



ROLE OF NATURAL ENEMIES FIELD RESERVOIR (NEFR) IN FARMER FIELDS FOR CONTROLLING PAPAYA MEALY BUG *PARACOCCLUS MARGINATUS* AT KARACHI

Riaz Mahmood¹, Imam Din Keerio¹, Abdul Rehman¹ And Khalid Rashid¹

¹CAB International Pakistan Center, Opposite 1-A Data Gunj Bakhsh Road, Satellite Town, Rawalpindi-Pakistan

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*Corresponding Author:

Imam Din Keerio

E-mail: i.din@cabi.org

ABSTRACT

This study was conducted in 2015-16 to assess the role of maintaining natural enemies field reservoir (NEFR) for controlling papaya mealy bug *Paracoccus marginatus* William and Granara de Willink. The NEFR was established at Memon Goth- Karachi in a papaya field about a hectare. A shelter was provided alongside the border of papaya orchard where field collected mealy bug infested farm debris were kept in open trays for 15 days. From debris thousands of parasitoid *Acerophagus papayae* Noyes and Schauff and generalists associated with mealy bug could be produced almost around the year. The parasitoid and the predators produced from mealy bug infested farm debris under NEFR shelter could naturally disperse into the environment around. Dispersal range of *A. papayae* was followed both in direction of sea side winds from NEFR and in opposite direction. Dispersal of the parasitoid and the predators was found more convenient to fields from NEFR in direction of sea side winds where dense colonies of the mealy bug became rare because of increase in parasitism in the mealy bug and increase in number of predators numbers. On opposite direction of the winds mealy bug dense colonies were encountered and less parasitism.

Keywords: : *Acerophagus papayae*, *Paracoccus marginatus*, natural enemies' field reservoir

INTRODUCTION

Tanwar *et al.* (2010) and (Muniappan *et al.* (2006) reviewed world distribution of *Paracoccus marginatus* William Granara de Willink. This originally known from Mexico is now wide spread in the Central America, Florida, tropical South America, Caribbean and Guam, Palau, and Hawaiian Islands in the Pacific. It was observed in India, Indonesia and Sri Lanka during 2008–09; and Thailand, Cambodia and the Philippines in 2010. It was also reported from the Reunion Island in the Arabian Sea and Ghana in West Africa in 2010. In Pakistan it was recorded in a survey in 2008 in Karachi, Sindh (survey report of Department of Sindh, Agriculture Extension 2008) and Vinder (Balochistan). Daily Ibrat of 24 October 2009 reported that more than 3000 acres (about 1224 ha) of coastal areas of Sindh (Darsano Channo, Memon Goth, Kathore, Deh Dimloty and other places were completely destroyed by this insect and about 400,000 trees were uprooted by the farmers. In current survey in 2014 it was found most common on papaya and other economic plants (banana, guava, vegetables, ornamental plants such as *Plumeria*, rose of China, weeds *Abutilon*, etc.) at altitude between 1-8m in Karachi up to Thatta. In Badin and elsewhere

in Sindh reports have been received on its presence on papaya up to Khairpur, but papaya mealy bug was not present in Khairpur (Baber *et al.*, 2015).

Successful introductions of three Encyrtid parasitoids namely *Anagyrus loecki* Noyes, *Pseudeptomastix mexicana* Noyes & Schauff and *Acerophagus papayae* Noyes & Schauff was reported in Guam, Palau, Florida, Hawaii, India and Sri Lanka since 2002 (Meyerdirk and Muniappan *et al.*, 2004; Muniappan *et al.*, 2006; Muniappan *et al.*, 2010). A survey conducted in 2014 in Karachi, a fortuitously introduced survey a parasitoid *Acerophagus papayae* and local coccinellid predators *Scymnus sp* and *Brumoides suturalis* (Fabricius), were found associated with this mealy bug. To maximize impact of biological control of the mealy bug through conservation and augmentation of already existing natural enemies in the environment, a natural enemy's field reservoir (NEFR) was established as reported by Mahmood *et al* (2011) for controlling mealy bug in cotton in Pakistan. This study was conducted to assess the role of maintaining natural enemies' field reservoir (NEFR) for controlling papaya mealy bug *Paracoccus marginatus* in Karachi

