

The invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* (Hemiptera: Aleyrodidae) **Martin**

Introduction: Agricultural crops in India are vulnerable to the threat posed from the invasive pest species. Till date 118 exotic species have invaded, which include several economically important whiteflies. Currently, there are 442 species of whiteflies belonging to 63 genera known from India. Two invasive whiteflies, viz., the spiraling whitefly *Aleurodicus dispersus* Russell and the solanum whitefly *Aleurothrixus trachoides* (Back) have invaded India in 1995 and 2014, respectively. Recently, yet another invasive species, *Aleurodicus rugioperculatus* Martin was recorded on coconut palm (*Cocos nucifera* L.) during September, 2016 for the first time from India as well as Oriental region. This species is commonly known as the rugose spiraling whitefly (RSW) or gumbo limbo whitefly. RSW has a wide range of host plants including palms, ornamentals and fruits.

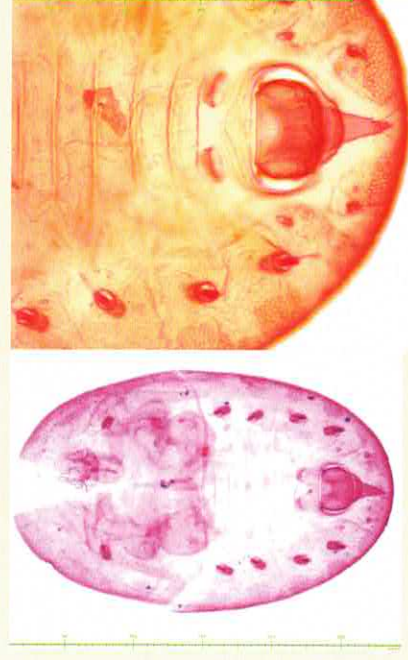
Origin: RSW was described by Martin in 2004 in Belize on coconut. Subsequently, it was reported as a pest on gumbo limbo (*Bursera simaruba* L.) in Miami-Dade county of South Florida in 2009. This whitefly is believed to have originated from Central America and its incidence is limited to Belize, Mexico, Guatemala and Florida in Central and North America. Mode of entry of RSW into India is unknown. However, it is likely that it has entered interception through the trade of plant materials.

Distribution: Initially, RSW infestation was observed in several coconut farms in Coimbatore district. Subsequently, its population increased greatly and spread across the coconut and banana growing regions in Southern India, probably due to the high dispersal potential of the pest and continuous availability of host plants in large areas. Invasion and infestation of RSW so far has been recorded from coconut growing southern states of the country except Karnataka. However, RSW is likely to spread to other states where coconut and banana are cultivated.

Identification characteristics: Colonies were in generally poor in condition with groups of woolly wax puparia untidily grouped under the leaves of the host. RSW is typically characterized by broadly cordate vasiform orifice, operculum ventro-basally spinulose and dorsally characteristically rugose, with a pair of ventro-median fine setae, lingual head protruding beyond vasiform orifice, finely spinulose, apically acute, its four setae situated close to apex.

The puparium of this species can be easily distinguished from *A. dispersus*, the other known congeneric species in India by the presence of a pair of small compound pores on each of abdominal segments VII and VIII, characteristically rugose operculum, atypically narrowly acute lingual apex and reticulated cuticle.

Biology: The pre-oviposition period is 2.7 days, life time fecundity 225.5±26 eggs on bird of paradise (*Strelitzia nicolai* Regel & Korn). Since it has an arrhenotokous parthenogenesis, unmated female produces only male progeny. Adult longevity is 27.5±2.7 and 36.8±3.5 days for females and males, respectively.



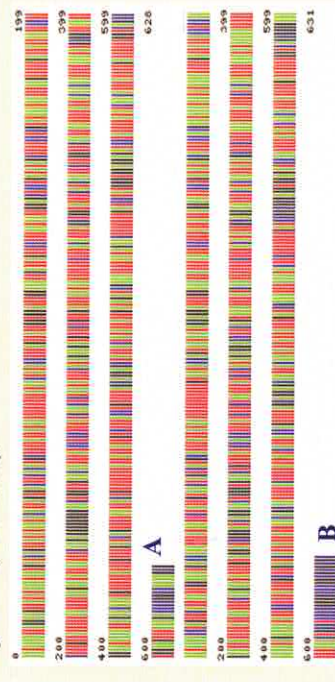
Puparium of RSW (National Acc. No. NBAIR-Aleuro /21/2017) showing operculum and characteristic triangular shape of the lingual with setae

Host plants: RSW is a highly polyphagous pest reported to feed on about 120 plant species including economically important cultivated plants and palms,

fruit crops and ornamental plants. It is classified as a serious threat for coconut cultivation in Florida. In India, initial infestation observed in coconut in Tamil Nadu, subsequently the pest was found to feed on banana, custard apple, sapota, and several ornamental plants like bird of paradise, oleander, African tulip tree and butterfly palm in Tamil Nadu, Kerala and Andhra Pradesh. Few life stages of RSW were found on cocoa, citrus, jackfruit, *Hibiscus* and garden cordon.

