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Emerging Insect Threats in India: Identification and Mitigation Strategies

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Introduction

India, with its intricate topography, diverse climate, and rich vegetation, presents an enticing landscape for exotic species to establish themselves. This biological invasion, a form of biological pollution, poses a significant threat to biodiversity, agriculture, and human and animal health. These invasive species, highly adaptable and capable of rapid dispersal, can wreak havoc in ecosystems devoid of their natural predators. Since 2018, India has grappled with the emergence of ten exotic insect pests. Notably, seven of these belong to the order Homoptera, two to Lepidoptera, and one to Thysanoptera. The following sections delve into the specifics of these invasive insects and the strategies employed to manage them.

Fall Armyworm, *Spodoptera frugiperda*, Noctuidae, Lepidoptera

Native Place: North and South America.

- Noticed in May, 2018 at Shivamogga, Karnataka.

Damage symptoms

- Young worms gregariously feed by scrapping the leaves led to the transparent patches in the leaves.
- Caterpillars enter the cob and feed on developing kernels.
- One to two larvae can be seen in each whorl.

Biology

- Females may lay up to 300 to 1000 eggs in their life time depending upon the environmental condition.
- Eggs hatch in two to four days.
- There are totally of six larval instars.
- Larval period completes in 13 to 20 days and the pupal period in 7 to 10 days.
- Total life cycle completes in 25 to 33 days depending upon the climatic conditions.

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Management

- Cyantraniliprole 19.8 % + Thiamethoxam 19.8 % FS at the rate of 6 ml/Kg of seeds will offer protection for up to 15 to 20 days.
- Intercropping pulses and using the Napier grass as a trap crop – 3 to 4 rows.
- Installation of pheromone trap at the rate of 10 Nos/acre after the emergence of seedlings.

Schedule

For the first two weeks

- *Trichogramma chilonis*/ *T. Pretiosum* at the rate of 1 lakh/ha or *Telenomus remus* at the rate of 15000 to 20000/ha at the weekly interval - 3 to 4 releases, when one to two adults were noticed in the trap.
- Neem oil at the rate of 3 ml/lit or NSKE at the rate of 5 ml/lit.
- Spray NBAIR Bt 25 at the rate of 20 ml/lit, if required after the neem spray.

From the second to fourth week

- Release *Bracon sp* @ 4000 adults/ha.
- NBAIR Ma 35 at the rate of 5 g/lit or Spfr NPV at the rate of 4 ml/lit.
- Spray any one of the chemicals – Chlorantraniliprole 18.5 Sc at the rate of 80 ml/acre / Thiamethoxam 12.6 % + Lambda Cyhalothrin 9.5 % at the rate of 0.25 ml/lit / Spinetoram 11.7 % Sc at the rate of 100 ml/acre.

From mid-whorl to late whorl stage

- If a new brood is noticed in the field, follow the recommended practices as mentioned for the second to fourth week.

From tassel to harvest stage

- Strictly no usage of insecticides.

Note: If parasitoids are released in the field, it is recommended to take no action by means of any insecticides/Ma/Bt/NPV for a minimum period of one week.

***S.frugiperda* larvae**

***S.frugiperda* adult**

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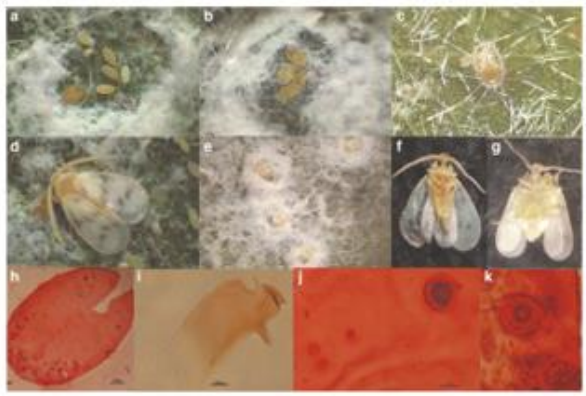
Nesting Whitefly, *Paraleyrodes minei* and Bondars Nesting Whitefly, *Paraleyrodes bondari*, Aleyrodidae, Homoptera

