

Survey of New Invasive Pest Rugose Spiralling Whitefly, *Aleurodicus rugioperculatus* Martin in and around Bhubaneswar

Thalluri Revanth Sri^{1*}, Jayaraj Padhi¹, Ajit Kumar Sahoo² and Yogesh Kumar H.D.¹

¹Department of Entomology, Odisha University of Agriculture and Technology,
Bhubaneswar (Odisha), India.

²Department of Fruit Science and Horticulture Technology,
Odisha University of Agriculture and Technology, Bhubaneswar (Odisha), India.

(Corresponding author: Thalluri Revanth Sri*)

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ABSTRACT: The new invasive pest Rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin has spread in around Bhubaneswar (Odisha) since its first report and has become a serious pest in the several pockets of India. The polyphagous nature of this pest allows it to spread on various hosts effortlessly. Consequently, a survey was conducted to observe the incidence of rugose spiralling whitefly (RSW) on various crop plants in and around Bhubaneswar during 2020-21. Various sampling methods were employed to record the population dynamics of various growth stages of the pest. The intensity of RSW damage was calculated using the scale given by Central Plantation Crops Research Institute (CPCRI), ICAR, Kasaragod, Kerala. From the entire investigation it was observed that RSW has become a serious pest invading several hosts such as plantation crops, fruit crops, medicinal plants, spices, ornamentals, avenue trees, vegetables and field crops which are spreading over 24 families. Coconut, banana and guava proved to be preferred host for RSW with highest number live spirals, eggs, nymphs, pupae and adults per leaflet or leaf.

Keywords: Rugose spiralling whitefly, survey, incidence, infestation, fruit crops, ornamentals, plantation crops.

INTRODUCTION

Rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin, is a recent invasive pest, initially reported on gumbo limbo (*Bursera simaruba* L.) at Sarg from Miami-Dade County, Florida in 2009 (Francis *et al.*, 2016). RSW was first described by Martin in 2004 from samples collected in Belize on coconut palm leaves. It is believed to have originated from Central America and its mode of entry into India is unknown. However, the pest was most likely to have entered the country *via* trade in ornamental plants (Shanas *et al.*, 2016).

In India, RSW was first reported on coconut palm in Tamil Nadu at Coimbatore during September, 2016 (Sundararaj and Selvaraj, 2017). It was also found infesting banana, mango, sapota, Indian almond, custard apple and several ornamental plants in Kerala, Karnataka and Andhra Pradesh. It almost affects each and every part of the coconut palm including inflorescence, exocarp and entire under surface of leaf lamina (Selvaraj *et al.*, 2016). RSW is highly polyphagous with 118 host plants belonging to 43 plant families including economically important crops (Francis *et al.*, 2016).

Their adults are three times larger (about 2.5 mm) in size than common whiteflies and are typically lethargic. Adults are characterized by their enormous size and a pair of uneven light brown stripes across the wings. Males have elongated pincer like structures at the end

of their abdomen. Females deposit eggs in a concentric circular or spiral manner on the ventral side of the leaves and are covered with white waxy substance. Eggs are oval in shape and colour varies from creamy white to dark yellow. Nymphs are typically 1.1–1.5 mm long, although their size varies depending on instar. The nymphs are light to golden yellow in colour and generate a thick, cottony wax as well as long, thin waxy filaments which become denser over time (Stocks and Hodges 2012).

The RSW infestation ranged from 20 to 35 % in coconut and 24 to 38 % in banana in Mangaluru and Udupi districts of Karnataka (Selvaraj *et al.*, 2017). The RSW infestation ranged from 75.85 to 95.00 % on coconut, 82.93 % on banana and 63.50 to 79.00 % on guava, whereas the incidence of RSW ranged from 81.42 to 100.00 % on coconut, 83.13 to 100.00 % on banana and 53.30 to 92.00 % on guava in West Godavari district of Andhra Pradesh (Sushmitha *et al.*, 2020).

Various indigenous predators like *Pseudomallada* sp., *Cybocephalus* sp., *Diadiplosis* sp. and *Jauravia pallidula* were observed on RSW by Poorani and Thanigairaj, 2017. Predators like *Chrysoperla zastrowii* and *Dichochrysa* sp. *nr. astur* were predominantly recorded in the infested tracts of RSW in Andhra Pradesh (Krishnarao and Rao, 2019). Parasitoids like *Encarsia guadeloupae*, *E. noyesi*, *E. dispersa* were found associated with RSW (Karthick *et al.*, 2018).

The present research was conducted to know the incidence and infestation of RSW in and around Bhubaneswar on various host plants. An attempt was also made to find out the occurrence of natural enemies of RSW.

