Short Scientific Report

doi:10.25081/jpc.2023.v51.i2.8670
Journal of Plantation Crops, 2023, 51(2): 96-100

Influence of abiotic factors on the co-occurrence of rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin and Bondar's Nesting Whitefly, *Paraleyrodes bondari* Peracchi in coconut palms

L. Gopianand* and C.Kathirvelu

**Insect Taxonomy Laboratory, Department of Entomology, Faculty of Agriculture, Annamalai University, Annamalainagar - 608 002, Tamil Nadu, India*

(Manuscript Received: 11.05.2023, Revised: 15.08.2023, Accepted: 17.08.2023)

Keywords: BNW, exotic pests, multiple regression, population dynamics, RSW

Whiteflies (Homoptera: Aleyrodidae) are polyphagous sucking pests that feed on plant sap and resemble small moths on their outer appearance, with over 1707 species belonging to 192 genera were recorded worldwide (Evans *et al.,* 2023). In India, a total of 469 whitefly species under 71 genera were identified (Sundararaj *et al.,* 2021). Coconut (*Cocos nucifera* L.) is the most valuable crop in the coastal region of Tamil Nadu. Coconut palms are associated with over 900 pest species, including various arthropods (Kumara *et al.,* 2015). In recent years, rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin and Bondar's Nesting Whitefly (BNW), *Paraleyrodes bondari* Peracchi are the two invasive whitefly species that have caused severe damage in major coconut growing districts of Tamil Nadu (Sundararaj and Selvaraj, 2017; Chandrika *et al.,* 2018; Josephrajkumar *et al.,* 2020). It is necessary to have an in-depth understanding of the seasonal abundance of these whiteflies since the prevalence of RSW and BNW varies with the season. Hence, the present study attempted to provide predictions of RSW and BNW population occurrence in the coastal areas of Tamil Nadu so that management measures could be planned ahead of time.

The current study was conducted at the Insect Taxonomy Laboratory, Department of Entomology, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India located in the coastal belt of Cuddalore district (11.3878ºN; 79.7230ºE and 4 mMSL).The study area receives an average maximum temperature, minimum temperature and rainfall of 34ºC, 17ºC and 120.67 cm, respectively. The population density of *A. rugioperculatus* and *P. bondari* was evaluated on three-year-old "East coast Tall" coconut palms from

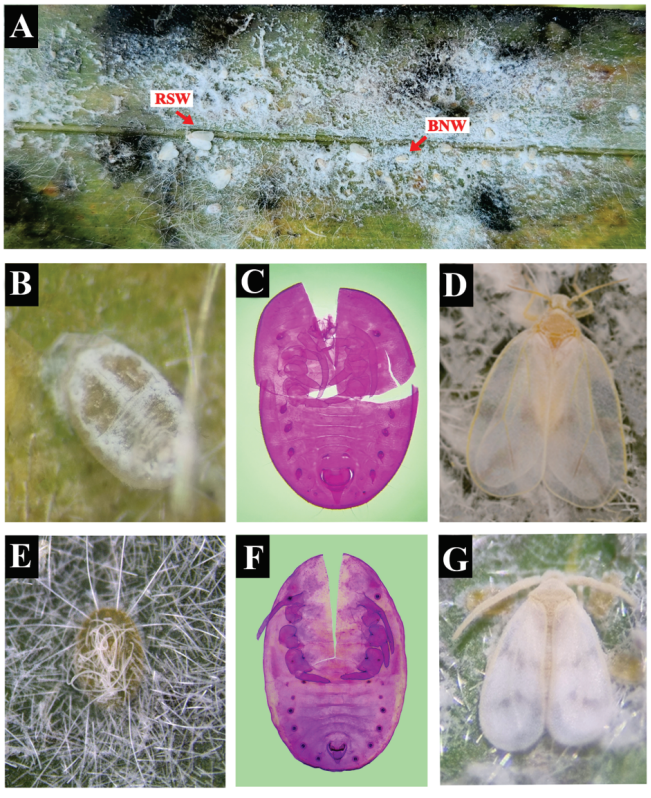

Fig 1. Infestation of RSW, *A. rugioperculatus* and BNW, *P. bondari* on coconut trees(A) Co-existence of RSW and BNW; (B) Habitat image of RSW nymph; (C) Stained puparium of RSW; (D) Adult RSW and (E-G) BNW

