Research Article

Feeding Potential of Adult *Menochilus sexmaculata* and *Coccinella septempunctata* on Passionvine Mealybug, *Planococcus minor* Eggs and Nymphs

Muhammad Ishaque Mastoi[1*], Ibtasam Riaz[2], Syed Muneeb Haider[2], Arfan Ahmed Gilal[3], Anjum Shehzad[4], Ahmed Zia[4] and Abdul Rauf Bhatti[4]

[1]Plant Sciences Division, Pakistan Agricultural Research Council Islamabad, Pakistan; [2]Department of Zoology, University of Gujrat, Sub-campus Sialkot, Pakistan; [3]Department of Entomology, Faculty of Crop Protection, SAU, Tandojam, Pakistan; [4]National Insect Museum, IPEP, NARC Islamabad, Pakistan.

Abstract | Passionvine mealybug, *Planococcus minor* has caused severe losses to many important crops and vegetables. However, many natural enemies, particularly predators have demonstrated key influence on its population regulation. Thus, this laboratory study was conducted to evaluate feeding potential of two coccinellid predators i.e., *Menochilous sexmaculata* and *Coccinella septempunctata* on eggs and nymphs of *P. minor*. Results confirmed that both species of coccinellid showed feeding potential against eggs and nymphs of *P. minor*. Comparatively, *M. sexmaculata* showed higher feeding than *C. septempunctata* on various immature stages of *M. minor*. Moreover, both the species showed relatively more preference on eggs of *P. minor* than nymphs. Therefore, both the species can be exploited in field conditions against *P. minor* to keep its populations below threshold level.

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***Correspondence** | Muhammad Ishaque Mastoi, Plant Sciences Division, Pakistan Agricultural Research Council Islamabad, Pakistan; **Email:** ishaqnscri@yahoo.com
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Introduction

Planococcus minor (Maskell) (Hemiptera: Pseudococcidae), commonly known as passionvine mealybug, is a polyphagous pest that can potentially damage many tropical and subtropical plants (CAB, 2003; Venette and Davis, 2004). Although, this species is widely distributed in many South-Asian countries, but, it has cause serious damages in India and Taiwan (Reddy et al., 1997; Tandon and Verghese, 1987; Ho et al., 2007). *Planococcus minor* is a highly polyphagous pest that attack more than 250 plant species from 80 families (Bastos et al., 2007). Citrus, banana, cocoa corn, coffee, mango, grape, potato, and soybean are some of the important hosts of this mealybug (Ben-Dov, 1994, Venette and Davis, 2004). Besides, it also possesses highly invasive characteristics; free spread along with shipping goods particularly fruits (Venette and Davis, 2004), comparatively short life cycle (Martinez and Suris, 1998) and a high reproductive potential (Maity et al., 1998).

Mealybug infestation may occur within vegetative shoots or apexes and can be extremely difficult to detect. Basically, *P. minor* is phloem feeder that cause stunting growth of the plants along with defoliation

that eventually cause considerable losses to yield of crops. Indirectly, this pest cause damage by developing sooty mold on the infested parts on their honey dew secretions and as a vector of plant viruses such as swollen shoot virus of cacao, *Theobroma cacao* L. (Cox, 1989). Moreover, ability of mealybugs to forms dense colonies, particularly within the shoots and apex, often makes chemical control of mealybugs quite difficult. Although, application of new insecticides has improved the control strategies, but, due to their polyphagous nature, they can move from one host to another to make the chemical control less effective (Williams and Granara de Willink, 1992; Francis et al., 2012).

Typically, mealybugs in their countries of origin are not pest problems because naturally occurring parasitoids and predators in the locality keep their numbers in check. The most serious outbreak occurs when mealybugs are accidently introduced to new countries without their natural enemies. The introduction of pests via infested plant material has unfortunately become fairly common (Williams and Granara de Willink, 1992; Francis et al., 2012).

