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RESEARCH ARTICLE

# Insect diversity on rambutan (*Nephelium lappaceum* L.) – A tropical fruit tree of East Asia

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## Abstract

Rambutan (*Nephelium lappaceum* L.) is a tropical fruit from the Sapindaceae family and an emerging popular fruit tree in India and other Southeast Asian countries. Insect pest infestation in rambutan has not been systematically documented earlier. As the area of rambutan planting is increasing, a systematic documentation of arthropod diversity associated with rambutan is necessary. This study identified and documented 32 insect pest species on rambutan trees across Kerala, India. Sucking pests were predominant in rambutan followed by leaf and inflorescence caterpillars and beetles. The fluctuation of insect infestation on rambutan with respect to abiotic factors was studied for one year from November 2022 to November 2023. Pest infestations were highest from March 2023 to May 2023 during the flowering and fruit-setting stages. The pest incidence in rambutan showed a positive correlation with temperature and a negative correlation with rainfall and relative humidity. A study was conducted during the flowering season of rambutan to document pollinators. Ten pollinator species were observed on rambutan, with the stingless bee *Tetragonula travancorica* (Shanas and Faseeh) being the most frequent and abundant flower visitor. Understanding insect diversity can help farmers more effectively anticipate and manage sporadic pest outbreaks.

**Keywords:** documentation; insect pests; *Nephelium lappaceum*; pollinators

## Introduction

The tropical fruit rambutan, *Nephelium lappaceum* (Linnaeus), from the family Sapindaceae, is thought to have originated in Southeast Asia, particularly in Indonesia and Malaysia (1). In India, rambutan is mainly cultivated in Kerala, Tamil Nadu and Karnataka states and the projected area is less than 1000 ha (2). Insect pests can rapidly spread and cause significant damage to rambutan. Pests such as the mealybug (*Planococcus citri*), red borer (*Zeuzera* sp.), bostrichid beetle (*Sinoxylon* sp.) and fruit flies (*Bactrocera dorsalis* and *B. caryeae*) have been reported in rambutan-growing regions of South India (3). Mealybug (*P. citri*), an armoured scale of an unidentified species, lobster caterpillar (*Stauropus alternus*), fruit borer (*Conogethes punctiferalis*), fruit webber (*Eublemma anguilifera*) and leaf folder (*Thalassodes quadraria*) were documented as major pests in rambutan trees across Kerala (4).

In Mexico, introducing the pink hibiscus mealybug (*Maconellicoccus hirsutus* Green) posed a significant threat to rambutan cultivation (5). They also reported the mealybug, *Dysmicoccus brevipes* (Cockerell), as another potential risk to rambutan. As a member of the family Sapindaceae, rambutan depends heavily on insect pollinators for successful fruit set, with *Apis cerana*, *Trigona* sp. and various lepidopterans and dipterans reported as frequent floral visitors (6).

The internal market for exotic fruits such as rambutan, avocado, dragon fruit and pulasan is growing yearly, with expanding cultivation areas, raising the risk of insect pest outbreaks in rambutan. Despite its agricultural importance, comprehensive studies on insect diversity associated with rambutan remain limited. Understanding insect visitor's composition, abundance and diurnal activity patterns is essential for integrated crop management, pollination biology and pest surveillance. Given the rising demand for rambutan, systematic documentation of pests is crucial; however, available pest data for this crop remains limited. This study, therefore, aimed to document the entomofauna associated with rambutan and the seasonal occurrence of the pest species on rambutan in Kerala, the southernmost state of India.

## Materials and Methods

### Study area and sampling

Pests in rambutan were mainly documented from the College of Agriculture, Vellayani, Thiruvananthapuram and the College of Agriculture, Vellanikkara, Thrissur under Kerala Agricultural University. Farmers' fields from the districts of Thiruvananthapuram, Kollam, Kottayam and Malappuram were visited multiple times for the documentation. Leaves, shoots, bark, flower buds, inflorescence, immature and mature fruits

were examined for the presence of pests. The immature stages of these pests were collected and reared in the laboratory until they emerged as an adult. Rearing was carried out in plastic containers, with host plants provided as a food source. To ensure proper ventilation, the mouths of the containers were covered with muslin cloth. The containers were maintained at room temperature and ambient humidity conditions. The collected specimens were subsequently dried and preserved for identification. Soft-bodied specimens were stored in 70 % alcohol and the identification was done with the help of expert taxonomists across India.

