Bio control management options for invasive whiteflies on coconut

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The coconut crop is mainly confined to the four southern states, accounting 90% of the area under coconut, among which Andhra Pradesh shares about 1.11 lakhs ha. area with a production of 1567.60 million nuts. An invasive rugose spiraling whitefly (RSW), *Aleurodicus rugioperculatus* Martin (*Hemiptera: Aleyro¬didae*) has entered India and reported on coconut palm (*Cocos nucifera L.*) for the first time during August-September, 2016 at Pollachi taluk, Coimbatore district in Tamil Nadu and Palakad taluk in Kerala . In Andhra Pradesh it was first reported at Kadiyam in the nursery gardens during late December 2016 probably entering Andhra Pradesh through infested coconut seedlings obtained from Kerala and on Oil palm too from Kalavalpalli village in West Godavari district in February 2017 .

As per the Department of Horticulture , Government of Andhra Pradesh statistics in February 2019 in Andhra Pradesh East and West Godavari districts had a severe (more than 30 spirals/leaflet) incidence of this pest and an area of 1535 ha of coconut and 2461 ha of Oil palm plantations (Total 3997 ha) in East Godavari district, an area of 4428 ha of coconut and 9092 ha of Oil palm plantations (Total 13518 ha) in West Godavari district were found to be more affected as compared to other coconut growing districts. Contiguous areas of coconut and oil palm particularly in West Godavari district might had been the reason for increased area of infestation by white fly in this district as compared to East Godavari district where coconut and oil palm plantation areas are clearly demarcated. In other coastal districts viz., Srikakulam an area of 2185 ha of coconut and 129 ha of oil palm plantations (Total 2314 ha) in Vizianagaram an area of

Name of the district	Number of villages affected	Area affected with Rugose spiralling whitefly		
		Coconut (ha.)	Oil Palm (ha.)	Grand Total area (ha.)
West Godavari	63	4428.20	9092.60	13520.80
East Godavari	155	1535.80	2461.50	3997.30
Krishna	1	2.80	0.00	2.80
Srikakulam	36	2185.25	129.00	2314.25
Vizianagaram	36	1336.0	45.00	1381.00
Visakhapatnam	28	738.20	16.00	754.20
Total	**319**	**10226.25**	**11744.10**	**21970.35**

Source : Department of Horticulture., Govt of AP

Bondars nest fly infestation

1336 ha of coconut and 45 ha of oil palm plantations (Total 1381 ha) and in Visakhapatnam an area of 738 ha of coconut and 16 ha of oil palm plantations (Total 754 ha) were found affected in February 2019 and the recent surveys and inputs from Department of Horticulture indicated in January 2020 indicated an increase in the area affected by rugose white fly in all these districts . The favourable period for this pest is from September to March months and a low population with extended pupal periods was observed in unfavourable conditions from April to August in 2019 under Andhra Pradesh conditions.

Extent of area infested by Rugose spiralling whitefly in Andhra Pradesh(February 2019)

The data collected on RSW population as per standard week at HRS., Ambajipeta in 2020 revealed the establishment and re-emergence of the invasive rugose spiralling whitefly on coconut in the month of June 2020 . Unlike in 2019 where the establishment and re-emergence was observed in the month of August low incidence is being observed in the second fortnight of June 2020 itself. Unlike the regular adult rugose spiralling whitefly which has a body length of about 2 mm with a pair of irregular light brown bands across the wings, the whitefly which is surviving in off season is less than 0.5 mm in body length without these bands. Unlike regular egg spirals which have 30 to 40 number of eggs the offseason population of whitefly is laying eggs numbering 5 to 10 in non conspicuous spirals. The incidence is particularly observed on dwarf varieties ie., Gangabondam, Chowghat Orange Dwarf (COD), Malayan Yellow Dwarf (MYD) and on hybrid Godavari Ganga as compared to local East coast tall.

Further, three years after the appearance of the rugose spiralling whitefly on coconut in Andhra Pradesh, Bondars nest fly species (BNW), Paraleyrodes bondari Peracchi was observed from Chagalu and Kalavalapalli villages of West Godavari feeding on the lower surface of coconut palm leaflets. This whitefly is very small (< 1.0 mm) and has conspicuous X-shaped oblique grey bands on the wings. Nymphs and adults are present nesting chambers of woolly wax resembling bird's nest . The adult whitefly lays stalked eggs and the nymphs are flat with fibreglass like projections from the dorsum. BNW incidence was noted in lower leaf of Godavari Ganga hybrid coconut varieties with nest colonies exceeding 10 per leaflet.