MATERIAL AND METHODS

Survey on incidence and infestation of RSW was conducted in Horticultural Research Station (HRS). All India Coordinated Research Project (AICRP) on Palms, Odisha University of Agriculture and Technology, Bhubaneswar, Coconut Development Board (CDB), Khordha and other various households in and around Bhubaneswar, which comes under the coastal zone. The incidence RSW was recorded in plantation crops, fruit crops, medicinal plants, spices, ornamentals, avenue trees, vegetables, and field crops. An attempt was also made to explore occurrence of natural enemies.

The damage intensity of RSW was recorded by observing number of egg spirals from three leaflets per palm, one each from top, middle and bottom whorls of the palm in case of coconut, whereas in case of guava and banana leaves were randomly selected from top, middle and bottom canopy of the plants/trees from North, South, East and West directions. The intensity of RSW damage was calculated using the scale given by Central Plantation Crops Research Institute (CPCRI), ICAR, Kasaragod, Kerala (Table 1).

Table 1: Damage score for RSW as per CPCRI scale.

Sr. No	Egg spirals per leaflet	Damage level
1.	< 10	Low
2.	10 - 20	Medium
3.	> 20	High

In order to observe the incidence of RSW, total number of different host plants were counted in various orchards and households in Bhubaneswar and the number of plants infested with RSW were recorded. Percentage incidence of RSW was calculated using the following formula.

$$\text{RSW incidence \%} = \frac{\text{No. of plants infested with RSW}}{\text{Total no. of plants in garden}} \times 100$$

To find out the percentage infestation of RSW, total number of leaves were counted on the crown of coconut plants, while in case of other host plants 20 leaves were counted and the leaves infested with RSW were recorded. Percentage infestation of RSW was calculated using the following formula.

$$\text{RSW infestation \%} = \frac{\text{No. of leaves infested with RSW per plant}}{\text{Total no. of leaves per plant}} \times 100$$

Number of egg spirals were recorded from three leaflets per palm, one each from top, middle and bottom whorls of the palm in case of coconut, whereas in case of guava and banana leaves were randomly selected from top, middle and bottom canopy of the plants/trees from North, South, East and West directions and averaged to number of galleries or spirals per leaflet/ leaf. Among the total number of spirals, live galleries are sorted by the presence of eggs in the spirals and the count was averaged to number of live galleries per leaflet or leaf.

Presence of eggs were observed with the help of a pocket magnifying glass (24 X) from two spirals observed on three leaflets/ leaf on each 5 randomly selected plants. The total number of eggs per leaf was calculated based on the number of spirals present on the leaf. Total number of nymphs, pupae and adults were recorded from five leaflets/ leaf on each five randomly selected plants and then averaged to number per leaflet or leaf.

RESULTS AND DISCUSSION

The survey on RSW incidence on various host plants revealed that among the different host plants infested by RSW, the highest incidence (100.00 %) was observed in seven families viz., Amaryllidaceae, Moraceae, Malvaceae, Magnoliaceae, Combretaceae, Myrtaceae and Sterlitzaceae. The crop families such as Annonaceae, Arecaceae and Sapotaceae, were recorded with more than 90 percent RSW incidence. Survey carried out at various research institutes of Bhubaneswar showed 85.00 to 100.00, 100.00 and 35.00 percent RSW incidence on coconut, banana and guava, respectively (Table 2). The present findings are well supported to the results observed by Sushmitha *et al.* (2020), who reported 81.40 to 100.00 % incidence on coconut, 100.00 % incidence on banana and 92.00 % incidence on guava in west Godavari district of Andhra Pradesh.

The survey undertaken on incidence of RSW on fruit crops (Table 4) showed that Jamun (*Syzygium cumini*) recorded highest RSW incidence (100.00 %), while phalsa observed with least RSW incidence (5.60 %). In ornamental plants (Table 5) 100.00 % RSW incidence was observed on beach, spider lilly and bird of paradise, whereas lowest incidence was found in Ixora plant (19.00 %). In case of avenue trees (Table 6) cent per cent RSW incidence was recorded on champak, kapok and Indian almond, whereas least incidence was noticed in karanj (12.53 %). The survey conducted on field crops revealed that *Saccharum officinarum* and *Zea mays* recorded 20 and 70 % RSW incidence, respectively.

The RSW infestation on coconut, banana and guava at various research institutes of Bhubaneswar was recorded 67.00 to 71.35 %, 72.00 to 81.69 % and 40 %, respectively (Table 2). The present findings are in agreement with the results of Sushmitha *et al.* (2020), who reported RSW infestation of 75.85 to 95.00 %, 82.93 % and 63.50 to 79.00 % on coconut, banana and guava, respectively in west Godavari district of Andhra Pradesh. The results of present investigation are similar with the findings of Mohan *et al.* (2017), who recorded that 60 to 70 % RSW infestation of the fronds in affected coconut gardens. The current research work derived ample support from the findings of Srinivasan *et al.* (2016) who observed 70 % infestation in banana crop.