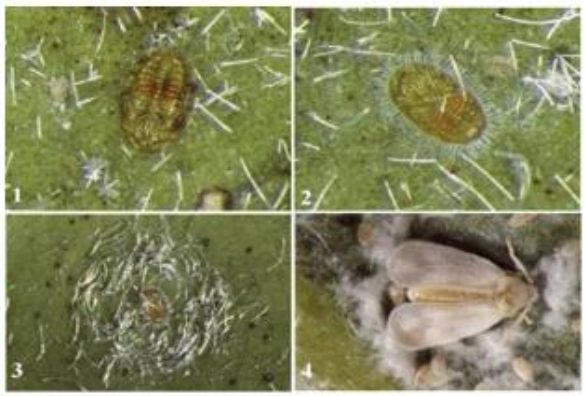
In 2018, these two exotic whitefly species have been recorded in Kerala.

Distinguishing morphology characters of P.bondari and P.minei

P.bondari	***P.minei***
Construct dense woven nest.	Construct loose woven nest.
Eggs are staked inside the nest without waxy covering.	
Crawlers: Yellow, flat margin – band of setae/wax all around the body.	**Crawlers:** Cream in colour with wax on the dorsal surface.
Later instars – Transparent yellow with short filaments on margin.	**Later instars –** Cream colour with fiberglass like wax rods**.**
Adults: Oblique grey band on fore wings, when both wings united forms like X-band.	**Adults:** Yellow colour with no band.



Bondars Nesting Whitefly



Nesting Whitefly

In 2019, another two whitefly species have invaded into our country, one is Woolly whitefly, *Aleurothrixus floccocus* and another one is Neotropical whitefly, *Aleurotrachelus atratus.*

Woolly Whitefly, *Aleurothrixus floccocus*

It was noticed in guava at Kozhikode and Malapuram, Kerala. In guava, co-occurrence of *Aleurodicus dispersus, A. rugioperculatus, P.bondari* and *P.minei* have been reported. But this exotic whitefly species dominates all the existing species and replace all. It is polyphagous in nature prefer mainly citrus but in India it prefers guava.

Diagnostic characters

- Eggs (before hatch), later instars and mature pupae are brown in colour.

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- Eggs are laid in circular pattern; due to concrete nature of whiteflies it is difficult to distinguish. Eggs are at upright position/at an angle, granular powder wax was noticed in all around the eggs.

Damage symptoms

- Nymphs and adults suck the sap from phloem leads to wilt, yellow and leaf fouling.
- Severe infestation leads to complete blackening leads to leaf fall, senescence and death.

Biology

- Sausage shaped, pale white eggs at under surface of leaf changes to brown colour before hatch.
- 1st instar – light green, flat, oval and little marginal wax.
- Subsequent instar – sedentary and brown.
- Late instars – completely obscured by copious amount of wax (many times thicker than body).
- Egg to nymph – around 3 weeks.
- Adult longevity – 30 days. Total life cycle around – 51 to 57 days.

Management

- Follow the stringent quarantine protocols.
- Yellow sticky traps at the rate of 10/ha.
- *Pseudomallada astur* at the rate of 1000 eggs/ha/15 days interval.
- Two sprays of *Isaria fumosorosea* at the rate of 5g/lit/15 days interval.
- In case of severe outbreaks, use neem oil 1%.
- No natural parasitism has been recorded so far, but *Cales noacki* been noticed in the vicinity.

Aleurothrixus floccocus

Cales noacki

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Neotropical whitefly, *Aleurotrachelus atratus*

- It is also called as Oil-palm whitefly, because though it is a polyphagous species preferred to colonize on coconut, oil palm and ornamental palm trees.
- It is reported in Karnataka in 2019.

Biology

- Eggs are stacked in semi-circular pattern, black in colour before hatch.
- All the nymphal and pupal stages are black in colour.
- Total life cycle completed in 36 to 41 days in coconut.

Management

- Follow the stringent quarantine protocols.
- Yellow sticky traps at the rate of 10/ha.
- *Pseudomallada astur* at the rate of 1000 eggs/ha/15 days interval.
- Two sprays of *Isaria fumosorosea* at the rate of 5g/lit/15 days interval using high volume sprayer with medium droplet size nozzle preferably in evening hours.
- Beetle, *Cybocephalus indicus* have been noticed to feed whiteflies.
- Parasitisation rate of 46 to 68% by *Encarsia cubensis* (Solitary endoparasitoid on puparium) on *A. atratus* was reported by NBAIR in different locations of Karnataka.
- *Encarsia cubensis* might invaded along with Solanum Whitefly, *Aleurotrachelus trachoides* in 2015 and *A. flocosus* in 2019.