**Corresponding Author:l.gopianand@gmail.com*

2021 to 2023. A random selection of ten coconut trees was made within the orchard of the Faculty of Agriculture, Annamalai University. These coconut palms grown in a pesticide-free environment were chosen to observe the population dynamics of RSW and BNW. Those trees received appropriate macro and micronutrients as well as irrigation.The study was conducted from August 2021 to February 2023, encompassing the 31st standard meteorological week (SMW) of 2021 to the 8th SMW of 2023. From every tree, the five fully matured fronds at the bottom were chosen, and within each frond, five leaflets were specifically marked to observe the population of whitefly nymphs on the abaxial surface of the leaves (Fig. 1). Observations were conducted weekly on selected leaflets of the coconut palms, and the count of nymphs per leaf per frond was recorded (Elango and Nelson, 2020).The population of RSW and BNW was documented and then correlated with various weather factors, specifically maximum temperature (X_1), minimum temperature (X_2), relative humidity (X_3), total rainfall (X_4), windspeed (X_5) and solar radiation (X_6). Subsequently, the whitefly nymph count/fronds/ leaf was regressed for the prediction of the population. Statistical analyses were performed using the "Agricolae" package version 1.4.0 (Mendiburu, 2015) and the "ggplot2" package for graphs (Wickham, 2016) in R-software 4.0.0.

The two-whitefly species *viz.,*RSW and BNW were observed for a period of around two years for their occurrence and co-existence on coconut palms in Annamalainagar, Chidambaram. The result of the study revealed that the infestation of RSW, *A. rugioperculatus* was less during monsoon and attained the lowest population (30.5 nymphs leaf^{-1} frond^{-1}) on the fourth week of December 2021 which coincided with SMW52 - 2021 (52 SMW) during post-monsoon, 2021 (Fig. 2). During winter (2022), the average population tends to fluctuate and starts increasing during summer (2022). The highest population was recorded (180.9 nymphs leaf^{-1} frond^{-1}) on SMW 25 - 2022 during monsoon, 2022 and starts to decline gradually. A similar observation was noticed from the post-monsoon season of the preceding year (Fig. 2). The lowest population of BNW, *P. Bondari* was recorded (34.4 nymphs leaf^{-1} frond^{-1}) in SMW 32 - 2022 during monsoon, 2022. Further, it increased gradually and attained the maximum population (156.4 nymphs leaf^{-1} frond^{-1}) on the 1st week of January 2022, coinciding with SMW1 - 2022 during post-monsoon, 2021-22. Similar results were observed in post-monsoon, 2022-23. One of the main factors contributing to the exponential rise of RSW might be due to drastic changes in weather patterns with a