### Pollinator observation protocol

A study on the pollinators of rambutan was conducted at the Instructional Farm, College of Agriculture, Vellayani, during the flowering seasons. To assess pollinator diversity, five rambutan plants of less than 8 years of age were selected from the fruit orchard and five inflorescences were randomly chosen from each tree. Floral visitors were observed visually, with pollinators recorded on these inflorescences for 5 min at hourly intervals between 600 and 1800 hr. The collected data were compiled and the results were expressed as the mean number of pollinators per five inflorescences over 5 min. Observations were made once a week and repeated over four weeks.

### Seasonal incidence and correlation analysis

To observe the seasonal incidence, five trees were chosen from the orchard of College of Agriculture, Vellayani tagged and deliberately left untreated with insecticides for the entire study duration. The occurrence of major pests was systematically recorded at biweekly intervals for one year. The data obtained was then correlated with climatic parameters like temperature, average relative humidity, total rainfall, wind velocity and sunshine.

## Results and Discussion

A total of 32 phytophagous insects were recorded on rambutan, classified into the orders Lepidoptera (14 species), Hemiptera (11 species), Coleoptera (5 species) and Hymenoptera (2 species) (Table 1, Fig. 1-8). Eleven species of sucking pests *viz.*, *P. lilacinus, C. hirsutus, F. virgata, P. citri, C. floridensis, Icerya* sp., *R. pedestris, O. oneratulus, Gargara* sp., *Ricania* sp. and *Flatormenis* sp. were documented on rambutan in this study. *F. virgata, C. floridensis, Icerya* sp., *R. pedestris, O. oneratulus, Gargara* sp., *Ricania* sp. and *Flatormenis* sp. were documented for the first time based on available Indian literature in rambutan from India.

Fifteen inflorescence feeders were also documented in rambutan. Among them, 10 were lepidopteran caterpillars like *P. chlora, R. manea, H. tritonaria, S. scintillans, O. mendosa, C. cassidara, A. lycaenina, E. abrupta*, *E. versicolor* and an unidentified flower webber. Flower feeding beetles like *Popillia* sp., *E. salemensis, Monolepta* sp. and *O. versicolor* were also in the list. *P. chlora, R. manea, H. ritonaria, S. scintillans, O. mendosa, C. cassidara, A. lycaenina, E. abrupta, E. versicolor,* flower webber, *Popillia* sp., *E. salemensis, Monolepta* sp. and *O. versicolor* were documented for the first time as the pests of rambutan from India. The leaf feeders observed on rambutan were *A. discolor* and two unidentified species of bagworms. *A. discolor* is documented for the first time as the pest of rambutan in India. Two unidentified bark borers from the family Lecithoceridae and

