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POPULATION DYNAMICS AND SEASONAL INCIDENCE OF WHITEFLY COMPLEX ON COCONUT (*COCOS NUCIFERA* L.)

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ABSTRACT

Seasonal incidence of the whitefly complex, namely *Aleurodicus rugioperculatus* Martin, *Paraleyrodes bondari* Peracchi, *Paraleyrodes minei* Iaccarino and *Aleurotrachelus atratus* Hempel was studied on coconut at the College of Agriculture, Karekere, Hassan, Karnataka, during *Rabi* 2024-25, Summer 2025 and *Kharif* 2025. Among the four species, *P. bondari* consistently recorded the highest population and peaked at 139.98 nymphs and 95.78 adults per leaflet during Summer 2025. *A. rugioperculatus* also showed marked seasonal fluctuation with maximum nymphal (19.84/leaflet) and adult (7.68/leaflet) populations recorded during Summer. But *P. minei* and *A. atratus* remained at low levels throughout the study period. Correlation analysis revealed that maximum temperature and sunshine hours were significantly positively correlated with egg, nymphal and adult populations of *A. rugioperculatus* and *P. bondari*, whereas, minimum temperature, relative humidity and rainfall were negatively correlated. No consistent weather driven trends were observed for *P. minei* and *A. atratus*. Hot and dry summer conditions were most favourable for whitefly buildup, with *P. bondari* emerging as the dominant invasive species.

Key words : Coconut, Whitefly complex, *Aleurodicus rugioperculatus* Martin, *Paraleyrodes bondari* Peracchi, *Paraleyrodes minei* Iaccarino, *Aleurotrachelus atratus* Hempel, Seasonal incidence.

Introduction

Coconut (*Cocos nucifera* L.) is a major plantation crop of the tropics and is valued for its nutritional, industrial and socioeconomic importance. India ranks among the leading global producers, with approximately 2.17 million hectares under cultivation and an annual production of about 21.4 billion nuts (Coconut Development Board, 2023-24). Despite its economic significance, coconut production is severely constrained by numerous insect pests (George and Kuruvila, 2023; Selvaraj *et al.*, 2024). More than 900 insect species have been recorded on coconut worldwide, among which non insect pest, *Aceria guerreronis* Keifer (coconut eriophyid mite) and insect pests namely *Oryctes rhinoceros* L. (rhinoceros beetle), *Rhynchophorus ferrugineus* Olivier (red palm weevil), *Opisina arenosella* Walker (black-headed caterpillar) and *Leucopholis coneophora* Burmeister (white grub) are considered the most economically important (Abhishek and Dwivedi, 2021).

In recent years, the incidence of invasive alien insect pests has increased due to globalization, international trade and the movement of planting materials (Josephrajkumar *et al.*, 2020). More than 110 non-native insect species have been reported as established in India, including several species of whiteflies (Mandal, 2011). Historically, whitefly infestation on coconut was considered minor; however, the introduction of four invasive Neotropical species has significantly altered the pest scenario. These include *Aleurodicus rugioperculatus* Martin (rugose spiralling whitefly, RSW), *Paraleyrodes bondari* Peracchi (Bondar's nesting whitefly, BNW), *Paraleyrodes minei* Iaccarino (nesting whitefly, NW) and *Aleurotrachelus atratus* Hempel (palm infesting whitefly, PIW) (Mohan *et al.*, 2018; Josephrajkumar *et* *al*., 2019; Selvaraj *et al*., 2019).

Among these, rugose spiralling whitefly is considered the most destructive, with damage levels ranging from 40 to 63 per cent in Tamil Nadu (Elango *et al*., 2019). It is highly polyphagous, infesting more than 118 host plants across diverse families (Karthick *et al*., 2018). Bondar's nesting whitefly and Nesting whitefly form characteristic woolly wax nests on the abaxial surface of leaflets. Palm infesting whitefly first detected in Karnataka in 2019, has been spreading rapidly across southern India (Sundararaj *et al*., 2021).

