



Status of Rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin) in Konkan region of Maharashtra

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ABSTRACT: Systematic surveys of three different coconut gardens were carried out during 2018 to 2021 to study the status of rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin in Ratnagiri district of Maharashtra, India. The data indicated that the incidence and intensity of RSW had increased during the rainy season which recorded 31.9 and 18.1 per cent, respectively in October. It has gradually declined after January. Rugose spiralling whitefly populations (34.1 nos.) were maximum in the month of April. *Encarsia* parasitism was observed maximum during February (40%) as it has increased from October (6.8 %) onwards. The spiders (3.7 nos.) and predators (5.0 nos.) were found maximum in April, 2020. The maximum temperature had positive impact on the incidence and intensity of RSW. However intensity of RSW was negatively correlated with rainfall and evening humidity. *Encarsia* parasitism of RSW was negatively correlated with the minimum temperature.

Keywords: *Aleurodicus rugioperculatus*, biological suppression, coconut, invasive whiteflies, natural control, Rugose whitefly

INTRODUCTION

Coconut is an important plantation crop which is being mainly cultivated in southern and coastal states in India. It is the most versatile tree crop cultivated in the tropics providing livelihood and employment securities to the rural agrarian mass in the region. The agricultural economy of India is vulnerable to the threat posed from the introduction of exotic pests/diseases. Mandal (2011) listed 116 exotic insect species in India. Among the insect pests, exotic whiteflies have invaded several countries causing direct losses in agriculture, horticulture and forestry. Currently, there are 442 species of whiteflies belonging to 63 genera known from India; of these, a few are economically important. Two invasive whiteflies viz., the spiraling whitefly, *Aleurodicus dispersus* Russell (Hemiptera: Aleyrodidae) (David and Regu, 1995) and the solanum whitefly, *Aleurothrixus trachoides* (Back) (Hemiptera: Aleyrodidae) (Dubey and Sundararaj, 2015). Recently, an infestation of yet another invasive species, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae), commonly known as rugose spiralling whitefly (RSW) was observed by Sundararaj and Selvaraj (2017). Initially, this whitefly in several coconut farms in the Coimbatore district, Tamil Nadu, India during the month of September, 2016. Subsequently, the whitefly population increased greatly and spread across the coconut palm growing areas of Pollachi region mostly on high yielding hybrid varieties of coconut was observed on coconut palm (*Cocos nucifera* L). Karthik *et al.* (2018) was detected rugose spiralling whitefly

from coastal areas of Karnataka, Kerala and Andhra Pradesh. It was observed from several districts of Assam (Pathak, 2019). Rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin was originally described from Belize (Martin, 2004) and It is mainly infests coconut palms and other broad-leaved hosts in its native range and naturally distributed in Belize, Guatemala, Mexico (Martin, 2008) and subsequently, it has spread to 22 other countries, India is the only country in the Oriental region where the whitefly has been introduced. During August, 2017, infestation of

this pest was observed on coconut seedling and later on it was spread to other crop viz., banana, custard apple, mango, cashew nut, almond, areca palm and bush pepper in Maharashtra. South West coastal regions of India comprising parts of Kerala, Karnataka, Goa, Maharashtra and Maharashtra - Gujarat border by Chakravarthy *et al.* (2017). It has become an escalating problem for coconut farmers. Feeding by this pest not only causes stress to its host plant, but the excessive production of wax and honeydew creates an enormous nuisance in infested areas. The presence of honeydew results in the growth of fungi called sooty mold, which then turns everything in the vicinity covered with honeydew black with mold. Hence, present experimental research work was carried out on 'Surveillance and assessment of rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin) on coconut' with a view to study the severity of its infestations and impact on coconut cultivation in Konkan region of Maharashtra.

MATERIALS AND METHODS

Surveillance and assessment of rugose spiralling whitefly (RSW) (*Aleurodicus rugioperculatus* Martin) on coconut was carried out at Regional Coconut Research Station, Bhatye Dist. Ratnagiri, Maharashtra, India. during 2018 to 2021. Fixed plot surveys on rugose spiralling whitefly were undertaken in three different coconut gardens at monthly interval. Four to six year aged coconut five palms in each location were considered for recording the observations. Percent incidence of RSW on leaves /palms was calculated by recording number of leaves infested by RSW/total leaf per palm x100. Percent Intensity of pest damage from three pest infested leaves per palm from the outer/middle whorl representing three directions (no. of leaflets infested by RSW/total leaflets per leaf). Four leaflet from each observed sample leaf (total of 4 leaflet/palm (20 leaflets/plot) were collected and brought to laboratory for assessment of live colonies *viz.*, eggs, nymphs, adults and natural enemies like spiders, predators, *Encarsia*. Thus generated data were subjected for statistical analysis. Palm indexing/grading was done as high (>20 live RSW colonies/leaflet; Grade 3), medium (10-20 live RSW colonies/leaflet; Grade 2), low (< 10 live RSW colonies/leaflet; Grade1) and no colony (Grade 0).