The RSW damage intensity in the current investigations were found to be medium to high on coconut and banana and low on guava (Table 2). Similar results were also reported by Selvaraj *et al.* (2017), who

observed severe damage by RSW in coconut and banana in Mangalore and Udupi's coastal areas.

The mean number of spirals per leaflet on coconut, banana and guava was observed to be 19.97, 23.10 and 7.60 respectively in various orchards in Bhubaneswar (Table 2). These results are in close proximity with the reports of Sushmitha *et al.* (2020), who reported 20.05, 26.33 and 7.5 spirals per leaflet/leaf on coconut, banana and guava, respectively in Godavari districts of Andhra Pradesh.

The data recorded on incidence of RSW in and around Bhubaneswar revealed that the highest number of spirals per leaf (11.00) was found on neem and lowest

number of spirals was observed in aloe vera (2.00) in case of medicinal and aromatic plants. In spices, turmeric recorded with 2.00 spirals per leaf (Table 3). Among the fruit crops maximum number of spirals (23.00) was observed in banana, whereas phalsa recorded the minimum number of spirals per leaf (1.00). In vegetable crops the ivy gourd was found with 2.00 spirals per leaf (Table 4), whereas in ornamentals highest number of spirals per leaf (26.00) was noticed on bird of paradise and lowest number of spirals per leaf (1.00) was present on acahypha, jatropa, rangoon creeper, devil's ivy and garden croton (Table 5).

Table 2: Incidence and intensity of RSW in orchards of various research institutes of Bhubaneswar.

Sr. No.	Location	Incidence (%)	Infestation (%)	Spirals/ Leaflet or leaf	Live spirals/ leaflet or leaf	No. of eggs/ leaflet or leaf	No. of nymphs/ leaflet or leaf	No. of pupae/ leaflet or leaf	No. of adults/ leaflet or leaf	Intensity/ damage level
1.	AICRP on Palms	85.00	67.00	24.00	21.00	344.04	39.72	24.50	66.90	High
2.	Horticulture Research Station	100.00	71.35	18.30	16.18	355.96	41.60	27.70	68.88	Medium
3.	Coconut Development Board	100.00	69.74	17.60	16.20	340.20	36.30	22.80	62.55	Medium
	Mean	95.00	69.00	19.97	17.79	346.73	39.21	25.00	66.11	-
1.	AICRP on Palms	100.00	72.00	23.60	19.20	360.96	32.00	22.75	61.00	Medium
2.	Horticulture Research Station	100.00	81.69	22.60	20.00	400.00	38.15	28.28	68.88	High
	Mean	100.00	76.85	23.10	19.60	380.48	35.08	25.52	64.94	-
1.	AICRP on Palms	35.00	40.00	7.60	6.40	97.79	17.20	20.00	58.20	Low

Table 3: Incidence and intensity of RSW on plantation crop, medicinal plants and spices in and around Bhubaneswar.

Sr. No.	Crop	Scientific Name	Order	Family	Spirals/ leaflet or leaf	Live spirals/ leaflet or leaf	No. of eggs/ leaflet or leaf	No. of nymphs/ leaflet or leaf	No. of pupae/ leaflet or leaf	No. of adults/ leaflet or leaf	Incidence (%)
Plantation crop											
1.	Coconut	<i>Cocos nucifera</i>	Arecales	Arecaceae	23.00	18.50	449.55	32.00	24.00	68.90	70.40
Medicinal plants											
1.	Aloe*	<i>Aloe vera</i>	Asphodelaceae	Asphodelaceae	2.00	2.00	35.00	0.00	0.00	0.00	66.60
2.	Neem*	<i>Azadirachta indica</i>	Sapindales	Meliaceae	11.00	11.00	187.00	0.00	0.00	0.00	56.50
Spices											
1.	Turmeric*	<i>Curcuma longa</i>	Zingiberales	Zingiberaceae	3.00	2.00	36.60	0.00	0.00	0.00	40.20

Table 4: Incidence and intensity of RSW on fruit and vegetable crops in and around Bhubaneswar.

