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Research Article

Field performance of three exotic parasitoids against papaya mealybug, *Paracoccus marginatus* (Williams and Granara de Willink) infesting cassava in Tamil Nadu

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ABSTRACT: The papaya mealybug, *Paracoccus marginatus* an invasive polyphagous exotic pest assumed alarming status in Tamil Nadu during 2009–2010 because of its sudden outbreak on number of crops. Three encyrtid parasitoids *viz.*, *Anagyrus loecki*, *Acerophagus papayae* and *Pseudleptomastix mexicana* were released in cassava gardens severely infested by papaya mealybug in 3 locations each at Salem, Namakkal and Dharmapuri districts of Tamil Nadu @ 200 individuals per location during November, 2010. An average of 6.08% parasitism and 11.51% reduction in *P. marginatus* population was noticed a month after release of parasitoids with a corresponding increase in percent parasitism @ 2, 3, 4 & 5th months. The population of *P. marginatus* from the tapioca garden was eliminated up to 93.15% @ 6th month corresponding to 76.33% parasitism. Among the parasitoids released, highest proliferation and field activity was observed in the case of *A. papayae* accounting for 80.89 – 94.31% parasitization and *P. mexicana* registered comparatively lesser performance (5.69 – 19.11%) whereas the field establishment of *A. loecki* was not noticed during the study period.

KEY WORDS: cassava, *Paracoccus marginatus*, parasitoids, *Anagyrus loecki*, *Acerophagus papayae* and *Pseudleptomastix mexicana*, field efficacy.

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INTRODUCTION

Outbreak of the alien pest, papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Pseudococcidae) in Tamil Nadu state of India was recorded on a number of agricultural and horticultural crops, trees, ornamental plants and weed species during 2009-2010. About 84 plant species were infested by the pest of which heavy population buildup and severe damage was noticed on 21 host plants including ten economically important crops (Jonathan *et al.*, 2010; Selvaraju and Sakthivel, 2011). The menace of *P. marginatus* on mulberry (*Morus alba* L.) and cassava (*Manihot esculenta* Crantz), the food plants of the silkworms, *Bombyx mori* L. and *Samia cynthia ricini* Boisduval respectively deteriorated the leaf quality and yield which rendered adverse effect on silk production and posed serious threat to sericulture industry (Sakthivel and Qadri, 2010; Sakthivel *et al.*, 2011a).

Chemical control measures by the farmers against the pest were found to be partially effective (Sakthivel *et al.*, 2012) due to the presence of protective waxy coating over the body of the pest, wider host range of the pest and resistance to the chemical insecticides (Meyerdirk *et al.*, 2004). Pesticide applications eliminated the native natural enemy complex from the agro ecosystem (Sakthivel *et al.*, 2011b). However, *P. marginatus* was managed effectively in countries like Guam, Palau, Mexico, Puerto Rico etc. after introducing classical biological control agents (Meyerdirk *et al.*, 2004; Muniappan *et al.*, 2006). Indiscriminate application of insecticides in India during the initial stage of out-break of papaya mealybug might have prevented the feasibility of fortuitous introduction of these effective exotic parasitoids along with the spread of this alien pest. Efforts were thus taken by National Bureau of Agriculturally Important Insects (NBAII), Bangalore to import the exotic parasitoids, their mass multiplication and release in hotspot zone through various agencies during 2010 (Rabindra and Shylesha, 2011). However, the information on proliferation and comparative effective-ness of these three introduced parasitoids of *P. marginatus* under field condition in India is limited. Therefore, a study was conducted to find out the comparative field efficacy of

these three parasitoids against *P. marginatus* infesting cassava, the major tuber crop as well as the food plant of eri silkworm in Tamil Nadu.

MATERIALS AND METHODS

Mass multiplication of parasitoids

The stock culture of three exotic parasitoids of papaya mealybug *viz.*, *A. loecki*, *A. papayae* and *P. mexicana* were obtained from National Bureau of Agriculturally Important Insects (NBAII), Bangalore during October 2010 and multiplied in mass under laboratory condition at Regional Sericultural Research Station, Salem and Research Extension Center, Central Silk Board, Srivilliputtur, Tamil Nadu by culturing of the pest on potato sprouts as suggested by Shylesha *et al.* (2010a).