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MATERIALS AND METHODS

Maintenance of Natural Enemies Field Reservoir (NEFR)

One hectare pesticides free area of papaya was selected at Memon Goth – Karachi. A shelter of 7x14x3m was built on border of the papaya orchard (Fig 1&2). Mealy bug infested refuse of papaya fruits, leaves and stems were placed in trays measuring 60x60x120cm for 15 days. The material kept in trays dried over the period. The parasitoids and predators that developed on this refuse in trays disperse around the area. The trays were emptied after 15 days and refilled with mealy bug infested debris. This site was named as natural enemies' field reservoir (NEFR). This activity was carried out throughout the year.



Fig.1
View of shelter provided on border of pesticides free papaya orchard at Memon Got

Counting of parasitoid and predators dispersing from NEFR

Size of predatory beetles and the parasitoids was so small that they were hardly detectable with naked eye. Exact counting of their numbers remained a question, therefore, for indirect estimates samples were taken of five leaves from a tray at NEFR shed every month and brought to laboratory to determine percentage parasitism and number of development stages and adults of the predators (coccinellids and others). Their estimates from a tray having about 500 mealy bug

infested leaves of papaya and totals of 10 trays every month were calculated that could have dispersed from NEFR around area.

Dispersal range of *Acerophagus papayae* determined by rate of parasitism

For observations on dispersal range of *A. papayae* from NEFR, orchards, in sea side winds direction, were surveyed at Memon Goth and Darsano Chanoo and on opposite sea winds direction at Landhi and Saleh Muhmmad Goth. Fifty leaves of papaya were randomly examined at distances up to 10 km from NEFR for mealy bug colonies. Mealy bug developmental stages (2nd – 3rd instar nymphs), were counted and leaves were kept in jars for a week at room temperature in laboratory. Mummies formed were counted for percentage of parasitism.

RESULTS

Dispersal of natural enemies reared at NEFR shelter

At NEFR not only the parasitoid *Acerophagus. papayae* was produced in huge numbers from the farm debris the generalists including *Chrysoperla carnea*, Stephens, *Brumoides suturalis* (Fabricius), *Menochilus sexmaculatus* (Fabricius), *Scymnus coccivora*, *Stethorus gilvifrons* (Mulsant), *Stethorus pauperuculs* Weise and *Coccinella septempunctata* (L.) (Table 1). More natural enemies were found in orchards nearer to NEFR.



Fig.2
Inside view of tray kept under shelter containing mealy bug infested farm debris

Table 1

Estimated numbers of parasitoid and general predators produced in trays at NEFR Shelter in 2015-16

Period	Number of parasitoid <i>Acerophagus papayae</i>	Number of Predators
Jan—June 2015	4,48,000	107,380
July – December 2015	9,49,000	134,830
Jan—June 2016	13,06,000	128,390
July – December 2016	14,49,000	90,370
Totals	41,52,000	460,970

Dispersal range of *Acerophagus papayae* from NEFR in direction of sea side winds

In 2015 parasitism increased at all orchards up to 5 km at Memon Goth from NEFR site. Highest parasitism was recorded above 80% at NEFR site as measured in September

at Memon Goth (Table 2). Comparing with parasitism level at NEFR site percent parasitism was low in papaya orchards at different distances at 10 Km and beyond being in the range of 35.35 and 36.78 in unsprayed orchards but extremely low in pesticides sprayed orchards (Table 3).

Table 2

Parasitism of *Acerophagus papayae* on 5 papaya leaves in September 2015 at different localities in Karachi

Locality	mealy bug (#)	mummies formed (#)	Parasitism (%)
At Memon Goth NEFR (unsprayed)	1210	1085	89.66
Darsano Channo (unsprayed, 10 km from NEFR)	2560	905	
Kathore (unsprayed, at 20 Km from NEFR)	2705	995	36.78
Saakran (pesticides sprayed orchard 30 km from NEFR.)	3910	72	1.84

At Memon Goth and part of Darsano Chanoo the mealy bug remained under control in all orchards up to 05 km from NEFR in direction of sea side wind. (Table 2). Pesticides

sprays completely stopped in these orchards for control of the mealy bug. Mealy bug dense colonies started disappear and only scattered individuals were found on papaya (Table 2).