**Table 1.** Insect pests documented from rambutan, *Nephelium lappaceum* L.

| Sl. no | Common Name | Scientific Name | Family | Nature of feeding |
|---|---|---|---|---|
| | | **ORDER: LEPIDOPTERA** | | |
| **1** | White looper moth | *Pingasa chlora* Stoll | Geometridae | Flower feeder |
| **2** | Slate flash | *Rapala manea* Hewitson | Lycaenidae | Flower feeder |
| **3** | Emerald moth | *Hemithea tritonaria* Walker | Geometridae | Flower feeder |
| **4** | Yellow-tail tussock moth | *Somena scintillans* Walker | Erebidae | Flower feeder |
| **5** | Tussock caterpillar | *Olene mendosa* Huebner | Erebidae | Flower feeder |
| **6** | Looper | *Comibaena cassidara* Guenee | Geometridae | Flower feeder |
| **7** | Pointed ciliate blue | *Anthene lycaenina* Felder | Lycaenidae | Flower feeder |
| **8** | Owl moth | *Avatha discolor* Fabricius | Erebidae | Defoliator |
| **9** | Flower feeding caterpillar | *Eublemma abrupta* Walker | Erebidae | Flower feeder |
| **10** | Flower Webber | *Eublemma versicolor* Walker | Erebidae | Flower feeder |
| **11** | Flower Webber | Unidentified | Unidentified | Flower feeder |
| **12** | Bark borer | Unidentified | Lecithoceridae | Bark feeder |
| **13** | Bark borer | Unidentified | Lecithoceridae | Bark feeder |
| **14** | Bag worm | Unidentified | Psychidae | Leaf feeder |
| | | **ORDER: HEMIPTERA** | | |
| **1** | Cacao mealybug | *Planococcus lilacinus* Cockerell | Pseudococcidae | Sap feeder |
| **2** | Hibiscus mealybug | *Crisicoccus hirsutus* Newstead | Pseudococcidae | Sap feeder |
| **3** | Striped mealybug | *Ferrisia virgata* Cockerell | Pseudococcidae | Sap feeder |
| **4** | Citrus mealy bug | *Planococcus citri* Risso | Pseudococcidae | Sap feeder |
| **5** | Florida wax scale | *Ceroplastes floridensis* Comstock | Coccidae | Sap feeder |
| **6** | Scale insect | *Icerya* sp. | Monophlebidae | Sap feeder |
| **7** | Bean bug | *Riptortus pedestris* Fabricius | Alydidae | Sap feeder |
| **8** | Cow bug | *Otinotus oneratus* Walker | Membracidae | Sap feeder |
| **9** | Tree hopper | *Gargara* sp. | Membracidae | Sap feeder |
| **10** | Black plant hopper | *Ricania* sp. | Ricaniidae | Sap feeder |
| **11** | Flatid Plant hopper | *Flatormenis* sp. | Flatidae | Sap feeder |
| | | **ORDER: COLEOPTERA** | | |
| **1** | Scarab beetle | *Popillia* sp. | Scarabaeidae | Flower feeder |
| **2** | Warty leaf beetle | *Exema salemensis* Bhasin | Chrysomelidae | Flower feeder |
| **3** | Leaf beetle | *Monolepta* sp. | Chrysomelidae | Flower feeder |
| **4** | Flower beetle | *Oxycetonia versicolor* Fabricius | Scarabaeidae | Flower feeder |
| **5** | Flower beetle | Unidentified | Bruchidae | Flower feeder |
| | | **ORDER: HYMENOPTERA** | | |
| **1** | Red ant | *Oecophylla smaragdina* Fabricius | Formicidae | Aphid association |
| **2** | Black ant | *Camponotus compressus* Fabricius | Formicidae | Cowbug association |