Whiteflies cause direct damage by feeding on phloem sap, resulting in reduced plant vigour and premature leaf drying. Indirectly, the excretion of honeydew promotes the development of sooty mould fungi, which significantly reduces photosynthetic efficiency and adversely affects nut yield and quality (Kumar *et al*., 2018; Hossain *et al*., 2019). Weather parameters play a crucial role in influencing population dynamics. In Kerala and Tamil Nadu, the outbreak of rugose spiralling whitefly associated with reduced monsoon rainfall, elevated temperatures and low relative humidity (Mohan *et al*., 2016).

As the whitefly complex infesting coconut is a relatively recent and evolving pest problem in India, understanding its seasonal incidence is essential for predicting outbreaks and formulating effective management strategies. Accordingly, the present study was undertaken to investigate the seasonal incidence of the whitefly complex on coconut.

Materials and Methods

Field study was conducted at the College of Agriculture, Karekere, Hassan during *Rabi* 2024-25, Summer 2025 and *Kharif* 2025 to monitor the seasonal occurrence of different developmental stages of the whitefly complex *viz*., *A. rugioperculatus*, *P. bondari*, *P. minei* and *A. atratus* on coconut. To assess seasonal incidence, four coconut palms of below ten years' age were randomly selected and tagged. From each palm, three lower fronds with six leaflets per frond were chosen for recording the number of egg spirals or clusters, nymphs and adults of all four whitefly species at fortnightly intervals. Observations were recorded using a 10× magnifying lens for a clear view. For species confirmation, pupae of all four whiteflies were collected, preserved in 70 per cent alcohol and sent to ICAR-NBAIR, Hebbal, Bengaluru, where identification was carried out by Dr. K. Selvaraj, Senior Scientist (Entomology). The population data for different stages of the whitefly complex were averaged and correlated with various weather parameters, including maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, rainfall and sunshine hours. Meteorological data was sourced from the Agro Meteorological Observatory, College of Agriculture, Hassan.

Results and Discussion

The data on the seasonal incidence of the whitefly complex revealed distinct variations across *Rabi*, Summer and *Kharif* seasons. During *Rabi* 2024-25, the population of *A. rugioperculatus* exhibited moderate fluctuations, with egg spirals ranging from 1.23 per leaflet (42nd SMW) to 3.25 per leaflet (7th SMW), nymphal populations from 6.51 (42nd SMW) to 15.91 per leaflet (52nd SMW) and adult populations from 2.98 (44th SMW) to 6.32 (52nd SMW) per leaflet. The lowest populations were observed during October. Peak nymphal and adult populations occurred in December, whereas the maximum egg spiral density was recorded in February (Table 1).

P. bondari consistently and substantially recorded higher populations than the other species throughout the season. Egg clusters ranged from 9.42 per leaflet (42nd SMW) to 19.05 per leaflet (9th SMW), while nymphal population increased from 38.65 (42nd SMW) to 90.17 per leaflet (9th SMW) and adult populations from 22.83 (42nd SMW) to 59.81 per leaflet (9th SMW). The gradual and steady rise in all life stages was observed from October to February, with peak population levels during February. In contrast, the populations of *P. minei* and *A. atratus* remained consistently low, with egg clusters rarely exceeding 0.39 per leaflet, nymphs remaining below 1.32 per leaflet and adult population were less than 0.59 per leaflet throughout the season, showed only slight increased population during December and February (Table 1).

During Summer 2025, *A. rugioperculatus* populations increased markedly, with the highest number of egg spirals (4.08 spirals per leaflet) recorded during April, 17th SMW, accompanied by peak nymphal population (19.84 per leaflet). However, adult (7.68 per leaflet) populations reached their maximum during March, 11th SMW. Similar trend was observed in *P. bondari*, which again dominated rest of the whitefly species, reaching peak nymphal (139.98 per leaflet) and adult populations (95.78 per leaflet) in the 17th SMW (April), The egg clusters (7.68 per leaflet) attained their maximum during the 15th SMW (April) and thereafter, all life stages declined progressively and reached lower levels by May (22nd SMW). Populations of *P. minei* and *A. atratus* remained low, with only marginal variations, exhibiting slight peaks in early summer followed by a gradual decline (Table 2).