RESULTS AND DISCUSSION

The infestation of RSW was maximum on lower leaves of 4-6 year old coconut palms and gradually increased from June 2018 onwards. However, maximum incidence, intensity and grade pest intensity of 77.9 per cent, 73.2 per cent and 1.85, respectively were recorded in December, 2018 and it had suddenly declined (58, 70 and 1.40, respectively) in January, 2019. Alagar *et al.*, (2020) studied the intensity of infestation of RSWF was significantly high in Tirunelveli (70.5%) and Kanniyakumari district (75.8%) during 2018-19 and 2019-20, respectively. Later on its increasing trends showed up to December which noticed 29.8 and 18.9 per cent, respectively. The minimum infestation of RSW was observed (Incidence 19.9%, intensity 0.9% and grade pest intensity 0.30) in June, 2018. The average incidence 39.7 per cent, intensity 27.8 per cent and 1.01 grade pest intensity (medium) were noticed during the year 2018-19 (table 1). The maximum RSW eggs and nymphs was recorded 65.5 and 46.5, respectively in February, 2019. Whereas, minimum was noticed in June, 2018 (Eggs 2.1 and nymphs 1.8). The natural enemies like spiders and predators was recorded maximum 7.0 and 3.0, respectively in March, 2019. However, it was recorded minimum 0.7 and nil in June, 2018, respectively. The maximum total RSW population (144 nos.) was recorded in February, 2019 whereas, minimum (5.5 nos.)

was found in June 2018.

The table 2 indicated that the incidence of rugose spiraling whitefly (RSW) was noticed in the range of 2.7 to 46.5 per cent. However, intensity of RSW was recorded 0.1 to 46.8 percent from April, 2019 to March, 2020. The maximum incidence and intensity were recorded 46.5 per cent and 46.8 per cent, respectively in April 2019. Whereas, minimum incidence and intensity were observed in July 2019 which was 2.7 and 0.1 per cent, respectively. The average pest infestation *viz.*, incidence, intensity, grade pest intensity, eggs, nymph and adults were recorded 18.3, 12.4, 0.52, 4.5, 14.7 and 9.1 per four leaflets, respectively. Stocks and Hodges, 2012 found that the RSW has been classified at the serious threat for coconut palm including many other host plants. The Grade pest intensity was recorded low during the surveyed period except in April, 2019 and January 2020 was recorded medium. The spiders, predators and *Encarsia* were recorded 2.5, 1.8 and 5.1 per cent, respectively during the survey. The maximum RSW eggs (11.6) and adults (27.6) were recorded in April 2019. However minimum (1.1 and 3.3, respectively) was noticed in March, 2020. The maximum RSW populations (64.2 nos.) were noticed in April 2019. Whereas, minimum (4.6 nos.) was found in March 2020. Highest *Encarsia* parasitism (9.3%) was observed in June 2019. However, Lowest parasitism (3.4%) was found in September, 2019. The maximum natural enemies like spiders (7.3) and predators (9.6) were recorded in April 2019. Mondal *et al.* (2020) revealed that a high population of neuropteran predators, few parasitoids and some Phytoseiid mites as natural enemies for the rugose spiralling whitefly in coconut. However, it was recorded minimum 0.4 and 0.1, respectively in February 2020.

The data presented in table 3 revealed that the incidence of rugose spiralling whitefly (RSW) was noticed in the range of 6.6 to 57.6 per cent. However, intensity of RSW was ranges 2.9 to 36.2 per cent from April 2020 to March 2021. The maximum incidence and intensity were recorded 57.6 and 36.2 percent, respectively in November, 2020. Elango *et al.* (2019) found that the rugose spiralling whitefly incidence was high in Coimbatore district followed by Tiruppur and Erode. Whereas, minimum incidence (6.6%) and intensity (2.9%) was observed in June 2020. Rugose spiralling whitefly infestation was not noticed in July, August & September, 2020 due to heavy rainfall at Konkan region of Maharashtra. The average RSW pest records *viz.*, incidence, intensity, grade index, total no. of live colonies, *Encarsia* parasitism (%), spiders and predators were recorded 17.8, 11.7, 0.38, 11.3, 25.3, 0.5 and 0.2 per four leaflet, respectively. The low grade index