a. Caterpillar b. Pupa c. Adult

**Fig. 1.** Life stages of white looper moth *Pingasa chlora* (Stoll) on *Nephelium lappaceum* L**.**

a. Caterpillar b. Pupa c. Adult

**Fig. 2.** Life stages of emerald moth, *Hemithea tritonaria* on *Nephelium lappaceum* L.

a. Caterpillar b. Pupa c. Adult

**Fig. 3.** Life stages of flower webber and its damage on *Nephelium lappaceum* L.

a. *Popillia* sp. b. *Monolepta* sp c. *Exema salemensis*

**Fig. 4.** Coleopteran beetles documented on inflorescence of *Nephelium lappaceum* L.

a. *Riptortus pedestris* b. *Otinotus oneratulus*

**Fig. 5.** Hemipteran pests observed on inflorescence of *Nephelium lappaceum* L.

a. *Planococcus lilacinus*

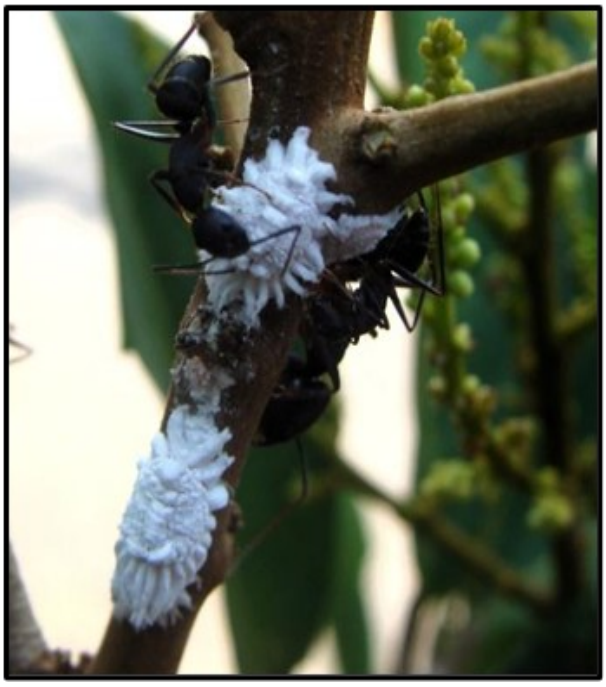
b. *Crisicoccus hirsutus*

c. *Ferrisia virgata*

d. *Planococcus citri*

**Fig. 6.** Mealybugs infesting *Nephelium lappaceum* L.

a. *Ceroplastis floridensis*



b. *Icerya* sp.

**Fig. 7.** Scales infesting *Nephelium lappaceum* L.

a. *Myzinum* sp.

b. *Tetragonula travancorica*

c. *Leucospis* sp

d. *Apis cerana indica*

e. *Nomada* sp

f. *Halictus* sp

**Fig. 8.** Pollinators visiting during flowering season in *Nephelium lappaceum* L.

Xylorictidae were recorded from rambutan. Infestation was evident by the presence of tunnels on the bark, which were sealed with excreta.

There have been limited comprehensive studies documenting pests of rambutan. Pests like the mealybug (*Planococcus citri*), red borers (*Zeuzera* sp.), bostrichid beetles (*Sinoxylon* sp.) and fruit flies (*Bactrocera dorsalis* and *B. caryeae*) were earlier recorded in India (3). A previous study in Malaysia documented 127 insect species associated with rambutan (7). Another study described 15 insect species infesting the crop (8). A survey by Waterhouse identified 28 rambutan pests in Southeast Asia (9). Rambutan was introduced to India from Malaysia and Sri Lanka around 70 years ago (2). As its cultivation expands, new insect pests continue to be reported. The red twig borer *Zeuzera* sp. and sucking pests like *P citri* and armored scales are reported on rambutan trees from Kerala (3, 4).

About ten pollinators were recorded on the inflorescence of rambutan *A. cerana indica, T. travancorica, Nomada sp., Leucospis sp., Myzinum* sp., *Halictus* sp., *Stomorhina* sp., *Ischidon* sp., *Ypthima* sp. and *E. impactella* were documented in rambutan (Table 2). Among them, the Hymenopteran pollinators were abundant. They recorded an average of 8.49 / 5 inflorescence / 5 min followed by Lepidoptera (1.06 / 5 inflorescence/ 5 min) and Diptera (0.03 / 5 inflorescence/ 5 min) (Table 3 & Fig. 9). The

**Table 2.** Insect pollinators documented from rambutan flowers

| Sl. No | Common name | Pollinators | Family |
|---|---|---|---|
| | | **ORDER: HYMENOPTERA** | |
| **1** | Indian honey bee | *Apis cerana indica* Fabricius | Apidae |
| **2** | Stingless bee | *Tetragonula travancorica* Shanas and Faseeh | Apidae |
| **3** | Nomad bee | *Nomada* sp. | Apidae |
| **4** | Leucospid wasp | *Leucospis* sp. | Leucospidae |
| **5** | Thynnid wasp | *Myzinum* sp. | Thynnidae |
| **6** | Furrow bee | *Halictus* sp. | Halictidae |
| | | **ORDER: LEPIDOPTERA** | |
| **7** | Common five ring | *Ypthima* sp. | Nymphalidae |
| **8** | Spurs-legged moth | *Eretmocera impactella* Walker | Scythrididae |
| | | **ORDER: DIPTERA** | |
| **9** | Snout fly | *Stomorhina* sp. | Rhiniidae |
| **10** | Hover fly | *Ischidon* sp. | Syrphidae |

