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## Biological control of invasive pest, rugose spiralling whitefly in coconut and impact on environment

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### Abstract

Biological Control of coconut rugose spiralling whitefly with entomopathogenic fungi, *Isaria fumosorosea* (NBAIR- Pfu 5) spraying with the introduction of exotic natural enemy, *Encarsia guadeloupae* parasite, its conservation and augmentation was proved effective in managing rugose spiralling whitefly and accepted by coconut farmers of north coastal districts of Andhra Pradesh state. Field evaluation of *Isaria fumosorosea* (NBAIR- Pfu-5) @ 2 x 10<sup>8</sup> spores/ ml (5 g/litre of water) two sprayings at one month interval was found effective in reducing rugose whitefly intensity by 58.1 to 97.03% in coconut orchards during 2018-19 . Noticed the establishment of *Isaria* fungus on whitefly population showing mycelial growth on eggs, nymphs and mummified adults. Similar results observed in 2019-20, *I. fumosorosea* two sprays at 15 day interval with release of exotic natural enemy, *E. guadeloupae* parasite for augmentation after first spraying of *Isaria* fungus effectively controlled rugose spiralling whitefly intensity by 71.01 to 75.5%. Interestingly, well establishment of parasitoid, *E. guadeloupae* was observed in coconut plantation with banana as intercrop which was inoculated after first spraying of *Isaria* fungus. The population of rugose spiralling whitefly in coconut orchards was reduced significantly with two sprays of *I. fumosorosea* (NBAIR- Pfu5) with one inoculative release of parasite, *E. guadelouape*. Capacity building of coconut farmers lead to the establishment of model biological control system for the farmer level production of *I. fumosorosea* with the efforts of AICRP on Biological Control, ANGRAU centre and ICAR-NBAIR, Bangalore. Experiences of successful farmers was helpful in the spread of biological control technologies in the management of coconut spiralling whitefly in 250 acres of coconut of north coastal districts of Andhra Pradesh.

**Keywords:** *Isaria fumosorosea*, *Encarsia guadeloupae*, coconut, rugose spiralling whitefly

### Introduction

Rugose spiraling whitefly reported first from coconut during 2004 at Belize, the pest had threatened coconut palms in Florida during 2009. Rugose spiraling whitefly has been reported affecting more than 100 plant species (Stocks 2012) <sup>[1]</sup> including landscape (coconut palm, black olive, gumbo limbo, weeping fig, live oak, rose, and sabal palm), agriculture (citrus, mango, avocado, and sugarcane), and natural areas (sabal palm, live oak, coconut palm, Brazilian pepper, and Virginia creeper). Rugose spiraling whitefly reproduces throughout the year with multiple, overlapping generations.

Infestation invasive species, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae), commonly known as the rugose spiralling whitefly (RSW), was observed on coconut palm (*Cocos nucifera* L) in Pollachi, Tamil Nadu, India (R. Sundararaj & K. Selvaraj, 2016) <sup>[2]</sup>. Severe infestation of the invasive rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) on oil palm (*Elaeis guineensis* Jacq.), (Arecales: Areaceae) in India is reported for the first time (Selvaraj *et al.*, 2017) <sup>[2]</sup>. The dangerous invasive pest was reported for the first time on coconut (*Cocos nucifera* L.) at Pollachi, Tamil Nadu in India during August 2016 (Sundararaj and Selvaraj, 2017) <sup>[3]</sup>. Subsequently, the pest was reported to feed on many horticultural plants such as banana, sapota, mango, guava, custard apple, water apple and many more ornamental plants including false bird of paradise, rubber fig, butterfly palm, ruffled fan palm, Calophyllum in Tamil Nadu, Karnataka, Kerala and Andhra Pradesh (Selvaraj *et al.*, 2016; 2017) <sup>[2, 3]</sup>. The RSW was reported to feed on more than 30 host plants in India and about 120 plant species including several economically important horticultural and ornamental crops globally. Recently, severe incidence and infestation of invasive rugose spiralling whitefly (RSW) *Aleurodicus*

*rugioperculatus* Martin (Hemiptera: Aleyrodidae) was found on oil palm in its growing areas in Andhra Pradesh and Karnataka in India (Selvaraj *et al.*, 2019) [4]. The invasion and establishment of RSW will further jeopardize the coconut industry in India in reducing coconut production, quality of nuts and increased production cost for management of the pest. During 2018, it is noticed in Andhra Pradesh and spreading to other coconut growing coastal areas as well as on other potential host plants like sapota, guava, banana, papaya, maize, beetlevine etc.

