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CONTENTS

Natural enemies of papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink in *Tarai* region of Uttarakhand

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ABSTRACT: The study was conducted to identify different biocontrol agents associated with papaya mealybug, *Paracoccus marginatus* at Pantnagar, India. A total of five natural enemies were recorded including four predators and one parasitoid out of which three important predators *viz.*, *Cryptolaemus montrouzieri* Mulsant, *Spalgis epius* Westwood, and *Gitonides* sp. were collected during the study. The grub of *Chrysopa* sp. was also reported to prey on *P. marginatus* in the laboratory. One of the parasitoids, *Acerophagus papayae* Noyes and Schauff was also observed from the parasitized cocoons. This survey provides a descriptive account of natural enemies of papaya mealybug, *P. marginatus* in *Tarai* region of Uttarakhand.

Key words: Natural enemies, Papaya mealybug, *Paracoccus marginatus*

Mealybugs are insects belonging to the family Pseudococcidae of the order Hemiptera. They are characterized by the presence of white mealy or waxy coatings all over their body. They are noxious pests attacking papaya and many other economically important crops (Miller and Miller, 2002). Among them, the papaya mealybug, *Paracoccus marginatus*, is found to be highly polyphagous and invasive pest that affects more than 200 plants, many of which are of greater economic importance. It is an exotic pest native to Mexico which was first time recorded in India during 2008 (Muniappan *et al.*, 2009). Infestation caused by *P. marginatus* is highly detrimental and can lead to crop losses of upto 91% (Macharia *et al.*, 2017). One of the studies from Ghana showed the infestation in a papaya orchard resulted in yield loss of 65%, which ultimately affected the export earnings (Goergen *et al.*, 2011). Neighbouring countries like Bangladesh recorded crop losses of approximately US$700 per hectare per year due to *P. marginatus* (Khan *et al.*, 2015). Thus, managing *P. marginatus* below threshold level has clear agricultural and economic benefits. Chemicals are usually applied in the field to keep the pests under control. But these chemicals are repeated many times to kill the same pest, which results in the development of resistance. This results in increased cost of cultivation but not the yield. Moreover, the waxy coatings over the body of nymphs and adult mealybugs also provide some degree of protection to the pest from the insecticides. Consequently, heavy reliance on synthetic chemicals for the management of mealy bugs has led to environmental and health issues. Thus, there is a dire need to develop environmental friendly biocontrol based measures to combat this menace. The biological control using introduced or native parasitoids and predators may render better control over the pest. Therefore, there is a great need to explore the native biocontrol agents of this devastating pest so that, these could be incorporated in pest management programmes. In this context, the present study was undertaken to explore the natural enemies of mealybug to develop management practices which will be a way forward towards organic farming.

MATERIALS AND METHODS

Survey of predators and parasitoids of papaya mealybugs was conducted on different host trees in G. B. Pant University of Agriculture and Technology, Pantnagar, during 2019-20. The scope of survey was around observing predators and parasitoids of papaya mealybug. Survey was conducted on 10 sites (primarily undisturbed lands) across 20 distinct plants of fruits and ornamental category from the vicinity during the study. Minimum five samples

were collected per site (Anonymous, 2011). Mealybugs and their natural enemies were collected from leaves and fruits after careful visual observation. Slow acting predators were gathered manually by hand, whereas, the other moving bioagents were collected using aspirators. Samples were thereafter segregated based on maturity level – immature ones were kept under controlled conditions for further supervision, and mature ones were pinned and tagged. In the laboratory, the live samples were kept in the BOD at (26±2^{0}C) temperature and 65±1% Relative Humidity. Mealybugs were also identified using the keys produced by Miller and Miller (2002).

RESULTS AND DISCUSSION

On investigation, the mealybugs were found to be papaya mealybug, *Paracoccus marginatus*. Number of other parasitoids and predators were also found on incubating (keeping samples at right temperature and growth conditions so that mealybug and its natural enemies can grow properly) the samples under laboratory conditions.