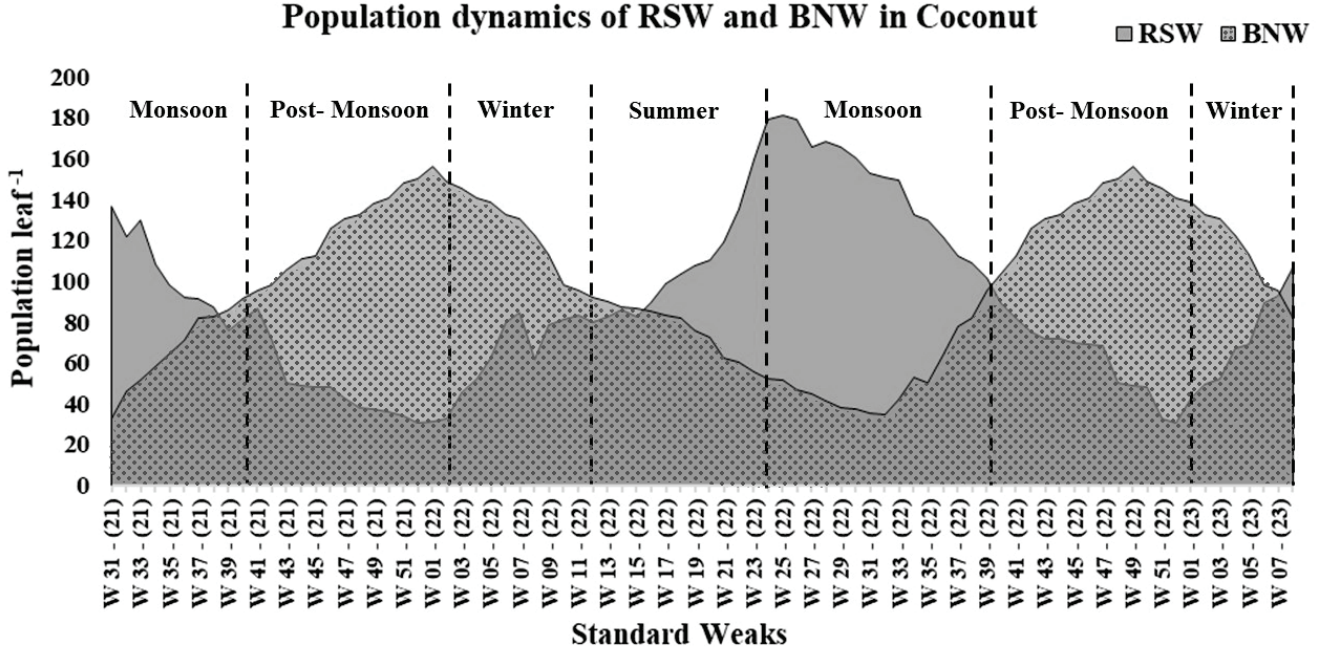

Fig 2. Seasonal occurrence of *A. rugioperculatus* and *P. bondari* on coconut trees from August 2021 to February 2023