Impact of various biological control strategies on Rugose white fly :

▶ ***1. Field evaluation of Isaria fumosorosea (NBAIR Pfu-5) against rugose spiraling white-fly*** Field experiments were conducted in association with NBAIR- ICAR Bangalore in Madavaraidupalem

Demonstration on Spraying of entomopathogen Isaria

Visit to RSW infested coconut planation in West Godavari district

in East Godavari and Kalavalapalli village in West Godavari district, Andhra Pradesh (two gardens) during November- March , 2018-19 to field evaluate the efficacy of I. fumosorosea against rugose spiraling whitefly on coconut (Godavari Ganga hybrid). The results revealed that I. fumosorosea Pfu-5 reduced the egg hatching (62-78%), caused mortality on early nymphal instars (52-68%) and late nymphal instars (48-63%). However, during high temperatures (at a temperatures of >350C) there is a comparatively lower suppression of eggs (18.6%), nymphs and pupae (20.3%)

Field experiment conducted in 2019-20 at HRS., Ambajipeta in December in Gangabondam variety (dwarf) revealed that I. fumosorosea Pfu-5 reduced the egg hatching (37-50 %), caused mortality on nymphal instars (35-40%) and sprayings carried out at higher temperatures showed very low impact on egg and nymphal stages of white fly .

Good results with I. fumosorosea Pfu-5 can be obtained if sprayings are carried out at 10 to 15 days interval with high jet sprayers when there are no high temperatures . Further spraying operations should be initiated very early in the season as and when RSW population is observed as it can have more impact and can reduce and arrest the RSW population build up.

▶ *2. Field establishment studies of predator Dichochrya astur on rugose spiralling white fly*

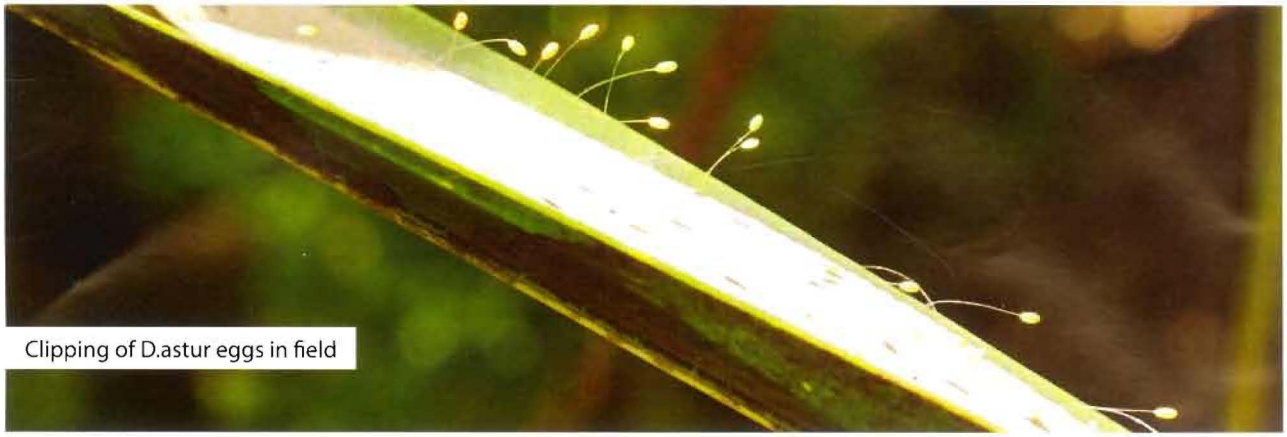
Green lacewing (Chrysoperla zastrowi), is believed to be a natural predator of the whitefly but failed to establish successfully after release in the infested coconut and oil palm plantations in Andhra Pradesh . However another neuropteran predator D. astur was found to feed and establish on RSW eggs naturally under field conditions providing scope for biological control of RSW utilizing this predator if mass multiplication and large scale production is attempted . Further this predator was also reported to be more frequently encountered on A. disperses on guava in South India

Natural abundance and feeding of D. astur, on rugose white fly was observed in many RSW infested coconut gardens in Andhra Pradesh and hence, keeping in view of this predator potential and demand from farmers a project entitled "Bio-control based management of rugose spiralling whitefly, *A. rugioperculatus* on coconut in Andhra Pradesh" was submitted to CDB , Kochi with a view to standardize and mass produce this predator. With the funds provided under the project the mass production of predator D.astur is being standardized along with increased production of its surrogate host *Corcyra cephalonica* and supply the predator egg strips to the needful plantation farmers.

Initial studies on successful field establishment of predator D. astur

A field experiment was conducted in 4 year old hybrid Godavari Ganga plantation in the month of December 2019 at Sri Bezawada Srinivas farm at Chikkala village, Chagallu mandal in West Godavari District ; initially no *D. astur* population was observed in the garden and low to medium infestation (9- 15 spirals/leaflet) of white fly was recorded. A total 500 numbers of D. astur eggs and were clipped in five palms @ 100 per palm in 10 leaflets randomly on 17-12-2019 and 20 days after clipping 6 per cent grub and 2 per cent egg and 1 percent pupal stage natural recovery of predator *D. astur* was observed. The white fly population dwindled to low with less than 3 spirals/leaflet in the palms due to successful establishment of predator.