Taxonomic identification of papaya mealy bug

Both nymphs and adult mealybugs possess the piercing and sucking type of mouthparts. They suck the sap of the plant causing yellowing and withering of plants. Their body is elongate oval, creamish yellow in colour, covered with mealy wax, legs are yellowish brown, and 15-17 pairs of marginal short wax filaments are present. The body contents of specimens turn black within 12-24 hours when placed in 70 per cent of ethyl alcohol (Muniappan *et al.*, 2009). The adult female is yellow, approximately 2.2 mm long and 1.4 mm wide and is covered with a white waxy coating. Adult males are pink, approximately 1.0 mm long, with an elongate oval body that is widest at the thorax (0.3 mm). Adult males have a heavily sclerotized thorax and head and also a ten-segmented antennae, and well-developed wings. Female antennal segments are eight. When pressed, the body fluid of yellow colour comes out. Infestation on the fruits makes them inedible due to the build-up of thick white wax (Biswas *et al.*, 2015). Clusters of cotton-like masses on the above-ground portion of plants are also observed in case of severe infestation. (Tanwar *et al.*, 2010).

Natural enemies associated with papaya mealybugs

Five natural enemies belonging to different orders were collected from the colonies of papaya mealybugs collected from Pantnagar (Table 1 and Figure 1). A wide diversity was found among the bioagents as they belonged to different orders including Lepidoptera, Diptera, Coleoptera and most importantly Hymenoptera. Three important predators *viz.*, *Cryptolaemus montrouzieri*, *Spalgis epius*, and *Gitonides* sp., were collected from these samples. The grubs of *Chrysopa* sp. were also reported to prey on *P. marginatus* in the samples in the laboratory. One of the parasitoids, *Acerophagus papayae* was also observed from the parasitized cocoons. All the four bioagents (*Acerophagus papayae*, *Cryptolaemus montrouzieri, Spalgius epius*, and *Gitonides*) were categorized to be major bioagents in the field on the basis of their presence on the infested site except the *Chrysopa* sp. which were found from few samples only (Table 1).

Predators

Apefly, *Spalgis epius* (Lycaenidae: Lepidoptera)
Larva of Apefly, *Spalgis epius* was predatory in nature and found among the waxy covering over the infested fruit cultured in the laboratory. It belongs to the family Lycaenidae and subfamily Miletinae. Adult is a small butterfly with dark brown wings above and grey underside with dark striations. Forewing has a prominent small white quadrate spot at the cell end and eyes are yellowish green. Caterpillar is flat-oval and dusted with mealy coatings which gives a camouflage effect with mealybugs. The pupa of *S. epius* is very peculiar in its appearance and resembles the face of a monkey hence called as monkey-faced pupa or Apefly. Larvae are potential predators of different species of mealybugs in India. A total of 10 *Spalgis epius* larvae were collected manually and most of them

were collected in the month of September-November in Pantnagar. It (Lepidoptera: Lycaenidae: Miletinae) has also been recorded as a predator of other species of mealybugs, *viz.*, *Dactylopius* sp., *Planococcus virgatus* (Ckll.), *P. lilacinus* (Ckll.), *P. citri* (Risso), *Ferrisia virgata* (Ckll.) and *M. hirsutus* (Dinesh *et al.* 2010; Thangamalar *et al.* 2010; Anegunda *et al.* 2011).

Fig 1: (a) Infestation of *Paracoccus maginatus* in papaya plant (b) *Paracoccus marginatus* on papaya leaf (c) *Cryptolaemus montrouzieri* (d) Adult of *Gitonides* sp. (e) Pupa of *Gitonides* sp. (f) *Acerophagus papayae* (g) Prepupa of *Spalgis epius* (h) Monkey faced pupa of *Spalgis epius* (i) Adult of *Spalgis epius*

Table 1: Predators and parasitoids identified on papaya mealybug, *P. marginatus* at Pantnagar

Scientific name	Family	Order	Position
Parasitoids			
Acerophagus papayae	Encyrtidae	Hymenoptera	Major
Predators			
Chrysopa sp.	Chrysopidae	Neuroptera	Minor
Cryptolaemus montrouzieri	Coccinellidae	Coleoptera	Major
Spalgis epius	Lycaenidae	Lepidoptera	Major
Gitonides	Drosophilidae	Diptera	Major

Australian lady bird beetle, *Cryptolaemus montrouzieri* (Coccinellidae: Coleoptera)

It is an introduced predator from Australia. Adult is a hemispherical insect with black body and reddish orange head. It was widely utilized in controlling citrus mealybug and provided partial to complete control of *P. citri* on citrus in Spain, Turkey, Eastern Australia and South Africa. In Pantnagar, *C. montrouzieri* was found to be associated with *P. marginatus* infesting *Hibiscus* plant. Larvae secretes white waxy filament on feeding, hence difficult to differentiate them with the mealybugs. Both larva and adult stages of this predator were recorded to predate upon the mealybug eggs. The predation rate on *P. marginatus* is similar to that on *M. hirsutus*. For biological control, ten beetles were released per mandarin tree in Karnataka. However, release of the predator needs to be repeated whenever the mealybug reappears (Singh, 1978).