Table 1. Extent of infestation of coconut rugose spiralling whitefly and their natural enemies (2018-19)

Month	Incidence of RSW (%)	Intensity of RSW (%)	Grade Pest Intensity	Live colony/ four leaflets			Natural enemies/ four leaflets		
				Eggs	Nymph	Adult	Total	Spider	Predators
June, 18	19.9	0.90	0.30	2.1	1.8	1.6	5.5	0.7	0.0
July, 18	20.1	1.93	0.53	2.8	4.3	1.9	9.0	1.0	0.0
Aug., 18	21.6	0.79	0.63	4.5	4.0	1.9	10.4	0.7	0.1
Sept., 18	31.1	1.92	1.23	7.0	14.8	5.5	27.3	2.9	0.4
Oct., 18	42.3	1.70	1.35	8.8	21.3	7.6	37.7	3.6	0.3
Nov., 18	59.2	1.92	1.55	13.1	21.7	9.7	44.5	3.3	0.7
Dec., 18	77.9	73.2	1.85	11.0	24.2	33.3	68.5	3.3	1.3
Jan., 19	58.0	70.0	1.40	2.3	22.2	23.0	47.5	0.7	0.6
Feb., 19	35.1	66.7	0.88	65.5	46.5	32.0	144	6.0	3.0
Mar., 19	31.9	59.4	0.45	7.0	20.0	35.5	62.5	7.0	3.0
Mean ± SE	39.7 ± 6.5	27.8 ± 11.3	1.01 ± 0.1	12.4 ± 6.3	18.0 ± 4.3	15.2 ± 4.7	45.7 ± 13.6	2.9 ± 0.7	1.1 ± 0.3

Table 2. Extent of infestation of coconut rugose spiralling whitefly and their natural enemies (2019-20)

Month	Incidence of RSW (%)	Intensity of RSW (%)	Grade Pest Intensity	Live colony/ four leaflets				<i>Encarsia</i> parasitism (%)	Natural enemies/ four leaflets	
				Eggs	Nymph	Adult	Total		Spider	Predators
April, 19	46.5	46.8	1.38	11.6	25.0	27.6	64.2	7.3	7.3	9.6
May, 19	19.2	33.3	0.23	4.0	26.2	9.3	39.5	6.0	2.3	2.6
June, 19	9.1	22.8	0.19	5.6	32.6	16.0	54.2	9.3	2.3	1.3
July, 19	2.7	0.1	0.11	0.0	10.0	9.3	19.3	0.0	1.6	0.3
Aug., 19	2.8	0.1	0.13	0.0	10.3	11.6	21.9	0.0	3.3	2.3
Sept., 19	19.0	2.9	0.89	4.2	17.4	9.0	30.6	3.4	0.8	0.4
Oct., 19	27.3	8.2	0.56	7.9	5.4	6.8	20.1	3.6	4.0	1.3
Nov., 19	27.0	8.4	0.56	8.4	6.1	7.4	21.9	4.6	4.3	1.3
Dec., 19	22.2	8.4	0.53	2.2	10.2	4.6	17.0	8.6	2.6	2.6
Jan., 20	24.9	9.7	1.20	7.6	26.6	7.26	41.5	5.1	0.8	0.4
Feb., 20	10.9	4.4	0.40	1.4	3.7	0.73	5.83	8.0	0.4	0.1
March, 20	9.0	3.9	0.13	1.1	3.3	0.26	4.69	6.3	0.4	0.0
Mean ± SE	18.3 ± 3.7	12.4 ± 4.3	0.52 ± 0.1	4.5 ± 1.1	14.7 ± 3.1	9.1 ± 2.1	28.3 ± 5.5	5.1 ± 0.9	2.5 ± 0.6	1.8 ± 0.7

Table 3. Extent of infestation of coconut rugose spiralling whitefly and their natural enemies