Table 3

Numbers of dense colonies of mealy bug each of 50 fruit bunches and leaves on 50 papaya plants at NEFR site Memon Goth and other orchards up to 5 km in 2015

Locality	May		September (4 months after)	
	On Fruits	On Leaves	On Fruits	On Leaves
At Memon Goth NEFR	0	25	0	0
At 1 km from NEFR	26	24	0	1
At 2 km from NEFR	35	31	1	1
At 3 km from NEFR	38	36	1	0
At 4 km from NEFR	22	15	0	0
At 5 km from NEFR	10	26	0	0

In 2016 no papaya orchards was found at the circle of 1-2, at 5th 7th km area. Because in the area papaya orchards not cultivated in the mention kilometers, the parasitism in mealy

bug continued to be high ranging from 32.67 to 69.71%. It was lower in orchards at different distances from the NEFR ranging from 11.46 to 46.91% NEFR (Table 4).

Table 4

Parasitism of *Acerophagus papayae* and range of effectiveness of NEFR for Controlling papaya mealy bug in sea side wind direction of Memon Goth toward Darsano in 2016

Locality	March	June	September	December
	Parasitism (%)	Parasitism (%)	Parasitism (%)	Parasitism (%)
At Memon Goth NEFR	69.71	49.64	62.29	32.67
At 3 km from NEFR	11.46	17.69	31.08	21.55
At 4 km from NEFR	28.79	21.57	46.91	32.94
At 6 km from NEFR	18.11	26.79	28.43	25.40
At 8 km from NEFR	15.42	20.96	38.77	20.12
At 10 km from NEFR	21.09	29.56	25.64	29.86

Dispersal range of *Acerophagus papayae* from NEFR in opposite direction of sea side winds

Observations on this side were made in 2016. On this side no orchard was found at the circle of 2-3 km and from NEFR and at 7th and 9- 10th km, because in the area papaya orchards not cultivated in the mention kilometers. (Table 5) at Saleh

Mohammad Goth and Landhi. Parasitism in orchards on this side ranged from 20.56- 42.57% in March - September being almost same as in orchards towards Darsano at different distances from Memon Goth NEFR (Table 4). Thus winds direction did not seem effect much impact parasitoid dispersal from the NEFR.

Table 5

Parasitism of *Acerophagus papayae* and range of effectiveness of NEFR for Controlling papaya mealy bug in orchards opposite to sea wind direction from Memon Goth NEFR towards Landhi + Saleh Mohammad Goth in 2016.

Locality/distance from NEFR	March	June	September	December
	Parasitism (%)	Parasitism (%)	Parasitism (%)	Parasitism (%)
At Memon Goth NEFR	69.71	49.64	62.29	32.67
At 1 km from NEFR	39.25	34.73	41.37	28.43
At 4 km from NEFR	27.86	31.24	37.89	30.90
At 5 km from NEFR	34.61	28.70	42.57	26.64
At 6 km from NEFR	22.19	26.42	29.14	32.16
At 8 km from NEFR	20.56	23.91	32.41	21.43

DISCUSSION

Population of *P. marginatus* on papaya and parasitism percentage in the three sampling sites before and after release of parasitoid. Heavy population load at 38.70, 43.85 and 41.21 numbers / 5cm² was recorded in Salem, Dharmapuri and Namakkal districts respectively, whereas no parasitism was observed in a pre-release survey in all three locations. An average of 6.08% parasitism and 11.51% reduction in papaya mealybug population was noticed a month after release of parasitoid recording highest parasitism in Namakkal (8.45%) followed by Salem (7.42%) and Dharmapuri (2.38%). However, the population of *P. marginatus* declined uniformly consistent to regular increase in percent parasitism @ 2, 3, 4 & 5th months in all the three locations. The average population of *P. marginatus* from the tapioca garden in the study sites was eliminated up to 93.15% on the 6th month corresponding to 76.33% parasitism. Similarly, the effectiveness of these introduced parasitoids against *P. marginatus* was reported from different hot spot zones viz., Erode and Coimbatore districts of Tamil Nadu (Kalyanasundaram *et al.*, 2010), Shylesha *et al.*, 2010). Parasitoid presence of different population levels was recorded in all orchards. Parasitism was highest at NEFR and nearby farms. Dispersal of *Acerophagus papayae* and of predators does not seem to be effected by the sea side wind directions. The studies conducted on dispersal of the parasitoid it looks induction of NEFRs like interventions are most effective in controlling mealy bug, as pesticides spraying against mealy bug completely stopped at these orchards.

