Holistic Package to Mitigate Exotic Whiteflies on Coconut

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Exotic pests have become a real threat and a bio-security risk to agricultural production mainly reflected by biodiversity decline and in the absence of specific natural enemies the introduced pest outnumber considerably. Coconut being an excellent ecological service provider fostering livelihood security to more than 12 million farm families, is currently subjected to incursion by non-native pests, especially the invasive whiteflies. Though the primary exotic spiralling whitefly, Aleurodicus dispersus was reported as a minor pest on coconut during 1996, it never assumed a pest status due to non-preference and fortuitous introduction of aphelinid parasitoids, Encarsia spp. from Minicoy Island probably migrated from Maldives. This followed the introduction of the devastating and invasive coconut eriophyid mite (*Aceria guerreronis*) during 1998 and ICAR-CPCRI had evolved a holistic package and subdued the damage potential of *A. guerreronis*. A wide array of predatory mites (*Neoseiulus baraki, Amblyseius sp.*), acaropathogenic fungus (*Hirsutella thompsonii*), neem formulation in synergy with nutritional and soil-health management strategies suppressed the invasive potential of mite.

Exotic whiteflies

In a span of four years (2016-2019), four exotic whiteflies from Neotropical region had emerged in to Peninsular India, impeding the production potential of palms. Increased trade and transport by globalization could be one of the major reasons for this sudden entry. The non-native rugose spiralling whitefly (*Aleurodicus rugioperculatus*) (Fig 1 a,b) was reported first on coconut from Palakkad (Kerala) and Pollachi (Tamil Nadu) during 2016 still remains as a key pest on coconut in isolated pockets causing national concern. It is also found as a major pest on oil palm and a minor pest on banana in certain coconut growing belts. Rugose spiralling whitefly (RSW) has reached Maharashtra, Assam, West Bengal, Gujarat and Lakshadweep Islands in a very short period. RSW is confined on the under surface of palm leaflets, desap profusely and release out honey dew excrements and get deposited on the upper surface of palm leaflets, which subsequently aid in the sooty mould fungus (*Leptoxyphium sp.*) turning black in colour affecting photosynthetic efficiency. This is one of the characteristic symptoms of pest attack. In general dwarf cultivars (Chowghat

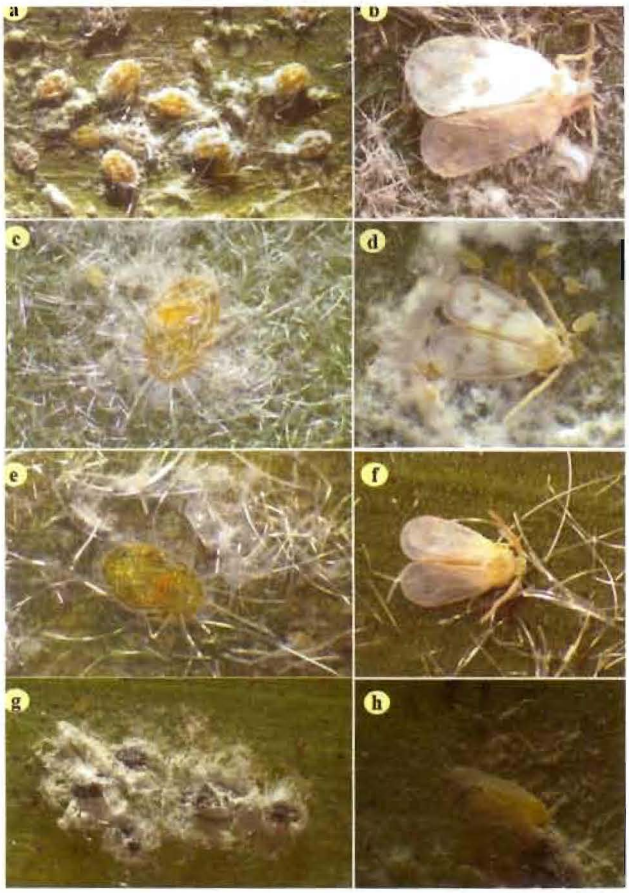

Fig 1. Diversity of exotic whiteflies.
a,b - Nymphs and adult of Aleurodicus rugioperculatus
c,d, - Nymph and adult of Paraleyrodes bondari
e,f - Nymph and adult of Paraleyrodes minei
g,h - Nymphs and adult of Aleurotrachelus atratus.

Orange Dwarf, Malayan Green Dwarf and Malayan Yellow Dwarf) are found susceptible whereas the Tall cultivars (West Coast Tall) are relatively tolerant.