Months	Incidence of RSW (%)	Intensity of RSW (%)	Grade Index	No. of live colonies				<i>Encarsia</i> parasitism (%)	Natural Enemies	
				Eggs	Nymphs	Adults	Total		Spiders	Predators
April, 20	8.2	3.2	0.10	0.6	2.2	1.2	4.0	5.4	0.2	0.4
May, 20	7.7	3.1	0.20	0.6	4.0	1.6	6.2	5.0	0.4	0.4
June, 20	6.6	2.9	0.20	1.4	4.6	0.8	6.8	21.7	0.4	0.2
July, 20	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug., 20	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sept., 20	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct., 20	36.6	28.1	0.68	5.2	5.0	2.5	12.7	10.0	0.4	0.5
Nov., 20	57.6	36.2	1.15	18.7	16.1	4.7	39.5	35.8	1.1	0.7
Dec., 20	37.5	29.4	0.63	6.6	9.3	4.2	20.1	46.0	1.6	0.4
Jan., 21	18.8	8.2	0.42	5.6	3.8	2.0	11.4	40.5	0.6	0.0
Feb., 21	21.6	6.8	0.37	5.8	7.6	1.1	14.5	72.0	0.8	0.3
Mar., 21	19.1	23.2	0.90	8.4	8.0	4.0	20.4	68.0	0.6	0.0
Mean ± SE	17.8 ± 5.4	11.7 ± 4.0	0.38 ± 0.1	4.4 ± 1.6	5.0 ± 1.4	1.8 ± 0.5	11.3 ± 3.4	25.3 ± 8.0	0.5 ± 0.1	0.2 ± 0.0

Table 4. Overall mean infestation of coconut rugose spiralling whitefly and natural enemies with weather factors

Month	Incidence (%)	Intensity (%)	RSW population	<i>Encarsia</i> (%)	Spiders	Predators
April	27.3	25	34.1	6.3	3.7	5.0
May	13.4	18.2	22.8	5.5	1.3	1.5
June	7.8	12.8	30.5	15.5	1.1	0.7
July	1.3	0.05	9.6	0.0	0.8	0.1
August	1.4	0.05	10.9	0.0	1.3	0.8
September	9.5	1.4	15.3	1.7	1.2	0.2
October	31.9	18.1	16.4	6.8	2.6	0.7
November	42.3	22.3	30.7	20.2	2.9	0.9
December	29.8	18.9	18.5	27.3	2.5	1.4
January	21.8	8.9	26.4	22.8	0.8	0.3
February	16.2	5.6	10.1	40.0	2.4	1.1
March	14.0	13.5	12.5	37.1	2.6	1.0
Max.Tem.(°C)	0.70 *	0.81*	0.59	0.55	0.53	0.43
Min.Tem.(°C)	-0.14	0.11	0.32	-0.83	-0.15	0.13
Mor.Hum. (%)	-0.64	-0.45	-0.17	0.03	-0.32	0.05
Eve.Hum. (%)	-0.71*	-0.73*	-0.51	-0.60	-0.53	-0.48
Rainfall (mm)	-0.73*	-0.72*	-0.39	-0.63	-0.60	-0.41

* Significant

was noticed throughout the year except November 2020, where recorded medium (1.15). The highest *Encarsia* parasitism (46%) was observed in December, 2020. *E. guadeloupae* was found as a dominant one with highest parasitism (20-60%) in coconut and banana crops by Sundararaj *et al.*, 2017. The maximum RSW eggs, nymphs and no. of RSW populations was noticed 18.7, 16.1 and 39.5, respectively in November, 2020. Whereas, it was recorded minimum (0.6, 2.2 and 4.0, respectively) in April 2020.

The generated overall data (table 4) indicated that the incidence and intensity of RSW was recorded maximum on lower leaves of coconut palms. This results was supported by previous workers Srinivasan *et al.* (2016), Elango *et al.*, (2019) and Krishnarao and Chalapathi Rao (2019). The infestation was very severe on lower leaves as compared to that of the middle and upper young leaves in dwarf and hybrid coconut palm which are about 4 to 6 years old observed by Sundararaj and Selvaraj (2017). It has increased over of rainy season which recorded 31.9 and 18.1 per cent, respectively in October. Srinivasan *et al.* (2016) reported that prolonged dry spell during June to September 2016, after deficit rainfall (69%) coupled with decreased relative humidity seem to favour the spread of the pest in coconut plantations. January onwards, its incidence and intensity were initiated from 21.8 and 8.9 per cent, respectively after that it was gradually declined. In the month of April its populations attained a major peak with increased of temperature. The maximum

