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Survey of rugose spiralling whitefly, *Aleurodicus rugioperculatus* (Martin) on coconut in Konkan region

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Abstract
The intensive survey of rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* (Martin) was carried out in five districts of the Konkan region *viz*., Sindhudurg, Ratnagiri, Raigad, Thane and Palghar etc. during January, 2021 to assess the intensity of infestation and damage grade index. The intensity of infestation was statistically low in Thane (37.87%) followed by Sindhudurga (41.51%) and Ratnagiri (52.14 %) district. The highest intensity of infestation was recorded in Palghar (76.86%) followed by Raigad (74.50%). The damage grade index of all districts was medium. The maximum damage grade index was recorded in Raigad district (1.74) while the minimum was recorded in the Sindhudurga district (1.02). The damage grade index of Thane, Ratnagiri and Palghar were 1.56, 1.65 and 1.71, respectively.

Keywords: Survey, RSW, coconut, Konkan region

Introduction
Coconut (*Cocos nucifera* L.) is eulogized as the 'Kalpavriksha', the 'Tree of life', due to its multifarious utilization as food, fuel, medicine, timber, and other utility purposes of different parts from root to leaves, from tender nut water to outer husk, etc. offers scope for sustaining the livelihood of growers, farm communities and industries in major coconut growing countries of the world. India occupies the premier position in the world, overtaking Indonesia and the Philippines, the other two prominent coconut-growing countries (Raghavi *et al*., 2019) [2]. Coconut is one of the major plantation crops in India with a total cultivated area of 2082.11 thousand hectares with a production of 23904.10 million nuts. Maharashtra occupies the 7th place in area and the 9th in production with the annual production of 209.87 million nuts over a period of 33 years from 1986-87 to 2018-2019, the area under coconut has increase from 6900 ha to 43320 ha and production from 76.32 million nuts to 209.87 million nuts (Shinde *et al*., 2020) [4]. The total area under coconut in the Konkan region is about 25035 hectares with a production of 1597.73 lakh nuts (Anonymous, 2016) [1]. In August-September, 2016, one invasive rugose spiraling whitefly (RSW), *Aleurodicus rugioperculatus* Martin (Aleyrodidae: Hemiptera) found heavily infesting coconut palm (*Cocos nucifera* L.) for the first time from India (Sundararaj and Selvaraj, 2017) [6]. Severe damage was noticed in the coastal areas of Mangalore and Udupi and the infestation ranged from 20-35 percent in coconut. (Selvaraj *et al*., 2017) [3]. Hence, the investigation was undertaken to study the intensity of infestation and damage grade index of RSW on coconut in different districts of Konkan region.

Material and Methods
An intensive survey was undertaken during January 2021 in five districts of Konkan region *viz.*, Sindhudurga, Ratnagiri, Raigad, Thane and Palghar. The survey was carried out to record the intensity of infestation of RSW on the coconut. For the survey, five villages from five tehsils of each district were selected. Five plantations were selected randomly in five locations in each village. The intensity of infestation and damage grade index were assessed in randomly selected twenty palms from each plantation. To study the intensity of infestation of *A. rugioperculatus*, a standard evaluation system was formulated based on the per cent intensity of infestation as follows:

$$\text{Intensity of infestation} = \frac{\text{Number of fronds infested/palm}}{\text{Total number of frond observed/palm}} \text{X } 100$$

The damage grade index was calculated using the damage rating scale for RSW by Srinivasan *et al.*, 2016. A damage rating scale was developed based on the number of egg spirals noticed on the third or fourth frond from the bottom focusing ten leaflets so as to give due weightage for RSW population spread within a frond. The damage was categorized into three grades as follows and the infestation index was calculated accordingly.

$$\text{Infestation Index} = \frac{(\text{No. of palms under Scale 0 X 0}) + (\text{No. of palms under Scale 1 X 1}) + \cdots . + (\text{No. of palms under Scale 3 X 3})}{\text{Total no. of palms observed}}$$