Field Release

The study was conducted in three potential cassava growing districts *viz*., Namakkal, Salem and Dharmapuri in Tamil Nadu, cassava gardens, irrespective of varieties and ages, infested heavily with *P. marginatus* in 9 locations @ 3 locations per district were selected for release of parasitoids. Two hundred individual parasitoids of each species were released per location in cooler hours between 6 and 7 AM in the month of November 2010. Pre-treatment count on the population of *P. marginatus* as well as the parasitization was carried out a day prior to the release of parasitoids in all locations as described by Meyerdirk *et al.* (2004). Care was taken to avoid application of any chemical pesticide in these experimental plots during the study period.

Observations on population of *Paracoccus marginatus* and parasitism

The counts on population of *P. marginatus* and parasitization were undertaken in monthly intervals in fixed plot method. Random samples @ 30 leaves per location were collected, brought to the laboratory and the population of papaya mealybug was recorded using binocular microscope and the data recorded per whole leaf sample were converted to total number of mealybugs per $5cm^2$ of the leaf. Simultaneously, mummies with and without exit holes were also counted and the percent parasitism was worked out. Thirty mummies without exit holes from the leaf samples of each location were isolated carefully using soft painting brush and kept in glass test tubes closed with thin muslin cloth using rubber bands, labeled and kept in room temperature for 30 days. Then the adult parasitoids emerged from the each test tube were examined and identified upto species level.

RESULTS AND DISCUSSION

Population densities of *P. marginatus* on cassava and percent parasitism in the three sampling sites before and after release of parasitoids are given in Table 1. Heavy population load @ 38.70, 43.85 and 41.21 numbers / $5cm^2$ 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 parasitoids recording highest parasitism in Namakkal (8.45%) followed by Salem (7.42%) and Dharmapuri (2.38%). However, the population of *P. marginatus* declined uniformly corresponding to gradual increase in percent parasitism @ 2, 3, 4 & 5^{th} 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 6^{th} 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), Kerala (Lyla *et al.*, 2012) and Karnataka (Shylesha *et al*., 2010b). The results are also in agreement with the reports on success of classical biological control from different countries. The reduction of *P. marginatus* population density below the detectable levels was observed in a six month period after the introduction of these three exotic parasitoids in Palau (Muniappan *et al*., 2006) where as, 99% reduction in the pest population was recorded one year after release of these parasitoids in Dominican Republic and Puerto Rico (Kauffman *et al*., 2001). Similar success in classical biological control of *P. marginatus* in Guam was reported with the reduced risk of spread of the pest in neighboring islands and Pacific region (Meyerdirk *et al*., 2004).

Among the parasitoids released, highest proliferation and field activity was observed in the case of *A. papayae* accounting for 80.89 – 94.31% parasitization whereas, *P. mexicana* registered poor proliferation (5.69 – 19.11%) and the field establishment of *A. loecki* was not noticed during the study period (Table 2). The results corroborate with the findings of Muniappan *et al.* (2006) in Republic of Palau and Kaushalya *et al*. (2008) in Florida who reported highest acclimatization and predominant activity of *A. papayae* and slow recovery of *A. loecki* and

Table 1: Population of *Paracoccus marginatus* on cassava and rate of parasitism after release of parasitoids