rugose spiralling whitefly population was noticed in the month of April (34.1 nos.). The lowest populations was recorded in July (9.6 nos.). After that it was gradually increased from August (10.9 nos.) where it attended major peak (30.7) in November. Later on, it was suddenly declined which noticed (101 nos.) in February. *Encarsia* parasitism was observed maximum during February (40%) its increased after rainy season, particularly in October (6.8%) onwards. The spiders and predators were recorded maximum in April which noticed 3.7 and 5.0, respectively. However, it was observed minimum (0.8 and 0.1, respectively) in July. Similarly, many natural enemies such as parasitoids, *E. guadeloupae*, *E. noyesi*, *Aleuroctonus* spp.; predators *viz.*, *Nephaspis oculata*, *Azya orbigera orbigera*, *Chilocorus cacti*, *Cryptolaemus montrouzieri*, *Delphastus pallidus*, *Harmonia axyridis*, *Hyperaspis bigeminata*, *Cybocephalus* sp. and chrysopid, *Ceraeochrysa* spp. in Florida associated with RSW by Antonio *et al.* (2016), Taravati *et al.*, (2013) and Stocks (2017). The natural parasitism by the parasitoids *Encarsia guadeloupae* (V.) and *Encarsia dispersa* (P.) with 5-15 per cent in coconut other commonly found natural enemies *viz.*, *Stethorus* sp. associated with mites and *Dichochrysa aster* reported by Selvaraj *et al.* (2017). Honeydew also attracts ants and wasps that protect the whiteflies from their natural enemies Srinivasan *et al.* (2016).

The incidence and intensity of RSW was positively correlated with maximum temperature. However, rainfall and evening humidity had negative impact

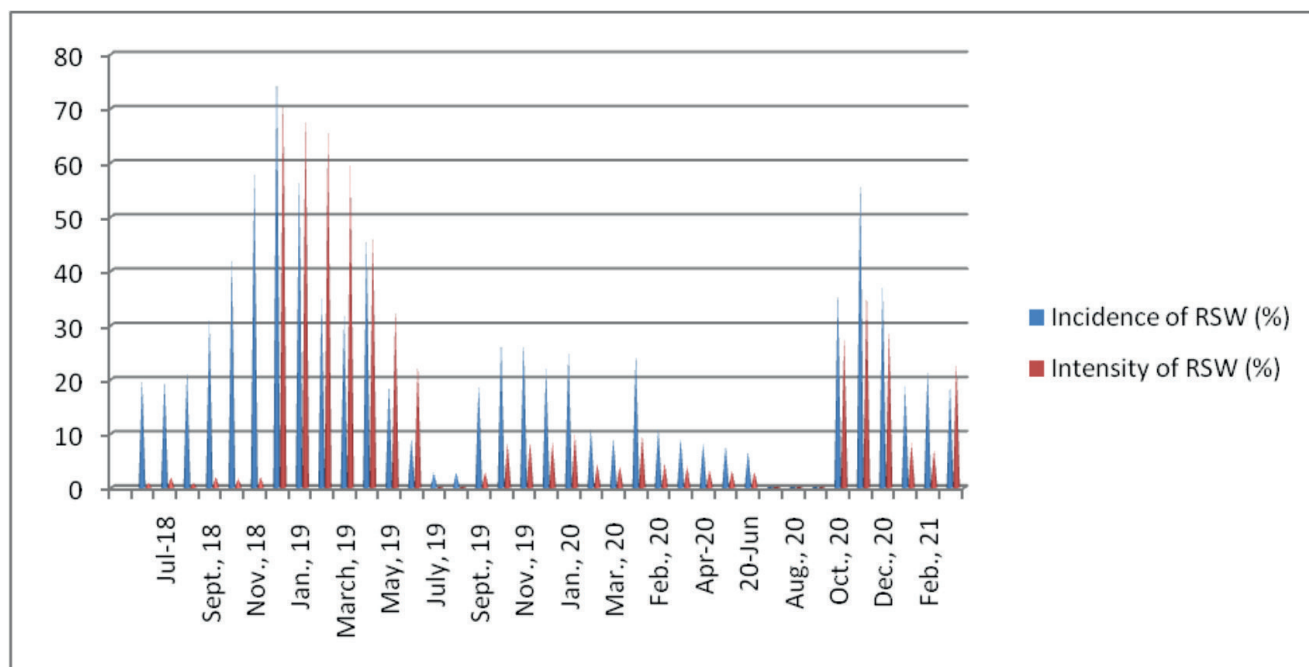


Fig.1. Status of Rugose spiralling whitefly (RSW) in Konkan region during 2018-21

on the incidence and intensity of RSW. The minimum temperature was negative significantly correlated with *Encarsia* parasitism of RSW. Morade (2014) noticed the incidence of spiralling whitefly occurred throughout the year except 44th meteorological week on guava. However, the peak period was noticed from first week of March to last week May. The correlation study with weather parameters showed significant positive correlation with maximum temperature and significant negative correlation with relative humidity (morning and afternoon) and rainfall.

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