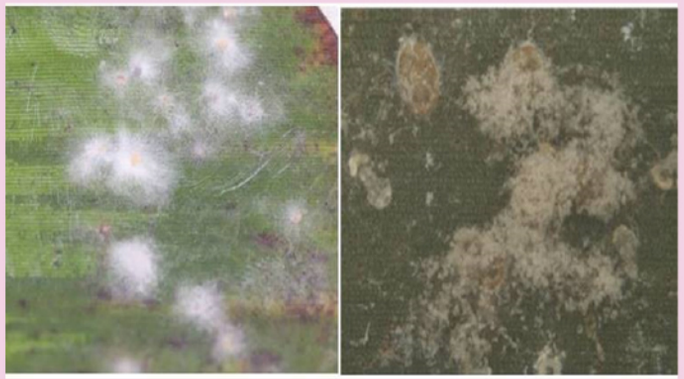
in Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, West Bengal and Maharastra, it was found the fungus is very effective in killing all the life stages of the pest. The egg and early nymphal instars mortality was up to 91% and the late nymphal instars and pupal mortality was up to 80%. Mass production technology for this fungus has been standardized using solid state fermentation (rice grains) and liquid state fermentation technology (Saboroud dextrose yeast broth, potato dextrose broth).

Talc, rice grain and oil formulations of *I. fumosorosea* have been developed with long shelf life, persistence and higher bio-efficacy. Due to its high field efficacy there is a huge demand for this entomopathogenic fungus from the coconut farming community. Farmers and other stakeholders are regularly trained on farm level production of this fungus using rice grains as substrate for their use in the infested coconut gardens.



ICAR-NBAIR is carrying out extensive research on biological control of this pest on a priority basis under its core programme as well as under a project funded by the Coconut Development Board, Kochi. ICAR-NBAIR has developed biocontrol strategies using parasitoids and the entomofungal pathogen *I. fumosorosea* for the effective management of the RSW.

Economic analysis of the impact of conservation and augmentation of *E. guadeloupae* and foliar application of *I. fumosorosea* for management of RSW indicated that about Rs 9500/ha crop protection cost and 900 ml of pesticides/ha are being saved.

Integrated Management Strategies:

1. Continuous monitoring on pest population by using yellow sticky trap and natural enemies on different host plants in field.
2. Avoid transportation of coconut seedling or any other host plants from rugose spiralling whitefly infested areas.
3. Periodic release of chrysopid predator, *Dichochrysa* sp. nr. *astur* @ 1000 eggs/ha at 15 days interval.
4. Re-distribution of parasitoid, *Encarsia guadeloupae* to the RSW affected areas through "Field insectary technique" i.e field collected parasitized pupae was strategically placed in, on, or next to infested vegetation for augmentation.
5. Pesticides holiday declared for the rugose spiralling whitefly. Therefore, application of unwarranted insecticides may be avoided to enhance the natural parasitism.
6. Conserve /encourage natural buildup of *E. guadeloupae* through growing reservoir plants/ banker plants (Banana/*Canna indica*)which enhances the multiplication of parasitoid and protect them from pesticides and unfavourable weather conditions.
7. Population of the parasitoid was also increased phenomenally over the period of time through breeding, favorable weather conditions and perennial nature of palms.
8. Foliar application (Two sprays) of entomopathogenic fungus, *Isaria fumosorosea* @ 2x 10^8 spores/ml (5 g/ litre of water) at 15 days intervals.
9. Under severe outbreak and absence of natural parasitism, neem oil 1% may be applied.
10. Awareness programme on the natural build up of the parasitoid *E. guadeloupae* is to be conducted in all epidemic zones to sensitize the farming community.
11. Community based approach warranted for the effective management of this invasive pest.