Table 1: A Damage rating scale for the infestation of *A. rugioperculatus*

Number of egg spirals	Grade	Category	Infestation index
No egg spirals and sooty mold encrustation noticed	0	Nil	0.0
Fewer than 10 egg spirals per leaflet; presence of sooty mold encrustation in 5- 6 lowermost fronds	1	Low	0.0 to 1.0
Ten to 20 egg spirals per leaflet; presence of sooty mold encrustation in 10-12 fronds	2	Medium	1.01 to 2.0
More than 20 egg spirals per leaflet; presence of sooty mold encrustation in more than 12 fronds	3	High	2.01 to 3.0

Results and Discussion

The survey of rugose spiralling whitefly was carried out in five districts of the Konkan region *viz.*, Sindhudurg, Ratnagiri, Raigad, Thane and Palghar and the intensity of infestation and grade index is presented and discussed in the following sub headings.

Intensity of infestation and grade index of *A. rugioperculatus* in Sindhudurg district.

The data on the Sindhudurg district presented in table 2 and graphically depicted in Fig. 1 indicated that the intensity of infestation was significantly low in Sawantwadi (24.07%) tehsil followed by Devgad (34.07%) and Malvan (40.59%) tehsil which was statistically at par with each other. It was also observed that the intensity of infestation of Malvan (40.59%) was at par with Vengurle (44.01%) tehsil. The highest intensity of infestation was recorded in Kankavali (64.83 %) tehsil.

The damage grade index was medium 1.15 and 1.36 in Malvan and Vengurle tehsils, respectively. While low damage grade index was recorded in Sawantwadi (0.74), Kankavali (0.98) and Devgad (0.89) tehsils.

Table 2: Intensity of infestation and grade index of *A. rugioperculatus* in Sindhudurga district

Sr. No.	Name of Tehsils	Intensity of infestation (%)	Infestation Index#
1	Malvan	40.59* (39.53)**	1.15
2	Sawantwadi	24.07 (29.34)	0.74
3	Kankavali	64.83 (53.76)	0.98
4	Devgad	34.07 (35.68)	0.89
5	Vengurle	44.01 (41.51)	1.36
	CD	5.35	-
	SE (m)	1.77	-

*Mean of five locations, **figures in parentheses are angular transformed values

#Infestation Index – Low - 0.01 to 1.0, Medium-1.01 to 2.0, and High-2.01 to 3.0

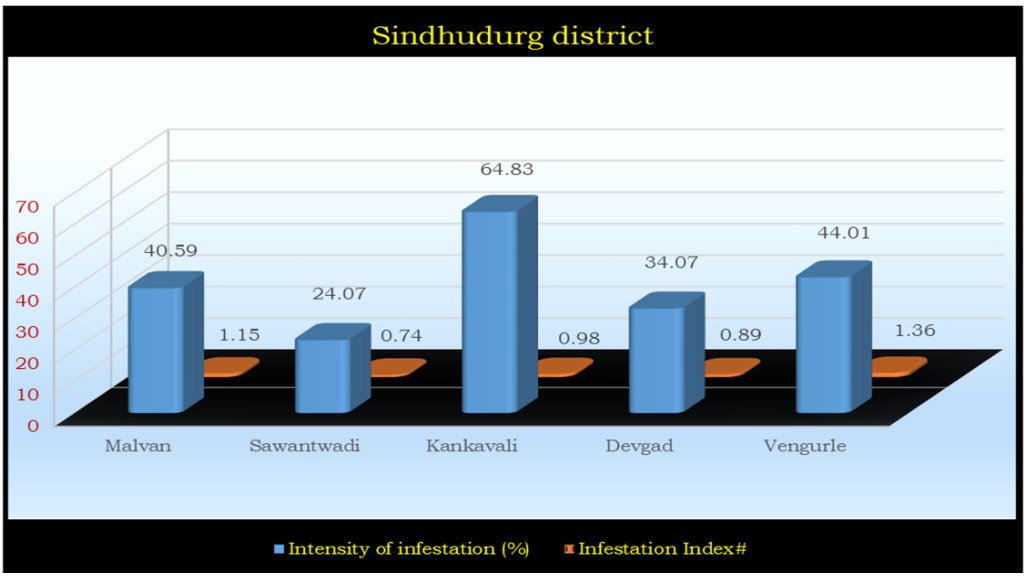

Fig 1: Intensity of infestation and grade index of *A. rugioperculatus* in Sindhudurga district