Exercise of establishing NEFRs on farmers' fields laid down strong foundation to promote conservation biological control of pests leading to less dependence on pesticides. The farm debris carry millions of developmental stages of natural enemies therefore instead of burning, burying, putting insecticides on them or feeding them to livestock part of this debris need to be utilized for on farm mass production of natural enemies of pests.

The innovation tested here is based on the concept of conversion of refuse into resources. There are some costs involved in construction of sheds and for pots but these is only one time investment. There are more advantages to gain overtime on saving on pesticides spraying, environment protection and sustainability in pest management on area wide basis. This new approach towards pest management can

be made applicable, with modifications, for a number of agricultural pests

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AUTHORS CONTRIBUTION

Riaz Mahmood conducted the experiment and wrote the study, Imam Din Keerio collected data and made the tables of experiment, Khalid Rashid collected data of experiment and Abdul Rehman carried out data analysis of experiment

REFERENCES

- Bajwa, E.B., R. Mahmood and S. Ahmed 2015. Baseline survey and Need Assessment of Biological Control Interventions in Horticultural Crops of Sindh and Baluchistan, Pakistan-CABI. 39pp
- Kalyanasundaram, M., P. Karuppuchamy, S. Divya, P. Sakthivel, R.J. Rabindra and A.N. Shylesha 2010. Impact of release of the imported parasitoid *Acerophagus papayae* on the management of paya mealybug, *Paracoccus marginatus* in Tamil Nadu, pp. 68–72. In: Proceedings of the national consultation meeting on strategies for deployment and impact of the imported parasitoids of papaya mealybug, 30 October, 2010, NBAlI, ICAR, Bangalore, India.
- Mahmood, R., M.N. Aslam, G.S. Solangi and A. Samad 2011. Historical perspective and achievements in biological management of cotton mealy bug *Phenacoccus solenopsis* Tinsley in Pakistan. 5th Meeting Asian Cotton

- Research and Development Network, held on February 23-25. Lahore, pp. 1-17. Online at http://www.icac.org/tis/regional_networks/asian_network/meeting_5/documents/papers/MahmoodR.pdf.
- Meyerdirk, D.E., R. Muniappan, Warkentin, J. Bamba and G.V.P Reddy, 2004. Biological control of the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae) in Guam. Plant Prot. Quart. 19: 110-114.
- Muniappan R.M., D.E.M. Meyerdirk, F.M.S. Sengebau, D.D.B. Berringer and G.V.P. Reddy 2006. Classical biological control of the papaya mealy bug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae) in the Republic of Palau. Fl. Entomol., 89: 212-217.
- Muniappan, R., 2010. Success Story: Biological Control of the Papaya Mealy bug. Global Plant Protection News produced by IAPPS, June 2010.
- Shylesha, A.N., Dhanyavathy, Shivaraj, 2010. Mass production of parasitoids for the classical biological control of papaya mealybug, *Paracoccus marginatus*, pp. 63–67. In: Proceedings of the national consultation meeting on strategies for deployment and impact of the imported parasitoids of papaya mealybug. 30 October, 2010, NBAIL, ICAR, Bangalore, India.
- Tanwar, R.K., P. Jeyakumar and S. Vennila, 2010. Papaya Mealybug and its Management Strategies. National Centre for Integrated Pest Management, New Delhi, India, Technical Bulletin, 22: pp22.