Ladybird beetles of coccinellidae family are worldwide effective predators of many noxious insect pests such as aphids, mealybugs, leafhoppers, lepidopterous eggs, borers, scale insects, white flies and mites during their various developing stages (Irshad, 2001). Around the world, more than 3,500 coccinellid species have been reported, whereas, around 75 species recorded in Pakistan (Mustafa et al., 1996; Irshad, 2001). Thus, significant role of these predatory beetles has been identified in regulating the population of many serious pests of crops, fruits and vegetables (Dhaka and Pareek, 2007). Considering the significant role of coccinellids, this study was conducted to determine the predatory potential of adult *Coccinella septempunctata* and *Menochilus sexmaculata* on eggs and nymphs of *P. minor.*

Materials and Methods

Collection and rearing of Planococcus minor

The collection of *P. minor* was carried out from the surroundings of National Agriculture Research Centre (NARC) research fields from *Hibiscus rosa-chinensis*. Both, adult females and immature stages of the mealybugs were collected, especially from the heavily infested China rose plants. The collected mealybugs were brought to the laboratory and transferred to pumpkin for further rearing. Fresh and thoroughly washed pumpkin fruits were used as the host for the multiplication of *P. minor.*

Collection and rearing of Menochilus sexmaculata and Coccinella septempunctata

Various stages of both coccinellid predators were also collected from the surroundings of NARC. After collections, they were brought to the laboratory and further reared on aphids and mealybug species.

The rearing of both *P. minor* and its coccinellid predators was done at 25±2°C temperature and 60±5% relative humidity.

Experiment setup

China rose was selected as host plant in the experiment. One leaf was placed in the petri dish (100×15 mm size), having a hole so that the petiole of the leaf can be passed through and dipped into the water kept in the plastic cup (100 ml capacity) to prevent the desiccation of leaf. Two treatments were used in the experiment i.e., T1 = *P. minor* eggs and T2 = *P. minor* nymphs. Both eggs and nymphs *P. minor* were supplied to *M. sexmaculata* and *C. septempunctata* adults in no-choice basis in separate petri dishes. Fifty individuals (either eggs or nymphs) obtained from laboratory reared culture were transferred to China-rose leaf in the petri dish with the help of a camel hair brush. One adult of either species, starved for 24 hours was released in the individual petri dish. The observations were recorded on daily basis till the death of adults, whereas, fresh eggs and nymphs of *P. minor* were supplied to them on daily basis.

The collected data was analyzed using ANOVA with mean separation done by the Least Significant Difference (LSD) at 0.05 probability using STATISTIX 8.1 software.

Results and Discussion

Table 1 showed the detailed results regarding the feeding preference of adult *M. sexmaculata* and *C. septempunctata* on eggs and nymphs of *P. minor.* According to results, a highly significant difference was recorded for feeding preference of *M. sexmaculata* on different stages ($F = 75.32$, $P = < 0.001$) of mealybugs on various observation days ($F = 28.29$, $P < 0.001$). It has been observed that mean consumption increases initially, but gradually decreased after day four and six respectively. Thus, the highest consumption of *P.*

minor eggs (34.67±2.96) and nymphs (42.67±2.91) by *M. sexmaculata* was recorded on day four and six, respectively. Mean feeding potential of *M. sexmaculata* for eggs and nymphs was observed 29.00±1.48 and 21.18±1.54, respectively. *Menochilus sexmaculata* showed comparatively more preference for *P. minor* eggs (29.00±1.48) than nymphs (21.18±1.54).

Table 1: *Feeding potential of M. sexmaculata and C. septempunctata adults on eggs and nymphs of P. minor under laboratory conditions.*

