Occurrence and status of exotic whiteflies in coconut ecosystem and their management

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Introduction

Coconut, *Cocos nucifera L.* (Arecaceae) is a major plantation crop grown in south India. Coconut is also called the King of Species or Tree of Heaven or Kalpavriksha or Tree of life. Coconut is originated from South East Asia and it is widely cultivated in all the tropical regions of the world, growing particularly well in coastal areas. Small and marginal farmers depend on coconut directly or indirectly for their livelihood. India is the third-largest producer of coconut after Indonesia and the Philippines, with a share of about 19.20% (NABARD, 2016). In India, southern states viz., Tamil Nadu, Kerala, Karnataka and Andhra Pradesh are the leading states in coconut production which account for more than 90% of the total coconut production of the country.

Cococnut is grown on 2.17 million ha producing 21,384.33 million nuts per year with average productivity of 9,815 nuts /ha (www.indiastat.com. 2018-2019). Out of the total production of coconuts in the country, about 50% is used as mature nuts, 35% is used for copra and 15% is consumed in the tender form for drinking purposes. Coir from the coconut palm is a versatile fiber and helps in the upliftment of livelihood of rural women by generating employment. Coconut is mainly produced for the oil cause and India has unbeatable quality in coconut oil production.

More than 900 species of insect pests, including Coleopteran, Lepidopteran, and Hemipterans, cause substantial economic damage to coconut. Of which, coconut eriophid mite, *Aceria guerreronis Keifer* (Eriophyidae: Acari), rhinoceros beetle, *Oryctes rhinoceros L* (*Coleoptera: Scarabaieidae*), red palm weevil, *Rhynchophorus ferrugineus Olivier (Coleoptera: Curculionidae)*, black-headed

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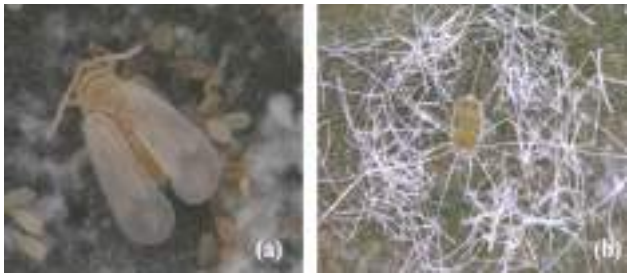
Spiralling whitefly,
Aleurodicus dispersus

Rugose Spiralling whitefly,
Aleurodicus rugioperculatus

Bondar's Nesting Whitefly,
Paraleyrodes bondari

Neotropical whitefly,
Aleurotrachelus atratus



Nesting whitefly, Paraleyrodes minei laccarino (PC: Selvaraj et al., 2021)

caterpillar, *Opisina arenosella Walker (Lepidoptera: Oecophoridae)* and white-grub, *Leucopholis coneophora Burmeister (Coleoptera: Scarabaieidae)* are considered as the major pests of coconut. Most species of beetles feed on leaves, roots, or bores in plant buds resulting in the loss of fronds and damage to palms. Lepidopterans are major devastating pests of coconut, mainly feeding on leaves and inflorescence. The coconut mite, *Aceria guerreronis Keifer* damages immature nuts causing serious yield losses and two whitefly species viz., areca nut whitefly, *Aleurocanthus arecae* and spiralling whitefly, *Aleurodicus dispersusare* considered as minor pests.

Occurrence of invasive whiteflies in coconut and their coexistence

Whiteflies are devasting phloem feeder of agricultural, horticultural and forestry ecosystem. Mandal (2011) recorded 116 exotic insect species in India. Sundararaj et al. (2020)enlisted 476 species of whiteflies under 67 genera from India, which comprises of five species under two genera in the subfamily Aleurodicinae Quaintance & Baker and 449 species under 64 genera in the subfamily *Aleyrodinae Westwood.* In India, so far, six species viz., *Aleurocanthus arecae, Aleurodicus dispersus, Aleurodicus rugioperculatus, Aleurotrachelus atratus, Paraleyrodes bondari* and *P. Minei* are known to infest coconut (Selvaraj et al., 2019). All these whiteflies are invasive except *A. arecae*, accidentally invaded along with their host plant and frequent distribution in different parts of the world due to plant trade, the small size, cryptic nature and immature stages being attached to the host-plant.