During 2019 two nesting whiteflies viz., Bondar's nesting whitefly *(Paraleyrodes bondari)* (Fig 1c,d) and Non-native nesting whitefly (*Paraleyrodes minei)* (Fig 1 e,f) co-existed in the colonies of RSW and regulated their population to greater extent was reported from Kerala, Tamil Nadu and Andhra Pradesh. Nesting whiteflies were relatively smaller (1.00 mm) whereas RSW is about 2.20 mm size with conspicuous brown mottling on wings. Nymphal stages of nesting whiteflies are flat whereas it is convex for RSW. In addition, a new non-native palm whitefly (*Aleurotrachelus atratus*) (Fig 1g,h) was recently reported on coconut from Mandya and Mysuru district of Karnataka. The nesting whitefly, *P. minei* was closely associated with *A. atratus* in most cases reducing the incursion potential of palm whitefly which otherwise causes damage including necrotic lesions on palm leaflets as reported from other countries. Adult palm whiteflies are smaller than RSW, longer than wide and the wings are held roof like upon rest unlike the nesting whiteflies which are absolutely flat. Eggs of palm whitefly are blackish with characteristic eight puffs on emerging nymphs and conspicuous blackish puparium clothed by dense white covering along the sides. The quantum of honey dew produced by RSW was found to be higher than other whiteflies reported so far. RSW was also found to be cosmopolitan and reached all over the country in a short period calling for a holistic package to hold down the severity.

Holistic package

a) Conservation biological control

Pesticide holiday approach aiding in the conservation biological control using the aphelinid parasitoid, *Encarsia guadeloupae* (Fig 2c,d) and the chrysopid predator, *Dichochrysa astur* (Fig 2a.b) as well as in situ preservation of the sooty mould scavenger beetle, *Leiochrinus nilgirianus* (Fig 2e.f) were found pivotal in the bio-suppression of the exotic whiteflies. This strategy was mainly preferred to avoid indiscriminate use of insecticide in coconut system to conserve the pollinators, aforesaid natural defenders and the bio-scavenger beetles which were actively involved in the regulation of *A. rugioperculatus*. The predator, *D. astur* and the parasitoid, *E. guadeloupae* co-occurred along with the pest and in a period of four to five months of pest introduction, these natural enemies subdued the pestilence potential of RSW, which is normally observed in coconut belts experiencing less precipitation, humidity as well as high temperature coinciding summer period. In addition, during the monsoon phase the sooty mould scavenger beetle, *L. nilgirianus* devoured the sooty mould encrusted on palm leaflets and completely cleaned the palms reviving back the photosynthetic efficacy in toto. This warranted the pesticide holiday approach which later proved quite successful in reducing the invasive potential of RSW coordinated by the natural enemies (*D. astur, E. guadeloupae*) and bio-scavenger beetle (*L. nilgirianus*) restoring the natural ecosystem and the dynamic pollinators involved in ecological services. In this conservation agriculture approach, the RSW population got reduced by 80% and parasitism reached as high as 85% in a period of five to six months.

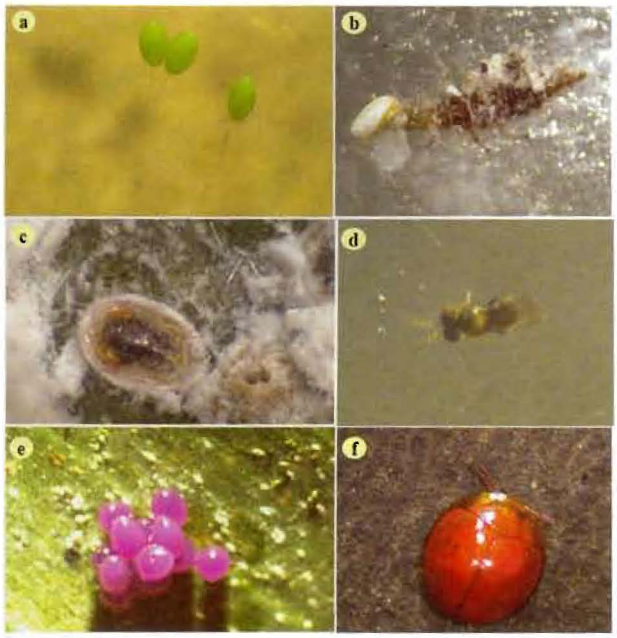

Fig 2: Conservation Biological control of Rugose Spiralling Whitefly
a,b - Eggs and grub of Dichochrysa astur
c,d - Parasitized pupa of Aleurodicus rugioperculatus and the aphelinid parasitoid, Encarsia guadeloupae;
e,f - Eggs and adult sooty mould scavenger beetle (Leiochrinus nilgirianus)

b) Mechanical control

All species of whiteflies preferred yellow colour than other colours including green, red, black, white etc. Since the whiteflies are active and mobile during crepuscular phase (Early morning and late evening), installation of yellow sticky traps (Fig 3c) all over the garden and affixing on palm trunk trapped the floating whitefly population and reduced the migratory potential of the pest. Even a yellow plastic sheet coated with white grease or castor oil could also serve the purpose in the non-availability of sticky traps. This method was quite easy to adopt and formed an essential strategy in the sustainable management of the pest. More than five to six adult whiteflies could be trapped in an area of 1 cm2 on the yellow sticky trap installed in the pest-inflicted garden.

