

**FIRST RECORD OF *PARACOCCUS MARGINATUS*
(HEMIPTERA: PSEUDOCOCCIDAE), AN INVASIVE
ALIEN SPECIES ON PAPAYA (*CARICA PAPAYA* L.)
IN JAMMU (J&K), INDIA**

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[Sharma, S., Bhatia, S., Sharma, J., Andotra, S., Sudan, M. & Sharma, K. 2013. First record of *Paracoccus marginatus* (Hemiptera: Pseudococcidae), an invasive alien species on papaya (*Carica papaya* L.) in Jammu (J&K), India. Munis Entomology & Zoology, 8 (2): 664-671]

ABSTRACT: The papaya mealybug, *Paracoccus marginatus*, an invasive alien species found to heavily infest papaya (*Carica papaya*), the major host. *Paracoccus marginatus* (Hemiptera: Pseudococcidae), was first described by Williams and Granara de Willink in 1992. It is a polyphagous species native to Mexico and Other Central American Countries. It is also recorded from many countries of the Caribbean region, causing huge economic losses to papayas since 1994. *Paracoccus marginatus* is a small hemipteran that attacks several genera of plants (more than 40 species), including economically important fruits, vegetables and ornamentals. It potentially posed a serious threat to numerous agricultural crops. Integrated pest Management (IPM) was identified as a key component in a management strategy for the papaya mealybug. *Paracoccus marginatus* damaging papaya in Jammu region is reported for the first time. Besides it, the fundamental biological data of *Paracoccus marginatus*, its existing host plants and its distribution in India and around the world was described.

KEY WORDS: Papaya mealybug, *Paracoccus marginatus*, *Carica papaya*, host range, control, Jammu (J&K).

Papaya mealybug, *Paracoccus marginatus* is an invasive pest and most of the mealybugs (Hemiptera: Pseudococcidae) are serious pests of agricultural plants, horticultural plants and ornamentals. Papaya mealybug, *Paracoccus marginatus* Williams & Granara de Willink was recently found in Jammu (J&K). It is a polyphagous species native to Mexico and Other Central American Countries and became a pest when it invaded the Caribbean region. Since 1994, it has been recorded from many countries and distributes over a wide range in the world (Tanwar et al., 2010). This pest induces leaf yellowing, reduce plant growth and destroy fruits of the host plants. Papaya mealybug was reported infesting papaya plants in Jammu (J&K), India for the first time in May 2009. The pest was observed to spread rapidly and occurred in large colonies on all aerial parts of the plant, including leaves and fruits. This paper summarizes the information collected on the identity, host plants, distribution and damage caused by mealybug and the control measures adopted against it.

MATERIAL AND METHODS

Sampling

The infested area was visited in June 2009, immediately after the problem was reported. Mealybugs were collected from 4 locations for identification. The insects collected from infested plants material were brought to the laboratory and

transferred from infested papaya plants fragments to glass vials. The three quarters of the vial was then filled with 90% ethanol, labeled, sealed and immersed in a water bath (100°C) for 20 minutes.

Identification

Preserved specimens and live mealybugs were studied under a binocular microscope to observe morphological and taxonomic characters for identification. The preserved samples (each containing approximately 70 specimens including all developmental stages were collected from host plant *Carica papaya* L. from four different locations in Jammu, (J&K) and was initially determined by comparison with descriptions given by Miller & Miller (2002) and then authoritative identification was made by using keys and description given by Williams & Granara de Willink (1992).

OBSERVATIONS AND DISCUSSION

Distribution

Paracoccus marginatus was originally reported from the Neotropical region including Mexico, Belize, Costa Rica, Guatemala (Williams & Granara de Willink, 1992) and subsequently from the Caribbean region, Florida, Antigua, British Virgin Islands, Montserrat, United States, St. Kittis and Nevis (Watson and Chandler, 1999) and also in Cuba, Dominican Republic, Haiti, Puerto Rico, St. Marten, Guadeloupe, St. Barthelemy, Barbados and St. Lucia.

In India, pest was reported from Tamil Nadu, Karnataka, Andhra Pradesh, Kerala, Tripura, Odisha and Maharashtra.

Hosts

The papaya mealybug is a polyphagous pest, which was recorded from at least 22 plant families and over 40 species that includes economically important crops such as papaya, cassava, citrus, *Annona* sp., sweet potato, peas, beans, ochro, egg plant, guava, *Acacia*, *Morus alba*, cotton, Red gram (*Cajanus cajan*), tomato (*Lycopersicon esculentum*), *Allamanda*, *Acalypha*, *Hamelia*, *Frangipani*, *Mangifera*, capsicum and ornamental plants such as hibiscus, *Jathropha*, and Leander and weeds such as sida, *Ipomoea* and *Parthenium* (Ben-Dov, 2008; Miller & Miller, 1999; McComie, 2000; Meyerdirk et al., 2000).