**Table 3.** Foraging pattern of insect pollinators in rambutan

| | **Mean population/ 5 inflorescences/ 5 min*** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species / time of day** | 0600-0700 | 0700-0800 | 0800-0900 | 0900-1000 | 1000-1100 | 1100-1200 | 1200-1300 | 1300-1400 | 1400-1500 | 1500-1600 | 1600-1700 | 1700-1800 | Mean |
| ***A. cerana indica*** | 0.55 | 1.20 | 1.80 | 2.25 | 2.30 | 2.40 | 2.05 | 1.70 | 1.25 | 1.50 | 1.00 | 0.50 | 1.54 |
| ***T. travancorica*** | 5.00 | 6.70 | 7.00 | 8.60 | 10.50 | 10.80 | 7.80 | 7.65 | 4.00 | 3.80 | 3.05 | 2.10 | 6.41 |
| ***Nomada* sp.** | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 | 0.00 | 0.05 | 0.20 | 0.10 | 0.10 | 0.00 | 0.00 | 0.07 |
| ***Leucospis* sp.** | 0.00 | 0.00 | 0.30 | 0.20 | 0.36 | 0.05 | 0.45 | 0.30 | 0.30 | 0.10 | 0.00 | 0.00 | 0.17 |
| ***Myzinum* sp.** | 0.00 | 0.00 | 0.10 | 0.00 | 0.80 | 0.60 | 0.60 | 0.40 | 0.40 | 0.10 | 0.00 | 0.00 | 0.25 |
| ***Halictus* sp.** | 0.00 | 0.00 | 0.00 | 0.05 | 0.05 | 0.30 | 0.10 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.06 |
| ***Stomorhina* sp.** | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| ***Ischidon* sp.** | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.01 |
| ***E. impactella*** | 0.00 | 0.35 | 0.35 | 0.75 | 1.46 | 2.45 | 2.35 | 2.45 | 1.47 | 0.50 | 0.25 | 0.25 | 1.05 |
| ***Ypthima* sp.** | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | 0.05 | 0.00 | 0.05 | 0.00 | 0.00 | 0.01 |