c) Water or botanical spraying

Whiteflies are susceptible to wetness and well distributed rainfall could suppress the pest population significantly. RSW population is very low during monsoon season. Simulating this approach, jet spray of water (Fig 3d) was found effective in dislodging the whitefly colony and this habitat modulation strategy could temporarily disperse the seriousness of the pest and encourage parasitism as well. If the colony exceeds 20 per leaflet, application of 0.5% neem oil admixed with Tween 80 (0.005%) is quite effective to reduce the pest population instantaneously. Dosage is very critical because any increase in neem oil concentration could also invariably affect natural defenders and ever sustaining pollinators. This water spray and neem oil spray is warranted only if the pest population exceeded the threshold level of >20 live colonies per leaflet. At low pest population, conservation biological control alone would be sufficient to counter the pest attack and check the population below the threshold level.

d) Nutrition management

Palm health management comprising adequate nutrition, optimising soil physico-chemical and biological properties, judicious water usage, and pest and disease management are very important to sustain income from palms which in fact justifies the commemoration of International Year of Plant Health in 2020. RSW normally de-saps from older leaves which had completed the nut production stage, however, the impact need to be corrected by supplementation of primary, secondary and micro nutrients on soil test basis (Fig 3a) to accelerate production of new fronds and inflorescence. Copious delivery of water through drip mode along with nutrients could withstand the health deterioration and make up the brunt of pest damage. Soil moisture conservation (Fig 3b) and basin management through mulches (Fallen leaves and petioles) is a long-term approach in palm health management for sustained conservation of microbes involved in nutrient recycling and other ecological benefits providing continuous farm income.

e) Ecological intensification

Mono-cropping in coconut is slowly replaced with crop pluralism to infuse diversity and multitude of volatile cues to disorient pests. In the classical experiment of ecological engineering (Fig 4) comprising Kalpa sankara (CGD x WCT) with diverse intercrops viz., nut meg, rambuttan, curry leaf, banana, lemon, jack, eco-feast crops like coral vine, flowering crops (marigold, cosmos etc) demonstrated at ICAR-CPCRI, Regional Station, Kayamkulam in 60 cents encouraged the defender (predators, parasitoids) and pollinator (bees, flies, wasps and butterflies) population and subdued pest (rhinoceros beetle, red palm weevil, rugose spiralling whitefly) population. There was about two

Fig 3. Bio-suppression of rugose spiralling whitefly

a) Fertilizer application, b) In situ basin mulching, c) Yellow sticky tap in coconut garden, d) Jet water spray

to three fold reduction in pest population including RSW in the diversified garden compared to coconut mono-cropping. While RSW damage was 4.3% in ecological engineered coconut garden, it was 24.8% in mono-cropped garden. This ecological agriculture approach encompasses species richness and diversity due to insect hotel (Indigenous trees) and crop cafeteria (diversification). A continuous income cum employment is being ensured in this stimulo-deterrancy model, where an inch of land is effectively utilized with the bunch of crops to become climate smart and lead to an environmentally responsible farming. Radiation from sun will not strike the soil surface directly in diversified garden and so is the rain droplets primarily fall on plant leaves rather than smacking on soil. From about 39 hybrid palms yielding more than 160 nuts per palm per year could realize more than 1.3 lakh rupees besides making the system self reliant even in COVID-19 pandemic period delivering consumables (fruits, curry leaf etc) on a regular basis.

The holistic package evolved in the bio-suppression of invasive whiteflies is very practical and eco-friendly resulting in doubling farm income, enhancing ecological benefits and sustainable pest management. This approach of ecological intensification would fit in with the conservation of biological control making it self-reliant coconut-based inclusive farming and hold down invasive whiteflies in the most efficient manner.

These strategies augment sustainable nut production accomplished through biological and organic pest management solutions. Lastly, strengthening quarantine and regulatory interception of alien invasive species at sea and airports is critical to prevent entry of transboundary pests and diseases in the near future. Prevention is indeed better than cure! ■ *Author for correspondence: joecpcri@gmail.com*