Sr. No.	Crop	Scientific Name	Order	Family	Spirals/ leaf	Live spirals/ leaf	No. of eggs/ leaf	No. of nymphs/ leaf	No. of pupae/ leaf	No. of adults/ leaf	Incidence (%)
Fruits											
1.	Bael*	<i>Aegle marmelos</i>	Sapindales	Rutaceae	2.00	2.00	34.00	0.00	0.00	0.00	32.50
2.	Banana	<i>Musa paradisica</i>	Zingiberales	Musaceae	23.00	21.00	430.50	34.00	23.00	81.50	70.20
3.	Custard apple	<i>Annona squamosa</i>	Magnoliales	Annonaceae	17.00	15.00	304.50	24.00	19.50	67.25	65.30
4.	Guava	<i>Psidium guajava</i>	Myrtales	Myrtaceae	16.00	15.00	292.50	24.00	14.00	54.50	81.10
5.	Jackfruit	<i>Artocarpus heterophyllus</i>	Rosales	Moraceae	10.00	9.00	189.00	15.00	12.70	12.50	51.30
6.	Jamun	<i>Syzygium cumini</i>	Myrtales	Myrtaceae	15.00	13.00	263.90	28.00	17.00	68.50	100.00
7.	Mango*	<i>Mangifera indica</i>	Sapindales	Anacardiaceae	3.00	1.00	18.00	0.00	0.00	0.00	10.50
8.	Phalsa*	<i>Grewia robusta</i>	Malvales	Malvaceae	1.00	1.00	12.00	0.00	0.00	0.00	5.60
9.	Ramphal	<i>Annona reticulata</i>	Magnoliales	Annonaceae	16.00	14.00	324.80	22.50	14.60	56.50	93.20
10.	Rose apple	<i>Syzygium malaccense</i>	Myrtales	Myrtaceae	21.50	20.50	399.75	28.50	22.50	75.80	85.50
11.	Sapota	<i>Manilkara zapota</i>	Ericales	Sapotaceae	12.00	10.00	228.00	17.00	12.00	32.55	91.30
12.	Sweet orange*	<i>Citrus sinensis</i>	Sapindales	Rutaceae	3.00	2.00	28.00	0.00	0.00	0.00	41.20
Vegetables											
1	Ivy gourd *	<i>Coccinia indica</i>	Cucurbitales	Cucurbitaceae	2.00	2.00	33.2	0.00	0.00	0.00	6.20

* Only egg stage was found

Among the avenue hosts detected the highest spirals per leaf were found on Indian almond (26.00) and least spirals per leaf was found in karanj (1.00). Highest number of spirals per leaf in field crops was found in maize (10.00) and lowest number of spirals per leaf was recorded in sugarcane (8.00) (Table 6). The mean number of live spirals per leaflet or leaf was 17.79, 19.60 and 6.40 on coconut, banana and guava, respectively in Bhubaneswar (Table 2). The present results are corroborating with the observations of Sushmitha *et al.* (2020), who reported 17.17, 19.67 and 7.50 live spirals per leaflet or leaf on coconut, banana and guava, respectively. In medicinal and aromatic plants highest number of live spirals were observed in

neem (11.00) and lowest number was found on aloe vera (2.00). In spices turmeric recorded 2.00 live spirals per leaf (Table 3). Among fruit crops banana reported maximum number live spirals per leaf (21.00) and minimum number of spirals (1.00) was recorded in both mango and phalsa. Ivy gourd was recorded with 2.00 live spirals per leaf (Table 4). Highest number of live spirals (21.00) was found on bird of paradise and butterfly palm (Table 5). In avenue trees maximum number of live spirals per leaf was present on peepal tree and minimum number of spirals present in karanj (1.00 per leaf). In field crops highest number of live spirals per leaf was found on maize (8.00) followed by sugarcane (6.50) (Table 6).

Table 5: Incidence and intensity of RSW on ornamental crops in and around Bhubaneswar.