Morphological and taxonomic characteristics of papaya mealybug, *Paracoccus marginatus*

Adult female

Adult females are soft bodied about 2-3 mm long and 1.4 mm wide covered with mealy white wax and the body contents are yellow. The surface wax on the dorsum showed transverse creases between the body segments. The mature female secreted an ovisac of white wax filaments from the ventral margins of the abdomen which eventually extended three to four times to the body length and entirely covered the female. Slide mounted adult female possess upto 18 pairs of cerarri on body margins, eight segmented antennae, ventral anal lobe bars, translucent pores on the hind coxa and usually on the tibia, auxiliary setae are present in the anal lobe cerarri only and oral rim ducts are present somewhere on the body. Dorsal surface with short slender setae; cerarri numbering 16 or 17 pairs only; oral rim tubular ducts restricted to marginal area of dorsum and venter; hind legs with translucent pores present on coxa only (Williams & Granara de Willink, 1992; Miller & Miller, 2002; Walker et al., 2003; Heu et al., 2007).

Adult male

The adult male appears yellow and approximately 1.0 mm long with an elongate oval body widest at the thorax (about 0.3 mm). The antennae were 10 segmented; the thorax and head were heavily sclerotized and a pair of lateral pores clusters occurred near the apex of the abdomen. The lateral pore clusters secreted a pair of white wax caudal filaments.

Biology

Mealybugs were most active in warm and dry weather and had piercing and sucking type of mouth parts and fed by inserting their mouth parts into the plant tissue and sucked the sap. Females had no wings and moved by crawling to short distances or blown in air currents. A female laid 200-500 eggs in an ovisac that is 3 to 4 times the body length and entirely covered with wax. The ovisac was developed ventrally on the adult female. Egg laying usually occurred over the period of one to two weeks. Eggs were greenish yellow in color and hatched in about ten days. Nymphs or crawlers actively searched feeding sites. Female crawlers have four instars with a generation taking approximately one month to complete depending on the temperature. Males have five instars, the fourth instar was produced in a cocoon and referred as pupa. The fifth instar of the male was the only winged form of the species capable of flight. Adult females attracted the males with sex pheromones. Reproduction occurred throughout the year and there were several generations per year.

Seasonal occurrence

Adults breed throughout the year, though activity slows down during December to March. During winter the papaya mealybugs remained confined to the covered parts of the host and became more active during pre-monsoon and monsoon period i.e. May to September. A widespread infestation occurred with hundreds of similar aged nymphs gregariously on the papaya. During these outbreaks, each papaya fruit and leaf of the infested plants fully covered with the mealybugs.

Damage

Paracoccus marginatus attacked and damaged various parts of the host plant including the leaves, stems, flowers and fruits. On lightly infested plants, papaya mealybugs looked like small pieces of cotton masses attached to the aerial parts of the plant. On severe infested plants, this symptom was more prominent as the insects were attached to the fruits and looked like the oozing of milky sap.

The papaya mealy bugs feeds on the sap of the plants by inserting its stylets into the epidermis of the leaf, as well as into the fruits, flowers and stems. In doing so, it injected a toxic substance into the plant parts. New flushes of growth on damaged plants were deformed due to toxicity of the saliva injected into the plant by the mealybugs while feeding.

The infestation led to chlorosis, plant stunting, leaf deformation, early leaf and fruit drop and a heavy build up of honey dew. Honey dew excreted by the mealybugs resulted in heavy sooty mould growth. The sooty mould turned the leaves completely black, blocking out light and air, so interfering with photosynthesis. Heavy infestations are capable of rendering fruit inedible due to the buildup of thick white wax. Heavily attacked plants were killed (Walker et al., 2003; Hue et al., 2007).

Damage symptoms of different parts of the host plant

Leaf damage – Curling, crinkling, rosetting, twisting and general leaf distortion; reduced in leaf size and surface area.

Stem and shoot damage - Shoots and young stems distorted and malformed; arrested growth at the shoot terminals lead to shortened internodes and rosetting at the shoot tip.

Flower damage - Flowers also distorted and failed to open; where they open, petals became twisted or malformed or show various types of blemishes. Premature flower drop and poor fruit set occurred.

Fruit damage - Fruits failed to develop normally and such fruits eventually shrivel and drop. Fruit blemish and sooty mould reduced the market value of the fruit.

