

Classical Biological Control
of the

PAPAYA
mealybug

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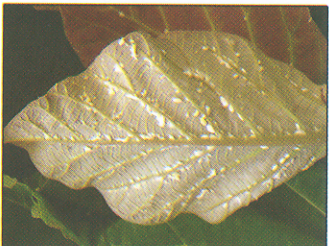
Nymphs and adults of *Paracoccus marginatus*



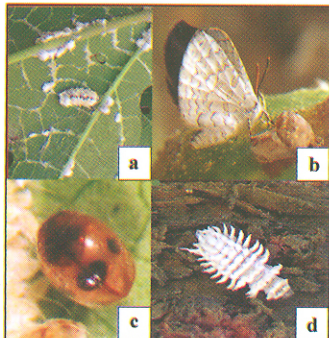
Mealybug infested papaya leaf



Mealybug colony on *Parthenium*



Infestation on teak



Predators to be conserved
S. epius a. larva b. adult
 c. *S. coccivora* d. *C. montrouzieri*

Invasion of the papaya mealybug in India

India is a leader in papaya production contributing to approximately 50 per cent of the world production of 6 million tons of fruits. It is cultivated in the states of Andhra Pradesh, Karnataka, Maharashtra, Gujarat, Orissa, West Bengal, Assam, Kerala, Tamil Nadu and Madhya Pradesh in about 8000 ha.

Recently, the papaya mealy bug (*Paracoccus marginatus* Williams & Granara de Willink) invaded India, the first record being on papaya plants from Coimbatore (Tamilnadu) in July 2008. It has now spread to Kerala, Karnataka, Maharashtra and Tripura, presumably due to the movement of infested fruits.

Research initiative by NBAII: The NBAII along with TNAU, Coimbatore and MPKV, Pune as partners in the AICRP on Biological Control and CSRTI, Mysore initiated pioneering studies to understand the biology and ecology of the pest as well as natural biological control.

Damage: Initially the mealybugs colonize the lower side of the papaya leaves along the veins and later cover all the fruits rendering them unmarketable. The loss is reported to be in the range of 60-80 per cent. Due to the explosive growth of the mealybug populations and the toxins produced, the younger plants are killed outright. Heavy sooty mould also develops due to the secretion of honey dew by the mealybugs.

Host range of the mealybug: This mealybug is polyphagous attacking several agricultural and horticultural crops like tapioca, pigeonpea, cotton, okra, tomato, brinjal, teak, silk cotton, *Jatropha*, mulberry, *Plumeria* and numerous weeds like *Parthenium hysterophorus*, *Sida acuta*, *Acalypha indica*, *Eupatorium adenophorum* and *Cassia sericea*.

Failure of chemical insecticides: Chemical pesticides gave only temporary relief and often farmers had to spray repeatedly resulting in toxicity hazards and pollution as well as ecocidal effects killing several beneficial insects.

Natural enemies: Larvae of the lepidopteran predator *Spalgis epius* have been found to feed voraciously on the papaya mealybugs. Other commonly found predators are *Cryptolaemus montrouzieri* and *Scymnus coccivora*. However, due to the density-dependent nature of the predator-prey relationship as well as mortality due to heavy pesticide use, these predators have not been able to keep the papaya mealybug population under check.

Parasitoids imported
from USDA-APHIS
Puerto Rico



Acerophagus papayae



Pseudoleptomastix mexicana



Anagyrus loecki

Classical Biological Control

Three species of encyrtid parasitoids *Acerophagus papayae*, *Pseudoleptomastix mexicana* and *Anagyrus loecki*, known to suppress the papaya mealybug in its native range, effectively controlled the papaya mealybugs when introduced into Guam, Palau islands and more recently to Sri Lanka. In Sri Lanka, *A. papayae* alone could suppress the papaya mealybug population within six months of release.

Import of parasitoids by NBAII

The NBAII has successfully imported the three species of parasitoids with the help of the United States Department of Agriculture - Animal and Plant Health Inspection Services (USDA-APHIS) from their facility at Puerto Rico and completed all the mandatory safety and specificity tests in the quarantine facility.

Quarantine studies

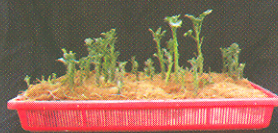
Specificity: The parasitoids did not parasitize other species of mealybugs, viz., *Phenacoccus solenopsis*, *Ferrisia virgata*, *Maconellicoccus hirsutus*, *Lankacoccus ornatus*, *Pseudococcus longispinus*, *Planococcus lilacinus* and *Planococcus citri*.