Table 1 : Incidence of whitefly complex on coconut during *Rabi* 2024–25.

Months	SMW	Mean population of whitefly complex per leaflet											
		A. rugioperculatus			*P. bondari*			*P. minei*			*A. atratus*		
		Egg spirals	Nymph	Adult	Egg clusters	Nymph	Adult	Egg clusters	Nymph	Adult	Egg clusters	Nymph	Adult
October	42	1.23	6.51	3.01	9.42	38.65	22.83	0.08	1.12	0.31	0.11	0.94	0.43
	44	2.39	7.93	2.98	11.95	41.62	23.25	0.10	1.26	0.42	0.23	0.97	0.49
November	46	2.98	9.65	4.02	12.68	43.61	25.05	0.28	1.29	0.51	0.31	1.14	0.59
	48	3.15	12.38	4.97	15.31	46.38	27.63	0.36	1.28	0.54	0.38	1.28	0.58
December	50	2.76	10.01	4.31	13.83	44.23	24.21	0.23	1.32	0.52	0.20	1.12	0.49
	52	3.22	15.91	6.32	18.46	80.15	49.21	0.39	1.24	0.48	0.27	1.16	0.16
January	2	2.83	12.67	4.86	17.61	71.05	36.38	0.21	1.21	0.41	0.24	1.21	0.29
	4	3.01	14.23	6.01	17.43	73.28	39.46	0.19	1.19	0.26	0.21	1.14	0.31
February	7	3.25	14.92	5.83	18.97	89.36	50.29	0.26	1.13	0.38	0.26	1.26	0.35
	9	3.17	15.28	5.99	19.05	90.17	59.81	0.24	1.20	0.45	0.19	1.31	0.27
S. Em (±)		0.19	1.03	0.39	1.06	6.62	4.25	0.03	0.02	0.03	0.02	0.04	0.05
CD @5%		0.44	2.34	0.88	2.41	14.97	9.60	0.07	0.05	0.07	0.05	0.09	0.10

SMW- Standard Meteorological Week.

Table 2 : Incidence of whitefly complex on coconut during Summer 2025.

Months	SMW	Mean population of whitefly complex per leaflet											
		A. rugioperculatus			*P. bondari*			*P. minei*			*A. atratus*		
		Egg spirals	Nymph	Adult	Egg clusters	Nymph	Adult	Egg clusters	Nymph	Adult	Egg clusters	Nymph	Adult
March	11	3.65	17.95	7.68	25.14	120.21	89.81	0.29	1.14	0.47	0.24	1.34	0.32
	13	3.01	15.08	6.71	16.78	91.30	54.08	0.11	1.13	0.29	0.31	1.39	0.41
April	15	3.52	17.43	7.29	27.39	108.98	81.23	0.18	1.39	0.21	0.27	1.28	0.26
	17	4.08	19.84	7.50	26.79	139.98	95.78	0.27	1.27	0.32	0.26	1.32	0.43
May	19	2.98	13.71	6.93	17.53	96.03	63.51	0.15	1.19	0.18	0.21	1.27	0.32
	22	2.76	13.15	5.02	16.03	81.25	53.95	0.16	1.14	0.29	0.19	1.21	0.21
S. Em (±)		0.20	1.07	0.39	2.19	8.74	7.48	0.03	0.04	0.04	0.02	0.03	0.03
CD @5%		0.52	2.76	1.02	5.63	22.47	19.24	0.07	0.11	0.11	0.05	0.07	0.09

SMW- Standard Meteorological Week.