*Mean of 4 observations

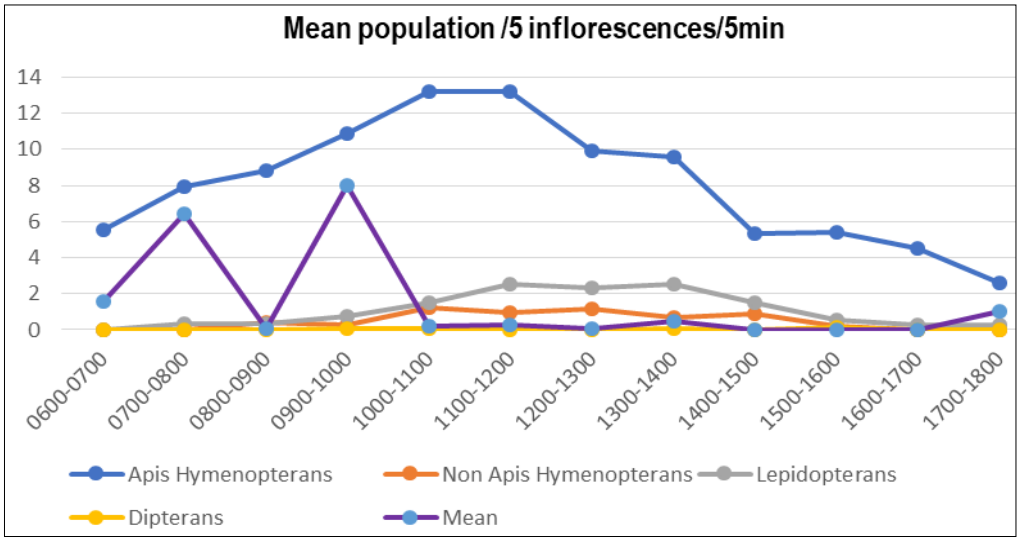



**Fig. 9.** Mean foraging pattern of apis and non-apis pollinators in rambutan.

foraging activity of stingless bees (*T. travancorica*) and honey bees (*A. cerana indica*) commenced at 0600 hrs and continued until 1800 hr. These Hymenopteran pollinators were observed to be the most frequent visitors to rambutan flowers. The spur-legged moth (*E. impactella*) was also recorded hourly throughout the observation period, indicating a consistent presence on the flowers. In contrast, dipteran visitors such as *Stomorhina* sp. and *Ischiodon* sp. were infrequently observed, suggesting their relatively minor role in the pollination of rambutan compared to hymenopterans. These findings provide valuable insights into the diverse dynamics of pollinators within the hymenoptera order, highlighting the significant roles played by *T. travancorica, A. cerana indica* and other species in the pollination of rambutan. It is documented that the stingless bee (*Trigona iridipennis*) and the Indian honeybee (*Apis cerana*) were the most predominant pollinators of rambutan (10). Stingless bee species *Scaptotrigona sp.* and *Tetragonisca* sp. in open pollination treatments and within cages showed that fruit production increased nearly 10-fold in rambutan (11).

Seasonal incidence of pests infesting rambutan was recorded for one year from November 2022 to November 2023 (Fig. 10). The pest infestation in rambutan was highest during March to May, covering the flowering to fruit-setting season. During this period, the insect pests noticed on rambutan were *Monolepta* sp., *Popillia* sp., *E. salemensis*, *O. oneratulus*, *R. pedestris*, *P. chlora*, *H. tritonaria* and an unidentified flower webber. It was observed that the infestation of the hemipteran bug *R. pedestris* was present on the trees up to September, feeding on the flowers and young fruits. In North Queensland, yellow peach fruit piercing moths were found in rambutan from December to March and were most active from February to April. They fed on the fruit juices of maturing fruit by damaging the skin, predisposing to secondary pathogens, causing rots on fruits (12). Fruit fly *Bactrocera dorsalis*, *Conogethus punctiferalis* and

