Punjab University Journal of Zoology

OPEN ACCESS

37(1): 23-28 (2022)
https://dx.doi.org/10.17582/journal.pujz/2022.37.1.23.28

Check for updates

Research Article

Population Dynamics of Mealybug *Drosicha mangiferae* (Green) (Hemiptera: Pseudococcidae) in Citrus Orchards of District Sargodha (Punjab, Pakistan)

Muhammad Rizwan, Abu Bakar Muhammad Raza, Muhammad Zeeshan Majeed*, Muhammad Arshad

Department of Entomology, College of Agriculture, University of Sargodha, Pakistan.

Article History
Received: December 14, 2021
Revised: January 18, 2022
Accepted: February 26, 2022
Published: March 17, 2022

Authors' Contributions
MR conducted experiments and recorded data. MR and ABMR wrote the manuscript. ABMR conceived the idea and designed the experimental protocol. MZM provided the technical support and revised the manuscript. MA analysed the data, prepared results and proofread the manuscript.

Keywords
Population dynamics, Mealybugs, Citrus orchards, Nymphal population, Abiotic weather factors

Abstract | Mealybug species *Drosicha mangiferae* (Green) (Hemiptera: Pseudococcidae) has become a serious pest of many horticultural crops including citrus. Population studies are important to understand the abundance, life history and estimating extinction probability. The present study was conducted in three localities (tehsils) of district Sargodha during 2017 to determine the population dynamics of *D. mangiferae* nymphs and adults on citrus plants. Results showed that the average population of mealybug nymphs (9.92 individuals per branch) and adults (14.55 individuals per branch) was higher in Bhalwal as compared to Kotmomin and Sargodha. The maximum population of nymphs (31.93 individuals per branch) was observed during April and the adult population was maximum (34.86 individuals per branch) during May. The nymphs and adults were remained lower in January and February. A positive but non-significant ($P > 0.05$) correlation of maximum and minimum temperature was observed with the nymphal population, while relative humidity showed negative but significant ($P < 0.05$) correlation. In case of mealybug adults, temperature had a positive and significant ($P < 0.05$) correlation, while relative humidity showed a negative and significant ($P < 0.05$) correlation. The findings of this study could be useful for local citrus growers in devising timely and suitable control strategies against *D. mangiferae* infestations on citrus plantations.

Novelty Statement | This research work describes the prevailing population dynamics of mealybug *Drosicha mangiferae* (Green) (Hemiptera: Pseudococcidae) on citrus plantations of district Sargodha and worked out its correlation with the abiotic weather factors. The findings of this study could be useful for local citrus growers in devising timely and suitable control strategies against *D. mangiferae* infestations on citrus plantations.

To cite this article: Rizwan, M., Raza, A.B.M., Majeed, M.Z. and Arshad, M., 2022. Population dynamics of mealybug *Drosicha mangiferae* (Green) (Hemiptera: Pseudococcidae) in citrus orchards of district Sargodha (Punjab, Pakistan). *Punjab Univ. J. Zool.*, **37**(1): 23-28. https://dx.doi.org/10.17582/journal.pujz/2022.37.1.23.28

Introduction

Citrus is an important fruit crop and Pakistan is at 6th position in citrus production worldwide. It is primarily produced in Sargodha region of Punjab province (GOP, 2018). The production of citrus fruits is being reduced due to the attack of various insect pests and plant pathogens. Mealybugs (Pseudococcidae: Hemiptera) are destructive pests of a wide array of horticultural crops and cause considerable losses annually. These are phloem-feeding insects that suck sap from different plant parts such as from tender shoots, twigs, leaves, immature fruits, roots, trunks and stems (Williams and Willink, 1992). More than 300 species of mealybugs belonging to 50 different genera have been reported in Southeast Asian countries

Corresponding Author: Muhammad Zeeshan Majeed
zeeshan.majeed@uos.edu.pk

infesting many crops including citrus, mango, grape, pineapple, banana, cotton, tomato and okra etc. (Williams and Willink, 1992; Sirisena *et al.*, 2013).