Intensity of infestation and grade index of *A. rugioperculatus* in Ratnagiri district

The data on Ratnagiri district presented in table 3 and graphically depicted in Fig. 2 indicated that the intensity of infestation was low in Lanja (42.14%) tehsil which was statistically at par with Chiplun (46.62%). It was followed by Ratnagiri (50.03%) and Dapoli (57.68%). The highest intensity of infestation was recorded in Guhagar (62.21%) tehsil which was found to be statistically significantly high than rest of the tehsils.

The damage grade index was medium in all tehsil *viz.*, Lanja, Chiplun, Guhagar, Ratnagiri and Dapoli *i.e.* 1.40, 1.54, 1.68, 1.78 and 1.84, respectively.

Table 3: Intensity of infestation and grade index of *A. rugioperculatus* in Ratnagiri district

Sr. No.	Name of Tehsils	Intensity of infestation (%)	Infestation Index
1	Ratnagiri	50.03 * (44.98)	1.78
2	Dapoli	57.68 (49.54)	1.84
3	Lanja	42.14 (40.40)	1.40
4	Guhagar	64.21 (53.32)	1.68
5	Chiplun	46.62 (43.03)	1.54
	CD	6.48	-
	SE (m)	2.14	-

*Mean of five locations, **figures in parentheses are angular transformed values
#Infestation Index – Low - 0.01 to 1.0, Medium-1.01 to 2.0, and High-2.01 to 3.0

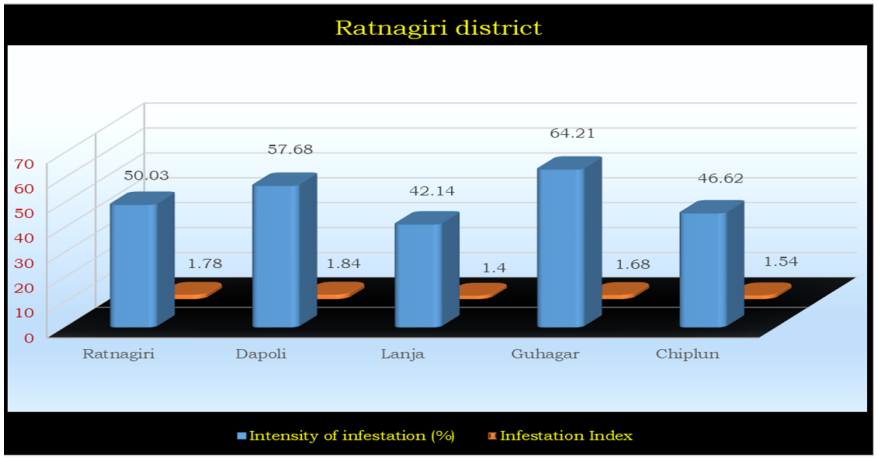

Fig 2: Intensity of infestation and grade index of *A. rugioperculatus* in Ratnagiri district

Intensity of infestation and grade index of *A. rugioperculatus* in Raigad district.

The data on the Raigad district presented in table 4 and graphically depicted in Fig. 3 indicated that the intensity of infestation was significantly low in Roha (65.38%) tehsil. The intensity of infestation of Alibag (75.58%) was statistically at par with Mhasal (75.84%), Murud (77.08%) and Shrivardhan (78.63%). The highest intensity of infestation was observed in Shrivardhan (78.63%).

The damage grade index was medium in Roha, Mhasala, Murud and Alibag tehsil *i.e.* 1.56, 1.61, 1.70 and 1.84, respectively. The highest damage grade of index 2.05 was recorded in Shrivardhan tehsil.