The current incidence of RSW in India is alarming due to its polyphagous nature and a holistic approach is needed for the adaptation of rapid response strategies against its invasion. Rugose spiralling white fly reproduces throughout the year with multiple overlapping generations and has potential for spreading into new areas.

Inappropriate and excessive applications of traditional insecticides harm natural enemies, both predators and parasites and may lead to potential concerns for environmental contamination and high risk of resistance developing in these pest species. So far, no chemical insecticides have been recommended against RSW as none of the insecticides have been labelled specifically for the control of this pest. *Isaria fumosorosea* is an important entomopathogenic fungi shown to be effective against different whitefly pests. Parasitoids viz., *Encarsia guadeloupeae* Viggiani (Hymenoptera: Aphelinidae) was known to parasitise *A. rugioperculatus*. Hence, Biological control of coconut rugose spiralling white fly with entomopathogenic fungi, *Isaria fumosorosea* (NBAIR- Pfu 5) along with the introduction of exotic natural enemy, *Encarsia guadeloupeae* parasite, its conservation and augmentation was studied in farmers's fields during 2018-19 and 2019-20.

## Materials and Methods

Studies on efficacy of entomopathogenic fungus, *Isaria fumosorosea* (NBAIR- Pfu-5) in the management of rugose spiralling white fly were conducted in major coconut growing areas of north coastal andhra pradesh during 2018-19 & 2019-20. Entomopathogenic fungus, *Isaria fumosorosea* (NBAIR- Pfu-5) at the rate 5 g/lt ( $2 \times 10^8$  spores/ ml) mixed with sticker @ 10 g/lt was sprayed in coconut orchards two times at monthly interval. Exotic natural enemy, *Encarsia guadeloupeae* parasite obtained from ICAR- NBAIR, Bangalore was released at 15 days after first spraying by clipping the coconut leaflets strips with parasitized whitefly colonies. Similarly, *Pseudomallada (Dichocrysa) astur* predator obtained from Horticultural research station, Ambajipeta, East Godavari district, Andhra Pradesh was released in another coconut orchard sprayed with *Isaria* fungus by clipping the paper strips having predator eggs during 2019-20.

Observations on RSW incidence made before the spray on palm infestation : Percentage of leaves infested/palm (no. of leaves infested by RSW /total leaf per palm), Intensity of pest damage from 10 pest infested leaflet/fronds per palm from the outer/middle whorl representing four directions (no. of leaflets infested by RSW/ total leaflets per leaf) and live colonies (Ten leaflets from each palm). The infestation level was assessed based on the pest status as Low: 0-10 live egg

spiral or adult/leaflet; Medium: 11-20 live egg spiral or adults/leaflet and Severe: more than 20 egg spirals or adults /leaflets, Observations recorded on *Isaria* fungus infection on RSW population ; *Encarsia guadeloupeae* parasitization based on exit holes on RSW pupae and *Pseudomallada (Dichocrysa) astur* predator eggs, nymphal population on whitefly colonies. Various activities organized Farmers training programmes, awareness programmes to field functionaries, hands on training for the farmer level production of entomopathogenic fungus, *Isaria fumosorosea* (NBAIR- Pfu-5) and establishment of model biological control system in villages for large scale promotion of biological control in the management of Coconut rugose spiralling whitefly.

## Results and Discussion

ICAR-NBAIR in collaboration with AICRP on BC, ANGRAU centre conducted field demonstrations with ICAR-NBAIR strain of *I. fumosorosea* (Pfu-5) at  $2 \times 10^8$  spores/ ml (5 g/litre of water) mixed with sticker @ 10 ml/lt for the management of RSW during 2018-19 and 2019-20 in four locations of two districts in north coastal Andhra pradesh. *Encarsia guadeloupeae* parasitoid was inoculated for augmentation in *Isaria fumosorosea* sprayed plot in 2019-20.

RSW infestation was reduced drastically in *I. fumosorosea* sprayed coconut orchards. It was observed that mycosis of *Isaria fumosorosea* on different life stages of RSW. During 2018-19, rugose spiralling white fly intensity after first and second spray of *Isaria fumosorosea* was 30.26% and 77.87%. Reduction in live colonies of RSW after first and second spraying of *Isaria* fungus was 40.76% and 66.57% (Table 1). During 2019-20, reduction in white fly intensity was high due to *Encarsia guadeloupeae* release between two sprays of *Isaria* fungus (75.16%). Drastic reduction in RSW live colonies per leaflet (77.95%) was noticed in orchards sprayed with *Isaria* fungus two times and *Encarsia* release. RSW infestation was reduced drastically wherever *Encarsia guadeloupeae* released. Interestingly, well establishment of parasitoid, *E. guadeloupeae* was observed in coconut plantation with banana as intercrop which was inoculated after first spraying of *Isaria* fungus (Fig. 1, 2). High parasitisation of *Encarsia guadeloupeae* was reported on *A. rugioperculatus* ranging from 40 to 70% on banana (Poorani and Thanigairaj, 2017) [1] and 20–60% parasitism on coconut (Selvaraj *et al.* 2016) [2] in Tamil Nadu and Kerala. The population of rugose spiralling whitefly in coconut orchards was reduced significantly with two sprays of *I. fumosorosea* (NBAIR- Pfu 5) and one inoculative release of *E. guadeloupeae*.