Drosicha mangiferae (Green) (Hemiptera: Pseudococcidae), commonly known as mango mealybug, is one of the most destructive species in Indo-Pak regions (Downie and Gullan, 2004; Gundappa and Shukla, 2018). Besides mango as a host plant, it has been found on many other agricultural and horticultural crops. This species has been reported as destructive pest of citrus crop in Pakistan for last decade (Ahmad *et al.*, 2018). It causes considerable qualitative and quantitative loss to the production of citrus (Tahir *et al.*, 2015; Afzal *et al.*, 2018).

Population dynamics of insects depend on the interaction between species, host plants availability and the environmental conditions of their associated habitats. Population dynamics or abundance of insect pests are greatly affected by various factors such as biotic and abiotic factors including weather conditions that impact the morphology and physiology of insects and their adaptation to the environment (Karl *et al.*, 2011; Nyamukondiwa *et al.*, 2013). The optimum climatic conditions for normal growth and development and abundance of insects directly impact habitat suitability. Temperature is the main factor across other abiotic stresses which impact the prevailing population dynamics or abundance of insects (Régnière *et al.*, 2012). Temperature can play a role in enhancing or decreasing the mortality and fecundity rate and the suitability of host plants (Finlay-Doney and Walter, 2012). Hence, different biotic and abiotic factors such as temperature, relative humidity, food availability, and interaction among insect species may affect the population or abundance of insect pests in the field (Danks, 2007; Konopka *et al.*, 2013; Milosavljević *et al.*, 2016; Tetsuo *et al.*, 2018; Barretto *et al.*, 2019).

Studying prevailing incidence and population dynamics of a pest will allow for devising its timely and effective control. It is therefore important to study the pest population dynamics during the crop growing season and creating a benchmark that could be helpful for the crop producers, researchers and consultants for the effective management of insect pests. The objective of this study was to assess the population dynamics of *mealybug D. mangiferae* in citrus orchards of district Sargodha.

Materials and Methods

Collection sites and sampling protocol

Three localities (main citrus growing tehsils of district Sargodha) i.e., Bhalwal (32°16'49.7"N:72°53'37.4"E), Kotmomin (32°10'52.3"N:73°01'56.6"E) and Sargodha (32°03'37.2"N:72°43'54.4"E) were selected from district Sargodha (Punjab, Pakistan). Three orchards were selected from each locality. Five points method was used for sampling in which an orchard was divided into four quadrants and one plant from each quadrant and one from the center was selected. Thus, five plants were selected from each orchard. A total of four branches (30 cm long apical twigs) were selected from each plant (one on each of the four sides of plant canopy) and the population of mealybug nymphs and adults was counted. Sampling was done on weekly basis. Data regarding weather parameters were collected from the Pakistan Metrological Department, Sargodha.

Statistical analysis

Data were recorded on weekly basis during 2017 starting from early January to the end of June. Data were subjected to factorial analysis of variance (ANOVA) keeping locations and months as the main factors. Means were separated using Tukey HSD all pair-wise comparison test at standard level of significance ($\alpha = 0.05$). Moreover, correlation coefficients and regression analysis were also performed to determine the correlation of the mealybug population with the prevailing weather factors i.e., with average maximum and minimum temperature and relative humidity. Statistical interpretation of data was done with Minitab 16.1 software.

Results and Discussion

This study was conducted to assess the prevailing dynamics of mealybug *D. mangiferae* in t citrus orchards of Sargodha district which is the hub of citrus production in Pakistan. The maximum population of mealybug nymphs (9.92 individuals per branch) was recorded in Bhalwal and Kotmomin (9.55 individuals per branch) compared to the Sargodha region (6.74 individuals per branch). A significant difference ($P < 0.05$) was recorded in the adult population among three different localities. The adult population was higher (14.55 individuals per branch) in Bhalwal, followed by 12.45 individuals per branch in Kotmomin and 10.85 individuals per branch in Sargodha (Figure 1).