Note

Isaria fumosorosea is safe to Encarsia guadeloupae i.e., using of Isaria + Encarsia at the same time is feasible. Encarsia adult emergence was recorded in whitefly nymph sprayed with Isaria. It is also safe to other beneficials like Pseudomallada astur, Bombyx mori and Goniozus nephantidis.

A. atratus nymph

Aleurotrchelus atratus Adult

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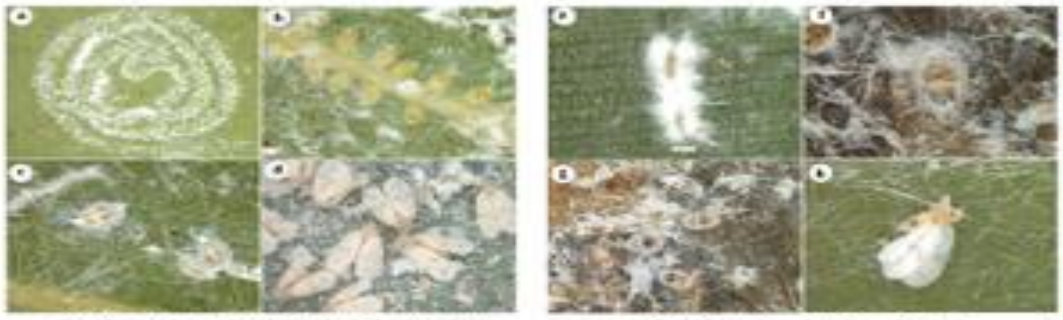
Cybocephalus indicus



Cassava mealybugs, *Phenacoccus manihoti,* Pseudococcidae, Homoptera

It was reported in May, 2020 from Thrissur, Kerala.

Biology

- Ovoid, pink with wax dust/ short lateral and caudal filaments (swell like tooth).
- Thelytokous parthenogenesis have been observed.
- Females lay 500 eggs at shoot tip and lower leaf.
- Eggs are golden yellow; 1st instar is mobile while subsequent instars are sedentary.
- In optimum conditions, total life cycle completed in 20 days.

Damage symptoms

- Chlorosis, stunt, dry/wilt, multiple shoot (bunchy top).
- In Salem, Tamil Nadu more than 1000 nymph/shoot tip have been recorded in severe condition.

Management

- Avoid using of Thailand white, MVD, H-165, Sree Vijaya and Sree athulya as these cultivars are highly susceptible to mealybugs.
- Cultivar, H-226 found to be less infected.
- Field release of *Scymnus coccivora* at the rate of 500 to 2000/acre depends on the level of infestation.

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- *Verticilium lecani* at the rate of 5 g/lit with tween 80.
- Neem Seed Kernel Extract at the rate of 5 ml/lit.
- Any azadirachtin (Min 1000 ppm) at the rate of 2 ml/lit.
- Fish Oil Rosin Soap (FORS) at the rate of 25 g/lit.
- Spray any one of chemical insecticides like Buprofezin 50 EC at the rate of 0.75 ml/lit or Profenophos at the rate of 2 ml/lit or Thiamethoxam at the rate of 0.6 g/lit.
- NBAIR has received the culture of parasitoid, *Anagyrus lopezi* from Thailand and IITA, Benin for mass production and distribution to tapioca growing farmers.

Phenacoccus manihoti ***A. lopezi* parasitizing on mealybug**

Tobacco thrips, *Thrips parvispinus*, Thripidea, Thysanoptera

A cosmopolitan species reported for the first time in India on *Carica papaya* – Brugmansia *sp* and Dahlia rosea in 2015. It is polyphagous pest recorded on vegetables like beans, eggplant and potato and fruits like papaya and strawberry etc. Severe infestation has been reported in chilli growing areas of Andhra Pradesh, Karnataka and Telangana in 2021-2022.