Biological control as means of preserving and conserving biodiversity

Printed at: cnu@cnu.net.in

ICAR–NBAIR Publication Series: 04/2019

Biocontrol Holds Back an Unwelcome Guest: Tackling the Menace of Rugose Spiralling Whitefly in Coconut

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2020

Published by :
ICAR- National Bureau of Agricultural Insect Resources
Post Bag No. 2491, H.A. Farm Post, Bellary Road
Bengaluru-560024
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Biocontrol Holds Back an Unwelcome Guest: Tackling the Menace of Rugose Spiralling Whitefly in Coconut

Within a span of two years, four highly polyphagous Neotropical exotic whiteflies *viz.,* Rugose spiralling whitefly, *Aleurodicus rugioperculatus,* Nesting whiteflies, *Paraleyrodes bondari & P. minei* and Palm nesting whitefly *Aleurotrachelus atratus* invaded in India's coconut plantation. Among these species, A. *rugioperculatus* is dominant, highly invasive, voracious sap sucker which was first reported on coconut at Pollachi, Tamil Nadu in 2016. Subsequently, the pest rapidly spread to coconut growing districts of entire South India. It was later found to be feeding on banana, sapota, maize, oil palm, mango, cashew and many other ornamental plants. Recently, its occurrence was reported in Goa, Assam, West Bengal, Maharashtra and Gujarat. Nymphs and adults damages the host plants by sucking the plant sap, especially from under surface of the leaves.

Adults produces prodigious quantities of honeydew which in turn gets darkened by the development of sooty mould on the upper surface of leaves. The characteristic concentric waxy spiralling symptoms are noticed symtoms are not only on the leaves but also on stem, fruit, nuts of coconut. The hybrid and dwarf varieties of coconut viz., Chowghat orange dwarf, Malayan orange dwarf and Ganga bondam are preferred by the RSW.

Failure of chemical pesticides

Alarmed by the invasion of a pest unknown to them, farmers resorted to spraying of chemical pesticides to control RSW. But the efforts were in vain as the chemicals turned out to be a temporary fix and moreover, other ill effects like environmental pollution, killing of natural enemies and health risks to the people involved in spraying operations made the insecticide application a risky business apart from being uneconomical.

Biological control as an effective and sustainable solution

Explorations were carried out so that the biological control of the pest could be accomplished through naturally occurring insect predators and parasitoids which are economically feasible, ecologically compatible and environmentally benign. Two aphelinid parasitoids, *Encarsia guadeloupae* and *E. dispersa* were found to have colonized the RSW and naturally suppressing the pest. The dominant parasitoid was found to be *E. guadeloupae* as it recorded natural parasitism of 56-82% while *E. dispersa* recorded 5-10%. Apart from these parasitoids, *Dichochrysa astur*, *Jauravia pallidula,*

Cheilomenes sexmaculata and *Cybocephalus* sp. were also observed to feeds on RSW.

Augmentation and conservation of *Encarsia guadeloupae*

Since natural enemies, particularly *E. guadeloupae* was found to be suppressing the population of RSW effectively; farmers and other stakeholders were advised to re-distribute the parasitoids wherever they were absent or found in inadequate numbers by using field insectary techniques such as strategically placing the field collected parasitized nymphs in, on or next to infested vegetation for augmentation and further they were strictly advised not to spray any chemical pesticides. In areas where chemicals were not sprayed, parasitoids were observed to have multiplied rapidly and natural parasitism increased phenomenally thus preventing severe outbreaks. Frequent monitoring of the pest occurrence were carried out and pesticide holidays were declared so as to conserve the natural enemies. Banana and *Canna indica* were found to be harbouring maximum population of parasitoids in field as well as in net-houses. The growers were advised to grow these plants as banker plants in coconut garden for the conservation and augmentation.

Entomopathogenic fungus, *Isaria fumosorosea* Wize (ICAR-NBAIR pfu-5) a promising bioagent

ICAR-NBAIR has identified a promising entomopathogenic fungus, *Isaria fumosorosea* (ICAR-NBAIR pfu-5) for management of RSW. Based on laboratory bioassays and multi-locational field evaluation