Pest significance

Paracoccus marginatus attacks over 40 species of plants, field crops, fruit trees, ornamentals, weed and scrub vegetation. The potential economic loss due to this pest has not been quantified. It is a serious risk when infested plants material is transferred from place to place. The waxy secretions with papaya mealy bugs may become attached to animals or birds or human clothing and may be transported from one place to another place in this way. 'Crawlers' may also become wind borne and be transported from place to place.

Outbreak and control of Papaya Mealybug

The pest was first observed on papaya crop (*Carica papaya* L.) in Jammu during 2009- 2010. Rapid spread of *Paracoccus marginatus* among agricultural and horticultural crops of economic importance was noticed and the pest emerged as a serious threat to papaya crop. It was necessary to take up immediate steps to manage it in the places of occurrence to limit the yield and crop losses.

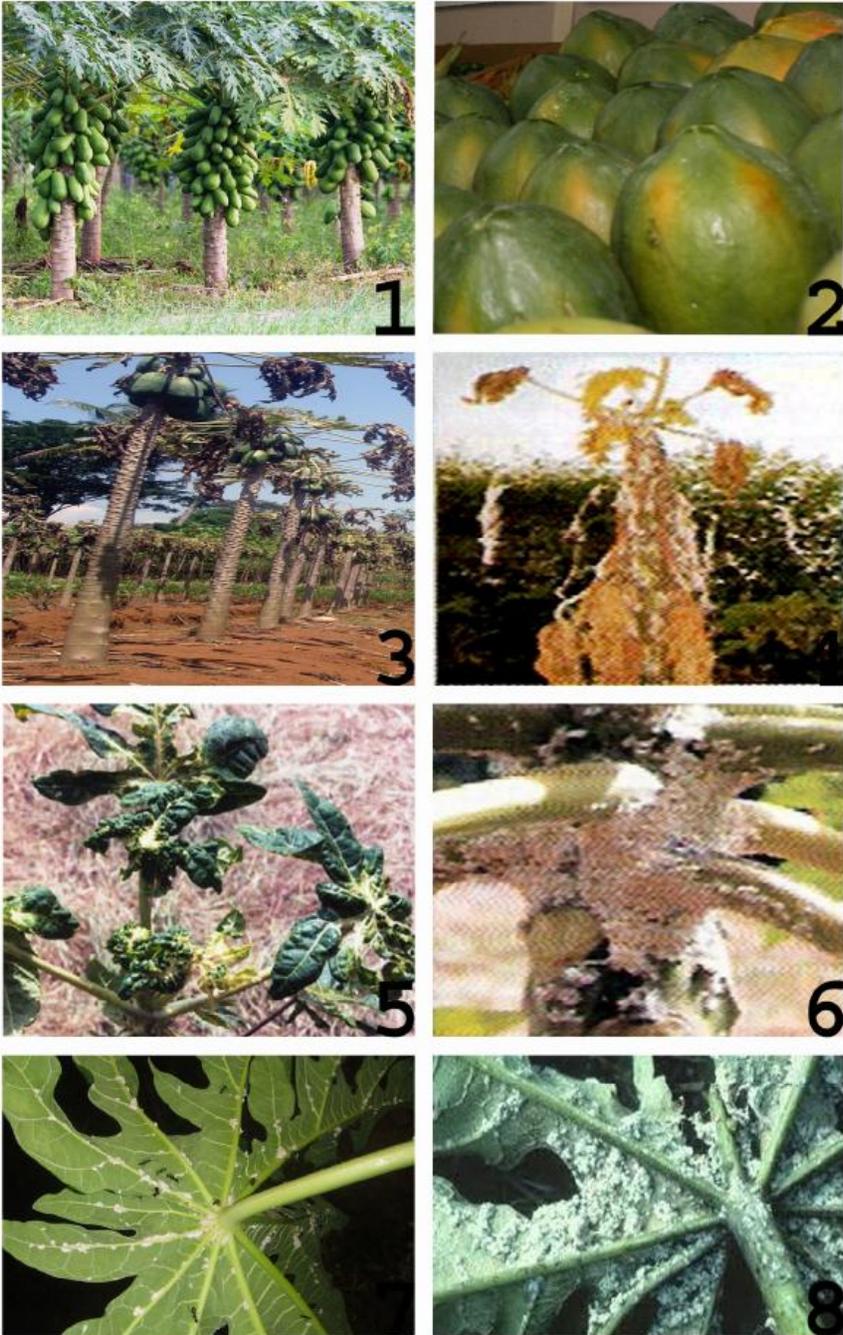
An integrated pest management (IPM) including cultural practices, chemical and biological control can be applied to manage papaya mealybug. The parasitoid natural enemies of the papaya mealybug include *Acerophagus papaya*, *Anagyrus loecki*, *Anagyrus californicus* Compere, and *Pseudaphycus* sp. (Noyes & Schauff, 2003). All the above parasitoids have been observed attacking 2nd and 3rd instar nymphs but not capable of reducing high population of this pest in a short period. *Spalgus epius* Westwood (Lepidoptera: Lycaenidae) being the dominant predator, feeds efficiently on the ovisacs, nymphs and adults of the papaya mealybug (Tanwar et al., 2010). The predatory larvae could devour about 42 to 53 (48.15± 4.08) ovisacs and 196 to 222 (210.99± 10.77) nymphs and adults of *Paracoccus marginatus* (Thangamalar et al., 2010) during the whole larval period (Chen et al., 2011). Botanical insecticides such as neem oil (1 to 2%), NSKE (5%), or Fish Oil Rosin Soap (25 g/L) and chemical insecticides such as profenophos 50 EC (2 mL/L), chlorpyrifos 20 EC (2 mL/L), buprofezin 25 EC (2 mL/L), dimethoate 30 EC (2 mL/L) etc were suggested to control this pest (Thangamalar et al., 2010). However, papaya mealybug is difficult to control because it inhabits protected areas such as cracks and under the bark of their host plants, where cultural practices and chemical control treatments are difficult to reach. Integrating monitoring and pest control measures are necessary for crop production.