Sr. No.	Plants	Scientific Name	Order	Family	Spiral s/ leaf	Live spirals / leaf	No. of eggs/ leaf	No. of nymph s/ leaf	No. of pupae / leaf	No. of adults / leaf	Incidence (%)
Ornamental plants											
1.	Acalypha *	<i>Acalypha macrophylla</i>	Malpighiales	Euphorbiaceae	1.00	1.00	19.50	0.00	0.00	0.00	68.20
2.	Acalypha *	<i>Acalypha wilkesiana</i>	Malpighiales	Euphorbiaceae	2.00	1.50	30.45	0.00	0.00	0.00	66.20.
3.	Ashoka *	<i>Saraca asoca</i>	Fabales	Fabaceae	5.00	3.00	0.00	0.00	0.00	0.00	53.50
4.	Beach spider lilly*	<i>Hymenocallis littoralis</i>	Asparagales	Amaryllidaceae	3.50	2.00	47.00	0.00	0.00	0.00	100.00
5.	Bird of paradise	<i>Sterlitia reginae</i>	Zingiberales	Sterlitaceae	26.00	21.00	487.20	38.50	28.90	78.50	100.00
6.	Butterfly palm	<i>Dypsis lutescens</i>	Arecales	Arecaceae	23.00	21.00	430.50	34.00	23.00	71.50	95.00
7.	Chinese fan palm	<i>Livistonia chinensis</i>	Arecales	Arecaceae	15.00	13.00	253.50	24.00	19.00	42.5	70.00
8.	Garden croton*	<i>Codiaeum variegatum</i>	Malpighiales	Euphorbiaceae	1.00	1.00	14.50	0.00	0.00	0.00	41.00
9.	Devil's ivy *	<i>Epipremnum aureum</i>	Alismatales	Araceae	1.00	1.00	6.50	0.00	0.00	0.00	0.00
10.	Dracaena*	<i>Dracaena marginata</i>	Asperagales	Asperagaceae	5.00	3.00	51.90	0.00	0.00	0.00	10.50
11.	Golden thryallis	<i>Galphimia glauca</i>	Polygalales	Malpighiaceae	3.00	2.00	8.00	16.00	5.00	16.30	53.00
12.	Ixora*	<i>Ixora chinensis</i>	Gentianales	Rubiaceae	3.00	1.50	28.95	0.00	0.00	0.00	19.00
13.	Jatropha *	<i>Jatropha curcas</i>	Malpighiales	Euphorbiaceae	1.00	1.00	21.00	0.00	0.00	0.00	41.00
14.	Philodendron	<i>Thaumatococcus bipinnatifidum</i>	Alismatales	Araceae	10.00	8.50	157.25	18.00	12.00	16.60	65.00
15.	Rangoon creeper*	<i>Combretum indicum</i>	Myrtales	Combretaceae	1.00	1.00	15.50	0.00	0.00	0.00	0.00
16.	Song of India *	<i>Dracena reflexa</i>	Asperagales	Asperagaceae	4.00	3.00	49.50	0.00	0.00	0.00	11.50

* Only egg stage was found

The mean number of eggs per leaflet or leaf was 340.20 to 355.96, 360.96 to 400 and 97.79 on coconut, banana and guava, respectively in Bhubaneswar (Table 2). This result derives support from the findings of Srinivasan *et al.* (2017), who observed 10.00 to 20.00 egg spirals per leaflet in Kenthali Dwarf (KTD). In medicinal and aromatic plants, the highest number of eggs per leaf (187.00) was obtained on neem and lowest number of eggs per leaf (35.00) was recorded in aloe vera (Table 3). Among the fruit crops highest number of eggs were recorded on banana (430.00) and lowest number of eggs per leaf was found on phalsa (12.00). In ivy gourd 33.20 eggs were found per leaf (Table 4). Among the ornamentals, highest number of eggs per leaf was found on bird of paradise (487.20) and least number of eggs per leaf was recorded from golden thryallis (16.00) (Table 5). In avenue trees highest number of eggs per leaf was found on Indian almond (579.80) and karanj recorded lower number of eggs per leaf (12.00). In field crops maize was observed with highest number of eggs per leaf (148.00) and sugarcane was reported with least number of eggs per leaf (87.75) (Table 6). The survey conducted on RSW incidence on medicinal aromatic

plants such as neem and aloe vera in and around Bhubaneswar recorded only egg stages. These findings are in accordance with Elango and Nelson (2020), who stated that neem supported only the egg stage of RSW. Among the fruit crops, mango, citrus, bael and phalsa supported only egg stages, which are in accordance with the results of Srinivasan *et al.* (2017) who stated that mango couldn't support all life stages in Tamil Nadu. The present research is almost in the line of findings by Elango *et al.* (2019), who stated that amongst all host plants coconut and banana are the most preferable hosts to RSW.

In the present study only four ornamental plants were found supporting all the life stages of RSW, while twelve others did not support all the stages. This result is in agreement with the findings of Krishnarao *et al.* (2019), who stated that some ornamental plants discouraged the RSW development but adult whiteflies preferred for feeding and laying eggs. In field crops such as maize and sugarcane except eggs, no other growth stages were recorded. The results are similar to the findings of Bhavani *et al.* (2020), who reported that distinctive egg spirals were seen on leaves, but no

developmental stages like larvae or pupae were observed.