During *Kharif* 2025, populations of *A. rugioperculatus* exhibited a declining trend, likely influenced by increased rainfall and humidity. The egg spirals decreased from 2.79 (June, 24th SMW) to 1.03 per leaflet (August, 35th SMW), with corresponding reductions observed in both nymphal and adult populations. In *P. bondari*, egg clusters ranged from 18.49 to 11.61 per leaflet, nymphal population from 73.13 to 61.41 per leaflet and adults from 39.38 to 20.03 per leaflet, with the highest populations (egg clusters-19.15, nymphs-78.02 and adults-43.43 per leaflet) recorded during the 31st SMW of July. Conversely, *P. minei* and *A. atratus* again exhibited low and stable populations throughout *Kharif*, with only minor peaks in July (Table 3). Overall, seasonal trends indicated that *Rabi* and Summer conditions were conducive to population build-up of the whitefly species, whereas *Kharif* conditions resulted in marked population reductions.

Correlation studies indicated that weather parameters played a significant role in regulating the populations of

Table 3 : Incidence of whitefly complex on coconut during *Kharif* 2025

Months	SMW	Mean population of whitefly complex per leaflet											
		A. rugioperculatus			*P. bondari*			*P. minei*			*A. atratus*		
		Egg spirals	Nymph	Adult	Egg clusters	Nymph	Adult	Egg clusters	Nymph	Adult	Egg clusters	Nymph	Adult
June	24	2.79	16.03	5.81	18.49	73.13	39.38	0.14	1.13	0.34	0.16	1.20	0.20
	26	1.72	8.69	4.04	14.62	65.20	31.21	0.09	0.95	0.26	0.12	1.31	0.34
July	28	1.89	9.01	3.95	15.98	63.06	29.60	0.07	0.94	0.27	0.18	1.19	0.31
	31	2.94	15.12	6.59	19.15	78.02	43.43	0.16	1.28	0.39	0.19	1.16	0.26
August	33	1.91	6.01	4.92	16.40	68.29	30.65	0.11	1.05	0.19	0.14	1.11	0.19
	35	1.03	5.32	3.73	11.61	61.41	20.03	0.06	0.72	0.16	0.13	0.95	0.21
S. Em (±)		0.29	1.85	0.47	1.12	2.60	3.35	0.02	0.08	0.04	0.01	0.05	0.03
CD @5%		0.75	4.77	1.21	2.87	6.67	8.60	0.04	0.20	0.09	0.03	0.13	0.07

SMW- Standard Meteorological Week.

all four whitefly species. In *A. rugioperculatus*, egg spirals, nymphs and adults exhibited significant positive correlations with maximum temperature (r = 0.628, 0.593 and 0.592, respectively) and sunshine hours (r = 0.592, 0.640 and 0.653), that warm, dry and bright weather conditions favoured population multiplication. In contrast, morning and evening relative humidity showed strong negative correlations with all life stages, indicating that high humidity suppressed population development. Minimum temperature and rainfall also showed negative associations, although their effects were comparatively weaker.

P. bondari displayed similar but comparatively stronger relationship with weather parameters. Maximum temperature (r = 0.661 for egg clusters, 0.478 for nymphs, 0.658 for adults) and sunshine hours (r = 0.532, 0.663, 0.654) were positively and significantly associated with increased population. Evening relative humidity had the most pronounced negative effect across all stages (egg: r = –0.708; nymph: r = –0.540; adult: r = –0.591). Minimum temperature and rainfall were negatively associated but non-significant for this species.

In *P. minei*, the correlations with weather factors were generally weaker. However, significant negative associations were observed for minimum temperature (egg clusters: r = –0.671; adults: r = –0.505) and evening relative humidity (egg clusters: r = –0.510). Other weather factors were non-significant across the life stages. For *A. atratus*, egg clusters showed significant negative correlations with minimum temperature (r = –0.525) and evening humidity (r = –0.481). Nymphs exhibited significant positive correlations with maximum temperature (r = 0.482) and sunshine hours (r = 0.664), and strong negative correlations with morning and evening relative humidity (r = –0.453 and –0.592). A noteworthy observation was that adult population showed a significant positive correlation with rainfall (r = 0.545).