Molecular characterization & DNA Barcode:

Molecular identification of RSW (A-GenBank Acc. No. KY209909) and its potential aphelinid parasitoid *Encarsia guadeloupae* (B-GenBank Acc. No. KY223606) was done based on cytochrome oxidase I gene (658bp) and barcodes were generated (BOLD Systems, Canada).



Host plants of rugose spiraling whitefly

The Invasive Rugose Spiraling Whitefly *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in India



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creamy brownish yellow in colour and lightly dark before adult emergence. Immature stages produce profuse quantity of wax filaments both tufts of fluffy and long crystal like glassy rods. Adults can be distinguished by their large size and the presence of a pair of irregular light brown bands across the wings. Males have long pincer like structures at the tip of their abdomen.

Natural enemies: The most commonly recorded were green lacewing (*Mallada* sp.), Coccinellids (*Cybocephalus* sp.; *Jauravia pallidula*; *Cheilomenes sexmaculata*) and aphelinid parasitoid *Encarsia guadeloupae* with 20 to 60% parasitism. Parasitized nymphs turn dark brown in colour and the adults emerge by cutting a circular lid at the thoracic region. Adults are very tiny, solitary wasps and can be identified by their yellow scutellum against their brownish body. This parasitoid was fortuitously introduced with *A. dispersus* into India.



Management strategies: Due to the presence of *E. guadeloupae* in coconut and banana ecosystems in India, there is a significant reduction in RSW. Further, population of the parasitoid has increased phenomenally over a period of time through breeding, favourable weather conditions and perennial nature of palms. Therefore, it is recommended that application of unwarranted insecticides may be avoided to enhance the parasitism. Efforts may be made to sensitize growers about the pest, host range, conservation of biocontrol agents and other nonchemical methods for suppression of the pest.

Symptoms of damage: Nymphs and adults suck the sap by direct feeding especially on underside of the leaves / leaflets. Adults produce prodigious quantities of honey dew excretion which in turn completely darken the leaves through by sooty mold development. The typical concentric waxy spiraling symptoms were noticed on various parts of host plants in heavily infested areas. Waxy flocculent material produced by adults cause nuisance to human being. In coconut, RSW prefers to colonize on hybrid and dwarf varieties, especially Chowghat orange, Malaysian orange and Ganga Bondam.



Symptoms of damage in coconut palm

Life stages: RSW undergo six stages which include egg, three immature nymphal instars, the fourth nymphal stage known as "puparium" (sedentary) and the adult. RSW adults are about three times larger than the commonly found whiteflies and are lethargic by nature. It is closely related to giant whitefly *A. dugesii* and spiraling whitefly *A. dispersus*. The female of RSW lays eggs on the underside of leaves in a circular pattern or concentric waxy spirals and covers them with white flocculent wax. Eggs are elliptical and creamy white to dark yellow in colour and immature stages are

Invasion of Non-native Neotropical Woolly Whitefly *Aleurothrixus floccosus* (Maskell) on Guava in India

Introduction: Guava (*Psidium guajava*) is one of the important commercial fruits in India. It is the fourth most important fruit crop after mango, banana and citrus. More than 80 insect species reported to attack on guava resulting reduction in quality and yield. Among insects, fruit fly, mealybugs and whiteflies are major pests often causing economic damage and yield loss.

About 10 whiteflies, which includes four non-native species such as spiralling whitefly, *Aleurodicus dispersus*, rugose spiralling whitefly, *A. rugioperculatus*, Bondars nesting whitefly, *Paraleyrodes bondari*, Nesting whitefly, *P. minei* attack on guava in India. During 2019, occurrence of the invasive woolly whitefly, *Aleurothrixus floccosus* (Maskell) on guava was recorded for the first time from India at Kerala.