ACKNOWLEDGEMENTS

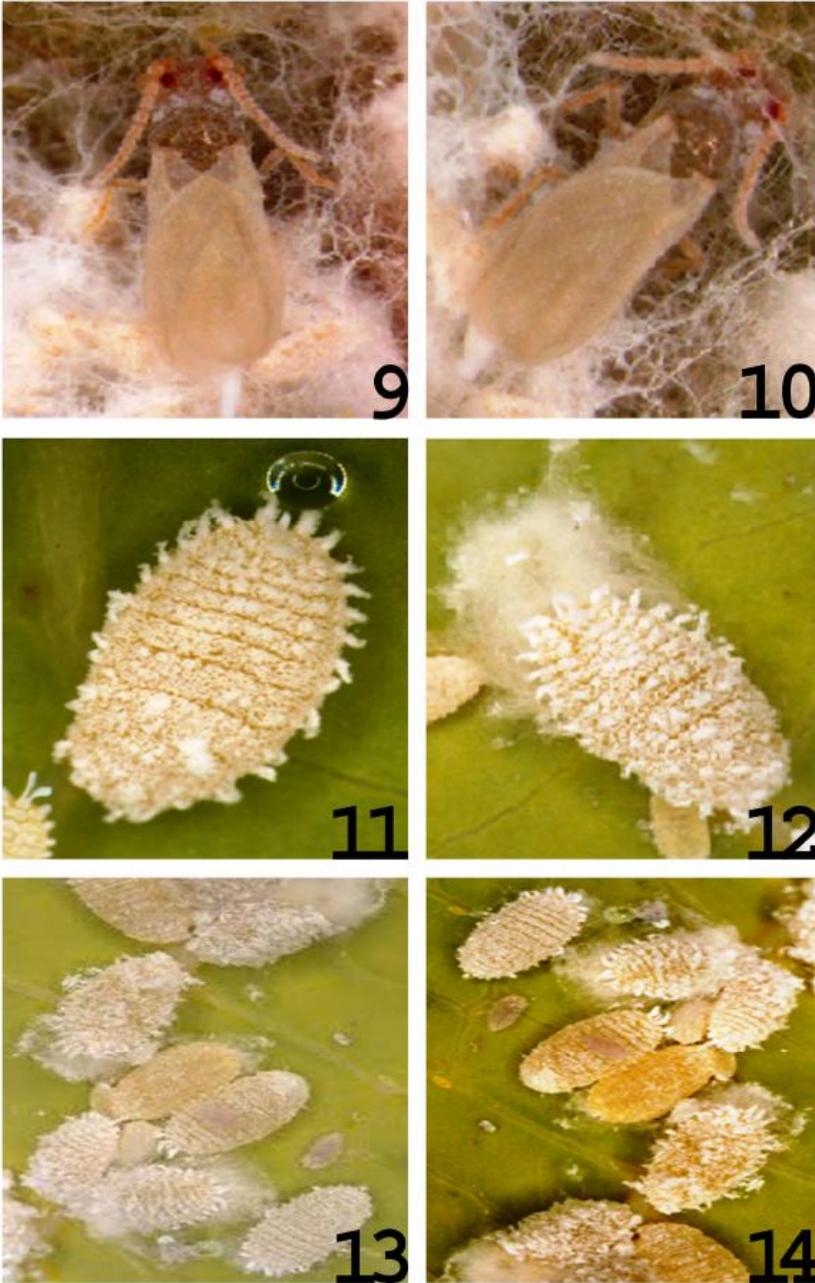
The authors are greatly thankful to Head, Department of Zoology, University of Jammu for providing necessary facilities to work.

