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PAPAYA MEALYBUG AND ITS BIOLOGICAL CONTROL - A REVIEW

Mini Review Article

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ABSTRACT

The papaya mealybug *Paracoccus marginatus* is likely to invade several countries in the World. Several methods like cultural, chemical, legal and biological have been adopted to tackle the mealybug problem. However only chemical and biological control methods have been widely practiced for the management of mealybugs. Only the host specific parasitoids have given control of *P. marginatus*. More specifically the hymenopteran parasitoid *Acerophagus papayae* played a predominant role in suppressing the papaya mealybug in several countries.

Introduction

Papaya (*Carica papaya*) is a tropical fruit having commercial importance because of its high nutritive and medicinal value. Papaya cultivation had its origin in South Mexico and Costa Rica. In India Papaya is mainly cultivated in the states of Uttar Pradesh, Bihar, Assam, Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat, Maharashtra, West Bengal, kerala, Madhya Pradesh in about 8000 ha. The reason for low productivity of papaya may be attributed to the attack of papaya plant by various insect pest and diseases coupled with the lack of proper scientific cultivation of the crop. Recently, the incidence of the papaya mealy bug *Paracoccus marginatus invaded* India, the 1st record being on papaya plant from Coimbatore (Tamil Nadu) in July 2008. It has now spread to Kerala, Karnataka, Maharashtra and Tripura, presumably due to the movement of infested fruits. It has became a major threat to other important crops like cotton, okra, mulberry, teak, jatropha and other cultivated crops and is spreading to many of the new host plants. The papaya mealybug , *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera : Psuedococcidae) is a small polyphagous sucking insect with pest status that attacks several genera of host plants, including economically important tropical fruits, vegetables and ornamentals (Miller *et al*., 1999).

Origin and distribution of papaya mealybug

Paracoccus marginatus is native to Mexico and/or Central and North America where it never acquired the status of a serious pest, probably due to the presence of an endemic

natural enemy complex (Miller *et al*., 1999). During 2008-2009 it was noticed in South and South East Asia (Shylesha *et al*., 2011). In India it was first reported from Coimbatore in Tamil nadu in July, 2008 infesting papaya plants (Muniappan *et al*., 2008 and 2009). Since July 2007 it has been recorded at TNAU, Coimbatore and subsequently spread to neighbouring districts (Mahalingam et *al*., 2010). The pest has been recently noticed in other states such as Karnataka, certain parts of Andhra pradesh and Malappuram and Thrissur districts of Kerala. The pest has now spread to Pune area of Maharashtra also and is likely to be reported from other part of country as well and to distant states like Tripura, Assam and Orissa (Shylesha et *al*., 2011).

Table 1. Sequence of *P. marginatus* appearance in different states of India

Place	Pest status	Year of appearance	Reference
Kerala	Major	2011	Jacob Methew., 2011.
Odisha	Major	2011	Shylesha *et al*., 2011.
Pune region of Western Maharashtra	Major	2010	Pokharkar *et al.*, 2011
Tamil Nadu	Major	2008	Jonathan *et al*., 2011
Tripura	Minor	2009-10	Agarwala, 2011

Nature of damage and estimated loss caused by papaya mealybug

Paracoccus marginatus attacks many species of plants including field crops, fruit trees, ornamentals, weeds and scrub vegetation. The potential economic loss due to this pest ranges from 60-80% in papaya. It inflicts damage on various parts of the host plant including the leaves, stems, flowers and fruits (Walker *et al*., 2003). Papaya mealybug infestations are typically observed as clusters of cotton like masses on the above ground portion of plants. It shows very similar symptoms to pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) (Pollard,1999). The insect sucks the sap by inserting its stylets into the epidermis of the leaf, fruit and stem. While feeding, it injects a toxic substance into leaves resulting in curling, crinkling, rosetting, twisting and general leaf distortion, reduced leaf size and surface area (Miller *et al*., 1999). After the invasion of the papaya mealybug the production of quality fruits have reduced and the cost of papaya has gone up from the usual 8-15 Rs a kilo to 25-30 Rs a kilogram (Muniappan *et al*., 2010). Estimated loss in some of the states due to papaya mealybug infestation in terms of fruit production loss is in Karnataka 90.44MT, in Maharashtra 69.66 MT, and Kerala 3.56MT. In addition the pest has taken on to tapioca, mulberry, cotton, cocoa, and rubber which are of prime importance in southern India (Tanwar *et al*., 2010).

Failure of conventional control measures

Mealybugs are difficult to control as they live in protected areas such as cracks, crevices and under the bark of their host plants. Most of the stages including eggs of mealybug are covered with waxy secretions that protect them (Shylesha *et al*., 2010). Wax layer and waxy fibres over the ovisac and body of mealybug nymphs and adult female protect them from adverse environmental conditions and routine chemical pesticides. Chemical pesticides gave only temporary relief and often farmer had to spread repeatedly resulting in toxicity hazards and pollution as well as ecocidal effects killing several beneficial insects. (NBAII, Bangalore).

It is hard to kill pest with conventional insecticides because of cryptic habit and waxy coating over the body. Particular emphasis on biological control will be ultimately useful for the successful management of papaya mealybug.(NBAII,Bangalore).