The number of RSW nymphs per leaflet or leaf on coconut, banana and guava were 36.30 to 41.60, 32.00 to 38.15 and 17.20, respectively in different research institutes of Bhubaneswar. Number of RSW pupae per leaflet or leaf was 22.80 to 27.70, 22.75 to 28.28 and 20.00 on coconut, banana and guava, respectively in Bhubaneswar (Table 2). In fruit crops highest number of RSW nymphs per leaf (34.00) was recorded on banana and lowest number of nymphs per leaf (15.00) was found on jack fruit (Table 4). Among the ornamentals bird of paradise recorded highest number of nymphs per leaf (38.50) and lowest number was noticed on golden thryallis (12.00) (Table 5). In avenue trees maximum number of nymphs per leaf (36.50) was recorded on Indian almond while cassia registered minimum number (21.00) (Table 6). Among the fruit crops highest number of pupae per leaf was recorded on banana (23.00) and lowest number were found on sapota (12.00) (Table 4). In ornamentals bird of paradise registered maximum number of pupae per leaf (28.90) while minimum number was recorded on golden thryallis (5.00) (Table 5). Amongst avenue trees highest number of pupae per leaf was found on Indian almond (26.00) while cassia recorded lowest number (14.60) (Table 6). The mean number of RSW adults per

leaflet or leaf was 66.11, 64.94 and 58.20 on coconut, banana and guava, respectively in various research institutes (Table 2). Highest number of adults per leaf was recorded on banana (81.50) and lowest number was found on jack fruit (12.50) in case of different fruit crops recorded in and around Bhubaneswar (Table 4). Among the ornamentals bird of paradise registered maximum number of adults (78.50) while minimum number of adults per leaf was found on golden thryallis (16.30) (Table 5). In avenue trees highest number of adults per leaf was found on Indian almond (83.50) whereas cassia recorded lower number of adults per leaf (32.00) (Table 6). The present results are in conformity with the findings of Sushmita *et al.* (2020), who reported RSW population (all the growth stages) of 121.60 to 127.25, 109.37 and 144 to 172.20 per leaflet on coconut, banana and guava, respectively.

In the present study several natural enemies were encountered with RSW such as predators like *Cybocephalus* spp., *Chrysoperla* sp., *Nephaspis oculata*, *Oxyopes salticus* and *Uloborus* sp. and a parasitoid, *Encarsia* sp. in and around Bhubaneswar. The present results derive support from the findings of Elango and Nelson (2020); Taravati *et al.* (2016). Elango and Nelson recorded a cybocephalid associated with RSW and Taravati *et al.* observed predation of RSW by *Nephaspis oculata* (Table 7).



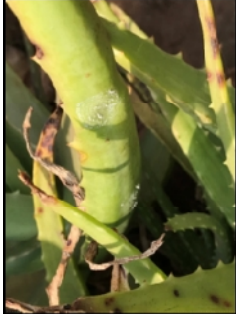

















Table 6: Incidence and intensity of RSW on avenue trees and field crops in and around Bhubaneswar.

Crop	Common name	Scientific Name	Order	Family	Spirals/ leaf	Live spirals/ leaf	No. of eggs/ leaf	No. of nymphs/ leaf	No. of pupae/ leaf	No. of adults/ leaf	Incidence (%)
Avenue trees											
1	Cassia	<i>Cassia abbreviate</i>	Fabales	Fabaceae	17.00	13.00	273.00	17.00	14.60	32.00	43.20
2	Champak	<i>Magnolia champaca</i>	Magnoliales	Magnoliaceae	21.00	17.75	417.13	28.00	18.00	65.6	100.00
3	Indian almond	<i>Terminalia catappa</i>	Myrtales	Combretaceae	26.00	22.00	539.00	32.00	21.50	61.80	100.00
4	Kapok	<i>Ceiba pentandra</i>	Malvales	Malvaceae	23.00	18.00	459.00	30.50	18.5	64.00	100.00
5	Karanj *	<i>Pongamia pinnata</i>	Fabales	Fabaceae	1.00	1.00	12.00	0.00	0.00	0.00	12.53
6	Peepal	<i>Ficus religiosa</i>	Rosales	Moraceae	25 .00	22.30	579.80	36.50	26.00	83.50	100.00
Field crops											
1	Sugar cane*	<i>Saccharum officinarum</i>	Poales	Poaceae	8.00	6.50	87.75	0.00	0.00	0.00	20.00
2	Maize*	<i>Zea mays</i>	Poales	Poaceae	10.00	8.00	148.00	0.00	0.00	0.00	70.00

* Only egg stage was found

Table 7: Natural enemies recorded during survey.

Sr. No.	Natural Enemy	Family	Order
1.	<i>Chrysoperla</i> sp.	Chrysopidae	Neuroptera
2.	<i>Cybocephalus</i> spp.	Nitidulidae	Coleoptera
3.	<i>Encarsia</i> sp.	Aphelinidae	Hymenoptera
4.	<i>Nephaspis oculata</i>	Coccinellidae	Coleoptera
5.	<i>Oxyopes salticus</i>	Oxyopidae	Araneae
6.	<i>Uloborus</i> sp.	Uloboridae	Araneae

			
Coconut leaf	Coconut fruit	Aloe vera	Neem
			
Turmeric	Bael	Banana Leaf	Banana fruit
			
Custard apple	Guava	Jack fruit	Jamun
			
Mango	Phalsa	Ramphal	Water apple
			
Sapota	Sweet orange	Ivy gourd	Acalypha (red)