Period	Salem		Dharmapuri		Namakkal		Average		*% Reduction in PMB population
	PMB	Parasitism	PMB	Parasitism	PMB	Parasitism	PMB	Parasitism	
November 2010 (Pre-count & Release)	38.70 ± 3.67	00.00	43.85 ± 4.28	00.00	41.21 ± 3.69	00.00	41.25 ± 2.18	00.00	—
December 2010	35.33 ± 2.55	07.42 ± 0.83	40.56 ± 3.00	02.38 ± 1.11	33.62 ± 2.80	08.45 ± 1.23	36.50 ± 2.18	06.08 ± 0.73	11.51 ± 1.08
January 2011	30.55 ± 3.25	16.35 ± 1.19	32.15 ± 2.58	13.66 ± 1.17	31.27 ± 3.48	17.08 ± 1.76	31.32 ± 2.95	15.69 9± 1.20	24.07 ± 2.77
February 2011	17.14 ± 2.00	46.13 ± 4.21	18.59 ± 2.56	40.10 ± 5.10	19.22 ± 3.15	35.50 ± 4.48	18.31 ± 1.99	40.57 ± 5.00	55.61 ± .20
March 2011	09.65 ± 1.06	58.23 ± 5.66	05.73 ± 0.82	63.75 ± 4.37	07.19 ± 1.10	63.00 ± 5.71	07.52 ± 0.98	61.66 ± 5.87	81.76 ± 2.73
April 2011	05.26 ± 1.23	70.36 ± 3.69	03.99 ± 0.58	75.50 ± 4.80	05.28 ± 0.77	79.59 ± 6.38	04.84 ± 0.32	75.15 ± 4.52	88.26 ± 3.96
May 2011	03.78 ± 0.66	72.66 ± 3.33	02.15 ± 00.60	75.75 ± 5.25	02.55 ± 0.50	80.58 ± 5.40	02.82 ±0 0.29	76.33 ± 4.44	93.15 ± 3.90

Values are mean ± SD, PMB= Papaya mealybug (No. /5cm^2) & Parasitism (%)

*Per cent reduction over pre-count

Table 2: Comparative percent parasitism on *Paracoccus marginatus* by the parasitoids *Acerophagus papayae* and *Anagyrus loecki* under field condition

Period	Salem		Dharmapuri		Namakkal		Average	
	A. papayae	*P. mexicana*	*A. papayae*	*P. mexicana*	*A. papayae*	*P. mexicana*	*A. papayae*	*P. mexicana*
December 2010	92.15	7.85	93.12	6.88	97.65	2.35	94.31	5.69
January 2011	89.39	10.61	90.56	9.44	95.29	4.71	91.75	8.25
February 2011	84.66	15.34	88.11	11.89	94.86	5.14	89.21	10.79
March 2011	88.27	11.73	83.78	16.22	89.73	10.27	87.26	12.74
April 2011	81.36	18.64	86.10	13.90	85.67	14.33	84.38	15.62
May 2011	83.08	16.92	79.25	20.75	80.33	19.67	80.89	19.11
Mean	86.49	13.51	86.82	13.18	90.59	9.41	87.97	12.03

non establishment of *P. mexicana* under field condition. Sympatric parasitoid species that share the single host species may become the competitors to each other and their competitive abilities than among other factors determine their relative abundance (Van Strien-van Liempt, 1983). According to Dent (1995), when two species compete with another intensely enough over limited resources, then with time, one or the other can become extinct. In India, laboratory experiments conducted to find out the life history and interspecific competition of these three parasitoids showed a longer life cycle of *P. mexicana* than other two species. However, superior competitive ability of *A. papayae* was recorded over *P. mexicana* and *A. loecki* in early instar, preferably, second instar mealybugs (Shylesha *et al*., 2010b). This might have limited the availability of un-parasitized late instar mealybugs which were preferred by the other two parasitoids, to develop their progeny under field condition. Host searching ability and field activity of *P. mexicana* might be comparatively greater than *A. loecki* and this could have helped the parasitoid to effectively utilize the leftover hosts and to establish its survival after *A. papayae*. The present investigation also explains that the release of *A. papayae* @ 200 individuals per location alone sufficient to eradicate the population of *P. marginatus*, rather than the application of chemicals. However, field diversity of *A. papayae* need to be conserved by avoiding application of insecticides with high toxicity and long persistence against other pests to prevent resurgence of this pest in future.

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REFERENCES

Dent D. 1995. Principles of integrated pest management pp. 8–46. In: Dent, D. (Ed.), *Integrated Pest Management*, Chapman and Hall, New York.

Jonathan EI, Karuppuchamy P, Kalyanasundaram M, Suresh S, Mahalingam CA. 2010. Status of papaya mealybug in Tamil Nadu and its management, pp. 24–33. In: *Proceedings of the National consultation meeting on strategies for deployment and impact of the imported parasitoids of papaya mealybug,* 30th October, 2010, NBAII, Bangalore.