Table 4: Intensity of infestation and grade index of *A. rugioperculatus* in Raigad district

Sr. No.	Name of Tehsils	Intensity of infestation (%)	Infestation Index
1	Alibag	75.58 * (60.59)**	1.84
2	Roha	65.38 (53.96)	1.56
3	Shrivardhan	78.63 (62.45)	2.05
4	Mhasala	75.84 (60.65)	1.61
5	Murud	77.08 (61.60)	1.70
	CD	4.78	-
	SE (m)	2.23	-

*Mean of five locations, **figures in parentheses are angular transformed values
#Infestation Index – Low - 0.01 to 1.0, Medium-1.01 to 2.0, and High-2.01 to 3.0

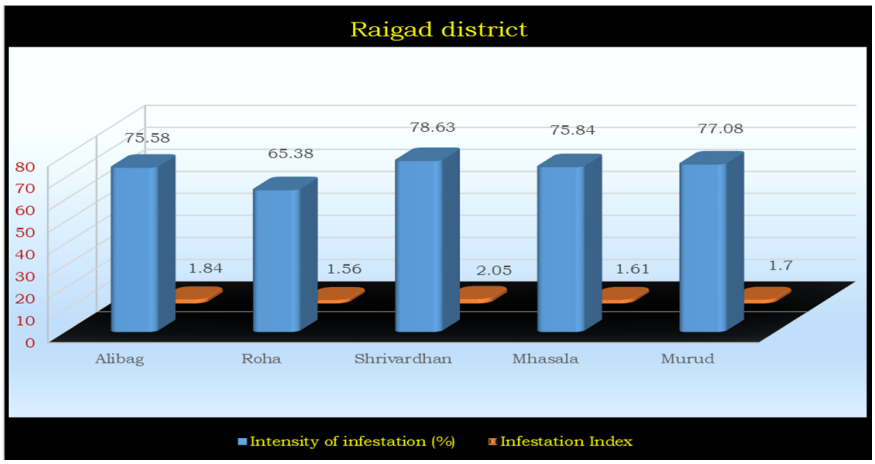

Fig 3: Intensity of infestation and grade index of *A. rugioperculatus* in Raigad district

Intensity of infestation and grade index of *A. rugioperculatus* in Thane district.

The data on the Thane district presented in table 5 and graphically depicted in Fig. 4 indicated that, no significant difference in intensity of infestation in all the tehsil were recorded. The intensity of infestation was found to be low in Ulhasnagar (22.50%) while the intensity of infestation was high in Ambernath (57.36). The intensity of infestation in Kalyan, Thane and Shahpur were 25.88, 31.76 and 51.86 per cent, respectively.

The damage grade index was medium in all tehsil *i.e.* 1.35, 1.47, 1.48, 1.49 and 1.99 in Murud, Kalyan, Ambernath, Thane and Shahapur district.

Table 5: Intensity of infestation and grade index of *A. rugioperculatus* in Thane district

Sr. No.	Name of Tehsils	Intensity of infestation (%)	Infestation Index
1	Thane	31.76 * (33.72)**	1.48
2	Ulhasnagar	22.50 (28.30)	1.35
3	Shahapur	51.86 (45.56)	1.99
4	Kalyan	25.88 (30.56)	1.47
5	Ambernath	57.36 (49.29)	1.49
	CD	N/A	-
	SE (m)	5.62	-

*Mean of five locations, **figures in parentheses are angular transformed values
#Infestation Index – Low - 0.01 to 1.0, Medium-1.01 to 2.0, and High-2.01 to 3.0