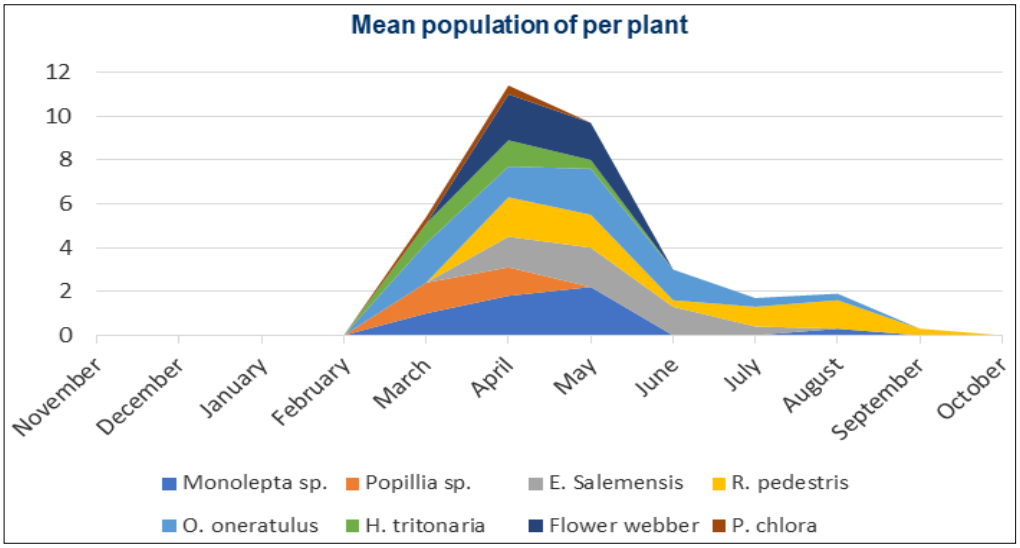



**Fig. 10.** Seasonal incidence of pests of rambutan from Nov.22- Nov.23.

*Cryptophlebia ombrodelta* were considered as significant rambutan pests in Vietnam during the fruit setting period (13). There was no pest infestation on rambutan trees from October to February. *Conopomorpha cramerella* populations peak during the flowering to fruit maturity stage (May-July) due to high humidity and fruit availability (14). *Planococcus lilacinus* outbreaks have been reported in the post-monsoon period (October-December), coinciding with new vegetative flushes (15). *Toxoptera aurantii* infests young shoots and peaks during early growth phases and after rainfall (16).

Correlation between the pest population of rambutan and weather parameters is presented in Table 4. The pest population had a negative correlation with rainfall and average relative humidity, while a positive correlation was observed with temperature, wind velocity and sunshine hours. All the documented pests showed a significant positive correlation with temperature. *R. pedestris* exhibited a significant positive correlation with wind velocity. On the other hand, *Popillia* sp., *H. tritonaria* and *P. chlora* populations displayed a significant negative correlation with average relative humidity. There was a strong positive ($r \approx 0.74$, $p<0.01$) correlation with relative humidity and incidence of *Planococcus lilacinus* (Mealybug) in India (15). Also, a strong positive ($r \approx 0.76$, $p<0.05$) with temperature, mild negative ($r \approx -0.43$) with relative humidity and bimodal – decline during heavy rainfall was recorded in the case of *Bactrocera dorsalis* incidence by various researchers from Malaysia, India, Philippines, etc (17-19).

## Conclusion

Exotic fruits cultivation has gained importance due to their high phytonutrient value. Cultivation of exotic fruits such as rambutan *Nephelium lappaceum* Linnaeus, dragon fruit *Selenicereus undatus* (Haworth), mangosteen *Garcinia mangostana* (Linnaeus) is becoming popular nowadays. Pest and disease infestations tend to increase and become economically significant as the cultivation of these exotic fruits expands. Documenting the pests and pollinators of these exotic fruits may help manage the infestation and increase the yield.

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## Authors' contributions

PA and TSV designed the experiment, examined the results. TSV and SA analysed the data, created the fiche, while AG reviewed the text. All authors read and approved the final manuscript.

## Compliance with ethical standards

**Conflict of interest:** The authors declare that there is no conflict of interest regarding the publication of this paper.

**Ethical issues:** None

**Table 4.** Correlation between pest population of rambutan and weather parameters

| Sl no | Pests | Temperature (°C ) | Average Relative Humidity (%) | Total rainfall (mm) | Wind velocity (km/h) | Sunshine (Hours) |
|---|---|---|---|---|---|---|
| **1** | *Monolepta* sp. | 0.867* | -0.503 | -0.296 | 0.446 | 0.464 |
| **2** | *Popillia* sp. | 0.689* | -0.693* | -0.396 | 0.534 | 0.507 |
| **3** | *E. Salemensis* | 0.686* | -0.128 | -0.143 | 0.352 | 0.209 |
| **4** | *R. pedestris* | 0.612* | -0.181 | -0.215 | 0.688* | 0.528 |
| **5** | *O. oneratulus* | 0.871* | -0.505 | -0.322 | 0.511 | 0.446 |
| **6** | *H. tritonaria* | 0.811* | -0.646* | -0.352 | 0.480 | 0.435 |
| **7** | Flower webber | 0.739* | -0.303 | -0.196 | 0.348 | 0.301 |
| **8** | *P. chlora* | 0.685* | -0.621* | -0.340 | 0.460 | 0.391 |

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