Kalyanasundaram M, Karuppuchamy P, Divya S, Sakthivel P. Rabindra RJ, Shylesha AN. 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, NBAII, ICAR, Bangalore, India.

Kauffman WC, Meyerdirk DE, Miller D, Schauff M, Hernandez HG, Jimenez JAV. 2001. Papaya mealy-bug biological control in Puerto Rico and Dominican Republic. ESA Annual Meeting 2001: Ann. Entomological Odyssey of ESA (http://creatures.ifas.ufl.edu/fruit/mealybugs/papayamealybug.htm).

Kaushalaya G, Amarasekare CM, Mannion, Epsky ND. 2008. Host instar susceptibility and selection and inter-specific competition of three introduced parasitoids of papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae). *Env Ent.* **39**: 1506–1512.

Lyla KR, Sinish MS, Vidya CV, Chellappan M. 2012. Classical biocontrol of papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink in Kerala using the parasitoid, *Acerophagus papayae* Noyes and Schauff (Hymenoptera: Encyrtidae). *J Biol Control* **26**(4): 386–388.

Meyerdirk DE, Muniappan R, Warkentin R, Bamba J, Reddy GVP. 2004. Biological control of the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae) in Guam. *Pl Prot Qtly* **19**(3): 110–114.

Muniappan R, Meyerdirk DE, Sengebau FM, Berringer DD, Reddy GVP. 2006. Classical biological control of the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae) in the Republic of Palau. *Florida Entomol.* **89**(2): 212–217.

Rabindra RJ, Shylesha, AN. 2011. Emerging alien invasive pests and classical biological control in India, pp. 106–122. In: *National Symposium on harnessing bio-diversity for biological control of crop pests*. May 25–26, 2011, Society for Biocontrol Advancement, Bangalore, India.

Sakthivel N. Qadri SMH. 2010. Incidence of papaya mealybug on tapioca in Tamil Nadu, *Indian Silk* **1** (5-6): 8–9.

Sakthivel N, Samuthiravelu P, Ravikumar J, Balakrishna R, Isaiarasu L. 2011a. Effect of papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink incidence on productivity of mulberry (*Morus alba* L.) and economic traits of silkworm (*Bombyx mori* L.), pp. 190–193. In: Dunston P. Ambrose, (Eds.) *Proceedings of international symposium on insect pest management, a current scenario*, Entomology Research Unit, St. Xavier's college, Palayamkottai.

Sakthivel N, Balakrishna R, Qadri SMH. 2011b. Comparative efficacy of water jetting and chemical measures against major sucking pests of mulberry and their safety to natural enemies. *J Biopest.* **4** (2): 219–230.

Sakthivel N, Qadri SMH, Balakrishna R, Kirsur MV, Helen SM. 2012. *Management strategies of papaya mealybug infesting mulberry*, Technical Bulletin, January 2012, Regional Sericultural Research Station, Central Silk Board, Allikkuttai, Salem, India. 4 pp.

Selvaraju NG, Sakthivel N. 2011. Host plants of papaya mealybug (*Paracoccus marginatus* Williams and Granara de Willink.) in Tamil Nadu. *Kar J Agric Sci.* **24**(4): 567–569.

Shylesha AN, Dhanyavathy, Shivaraj. 2010a. 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, NBAII, ICAR, Bangalore, India.

Shylesha AN, Rabindra RJ, Bhumannavar BS. 2010b. The papaya mealybug, *Paracoccus marginatus* (Coccoidea: Pseudococcidae), pp. 1–8. In: *Proceedings of the national consultation meeting on strategies for deployment and impact of the imported parasitoids of papaya mealybug.* 30 October, 2010, NBAII, ICAR, Bangalore, India.

Van Strien-van Liempt, WTFH. 1983. The competition between *Asobaratobida* Nees von Esenbeck, 1834 and *Leptoprilina heterotoma* (Thomson, 1862) in multiparasitized hosts. *Netherlands J Zool*. **33**: 125–163.