Exotic whiteflies with similar habits co-exist in more or less the same niche in coconut palm and have a similar pattern of growth and development. *Aleurodicus rugioperculatus, P. bondari, A. dispersus* and *P. minei* were found to co-exist on many of the host plants including coconut palms. It was observed that *A. rugioperculatusis* co-exist with *A. atratus, P. bondari, A. dispersus* and *P. minei* on coconut. Infestations of *A. atratus* and *A. rugioperculatus* along with native whitefly, Aleurocanthusarecae, commonly observed on coconut.

▶ *1. Spiralling whitefly, Aleurodicus dispersus Russell*

Spiralling whitefly, *Aleurodicus dispersus* is native to the Central America and in India. It was first reported in 1993 in Kerala. Female whitefly lays elliptical, smooth surfaced yellowish white eggs in a typical spiral manner. There are four nymphal instars, which are greenish, white and oval and total nymphal duration lasts for 13-14 days. Fourth instar nymphs (pupae) are covered with heavy white wax materials. The total nymphal period is normally for 12 to 14 days and pupal period about 2 to 3 days. Development from egg to adult takes around 18 to 29.66 days. Adults are larger (1.74 mm), coated with a fine dust like waxy secretion and fore wings with characteristic dark spots which live for 13 to 22 days. Nymphs and adults are congregate generally seen on the lower surface of leaves and secrete copious white, waxy flocculent materials which are readily spread elsewhere by wind and create a very unsightly nuisance. Sucking the cell sap by nymphs and adults which depletes nutrients and water from affected host plants and causes premature drying under severe infestation. Sticky honeydew is excreted which serves as a substrate for dense growth of sooty mould which may interfere with normal photosynthesis of affected plants and reduction yield parameters.

▶ 2. Rugose spiralling whitefly, Aleurodicus rugioperculatus Martin

Rugose Spiralling Whitefly (RSW), *Aleurodicus rugioperculatus* was originated from Central America and in India it was first observed in the coconut palms of the Pollachi area of Tamil Nadu and Palakkad area of Kerala during July-August 2016. Per cent infestation of RSW was recorded in coconut at 40-60% and banana leaves at 25-40% (Selvarajet al., 2017a). Rugose spiralling whitefly sucks the phloem sap from plants. It is stressful, defoliating plants and disrupting photosynthesis. Thus, RSW indirectly affects the quality of nuts by producing white waxy material and a copious amount of honeydew leading to sooty mould fungus growth and contributes to a reduction in photosynthesis of the palms thus, indirectly affecting the quality of nuts. Nymphs are golden yellow in colour and its body covered with white dense waxy material. Adult have three dark brown spots on both wings and males have pincer like structure at abdomen. It takes 35-49 days to complete the entire lifecycle from egg to adult stage. Summer season is very favorable to maximize its progeny(Selvarajet al., 2021).

▶ 3. Bondar's Nesting Whitefly, Paraleyrodes bondari Peracchi

Bondar's nesting whitefly was first observed in coconut farms of Kerala during 2018 and it was originated from Neotropical region. Life stages were confined to the lower surface of coconut leaflets. Adults are smaller than *A. rugioperculatus* and it constructs nests with densely woven, irregular layer of fiberglass-like woolly wax strands. Yellowish stalked eggs in clusters in the woolly wax nest without wax covering. Body of the nymph is covered with a band of white wax and surrounded by short setae. Adult whiteflies have two oblique grey bands occur on each forewing, and converge toward the midline such that it appears to form an "X"-pattern. Total life span including adult longevity is 32 –34 days. The feeding damage of *P. bondari* is not severe like *A. rugioperculatus* with reduced honey dew excretion and sooty mould fungal growth.

▶ 4. Nesting whitefly, Paraleyrodes minei Iaccarino

Nesting Whitefly was first observed in coconut farms of Kerala during 2018 and it is originated from neotropical region. Female adults construct loosely woven, woolly wax nest. Eggs are cream-coloured laid in clusters with short stalks on the lower surface of leaflets bending inwards towards the leaf surface. The emerging mobile crawlers are creamish, sub-elliptical with flocculent wax on the dorsum extending from thorax to abdomen. The crawlers shed their appendages, remain fixed, and become flat and creamish, producing a fringe of short hyaline wax rods rising from the dorsum with fibreglass-like wax rods. Female adults have broad and swollen abdomen with well-developed wax plates, whereas in male abdomen is narrow becoming pointed at the apex and the wax glands are not well developed. Adults are with dull yellow body with whitefly wings without any marking and spread wings wider. Total life cycle span including adult longevity is 31-32 days.