Another experiment on efficacy of this predator under high infestation levels was conducted in HRS., Ambajipeta in 6 year old cross combination where all leaflets in the 8 leaves were completely infested



Clipping of D.astur eggs in field

and merging of spirals (more than 30 spirals) was observed due to high population build up of RSW . About 100 eggs of predator *D. astur* were clipped to the leaf randomly on the leaf lets and all the infested leafs were clipped (800 eggs per palm) and 80 per cent of the RSW eggs were fed by the predator on the palm . Further an extended grub period *D. astur* of 32 days was observed in the field as compared to 14 days in lab when fed on corcyra eggs . As *D. astur* is an egg predator and does not feed on other stages of RSW spraying of bio pesticide I. fumosorosea Pfu-5 / or spraying of water with high jet sprayers should be done before clipping of predator eggs for successful management of RSW when incidence is high (More than 30 spirals per leaflet) by this beneficial

Further, this predator was also found to effectively feed on eggs of Bondars nest fly species (BNW), *P. bondari* which provides increased scope of utilising this predator in coconut plantations where combined infestation of all invasive white flies is present.

Production and supply of Dichochrysa astur eggs to plantation farmers in 2019-20 under CDM TMOC project

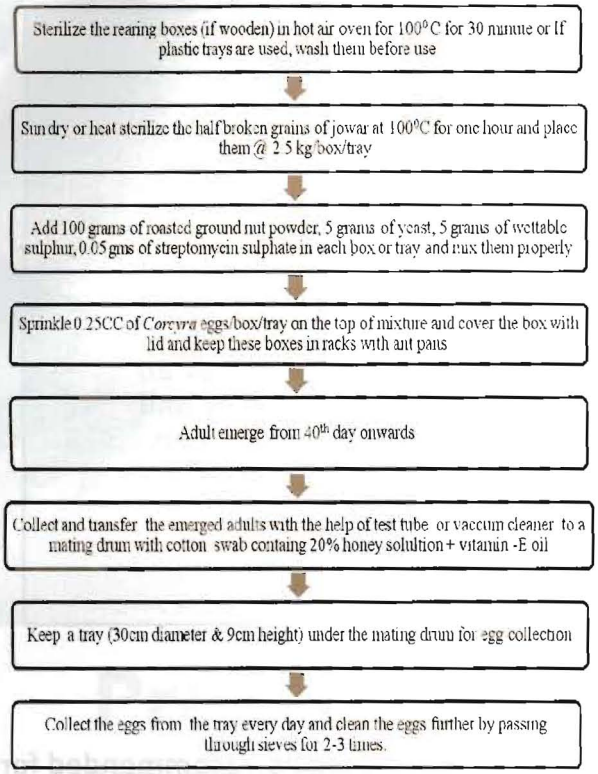
Month	No. of D. astur eggs supplied to farmers
April 2019	1,85,000
May 2019	-
June 2019	3000
July 2019	5000
August 2019	21,000
September 2019	-
October 2019	8000
November 2019	64000
December 2019	2,14,500
January 2020	7,87,000
February 2020	4,42,000
March 2020	4,11,000
Total	21,40,500

3. Field establishment studies of parasitoid *Encarsia guadeloupae* against Rugose spiralling white fly in AP :

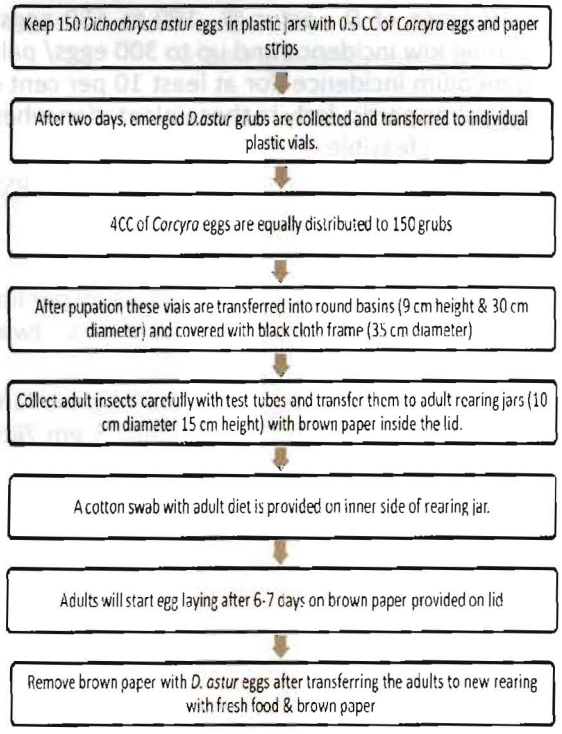
No initial presence *E. guadeloupae* and its parasitisation was observed in the rugose white fly infested gardens and nurseries up to December 2017 in A.P. Hence, in December 2017 and January 2018 three parasitoid consignments were obtained from Coconut Research station, Aliyarnagar, TNAU and clipped in coconut plantations in Kalavalapalli and Chikkala villages in West Godavari district. The data on parasitisation of rugose whitefly by *E. guadeloupae* was recorded to ascertain establishment of parasitoid in the released gardens. During January 2018, 20.01±1.69 per cent parasitized pupae were observed per 10 palms. Later the per cent parasitisation was increased to 72.06±3.15 during February which later decreased to nil during April till August 2018 .