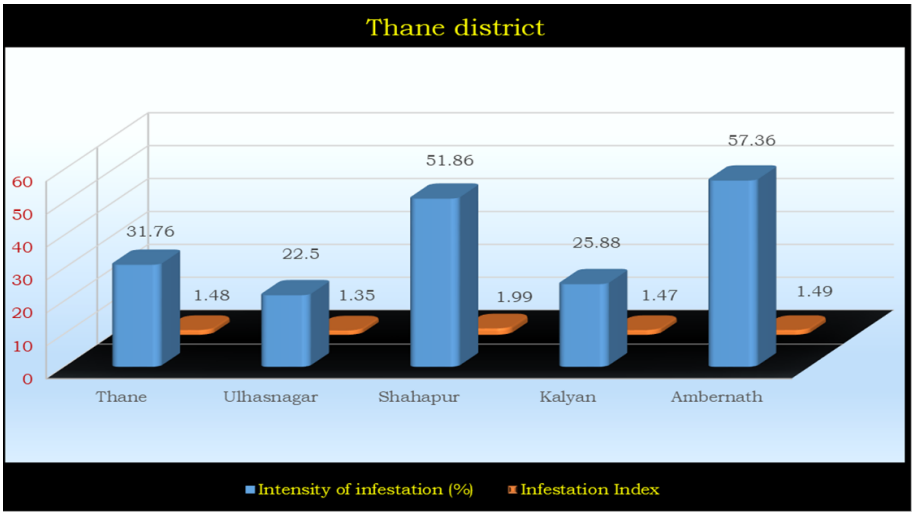

Fig 4: Intensity of infestation and grade index of *A. rugioperculatus* in Thane district

Intensity of infestation and grade index of *A. rugioperculatus* in Palghar district.

The data on Palghar district presented in table 6 and graphically depicted in Fig. 5 indicated that the intensity of infestation was low in Wada (60.73%) tehsil. The highest intensity of infestation 83.02 per cent was observed in Vasai followed by Palghar (81.48%), Dahanu (80.39%) and Talasari (78.70%) with no significant difference between them.

The damage grade index was low (0.99) in Talasari tehsil, medium in Wada, Vasai, Talasari and Dahanu tehsil *i.e.* 1.49, 1.52, 1.54 and 1.97, respectively. The high damage grade of index 2.02 was recorded in Palghar tehsil.

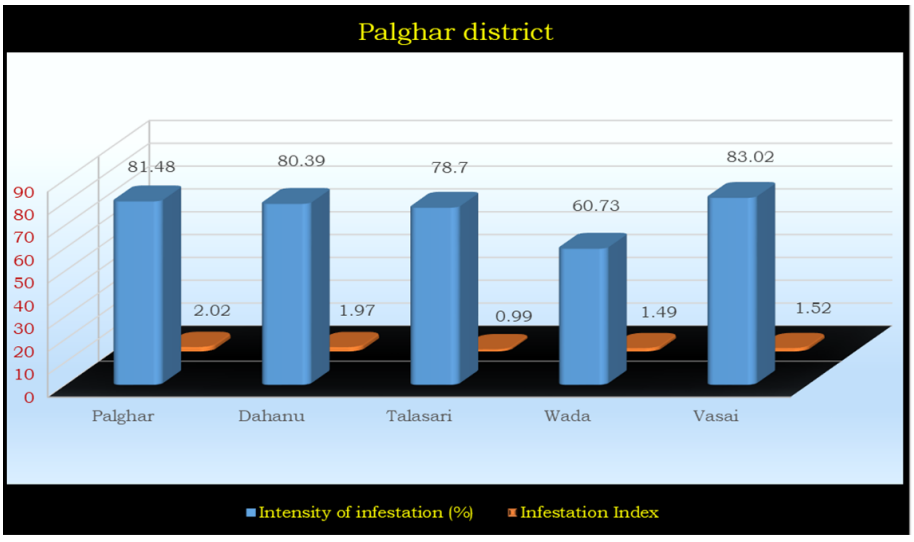

Fig 5: Intensity of infestation and grade index of *A. rugioperculatus* in Palghar district

Table 6: Intensity of infestation and grade index of *A. rugioperculatus* in Palghar district

Sr. No.	Name of Tehsils	Intensity of infestation (%)	Infestation Index
1	Palghar	81.48 * (64.52)**	2.02
2	Dahanu	80.39 (63.76)	1.97
3	Talasari	78.70 (62.53)	0.99
4	Wada	60.73 (51.41)	1.49
5	Vasai	83.02 (65.74)	1.52
	CD	6.13	-
	SE (m)	2.02	-

*Mean of five locations, **figures in parentheses are angular transformed values
#Infestation Index – Low - 0.01 to 1.0, Medium-1.01 to 2.0, and High-2.01 to 3.0

Intensity of infestation and grade index of *A. rugioperculatus* in Konkan region.