▶ 5. Palm infesting whitefly, Aleurotrachelus atratus Hempel

Aleurotrachelus atratus is a Neotropical whitefly, originated from Brazil. In 2019, it was first reported in coconut and ornamental palms during 2019 in Mandya district of Karnataka.Clustered creamy white stalked eggs are in semicircular pattern. The first instars are initially transparent black and have four pairs of wax plumes on dorsal surface excreted by glands at the base of dorsal setae. Each dorsal seta has curving longitudinal grooves that guide the wax flakes as they are secreted from the setal base and all the nympal instars are black in colour. Puparia are elliptical, black, 1.0-1.1 mm long with a long marginal white wax fringe and dorsal wax filaments that often completely cover the pupae. Adults differ from the other invasive whiteflies infesting palms; smaller than *A. rugioperculatus* but larger than *P. bondari* and P. minei and without any wavy marking on the wings. Total life span is about 54-59 days in Karnataka.

Integrated Pest Management strategies for invasive whiteflies

Biological control of these invasive whiteflies through naturally occurring insect predators and parasitoids which are economically feasible and ecologically compatible. Potential natural enemy, *Encarsia guadeloupae* and *E. dispersa (Hymenoptera: Aphelinidae)* were found to reduce the severe economic lossof *A. dispersus* and *A. rugioperculatus.* Avoiding application of synthetic pesticides to conserve natural enemies viz., Cybocephalus spp., Cryptolaemus montrouzieri,*Chilocorus nigrita*, *Menochilussexmaculatus*, *Curinus coeruleus, Mallada astur, Mallada boninensis* and *Chrysoperla zastrowisillemi* (preying mantis, spiders and nymphal parasitoid *Encarsia guadeloupae* and *E. dispersa*

of *A. rugioperculatus* and *A. dispersus* can be done.

Grow banana and Indian shots plants as banker plants in coconut garden as intercrop or border crops for conservation and augmentation of natural enemies to prevent severe pest outbreaks.Yellow sticky trap is an important plant protection measure for the monitoring of whiteflies (Uthamasamy et al., 1990). Whitefly adults are more attracted to yellow colour. Tying yellow polythene sheets (3 x 1 ft or 5 x 1.5 ft) smeared with castor oil at 5-6 ft height on the coconut tree to attract the whitefly adults can be done. Place yellow sticky trap 8 numbers per acre. Smear grease or castor oil once in three days on a yellow polythene sheet. Banding of coconut trunk with yellow sticky polythene sheet can also be done.

Forced water-spray need to be done underside of coconut leaflets to dislodge the whiteflies to arrest its reproduction wherever water availability is not a constraint. Rugose spiralling whitefly has the capacity to produce an enormous amount of honeydew secretion which leads to sooty mould growth. It indirectly affects the photosynthesis of the plant. For this 1% starch solution is recommended for removing the sooty molds adhered on coconut leaflets. For preparing 1% starch solution, boil 1 kg of maida in 5 litres of water and mix it in 20 litres of water for spraying.

Conclusion

The invasive whitefly species can maximize their progenies in a short time, exhibit high phenotypic plasticity, and have a strong potential to compete with native species and cause damage to economically important crop plants.Indiscriminate use of insecticides causes resistance and resurgence problem in the management of invasive whiteflies. All the above invasive species are polyphagous and absence of natural enemies in the introduced area favour host spread. There is urgent need to survey and document the natural enemies of *P. bondari, P. minei, A. floccosus* and A. atratus, and evaluate potential candidates for their introduction from their native countries to India for the development of efficient biocontrol management strategies.

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Coconut Chips

Coconut chips is a ready-to-eat snack food. It is prepared in salted and sweetened forms. The Central Plantation Crops Research Institute, Kasaragod has standardized the process for preparation of chips. Coconuts of 9-10 months are used for the preparation of chips.

Installed Capacity - 10000 nuts/day

Investment - Rs. 35 lakhs

IRR - 22 %

Incentive: 25% of the project cost or a maximum of Rs. 50 lakhs

Composition of Coconut Chips

Sl. No	Parameters	per 20 g
1	Fat	9.42g
2	Lauric acid	4.82g
3	Calcium	2.10mg
4	Fiber	1.93g
5	Iron	1.30mg
6	Cholesterol	0.00