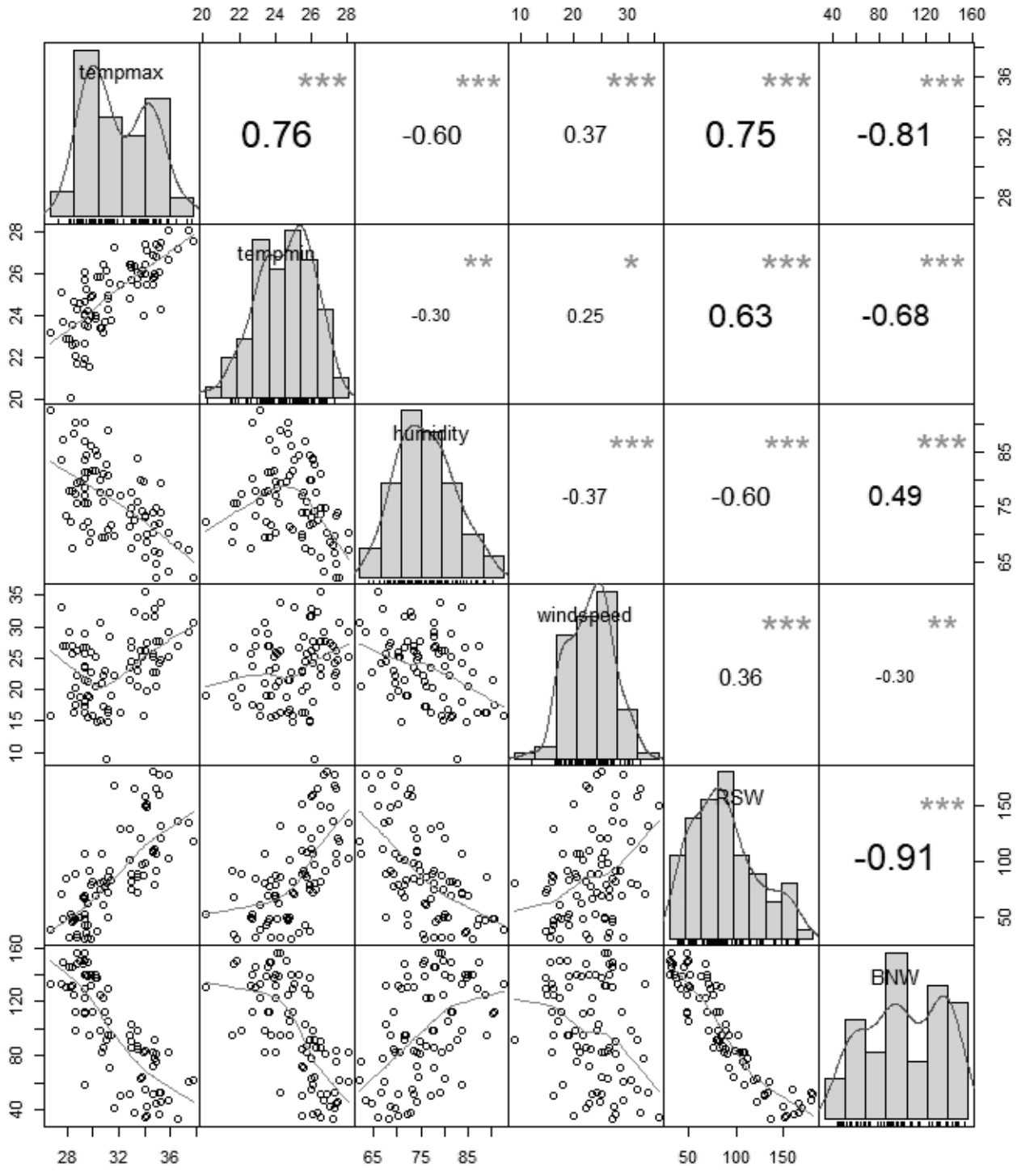

Fig 3. The population of *A. rugioperculatus* and *P. bondari* in response to weather parameters. (Graph's diagonal displays the distribution of weather parameters and whitefly population. Below, scatter plots with fitted lines. Above, correlation values and significance levels are displayed; Each significance level is represented by p-values of 0.001 are denoted as "***", 0.01 as "**", and 0.05 as "*".)

deficit of monsoon. RSW was particularly vulnerable to heavy rainfall, and another risk factor for an increase in their number is a rise in summer temperatures (Chandrika*et al.,* 2017). On the other hand, due to the small size and high fecundity of BNW compared to the RSW, the BNW could rapidly cover the abaxial surface of thefronds.

Correlation between weather parameters and the *A. rugioperculatus* population indicated that the maximum temperature (r = 0.75), minimum temperature (r = 0.63) and wind speed (r = 0.36) had significant positive correlations, and a significant negative correlation with relative humidity (r = -0.60) (Fig. 3). In the case of BNW, the maximum temperature (r = -0.81), minimum temperature (r = -0.68) and wind speed (r = -0.30) had significant negative correlations, and relative humidity (r = 0.49) indicated a strong positive association (Fig. 3). The impact of the RSW on the BNW population registered a negative significant correlation (r = -0.91). However, rainfall and solar radiation showed a non-significant negative correlation with the RSW and BNW populations. Conducive weather conditions and the abundance of host plants in coastal areas are responsible for the present rapid expansion of these introduced alien species (Sundararaj *et al.,* 2021).The earlier study by Josephrajkumar *et al*. (2018) confirms that inadequate rainfall, increasing temperatures, and low humidity contributed significantly to the upsurge and spread of the pest RSW, *A. rugioperculatus.* Elango and Nelson (2020) also observed that RSW expressed a strong positive correlation with the maximum temperature. In TamilNadu, the prevailing wind and prolonged dry spells along with other climatic variables were the prime reason for the rapid expansion of the RSW (Pradhan *et al.,* 2021). Mani (2010) observed that the density of a similar species of Spiralling whitefly, *A. disperses* reported a positive correlation with maximum temperature and a negative correlation with relative humidity. However, the differences in values might result from the environmental variables, tree varieties, natural enemies, and cultural operations that prevailed in the study area might have influenced the occurrence of the whiteflies.

The multiple regression analyses provided the linear equation for prediction of RSW and BNW populations as $Y = -48.909+5.563(X_1)+5.685(X_2)-2.350(X_3)+0.346(X_4)+0.367(X_5)-0.059(X_6)$ and $Y = 379.646-8.395(X_1)-4.158(X_2)+0.997(X_3)-0.346(X_4)+0.083(X_5)+0.057(X_6)$, respectively. The coefficient of determination (R^2) was recorded to be 65 and 69 per cent, and all the weather parameters together had a significant impact (F = 23.18** and 27.55**) on RSW and BNW populations, respectively. Similar results were observed by Elango and Nelson (2020) that the occurrence of *A. rugioperculatus* is significantly influenced by a combination of biotic and abiotic factors, which account for 85 per cent (R^2) of the population's variance and these factors collectively exert a significant effect on the population (F = 46.45**). This slight deviation from the aforementioned results might be due to the influence of climatic conditions, natural enemies and coconut cultivars employed in the current study.