			
Acalypha (green)	Ashoka	Beach spider lilly	Bird of paradise
			
Garden croton	Dracaena	Devil's ivy	Golden thryallis
			
Butterfly palm	Chinese fan palm	Ixora	Jatropha
			
Philodendron	Rangoon creeper	Song of India	Cassia
			
Champak	Indian almond	Kapok leaf	Kapok pod

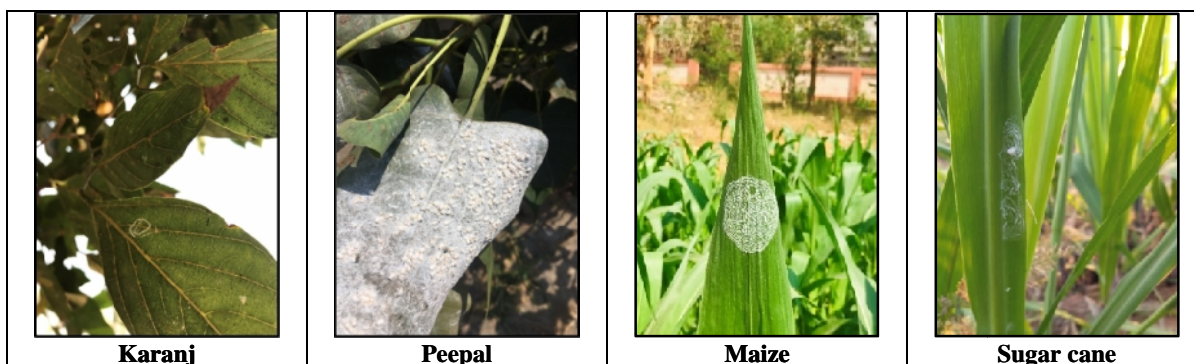


Fig. Rugose spiralling whitefly incidence in various host plants in Bhubaneswar

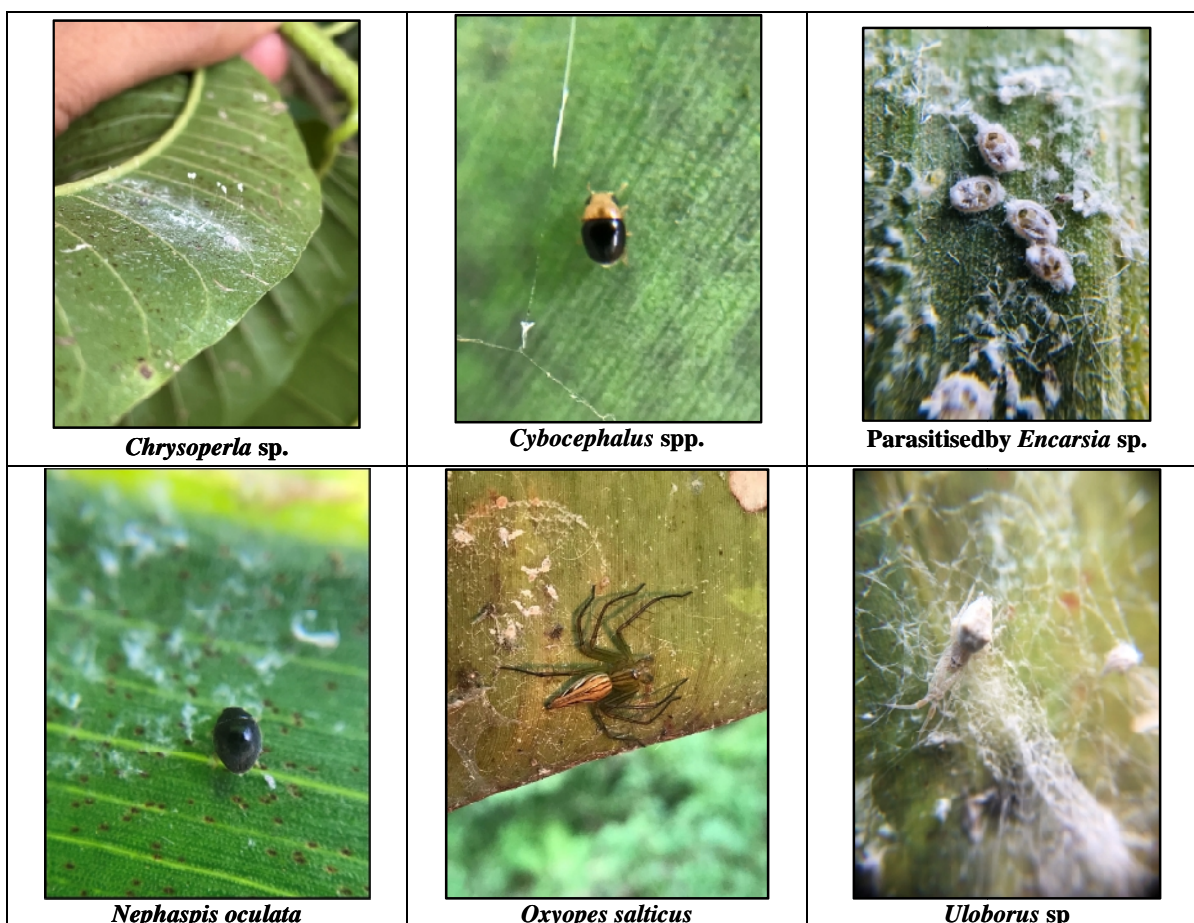


Fig. Natural enemies associated with rugose spiralling.

CONCLUSION

From the entire investigation it may be concluded that RSW has become a serious pest invading several hosts such as plantation crops, fruit crops, medicinal plants, spices, ornamentals, avenue trees, vegetable and field crops which are spreading over 24 families.

FUTURE SCOPE

Rugose spiralling whitefly is an invasive pest that poses a significant threat to the agricultural ecosystem; consequently, understanding the pest through the survey of its host ranges, population dynamics, and natural enemies aids in pest management and to control its further spread.

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Conflict of Interest. None.

REFERENCES

- Elango, K., & Nelson, S. J. (2020). Effect of Host Plants on the Behaviour of Rugose Spiralling Whitefly (*Aleurodicus rugioperculatus* Martin) and their Natural Enemies. *Research Journal of Agricultural Sciences*, 11(1): 120-123.
- Elango, K., Nelson, S. J., Sridharan, S., Paranidharan, V., & Balakrishnan, S. (2019). Biology, distribution and host range of new invasive pest of India

- coconut rugose spiralling whitefly *Aleurodicus rugioperculatus* Martin in Tamil Nadu and the status of its natural enemies. *International Journal of Agriculture Sciences*, 11(9): 8423-8426.
- Francis, A. W., Stocks, I. C., Smith., T. R., Boughton, A. J., Mannion, C. M., & Osborne, L. S. (2016). Host plants and natural enemies of Rugose spiraling whitefly (Hemiptera: Aleyrodidae) in Florida. *Florida Entomologist*, 99(1): 150-153.
- Karthick, K. S., Chinniah, C., Parthiban, & Pm, Ravikumar, A. (2018). Newer report of Rugose Spiraling Whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in India. *International Journal of Research Studies in Zoology*, 4(2): 12-16.