No parasitisation by *E. guadeloupae* was observed in April and May months inspite of availability of white fly stages probably due to high temperatures and hence once again consignments of Encarsia were obtained From CPCRI , Kasaragod and NBAIR , Bangalore was observed. The per cent parasitisation of 29.34±3.56, 42.38±5.48, 69.49±4.94 and 68.83±3.61 was observed during months of September, October, November and December 2018 respectively.

Flow chart on Mass production of surrogate host *Corcyra cephalonica*



Flow chart for low cost large scale mass production of RSW Predator *D. astur*



Similarly in the year 2019 after summer no natural establishment of this parasitoid was observed and 3000 parasitized pupae consignments of the parasitoid were obtained From TNAU , Coimbatore and NBAIR , Bangalore and released in Chikkala village, Chagallu mandal in West Godavari district and HRS., Ambajipeta in September–October 2019 . The establishment of E. guadeloupae was promising in Chikkala village where no spraying operation of any kind was resorted , while in HRS., Ambajipeta where various spraying operations were taken up the establishment of the parasitoid though present is not comparable to that in Chikkala village indicating detrimental effect of any spraying operations on *E. guadeloupae* and are in tune with the studies carried out by CPCRI Kasargod on conservation biological control strategy where no sprayings (pesticides) can enhance the population build up of parasitoids in the natural ecosystem from initial 10-15% to as high as 70-80% in a period of five to eight months.

Per cent parasitized whitefly pupae observed after parasitoid release on coconut in Kalavalapalli village (2018-19)

Month/Year	Per cent parasitized whitefly pupae observed (For 10 palms at random)
	Coconut (5 years old)
January 2018	20.01±1.69
February 2018	72.06±3.15
March 2018	52.81±3.07
April 2018	Nil
May 2018	Nil
June 2018	Nil
July 2018	Nil
August 2018	Nil
September 2018**	29.34±3.56
October 2018	42.38±5.48
November 2018	69.49±4.97
December 2018	68.83±3.61
January 2019	71.35±4.31
February 2019	65.44±2.63
March 2019	28.68±1.78

(Re-Release)*From CPCRI , Kasaragod and NBAIR , Bangalore in September 2018

Independence Day observed in CDB

Shri. Saradindu Das, Chief Coconut Development Officer hoisitng the National Flag at CDB Head Quarter premises on 15th August 2020. Officers and staff of the Board are also seen.

Further with the combined incidence of rugose spiralling whitefly and bondar nest fly there is always a chance of infestation by bondars nest fly in new areas if clipping of parasitized pupae of RSW with *E. guadeloupae* is resorted too. There fore due care should be taken on while redistributing *E. guadeloupae* parasitized RSW pupae and invariably lab reared or supervised and controlled production of *E. guadeloupae* parasitized pupae should only be redistributed.

Management strategies recommended for RSW in Andhra Pradesh

1. Avoid transportation of coconut seedling or any other ornamental plants from pest infested areas to new uninfested areas

2. Release of *D. astur* @ 100 to 150 eggs / palm during low incidence and up to 300 eggs/ palm during medium incidence for at least 10 per cent of infested palms particularly in those plantation where spraying is not feasible

3. Re-distribution of *E. guadeloupae* in RSW infested areas taking due care

4. Avoiding Pesticides spray

5. Spraying Azadirachtin @ 1% @ 1 ml per litre along with detergent powder @ 10 gms two / three sprays at 15 -20 days interval.

6. Foliar application of entomopathogenic fungi *I. fumosorosea* @ 1x108 spores/ml (5 gm /litre along with sticker 2 ml/litre)

7. Intermittent Jet water spray at fortnightly intervals

8. Installation of yellow sticky traps on palm trunk to attract adult white flies and regular smearing with castor oil at 7 to 10 days interval

9. Community based approach for management