Days	Species			
	M. sexmaculata		C. septempunctata	
	P. minor eggs	P. minor nymphs	P. minor eggs	P. minor nymphs
One	26.00±3.21	31.33±1.86	27.67±3.18	14.00±3.06
Two	29.67±2.60	33.67±2.85	27.33±1.45	16.33±2.85
Three	31.67±2.85	35.00±2.08	29.33±2.96	17.00±1.15
Four	34.67±2.96	36.33±2.03	31.33±3.48	18.67±1.20
Five	34.00±2.65	37.00±3.21	33.33±2.03	21.67±2.19
Six	23.33±3.84	42.67±2.91	25.00±2.31	18.67±1.45
Seven	18.00±2.52	33.00±1.15	21.33±1.45	16.00±1.00
Eight	16.67±2.60	31.00±2.08	17.33±2.33	13.00±1.15
Nine	15.67±1.76	27.00±1.15	16.33±1.86	12.33±1.45
Ten	13.33±1.86	22.00±2.08	13.33±1.86	9.00±0.58
Eleven	12.00±1.53	19.67±1.20	9.00±1.15	8.33±1.20
Twelve	11.00±1.15	15.33±1.45	7.33±1.20	7.33±1.45
Thirteen	9.33±1.86	13.00±1.00	7.00±0.58	6.33±1.45
Overall mean	29.00±1.48a	21.18±1.54b	20.44±1.54b	13.74±0.85c

**Overall means followed by same letters are not significantly different (LSD, P < 0.05).*

Similar to *M. sexmaculata,* a highly significant difference was recorded for the daily consumption (F = 26.20, P < 0.001) of *C. septempunctata* on eggs and nymphs (F = 77.50, P < 0.001) of *P. minor.* However, comparatively slower rise in consumption of *P. minor* nymphs and eggs by *C. septempunctata* was recorded in comparison to *M. sexmaculata.* The highest daily consumption of *C. septempunctata* on eggs (33.33±2.03) and nymphs (21.67±2.19) of *P. minor* was recorded day five. Moreover, rate of daily consumption of the beetle on eggs and nymphs declined afterwards. Overall mean feeding of *C. septempunctata* on eggs and nymphs of *P. minor* stood at 20.44±1.54 and 13.74±0.85, respectively.

Results of the study confirmed relatively higher feeding potential (F = 184.19, P < 0.001) of *M. sexmaculata* than *C. septempunctata* on both eggs and nymphs of *P. minor.*

Results of the study confirmed significant feeding potential of the both *M. sexmaculata* and *C. septempunctata* on the eggs and nymphs of *P. minor.* Many previous studies have also confirmed that coccinellid predators particularly *Cryptolaemus montrouzieri* on many species of mealybugs in various countries of the world (Mani, 1995; Mani and Krishnamoorthy, 2002; Persad and Khan, 2002; Ozgokce et al., 2006; Attia and El-Arnaouty, 2007). Besides, *C. montrouzieri,* various other coccinellids i.e., *Brumoides suturalis, C. septempunctata, M. sexmaculata* and others have also been identified to manage the populations of mealybugs (Chandrababu et al., 1997). A gradual increase in the daily consumption of both the species coccinellids was recorded on the eggs and nymphs of *P. minor*, but, it decreased after reaching at the highest feeding rate. It has been the general observation in previous research studies that feeding of adult predators including coccinellids showed an increasing trend and reach peak, corresponding the mating and oviposition of females. Moreover, significant effect of prey densities has also been identified on the feeding of coccinellids as comparatively higher consumption is observed in lower prey densities than higher densities, mainly because of searching, handling and consumption of prey is comparatively easy at lower densities (Agarwala et al., 2001; Omkar and Srivastava, 2003; Rana, 2006; Qin et al., 2014; Saleem et al., 2014).

Conclusions and Recommendations

Both species of coccinellid i.e., *M. sexmaculata* and *C. septempunctata* showed their feeding potential against eggs and nymphs of *P. minor.* Comparatively, *M. sexmaculata* showed higher feeding than *C. septempunctata* on various immature stages of *M. minor.* Moreover, both the species showed relatively more preference on eggs of *P. minor* than nymphs.

Author's Contribution

Muhammad Ishaque Mastoi: Conceived the idea and supervise the studies from data collection to report writing.
Arfan Ahmed Gilal: Statistical analysis and review and improvement of manuscript.
Anjum Shezad, Ahmed Zia and Abdul Rauf Bhatti:

Taxonomic identification of pest and predators and critical review of manuscript.

Ibtasam Riaz: Data collection and report writing on predatory potential of *Menochilus sexmaculata*.

Syed Muneeb Rizvi: Data collection and report writing on predatory potential of *Coccinella septem-punclata*.

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