Damage symptoms

- Shedding of flowers, malformation of fruits and fruit drop. In chilli, 90 to 95 % flower damage, 18.20 thrips/flower have been recorded.
- It attacks the *Capsicum annum* in Andhra Pradesh, Karnataka and Chhattisgarh.
- In Tamil Nadu, infestation have been noticed in *Mangifera indica*.

Management

- Use neem and pungam oil if heavy infestation is noticed.
- Erection of blue sticky traps @ 25-30 per acre for mass trapping in thrips infested fields.

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- Spraying of botanical based insecticides like Neem Seed Kernel Extract (NSKE) 5% or Neem oil 3% @ 2 ml/l or Pongamia oil @ 3 ml/l or Vitex negundo extract @ 50-80 ml/l.
- Microbial based insecticides like *Beauveria bassiana* @ 4 g or ml/l (spore load - $1x10^8$ cfu/g or ml) or *Pseudomonas fluorescence* – NBAIR PFDWD @ 20g/l or *Bacillus albus* – NBAIR-BATP @ 20 g/l uniformly covering whole plant.
- Conserve predators such as predatory mite (*Amblyseius swirskii*) and insidious flower bugs (*Orius insidiosus*) etc.

Thrips parvispinus

Thrips parvispinus **on chilli flower**

Apple Leaf Blotch Miner - *Leucoptera malifoliella*, Lyonetidae, Lepidoptera

Recently invaded India in Union Territory of Jammu and Kashmir in 2023. According to the survey conducted in four districts (Shopian, Anantnag, Pulwama and Kulgam) by the NBAIR scientists, it was revealed that South Kashmir is severely affected. This insect is also called as Pear Leaf Blister Moth (PLBM) and Ribbed Apple Leaf Miner (RALM).

Biology

- Eggs are 0.3 mm in discoid shape; larva head and prothoracic shield yellow in colour; larval body green turn into darker while nearing the pupation.
- Thoracic segments and abdominal segments from 1 to 7 are broadly rounded – gives moniliform appearance.
- Metallic grey coloured adults prefer to lay eggs on shade areas in leaves.

Damage symptoms

- Concentric circular mines that are initially small and whitish and become larger with brown spots.

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- All the larval development occurs in the mines and excrement becomes visible as dark circles within the mines.
- It is difficult to control, as the spray cant able to reach the pest; besides it kills all the natural enemies.

Blotch minor damage symptoms

Blotch miner larva

Adult

Management

- Strong or heavy pruning techniques leads to the vigorous growth, which reduces the susceptibility of pest. Weak pruning corelated with heavy infestations of this pest.
- Scraping and removing old, loose bark along with cocoons.
- Yellow sticky traps @ 0.5 m above ground level.
- Spreading of gunny bags and paddy straw on trunk which serves as a substrate for pupation, later destroy it.
- NSKE and neem leaf extracts affords more than 80% management.
- Apply insecticides like Metaflumizone or Chlorantraniliprole or Chlorfenapyr at the recommended dose before the larvae enter leaf mines.

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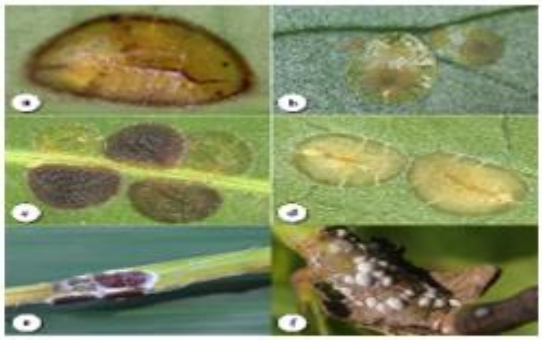
Mango Soft Scale, *Fistulococcus pokfulamensis*; Coccidea; Hemiptera

In 2023, the pest entered the India from Hong Kong infesting gymnosperms. In our country more than 80 percent it feeds on Umbrella and Jamun tree. It is noticed that it shifts its host range faster in horticultural crops. In august, 2023 heavy infestation in mango was reported from Bengaluru. Also, high infestation in four unrelated family indicated the polyphagous ability of this pest.

Biology

- Females usually broader; dorsum covered with wax; by removing wax, able to see the transparent yellow body with brown alimentary canal.
- The term Fistulococcus derived from Latin – pipe like duct; so it has pipe like ducts arranged in the periphery of the body.