***Gitonides* sp. (Drosophilidae: Diptera)**

Dipteran predators were also obtained from infested papaya samples kept under controlled conditions. It belongs to family Drosophilidae. Maggots are pale pinkish in colour with markings over the body. Adults have reddish orange eyes. Their body is amber coloured and is translucent. Thorax and scutellum are with brown dots and patterns. Abdomen is creamy yellow with black bands. Compound eyes have a median brownish elongated spot. It is a highly efficient predator of *P. marginatus*. Very few researches are available on the Drosophilids as bioagents of mealybugs. On an average, 11 maggots of this predator were collected manually from sample in Pantnagar on a colony of *P. marginatus*. They were found inside the debris gallery made up of honeydew and dust. Raspi *et al.* (2015) found twenty individuals of *Cacoxenus* (Gitonides) *campsiphallus* preying the invasive mealybug, *Maconellicoccus hirsutus* in southern Iran.

***Chrysopids* sp. (Chrysopidae: Neuroptera)**

One unidentified chrysopid predator was also observed from the colony of papaya mealy bug at Pantnagar. Although they were very less in number around the infested site but holds great potential to kill other sucking pests. Chrysopids generally known as aphid-lion predating on a wide range of pest species such as mealybugs, thrips, aphids, whiteflies and mites (Canard and Principi, 1984; Liu and Chen, 2001; Yadav and Pathak, 2010). The larvae of lacewing feed on a wide range of pest species while adults are free living and feed only on nectar, pollen and honey dew (Coppel and Mertins, 1977). It is widely distributed in India, South America, Sudan, Europe, Tanzania and Egypt. Being a generalist predator, chrysopids have greater potential for commercialization in combination with other pest management tactics.

Parasitoids

***Acerophagus papayae* (Encyrtidae: Hymenoptera)**

Many successful biological control programs mainly rely on the parasitoids belonging to Encyrtidae family. This microscopic hymenopteran parasioid is identified with its four segmented tarsi. Three black spots arranged in an inverted triangular shape in the vertex region are found. Adult is yellowish brown in colour with iridescent wings. Ventral side of thorax and legs slightly paler than dorsal side of thorax; forewing are hyaline. Thorax pale orange;

neck of pronotum brown, posterior margin translucent and side a little paler. During last decades, *A. papayae* was widely introduced in many countries of the world *i.e.,* Guam, Puerto Rico, Palau, Dominican Republic, Sri Lanka and India to regulate the populations of invasive *P. marginatus* (Walker *et al.*, 2003; Muniappan *et al.*, 2009). These wasps were collected using aspirators from the infested site in Pantnagar region and they were found along with mealybug population. Around 70 per cent of the mealybug colony showed frequent presence of wasps. These were the only parasitoid associated with the *P. marginatus*. However, it is possible that new parasitoid associations will be established with time.

CONCLUSION

Mealybugs are emerging as a major threat to the crop production in the country with a tremendous increase in its host plant range. Biological control is the only promising method to keep the mealybugs in check since chemical and cultural control fails due to mealybug's self defense mechanism, rapid reproduction and faster spread. Classical biological control using the introduced parasitoids has shown a significant control in India as well as in Sri Lanka. Extensive survey and exploration of natural enemies of mealybugs and development of mass rearing and field release technique may lead to the construction of efficient integrated pest management practices. In the present investigation a total of five natural enemies were found linked with papaya mealy bug at Pantnagar. *Chrysopa* sp. *Cryptolaemus montrouzieri* Mulsant, *Spalgis epius* Westwood, and *Gitonides* sp., were four important predators and one parasitoid, *Acerophagus papayae* Noyes and Schauff were reported during the study. Further, there is great need to go through the mass production programme of explored and highly efficient native natural enemy of papaya mealybug. So, these could be utilised in management programme of the *P. marginatus*.