Similar results observed in 2019-20, *I. fumosorosea* (NBAIR- Pfu-5)@ 5 g/lt with Sticker @ 10 g/lt, two sprays at one month interval at Venkataraoopeta, srikakulam district and Kumili, Vizianagaram district with release of exotic natural enemy, *Encarsia guadeloupeae* parasite for augmentation after first spraying of *Isaria* fungus effectively controlled rugose spiralling whitefly with 75.16% reduction in whitefly intensity (Table 1). *Pseudomallada (Dichocrysa) astur* stalked eggs and nymphs feeding on RSW egg spirals was noticed in *Isaria* fungus sprayed coconut orchards contributing the reduction of RSW populations (Fig. 3, 4).



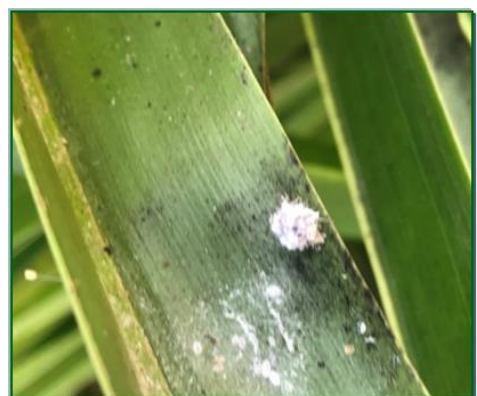
**Fig 1:** *Encarsia guadeloupae* parasitoid exit holes on RSW pupae



**Fig 2:** *Encarsia guadeloupae* adult on RSW egg spirals



**Fig 3:** *Pseudomallada (Dichocrysa) astur* predator stalked eggs in *Isaria* fungus sprayed coconut



**Fig 4:** *Pseudomallada (Dichocrysa) astur* nymphs feeding on RSW egg spirals

Group of fifteen farmers showed interest in learning skills on *Isaria* fungus multiplication and hands on training was given at AICRP on biological control laboratory during 2019-20. Capacity building of coconut farmers lead to the establishment of model biological control system for the farmer level production of *Isaria fumosorosea* fungus with the technical support of national bureau of agricultural insect resources (NBAIR), Bangalore. Experiences of successful farmers was helpful in the spread of biological control technologies in the management of coconut rugose spiraling whitefly at the farmer's level. Educating the department of horticulture and coconut farmers through awareness and training programmes, field visits and demonstrations helpful in promoting biological control of invasive rugose spiraling whitefly in coconut.

AICRP on Biological Control, ANGRAU centre and ICAR-NBAIR, Bangalore organized Awareness programme on management of Coconut rugose spiralling whitefly on 6<sup>th</sup> January, 2020 at Venkatarapeta, Ranasthalam mandal, Srikakulam district, Andhra Pradesh benefitting 100 farmers of Srikakulam district. Team of ICAR-NBAIR Scientists inaugurated entomopathogenic fungi, *Isaria fumosorosea* (NBAIR- pfu 5) production centre for farmer level production by trained farmers by trained farmers at Venkatarapeta village, Ranasthalam mandal, Srikakulam district along with Reddys' foundation – Mitra foundation for the benefit of 100 coconut farmers.

Motivated coconut farmers on management of Coconut rugose whitefly with entomopathogenic fungi, *Isaria fumosorosea* (NBAIR- pfu 5); Parasite, *Encarsia guadeloupae* and conducted method demonstration in 25 acres. Supplied *Isaria* (Pfu-5) mother cultures and talc based formulation of *Isaria* fungus (10 kg) to coconut farmers and Department of Horticulture.