Fistulococcus pokfulamensis



Mango soft scale – different stages

Damage Symptoms

- Initially feeds on undersurface of leaves, later spread to branches, which resulted into accumulation of sooty mould finally drooping of leaves.

Management

- Collection and destruction of affected plant parts along with scales.
- Use of botanicals like Neem oil (3 to 5%), Neem leaf extract (5 to 10%) and NSKE (5%).
- Entomopathogens like *Beaveria bassiana* (Mycotrol; Naturalis) and *Verticillium lecani* (Vertilac) at the rate of 5 g/ml per litre of water.
- Coccinellids like *Chilocoris nigrita* and Cryptolaemus *montrouzieri* and *Spalgis epius* feed on both nymphs and adults.

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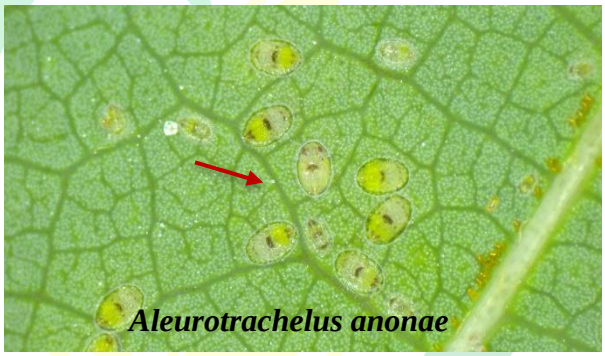
- There is no record of parasitoid association with this pest in India as well as from Hong Kong still now.
- Insecticides like Diafenthiuron, Flonicamid, Pymetrozine and Thiamethoxam at recommended dose in rotations affords protection.

Annona Whitefly, *Aleurotrachelus anonae*; Aleyrodidae; Hemiptera

First reported from Bengaluru in July, 2024. This species prefers to colonize on plants under the family, Annonaceae. In custard apple 20 to 35%, Cherimoya 5 to 10% and in Indian shot less than 5% damage was recorded. Globally this species is under the quarantine importance. It is also coexisted with recently invaded and native whitefly species. Non-anona plants like mulberry, cinnamon, avocado, elephant foot yam, banana and ginger also in list of hosts of this insect.



***Brown arrow indicates* - Three dorsal brown patches look like mid-dorsal horizontal stripe on the body**

Biology

- Adults prefer to colonize and lay stalked eggs on terminal leaves, which is initially creamy white turn dark before hatch.
- *Distinct pattern on nymph* – three dorsal brown patches look like mid-dorsal horizontal stripe on the body.
- *Diagnostic characters* - Puparium yellow, elongate, marginal teeth square shaped which is broadly separated with incision. Eyes spot absent, presence of meso and metathoracic setae, pores along lateral longitudinal fold. Puparium distinguished from other species by its white colour except *A. fici*. It is differentiated by lack of wax from *A. fici*.

Damage symptoms

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- Nymphs and adults colonize on the underside of the leaves which resulted into depletion of nutrients and water due to which the leaves turn yellow finally premature defoliation occurs.
- All nymphs are light coloured, without flocculent wax.

Management

- Follow the stringent quarantine protocols.
- Yellow sticky traps at the rate of 10/ha.
- *Pseudomallada astur* at the rate of 1000 eggs/ha/15 days interval.
- Entomopathogens like *Beaveria bassiana* (Mycotrol; Naturalis), *Verticillium lecani* (Vertilac) and Isaria *fumosorosea* at the rate of 5g/lit at 15 days interval.
- In case of severe outbreaks, use neem oil 1%.
- Utilization of Encarsia *Formosa* and *Eretmocerus sp* recorded 5 to 10% parasitisation.
- Coccinellid, *Scymnus latemaculatus* may be used.
- Insecticides like Diafenthiuron, Flonicamid, Pymetrozine and Thiamethoxam at recommended dose in rotations affords protection.

Conclusion

Due to developed globalization and trade, exotic species invasive have been inevitable one. Hence, management of exotic species is a challenge. Strict quarantine legislation laws must be followed to minimise the loss caused them. Besides, dissemination of awareness programme regarding the management practices to farmers is mandatory.

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