Josephrajkumar *et al.* (2023) reported that the rugose spiralling whitefly showed a strong positive correlation with maximum temperature (r = 0.89) and temperature difference (r = 0.71), whereas, relative humidity (r = –0.69) and rainfall (r = –0.49) were negatively associated, suggesting that warm and dry conditions highly favoured pest multiplication.

Logeshkumar *et al.* (2023) further reported that *A. rugioperculatus* populations peaked during April-May, while *P. bondari* attained its highest population between March and early June, periods characterised by higher temperatures and reduced rainfall and the populations of both species sharply declined during the northeast monsoon from August to December.

Khatik *et al.* (2024) recorded the presence of *A. rugioperculatus* throughout the winter season, with adult populations varied between 10.12 per leaflet during the 42nd SMW (mid-October) and 34.68 per leaflet during the 52nd SMW (late December), indicating that cooler but dry winter conditions supported moderate pest levels. Mehta *et al.* (2024) emphasized that temperature and rainfall are key abiotic factors influencing the distribution and abundance of Aleyrodids, noting that elevated temperatures between 15°C and 35°C promote whitefly development and favour rapid progression through egg, nymphal and adult stages. Collectively, these studies reinforce that warm, dry and rain-deficit conditions are highly conducive for the proliferation and dispersal of *A. rugioperculatus* and related species, while rainfall and

Table 4 : Correlation of whitefly complex with abiotic factors.

Whitefly complex		Correlation co-efficient (r)					
		Temperature (°C)		Relative Humidity (RH)		Rainfall (mm)	Sunshine (hrs)
		Minimum	Maximum	RH morning (%)	RH evening (%)		
A. rugioperculatus	Egg spirals	-0.451*	0.628**	-0.481*	-0.688**	-0.085	0.592**
	Nymph	-0.336	0.593**	-0.458*	-0.667**	-0.123	0.640**
	Adult	-0.225	0.592**	-0.429*	-0.637**	-0.133	0.653**
P. bondari	Egg clusters	-0.295	0.661**	-0.489*	-0.708**	-0.225	0.532*
	Nymph	-0.070	0.478*	-0.412	-0.540**	-0.259	0.663**
	Adult	-0.009	0.658**	-0.472*	-0.591**	-0.236	0.654**
P. minei	Egg clusters	-0.671**	0.306	-0.362	-0.510*	-0.053	0.235
	Nymph	-0.325	0.409	-0.174	-0.346	0.079	0.233
	Adult	-0.505*	0.016	-0.251	-0.237	0.161	-0.067
A. atratus	Egg clusters	-0.525*	0.402	-0.216	-0.481*	0.379	0.303
	Nymph	-0.208	0.482*	-0.453*	-0.592**	0.086	0.664**
	Adult	-0.065	0.075	-0.026	-0.024	0.545**	-0.056

*Significant at $p \leq 0.05$; **Significant at $p \leq 0.01$.

high humidity exert a suppressive effect. In the present study, *A. rugioperculatus* recorded its highest nymph and adult populations during April, which coincides with the peak activity reported by Chavan *et al.* (2022) for rugose spiralling whitefly.

The study clearly demonstrated that the population of whitefly complex on coconut was highest during Summer, followed by *Rabi*, while *Kharif* conditions substantially suppressed population build-up. Among the species, *P. bondari* emerged as the dominant species, consistently recording higher population levels across all seasons and exhibiting stronger positive correlation with maximum temperature and sunshine hours. *A. rugioperculatus* also thrived under warm, dry conditions, whereas *P. minei* and *A. atratus* maintained low baseline populations with limited seasonal change. Weather factors, particularly maximum temperature, sunshine hours and relative humidity, played decisive roles in shaping population dynamics, with high humidity consistently inhibiting most species except *A. atratus* adults.

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