- Krishnarao, G., & Chalapathirao, N. B. V. (2019). Surveillance and Eco-Friendly Management of new Invasive Alien Pest, Rugose Spiralling Whitefly, *Aleurodicus rugioperculatus* Martin: Inherent Menace. *Journal of Applied Zoological Researches*, 30(2): 148-158.
- Poorani, J., & Thanigairaj, R. (2017). 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*, 31(1): 1-4.
- Selvaraj, K., Ankita., G., Venkatesn, T., Jalali, S. K., Sundararaj, R., Chandish, R., & Ballal (2017). First record of invasive rugose spiralling whitefly *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) along with parasitoids. *Karnataka Journal of Biological Control*, 31(2): 74-78.
- Selvaraj, K., Sundararaj, R., Venkatesan, T., Ballal, C.R., Jalali S. K., Gupta, A., & Mrudula, K. (2016). Potential natural enemies of the invasive rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin in India. *Journal of Biological Control*, 30(4): 236-239.
- Shanas, S., Job, J., Joseph, T., & Krishnan, G. A. (2016). First report of the invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) from the Old World. *Entomon*, 41(4): 365-368.
- Stocks, I. C., & Hodges G. (2012). The rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin, a New Exotic Whitefly in South Florida (Hemiptera: Aleyrodidae), pest alert created 7-February-2012, DACS-P-01745.
- Sundararaj, R., & Selvaraj K. (2017). Invasion of rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae): a potential threat to coconut in India. *Phytoparasitica*, 45(1): 71-74.
- Sushmitha, S., Sujatha, A., Emmanuel, N., Uma, K. K., & Suneetha, D. R. S. (2020). Incidence, intensity and host dynamics of rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in Andhra Pradesh. *Pest Management in Horticultural Ecosystems*, 26(1): 109-120.
- Taravati, S., Mannion, C., Osborne, L., & McKenzie, C. (2016). Feeding and development of *Nephaspis oculata* (Coleoptera: Coccinellidae) on rugose spiraling whitefly (Hemiptera: Aleyrodidae). *Florida Entomologist*, 99(3): 516-521.

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