58 second instar mealybug nymphs followed by third instar grub with 41.50 mealybug nymphs. Minimum number (14.88) of second instar mealybug nymphs consumed by first instar grub of *C. montrouzieri* whereas the second instar grub of *C. montrouzieri* consumed maximum of 29.96 second instar mealybug nymphs. The maximum third instar mealy bug nymphs (31.46) consumed by fourth instar grub of *C. montrouzieri*

Table 4. Feeding potential of C. montrouzieri on different instars of *P. marginatus* (Free choice condition)

Different Instars of *C. montrouzieri*	Number of different instars of mealybug consumed* (mean ± SE)		
	1st Instar nymph	2nd Instar nymph	3rd Instar nymph
1st	24.50 ± 0.47 [a]	14.88 ± 0.45 [a]	7.71 ± 0.32 [a]
2nd	43.00 ± 0.48 [b]	29.96 ± 0.63 [b]	14.17 ± 0.48 [b]
3rd	60.17 ± 1.12 [c]	41.50 ± 0.50 [c]	23.13 ± 0.40 [c]
4th	84.46 ± 0.48 [d]	52.58 ± 0.27 [d]	31.46 ± 0.66 [d]
CD	2.00	1.39	1.39

* Mean of four replications

whereas the minimum number of 7.71 consumed by first instar *C. montrouzieri* grub. The second and third instar grubs of C. *montrouzieri* consumed 14.17 and 23.13 third instar mealy bug respectively.

In the no choice test the total number of life stages viz., ovisacs, first, second and third instars of the mealy bug consumed during the three larval instars of *C. zestrowi* were 6.51, 646.13, 228.39 and 137.63 respectively, while that by the four instars of *C. montrouzieri* were 34.28, 854.50, 442.50 and 306.64 respectively. In the free choice test the total number of life stages viz., first, second and third instars of the mealy bug consumed during the three larval instars of *C. zestrowi* were 62.75, 21 and 11.35 respectively, while that by the four instars of *C. montrouzieri* were 212,116 and75.98 respectively. The results of tests reveal that these two predators have great potential to reduce the field population of *P. marginatus.*

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REFERENCES

Babu T. R. and Azam K. M. 1987. Biology of *Cryptolaemus montrouzieri* Mulsant, (Coccinellidae: Coleoptera) in relation with temperature. Entomophaga 32(4): 381-386.

Liu T. X. and Chen T. Y. 2001. Effects of three aphid species (Homoptera: Aphididae) on development, survival and predation of *Chrysoperla carnea* (Neuroptera: Chrysopidae). Applied Entomology and Zoology, 36: 361-336

Mani M and Krishnamoorthy A. 2008. Biological suppression of the mealybugs *Planococcus citri* (Risso), *Ferrisia virgata* (Cockerell) and *Nipaecoccus viridis* (Newstead) on pummelo with *Cryptolaemus montrouzieri* Mulsant in India. Journal of Biological Control, 22: 169-172

Sakthivel P., Karuppuchamy P., Kalyanasundaram M. and Srinivasan T. 2012. Host plants of invasive papaya mealybug, *Paracoccus marginatus* (Williams and Granara de Willink) in Tamil Nadu. Madras Agricultural Journal, 99(7-9): 615-619.

Serrano M. S. and Laponite S. L. 2002. Evaluation of host plant and a meridic diet for rearing *Maconellicoccus hirsutus* (Hemiptera: Pseudococcidae) and its parasitoid *Anagyrus kamali* (Hymenoptera: Encyrtidae). Florida Entomologist, 85(3): 417-425.

Shylaja A.N., Rabindra R.J. and Bhumannavar B.S. 2011. The papaya mealybug *Paracoccus marginatus* (Coccoidea: Pseudococcidae). Proceedings of the National consultation meeting on strategies for deployment and impact of the imported parasitoids of papaya mealybug classical biological control of papaya mealybug *Paracoccus marginatus* in India. NBAII, Bangalore. p 1- 8.

Williams D. J. and Granara de Willink M. C.1992. Mealybugs of Central and South America, London, England, CAB International pp: 1-635

Yadav R. and Pathak P. H. 2010. Effect of temperature on the consumption capacity of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) reared on four aphid species. The Bioscan, 5: 271-274

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