Safety: The parasitoids were found to be safe to honeybees, lac insects, silk worms and predators like *Cryptolaemus montrouzieri*, *Scymnus coccivora*, *Brumoides suturalis*, *Spalgis epius*, chrysopids, *Trichogramma* spp. and *Goniozus nephantidis*.

Mass production of the parasitoid



Induction of eye buds in potatoes
for multiplication of mealybugs



Potato shoots ready for
infestation with mealybugs

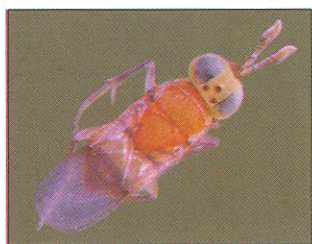
The NBAII has mass multiplied the parasitoids successfully in the laboratory on *Paracoccus marginatus* colonies grown on potato sprouts and shoots. Parasitoids could parasitize and develop on mealybugs cultured on other host plants also. Entomologists of State Agricultural Universities, ICAR institutes, KVKs, Central IPM centers, Government biocontrol laboratories and Central Sericulture Research and Training Institute have been trained by the NBAII on the mass production, field release and conservation of the parasitoids.



Mealybugs being raised on
potato shoots

Field release of parasitoids

The NBAII is now supplying all three parasitoids to entomologists all over India for field release and conservation. Field release of the parasitoids has been authorized by the Plant Protection Advisor to the Government of India. It is crucial that the released parasitoids as well as naturally occurring predators like *Spalgis* and *Cryptolaemus* are conserved by avoiding the use of chemical pesticides for the effective suppression of the papaya mealybug. If properly mass produced, released and conserved, the parasitoids are expected to bring about significant suppression of the papaya mealybug populations within six months to one year.



Acerothrips papayae
The most promising of the three imported parasitoids

Special features of NBAII initiative

1. Parasitoids are released in farmers fields free of cost.
2. Once released and conserved, the parasitoid will establish naturally and control the papaya mealybug not only on papaya, but all other crops on a long term basis.
3. Establishment of a nationwide network of stakeholders for the production, release and conservation of the parasitoids.

Strategy for classical biological control of papaya mealybug

1. Inoculative release of the exotic parasitoids *Acerothrips papayae*, *Anagyrus loecki* and *Pseudoleptomastix mexicana* @ atleast 500 parasitoids of each species per village in the mealybug-infested hot spot areas; releases may be repeated if necessary.
2. Conservation of the released parasitoids and naturally occurring predators like *Spalgis* and coccinellids by avoiding the use of chemical pesticides.
3. Redistribution of the natural enemies to new areas infested by the papaya mealybug.
4. Papaya mealybug-infested weeds like *Parthenium*, *Plumeria alba*, *Acalypha indica* and other hosts like teak as well as mulberry can be very valuable reservoirs of parasitoids and hence should not be destroyed or sprayed with chemical pesticides.
5. Initial releases can be concentrated in gardens producing organic papaya as well as in teak and mulberry plantations with heavy mealybug infestation.

Impact Assessment

The NBAII has initiated the task of impact assessment in partnership with the State Agricultural Universities, AICRP Biological Control Centres, Krishi Vigyan Kendras, Central IPM Centers, C.S. R.T.I. , Mysore and the National Center for IPM, New Delhi.

NBAII gratefully acknowledges

1. **Dr. S. Ayyappan**, Secretary, DARE and Director General, Indian Council of Agricultural Research for piloting the import of the exoitic parasitoids.
2. **Dr. Swapan Kumar Dutta**, Deputy Director General (CS) and **Dr. T.P. Rajendran**, Asst. Director General (PP) of ICAR for encouragement and support.
3. **Mr. Pankaj Kumar**, Joint Secretary (PP), DAC, Ministry of Agriculture, **Dr. S.K.G. Rahate**, Plant Protection Adviser to the Govt. of India and **Dr. Ravi Prakash**, Joint Director, Directorate of Plant Protection and Quarantine, Faridabad for the issue of the import and release permits for the parasitoids.
4. **Mr. Marc C. Gilkey**, USDA-APHIS Attaché INDIA, for shipments of parasitoids from the USDA-APHIS laboratory, Puerto Rico.
5. **Dr. S. M. H. Qadri**, Director, Central Sericultural Research and Training Institute, Mysore for collaboration through a CSB-sponsored project.

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