Capacity building programmes on farmer level production of entomopathogenic fungi, *Isaria fumosorosea* (NBAIR- Pfu5) were conducted at Koyyam village (Etcherla mandal, Srikakulam district) and Venkatarapeta village (Ranasthalam mandal, Srikakulam district) on 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> February 2020, respectively. ICAR-NBAIR, Bangalore gave technical support for hands on training on farm level production techniques of *I. fumosorosea* at village level. Total about 200 coconut farmers, official of Dr. Reddys' foundation and Department of Horticulture officials of Visakhapatnam, Vizianagaram and Srikakulam districts benefitted from training. The training programmes on farm level production of *Isaria fumosorosea* was widely covered in local newspapers (Telugu) for the benefit of large section of farming community and other stakeholders in the Andhra Pradesh. Beneficiaries of farmer level production of *Isaria* fungus includes three hundred (300) coconut farmers, twenty five (25) field staff of department of horticulture and four (4) scientists of Srikakulam, Visakhapatnam and Vizianagaram district with five trainings programmes for farmer level production with the supply of mother culture facilitated the production of entomopathogenic fungi, *Isaria fumosorosea* of 500 kg utilised for spraying in 250 acres coconut area in srikakulam district during 2019-20.

**Table 1:** Field efficacy of *Isaria fumosorosea* (NBAIR-Pfu-5) and *Encarsia guadeloupeae* in management of rugose spiralling whitefly (RSW) in Coconut orchards

Year	Treatment	Location	RSW Before Spray			RSW after First Spray		RSW after Second spray		Percent Reduction in RSW			
			% Infestation	% Intensity	Live colonies /leaflet	% Intensity	Live colonies /leaflet	% Intensity	Live colonies /leaflet	Intensity		Live colonies /leaflet	
										After one spray	After two sprays	After one spray	After two sprays
2018	<i>Isaria fumosorosea</i> (NBAIR –Pfu5) two sprayings	Patarlapalli Srikakulam Dt	29.34	30.32	45.7	20.09	26.4	0.9	9.0	33.74	97.03	42.23	80.31
		Chollangi peta, Vizianagaram Dt	68.14	87.94	53.2	64.4	32.3	36.31	25.1	26.77	58.71	39.29	52.82
		Mean	48.74	59.13	49.45	42.27	29.35	18.61	17.05	30.26	77.87	40.76	66.57
2019	<i>Isaria fumosorosea</i> (NBAIR –Pfu5) two sprayings + <i>Encarsia guadeloupeae</i> parasitoid release	Venkatarao peta, Srikakulam Dt	69.12	82.05	51.9	45.7	20.3	20.09	11.0	44.30	75.5	60.89	78.80
		Kumili, Vizianagaram Dt	32.51	53.2	39.31	46.22	22.0	13.4	9.0	13.12	74.81	44.03	77.11
		Mean	50.82	67.63	45.61	45.96	21.15	16.75	10.0	28.71	75.16	52.46	77.95

### Conclusion

Drastic reduction in rugose spiralling whitefly was noticed in coconut orchards sprayed with *Isaria fumosorosea* fungus (NBAIR- Pfu-5) @ 5 g/lt with Sticker @ 10 g/lt, two times with introductory release of parasitoid, *Encarsia guadeloupeae*. Holistic approach in creating awareness among farmers and field functionaries lead to farmer level production of entomopathogenic fungi, *Isaria fumosorosea* utilized for spraying along with re-distribution of *E. guadeloupeae* parasitoid resulted in effective management of rugose spiralling whitefly in coconut.

### References

- Poorani J, Thanigairaj R. First report of *Encarsia dispersa* Polaszek (Hymenoptera: Aphelinidae) as a parasitoid of rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae), a recent invasive pest in India, with notes on its predators. Journal of Biological Control 2017;31(1):1-4.
- Selvaraj K, Sundararaj R, Venkatesan T, Ballal CR, Jalali SK, Gupta A *et al.* Potential natural enemies of the invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin in India. Journal of Biological Control 2016;30(4):236-239.
- Selvaraj K, Gupta A, Venkatesan T, Jalali SK, Ballal CR, Sundararaj R. First record of invasive rugose spiraling whitefly *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) along with parasitoids in Karnataka. Journal of Biological Control 2017;31(2):74-78.
- Selvaraj K, Venkatesan T, Sumalatha BV, Kiran CM. Invasive rugose spiralling whitefly *Aleurodicus rugioperculatus* Martin, a serious pest of oil palm *Elaeis guineensis*. India journal of oil palm research 2019;31(4):651-656.
- Stocks I. Rugose spiraling whitefly host plants. Florida Department of Agriculture and Consumer Services (FDACS), Division of Plant Industry (DPI). Available from: [http://monroe.ifas.ufl.edu/pdf/Hort/RSW\\_Host\\_Plants](http://monroe.ifas.ufl.edu/pdf/Hort/RSW_Host_Plants) 2012.
- Sundarara R, Selvaraj K. Invasion of rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae): A potential threat to coconut in India. Phytoparasitica 2017;45(1):71-74.