Natural enemies associated with papaya mealybug

Predators:

A number of predators like Australian ladybird beetle *Cryptolaemus montrouzier*, indigenous *Scymnus spp*., the Cecidomyiidae *Diadiplosis coccidarum* (Cockerel), chrysopid (lace wing) larvae and adults and Syrphid (hover fly) larvae and *Spalgis epius* and lace wing flies are effective in rapidly reducing high populations of mealybugs.

Parasitoids:

Several primary parasitoids have been identified in the native range of papaya mealybug. Like *Anagyrus loecki*, *Apoanagyrus californicus*, *Acerophagus papayae*, *Pseudophycus sp and Pseudleptomastrix mexicana* and are augmented in many countries for biological control. (NBAII,Bangalore).

Table 2. Parasitoids introduced in India for management of papaya mealy bug

Order	Family	Species	Refrence
Hymenoptera	encrytidae	*Acerophagus papayae* (noyes and schauff)	Jothi *et al.* (2011)
Hymenoptera	encrytidae	*Anagyrus loecki* (noyes)	Nakata *et al*.(2011)
Hymenoptera	encrytidae	*Pseudleptomastrix mexicana* (noyes and schauff)	Nakata *et al*.(2011)

Table 3. Predator reported from India

Order	Family	Species	Reference
Lepidoptera	Lycaenidae	*Spalgis epius* (Westwood)	Krishnamurthy and Mani (2011).
Coleoptera	Coccinellidae	*Cryptolaemus montrouzieri* (Mulsant)	Jonathan *et al*. (2011)
Coleoptera	Coccinellidae	*Scymnus taiwanus* (Ohta)	Nakata *et al*. (2011)
Coleoptera	Coccinellidae	*Cheilomenus sexmaculatus* (Fabricius)	Jonathan *et al*. (2011)
Coleoptera	Coccinellidae	*Coccinella transversalis* (Fabricius)	Jonathan *et al.* (2011)
Neuroptera	Chrysopidae	*Chrysoperla carnea* (Stephens)	Ayyasamy and Ragupathy (2010)
Diptera	Syrphidae	*Ischiodon scutellaris* (Fabricius)	Shylesha *et al*. (2011)

Introduction of exotic natural enemies

Paracoccus marginatus invaded India in 2008 and has become severe on several agricultural and horticultural crops. The potential economic loss due to this pest ranges from 60-80% in papaya.

Table 4. Entomopathogenic fungi

Entomopathogenic fungi	Reference
Metarrhizum anisopliae (Metsch.)	Shylesha *et al*., 2010
Verticillium lecani (Zimm.)	Mani Chellappan, 2011
Paecilomyces pictus	Ayyasamy and Ragupathy, 2010
Beauveria bassiana (Bals.)	Shylesha *et al*., 2010
Neozygytes Chilocorus nigrata Fab	Shylesha *et al*., 2010

A concerned effort by NBAII through the USA consulate at New Delhi (Mark Gilkey) and Dr. Muniappan could obtain all the three exotic parasitoids , *Acerophagus papayae*, *Anagyrus loecki* and *Pseudleptomastix mexicana* from USDA-APHIS parasitoid rearing facility at Puerto Rico on 15th July 2010. A total of 3,429 of *A. papayae*, 1,485 of *P. mexicana* and 516 of *A. loecki* were received by National Bureau of Agriculturally Important Insects (NBAII, Bangalore during July-October, 2010. After ascertaining the safety in quarantine, these three parasitoids were distributed to different states in India.

Effectiveness of three introduced parasitic wasps against *P. marginatus*

Three exotic encyrtid parasitoids *viz.*, *Acerophagus papayae, Anagyrus loecki and Pseudleptomastix mexicana,* introduced in India during 2010 under the classical biological control programme against an outbreak of papaya mealybug, *Paracoccus marginatus*, an alien polyphagous pest, were evaluated on mulberry in Tamil Nadu. The nucleus culture of these three parasitoids were received from National Bureau of Agriculturally Important Insects, Bangalore, mass multiplied and released in mulberry gardens severely infested by papaya mealybug in 6 locations, 3 each at Virudunagar and Tirunelveli districts of Tamil Nadu @ 200 individuals per location during November 2010(Muniappan *et al*.,2006). An average of 10.4% parasitism and 9.7% reduction in papaya mealybug population was noticed a month after release of parasitoids and the population of the papaya mealybug was decreased gradually corresponding to the increase in percent parasitism @ 2, 3, 4 and 5th months. The population of papaya mealybug from the mulberry garden was almost completely eliminated with 96.6% at 6th month corresponding to 72.2% parasitism. Among the parasitoids released, the highest proliferation and field activity was observed in the case of *A. papayae*, which accounted for 75.6 – 81.7% parasitization followed by *P. mexicana* (9.3-24.4%) whereas *A. loecki* registered comparatively very poor performance (0.7- 9.0 %) and its field recovery was not found for 4 month after release in mulberry ecosystem of Tamil Nadu, India.

Table 5. Release of parasitoids in different localities

Parasitoid	State	Plants	Year	Reduction in pest population
A. papayae	kerala	Rubber, Plantation crops	2011	80%
A. papayae	Odisha	Agricultural and Horticultural crops	2011	70-80%
A. papayae	Bangalore	Jatropha	2010	80-90%
A. papayae	Maharashtra	Papaya	2010	85-92%
A. papayae	Tripura	Papaya	2009-10	60%

Source: Mani and Shivaraju, 2012

Fig 1. Life cycle and Damage symptoms of papaya mealybug

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