The occurrence of whiteflies (RSW and BNW) from 2021 to 2023 in coastal areas of Annamalainagar, Chidambaram revealed that all the weather parameters played a significant role in the incidence of RSW and BNW. Though the population of both species were present throughout the year in the coconut palm, the RSW increased as the temperature increases, and the population declined during the rainy season, and vice versa for BNW. Fluctuating weather facilitated their coexistence and highlighted the importance of timely control measures during weak nymphal stages to limit the population growth.

References

Chandrika, M., Josephrajkumar, A., Merin, B., Prathibha, P.S., Krishnakumar, V., Hegde, V. and Chowdappa, P. 2017. Invasive Rugose Spiralling Whitefly on Coconut, Technical Bulletin No. 117, (Centenary Series 60), ICAR-CPCRI, Regional Station, Kayamkulam, 16 pp.

Chandrika, M., Josephrajkumar, A., Singh, L.S. and Alpana D. 2018. New distributional record of rugose spiralling whitefly on coconut in Kamrup and Nalbari districts of Assam. *Indian Coconut Journal* **61**(4): 19-21.

Elango, K. and Nelson, S.J. 2020. Population dynamics of exotic rugose spiralling whitefly, *Aleurodicusrugioperculatus* Martin (Hemiptera: Aleyrodidae) on coconut as influenced

by weather factors and natural enemies. *Journal of Plantation Crops* **48**(2): 120-125.

Evans, G.A., Martin, J.H., Drohojowska, J., Szwedo, J., Dubey, A.K., Dooley, J.W. and Stocks. I.C. 2023. Whiteflies of the World (Hemiptera: Sternorrhyncha, Aleyrodidae)—a catalogue of the taxonomy, distribution, hosts and natural enemies of whiteflies. Part 1—Subfamilies Aleurodicinae, Udamoselinae, Bernaeinae and other fossil whiteflies. Zootaxa. [in press]

Josephrajkumar, A., Chandrika, M., Prathibha, P.S., Nalinakumari, T. and Nair, C.P.R. 2018. Pest dynamics and suppression strategies. In: *The Coconut Palm* (*Cocos nucifera* L.)-*Research and Development Perspectives*. (Eds.) Nampoothiri, U., Krishnakumar, V., Thampan, P. K., Nair, M. A. Springer Nature Singapore Pte Ltd. pp. 557-634.

Josephrajkumar, A., Mohan, C., Babu, M., Prathibha, P. S., Hegde, V. and Krishnakumar, V. 2020. Diagnosis of invasive whitefly species co-occurring on coconut. *Current Science* **119**(7): 1101-1105.

Mani, M. 2010. Origin, introduction, distribution and management of the invasive spiralling whitefly, *Aleurodicusdispersus*Russell in India. *Karnataka Journal of Agricultural Sciences***23**(1): 59-75.

Mendiburu, F.D. 2015. *Agricolae: Statistical Procedures for Agricultural Research*. R Package Version 1: 2–3. https://cran.r-project.org/package=agricolae

Ouvrard, D. and Martin, J.H. 2018. The Whitefiles – Taxonomic checklist of the world's whiteflies (Insecta: Hemiptera: Aleyrodidae). https://doi.org/10.5519/0095728, http://www.hemiptera-databases.org/whiteflies/

Pradhan, S.K., Shylesha, A.N., Selvaraj, K. and Sumalatha, B.V. 2021. Distribution, Host Range and Status of Invasive Rugose Spiralling Whitefly, *Aleurodicusrugioperculatus* Martin (Hemiptera: Aleyrodidae) in Karnataka. *Agricultural Research***11**(3): 499–505.

Sundararaj, R. and Selvaraj, K. 2017. Invasion of rugose spiralling whitefly, *Aleurodicusrugioperculatus* Martin (Hemiptera: Aleyrodidae): A potential threat to coconut in India. *Phytoparasitica***45**: 71–74.

Sundararaj, R., Krishnan, S. and Sumalatha, B.V. 2021. Invasion and expansion of exotic whiteflies (Hemiptera: Aleyrodidae) in India and their economic importance. *Phytoparasitica* **49**:851–863.

Wickham, H. 2016. *ggplot2: Elegant Graphics for Data Analysis*. 260pp.Springer-Verlag New York, USA.