REFERENCES

Anegunda, S., Dinesh, Melally, G., and Venkatesha (2011). Prey consumption by the mealybug predator *Spalgis epius* on pink hibiscus mealybug (*Maconellicoccus hirsutus*). *Phytoparasitica*, 39:11-17.

Anonymous (2011). Threat Specific Contingency Plan- Papaya mealybug. Plant Health Australia Version 2. Canberra, ACT.www.planthealthaustralia.com.au/plantplan.

Biswas, M.J.H., Khan, M.A.M. and Ahmed, K.S. (2015). Control strategies of papaya mealybug, *Paracoccus marginatus*, in the laboratory condition. *International Journal of Applied Sciences and Biotechnology,* 3(4): 687-691.

Canard, M. and Principi, M.M. (1984). Life histories and behaviour. In: Biology of *Chrysopidae* (M. Canard, Y. Semeria and T. R. New eds.). Dr W. Junk Publishers, The Hague, Pp. 57-149.

Coppel, H.C. and Mertins, J.W. (1977). Biological Insect Pest suppression. Springer-Verleg, Berlin, Germany.

Dinesh, A. S., Venkatesha, M. G. and Ramakrishna, S. (2010). Development, life history characteristics and behaviour of mealybug predator, *Spalgis epius* (Westwood) (Lepidoptera: Lycaenidae) on *Planococcus citri* (Risso) (Homoptera: Pseudococcidae). *Journal of Pest Science,* 83: 339-345.

Goergen, G.E., Tamo, M., Kyofa Boamah, M.E., BokononGanta, A.H. and Neuenschwander, P. (2011). Papaya mealybug: a new invading pest in West Africa. *Biocontrol News and Information*, 32: 9-10.

Khan, M., Biswas, M., Ahmed, K. and Sheheli, S.(2015). Outbreak of Paracoccus marginatus in Bangladesh and its control strategies in the fields. *Progressive Agriculture*, 25: 17– 22.

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: 361-366.

Macharia, I., Kimani, E., Koome, F., Kosiom,

T., Heya, H. and Otipa, M. (2017). First report and distribution of the papaya mealybug, *Paracoccus marginatus*, in Kenya. *Journal of Agricultural and Urban Entomol*ogy, 33: 142-150.

Miller, D.R. and Miller, G.L. (2002). Redescription of *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Coccoidea: Pseudococcidae), including descriptions of the immature stages and adult male. *Proceedings of the Entomological Society of Washington*, 104 (1):1-23.

Muniappan, R., Shepard, B.M., Watson, G.W., Carner, G.R., Sartiami, D., Rauf, A.and Hammig, M.D. (2009). First report of papaya mealybug (*Paracoccus marginatus*:Hemiptera: Pseudococcidae) in Indonesia and India. *Journal of Agricultural and Urban Entomol*ogy, 25(1): 37-40.

Raspi, A., Roohafza, A., Majid, F., Nazila, S. and Giovanni, B. (2015). The Oriental drosophilid *Cacoxenus (Gitonides) campsiphallus*, a predator of invasive mealybugs: First record for Palearctic region and female's description. *Journal of Asia-Pacific Entomology,* 18: 525–528.

Singh, S.P. (1978). Propagation of coccinellid beetle for the biological control of citrus and coffee mealybugs. *Scientific Seminar, CPA*, 2 p.

Tanwar, R.K., Jeyakumar, P. and Vennila S. (2010). Papaya mealybug and its management strategies. Technical Bulletin 22. National Center for Integrated Pest Management, New Delhi.

Thangamalar, A., Subramaian, S. and Mahalingam, C.A. (2010). Bionomics of papaya mealybug, *Paracoccus marginatus* and its predator *Spalgis epius* in mulberry ecosystem. *Karnataka Journal of Agricultural Sciences,* 23: 39-41.

Walker, A., Hoy, M. and Meyerdirk, D. (2003). Papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink (Insecta: Hemiptera: Pseudococcidae) EENY-302. Featured Creatures. Entomology and Nematology Department, Florida Cooperative Extension Service, Inst. of Food and Agri. Sciences, University of Florida, Pp. 1-7.

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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