The data on the Konkan region presented in table 7 and graphically depicted in Fig. 6 indicated that the intensity of infestation was statistically low in Thane (37.87%) which was at par with Sindhudurga (41.51%) district. Further, the intensity of infestation of Sindhudurga (41.51%) was at par with Ratnagiri (52.14 %). The highest intensity of infestation was recorded in Palghar (76.86%) followed by Raigad (74.50%) which were at par with each other.

The damage grade index of all districts was medium. The maximum damage grade index was recorded in Raigad district while the maximum was recorded in the Sindhudurga district. The damage grade index of Thane, Ratnagiri and Palghar were 1.56, 1.65 and 1.71, respectively.

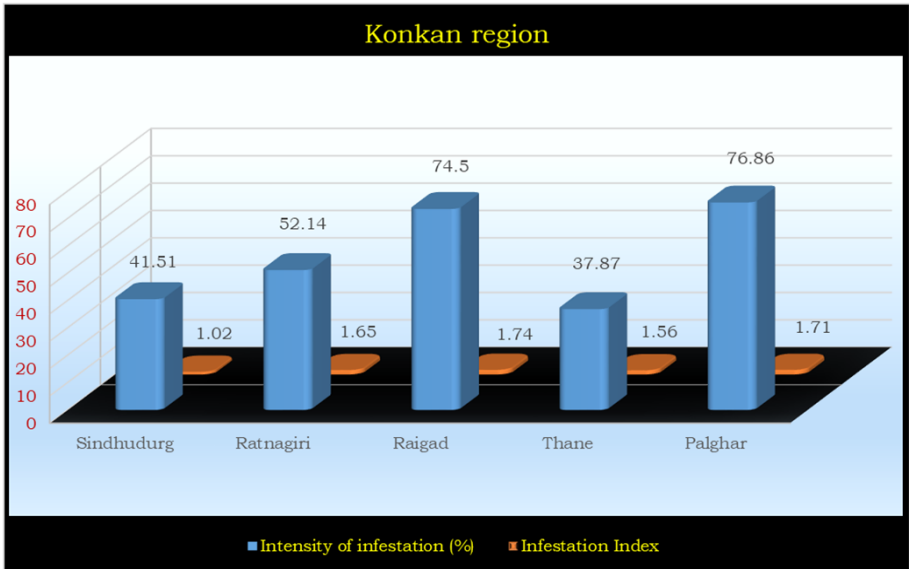

Fig 6: Intensity of infestation and grade index of *A. rugioperculatus* in Konkan region

Table 7: Intensity of infestation and grade index of *A. rugioperculatus* in Konkan region

Sr. No.	Name of Tehsils	Intensity of infestation (%)	Infestation Index#
1	Sindhudurga	41.51 * (39.95)**	1.02
2	Ratnagiri	52.14 (46.23)	1.65
3	Raigad	74.50 (59.73)	1.74
4	Thane	37.87 (37.68)	1.56
5	Palghar	76.86 (61.50)	1.71
	CD	8.22	-
	SE (m)	2.72	-

*Mean of five locations, **figures in parentheses are angular transformed values
#Infestation Index - 0.01 to 1.0 – Low, 1.01 to 2.0 – Medium and 2.01 to 3.0 High

Conclusion

The overall results of the present study revealed that, the incidence of RSW recorded was more in the tehsils near to the coastal area and start decreasing as we moved away from the coastal area. The most prominent reason for this might be the humid and warm climatic conditions available in coastal area. Also the incidence of the RSW was found to be highest in the north part (Palghar, Raigad) as compared to south part (Sindhudurg, Ratnangiri). This is might be due to the more mono cropping of coconut in north part of the Konkan region. In Thane district the incidence recorded is lower as compared to all other districts, this might be due to more urbanization in Thane.

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