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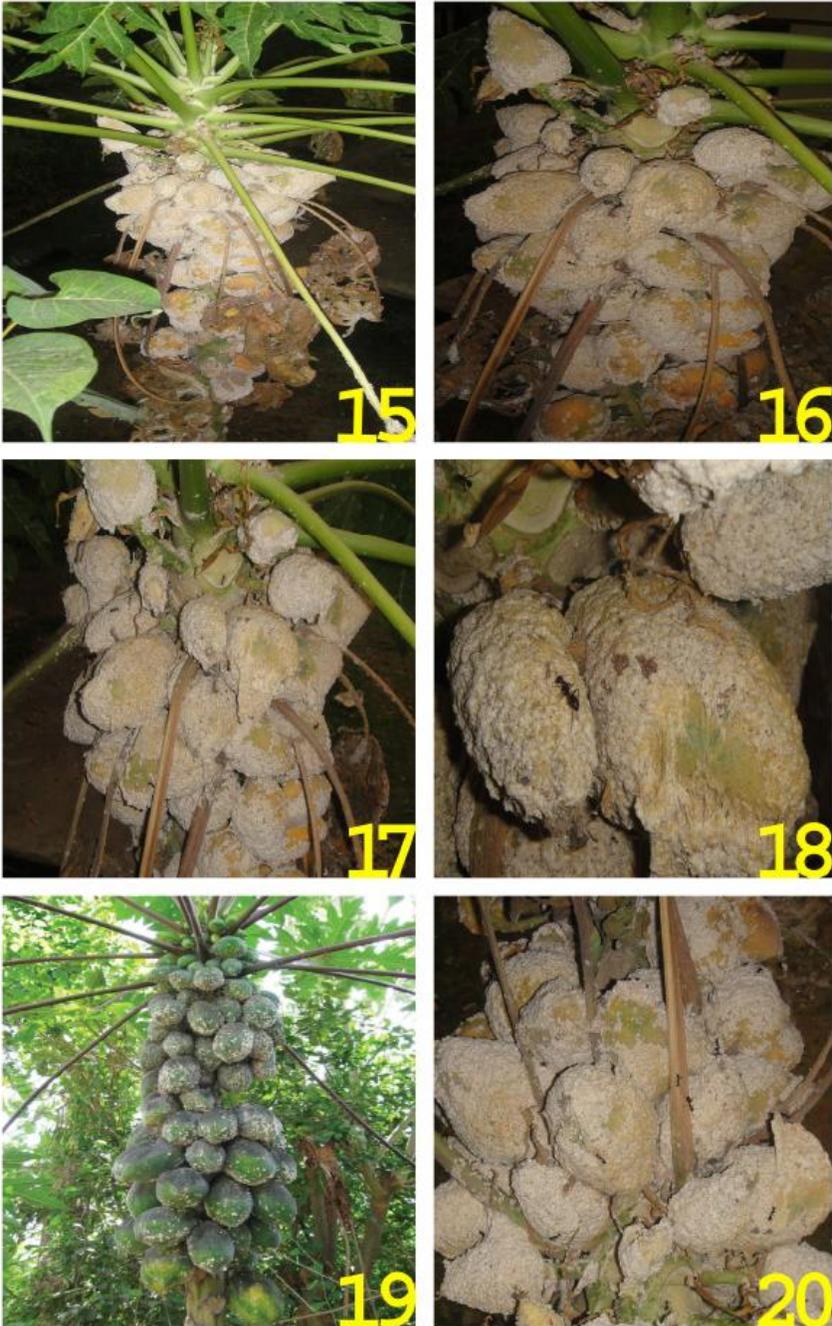
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1-2. Healthy plants and fruits of papaya, 3-4. Infested plants of papaya, 5. Deformed leaves and stunted growth of the plant, 6-8. Cotton like masses on the stem, leaf and leaf stalk.



9-10. Male adult of *Paracoccus marginatus*, 11-12. Female adult of *Paracoccus marginatus*, 13-14. Colony of papaya mealybug showing various stages with waxy secretion and honeydew.



15-17. Mealybug colony and sooty mould on papaya fruit, 18. Clusters of cotton like masses of *P. marginatus* on papaya fruits, 19-20. Damage symptoms on papaya tree.