Origin and distribution: The whitefly is believed to be Neotropical origin but is now found throughout the warmer parts of the world, wherever citrus is grown. In India, occurrence of this pest was observed in Kozhikode and Malapuram districts of Kerala on guava. Subsequently, it was found in Ramanagara, Mandya, Mysore, Udupi, Tumkur, Bengaluru Rural districts of Karnataka and Coimbatore, Dharmapuri, Krishnagiri and Salem district of Tamil Nadu and Lakshadweep islands. Spreading rapidly mostly through the infested seedlings.

Host plant: *A. floccosus* is broadly polyphagous, feeding on 20 plant families and exhibits a strong host preference for citrus species but so far in India, it was found to feed only on guava.

Co-occurrence with other insects: Within a span of four years, four exotic whiteflies invaded on guava. *A. floccosus* is in co-existence with *P. bondari*,

P. minei, *A. dispersus* and *A. rugioperculatus*. *A. floccosus* is found to be dominant species which may replaces the existing invasive and native species by inter-specific competition.

Diagnostic characteristics: Female adult lays eggs in circular pattern, however, the eggs were laid upright or at a slanting angle. When the large number of adults oviposited on a leaf, the spirals often overlapped together and individual spirals is difficult to distinguish. A granular, powdery wax mass was deposited all around the eggs and appears as a flat, circular, grainy white areas.



Woolly whitefly co-occurring with nesting whitefly

All the instars excrete honeydew and in older pupae the deposited honeydew droplets get dried and turned brownish orange as they became contaminated with saprophytic fungi. *A. floccosus* population was normally increased whenever there was new leaf/flush growth on the plants.

Symptoms of damage: Nymphs and adults suck phloem sap from host plants and these infested plants showed severe feeding damage such as wilting, yellowing and leaf fouling and indirectly causing damage by copious excretion of honeydew which supports the development of the sooty mould.

Presence of ants (mostly black and red ants), profuse whitefly mealy wax and black sooty mould is sign of the infestation of this pest.

Severe infestation leads to complete blackening which might reduce the photosynthetic ability of infested plants significantly, resulting in leaf fall, senescence and eventual death.



Symptoms of damage of woolly whitefly on guava

Biology and description: The sausage shaped, pale white eggs were deposited in a circular pattern and attached to the under surface of the leaf with stalks which changes to brown colour before hatching.

The first nymphal instar is light green, flattened, oval shaped and there was a little marginal wax and three pairs of wax dots on the dorsal surface of the nymphs.

Subsequent instars are sedentary, turn brown and developed a thin thread like wax strands that curled upside into a woolly mass substance as development progressed.

Late instar nymphs are often completely obscured by copious amounts woolly wax that was several times thicker than the body of the insect, honeydew droplets and cast skins.



Life stages of woolly

Adults emerge from the pupae by vertically splitting its skin and they are about 1.5 mm in length, with a yellow-white body and wings that are covered with a white waxy powder.

It takes about 24 to 27 days to complete the development of eggs to nymphs and adult longevity is 27 to 30 days. Total life span of this whitefly from eggs to adult is take about 51- 57 days.

Natural enemies: No natural parasitism either of the indigenous parasitoid or its potential parasitoid *Cales noacki* (Hymenoptera: Aphelinidae) was observed. Few predators such as *Acletoxenus indicus*, *Pseudomallada astur*, *Cryptolaemus montrouzieri* and *Scymnus nr. utilis* were found associated with *A. floccosus* colony.



***Pseudomallada astur* feeding on woolly whitefly**

Integrated management strategies

1. Stringent quarantine protocols to prevent its further spread to other guava and citrus growing areas in India immediately.
2. Avoid transportation of guava seedling from pest infested areas to un-infested areas.
3. Strict following of domestic quarantine.
4. Create awareness among farmers and other stakeholders on invasion of this pest.
5. Continuous monitoring on pest and natural enemies on different host plants in field.
6. Install yellow sticky traps @ 10 number /ha for monitoring the pest population.
7. Release of the predator *Pseudomallada* (= *Dichochrysa*) *astur* @ 1000 eggs/ha at 15 days interval.
8. Two spray entomopathogenic fungus *Isaria fumosorosea* (Pfu-5) at 5 g/litre at 15 days intervals.
9. Avoid usage of any synthetic pesticides, apply only neem @1% if severe outbreak situation prevails.
10. Follow community based approach to manage these whiteflies in coconut garden.
11. Exploration of importation of potential parasitoid for classical biological control programme.



Natural enemies of woolly whitefly

Invasion of Non-native Neotropical Woolly Whitefly *Aleurothrix floccosus* (Maskell) on Guava in India



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2020



Published by :

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