According to results, no considerable population was observed during the month of January. Nymphal population started to appear in February and gradually increased from an average population of 7.36 individuals per branch in March to its peak (31.93 individuals per branch) during April and again started to decrease during the month of May. The minimum population (i.e., 0.78 individuals per branch) of nymphs was observed during June. The population of mealybug adults started to increase during the month of April (26.64 individuals per branch) and the maximum population (34.86 individuals per branch) was recorded in May (Figure 2).

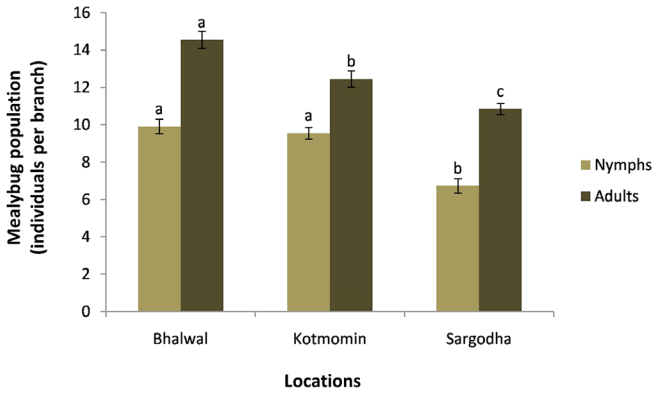

Figure 1: Abundance (mean individuals ± SE) of nymphs and adults of mealybug *Drosicha mangiferae* on citrus plants in different locations (tehsils) of district Sargodha. Different letters at bar tops indicate significant difference among treatments (HSD at P ≤ 0.05).

Regression analysis showed that all abiotic factors had a non-significant (*P* > *0.05*) correlation with the nymphal and adult population of mealybug. Maximum and minimum temperature showed 35.0 and 17.9% role in the nymph population, while relative humidity showed 60.03%. However, the combined effect of all factors showed 86.5% correlation with the nymphal population (Figures 3 and 4). Maximum (r = 0.598) and minimum temperature (r = 0.423) had positive and non-significant (*P* > *0.05*) correlation with the mealybug nymphs but relative humidity showed a negative and significant (r = -0.774) correlation. In case of adults, maximum (r = 0.837) and minimum temperature (r = 0.812) showed positive and significant relation (*P* < *0.05*). While, humidity showed a significant and negative (r = -0.802) correlation with adult population (Table 1).

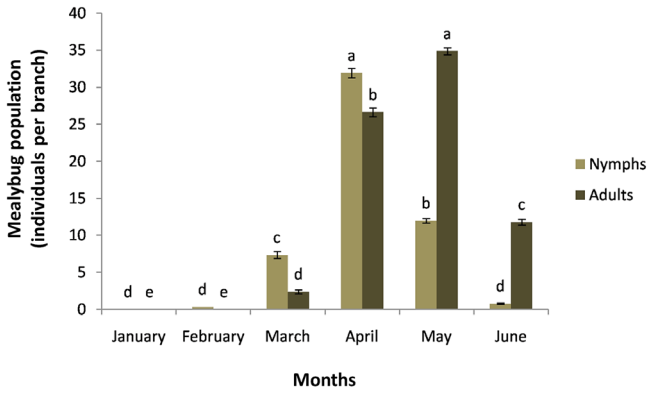

Figure 2: Abundance (mean individuals ± SE) of nymphs and adults of mealybug *Drosicha mangiferae* on citrus plants in district Sargodha recorded in different months of 2017. Different letters at bar tops indicate significant difference among treatments (HSD at P ≤ 0.05).

The population of *D. mangiferae* mealybugs was found higher in Bhalwal and Kotmomin tehsils. This species (*D. mangiferae*) is an important pest of mango trees (Waheed *et al.*, 2014; Kumar, 2016) but has also been damaging the citrus plants from last decade (Tahir *et al.*, 2015; Afzal *et al.*, 2018). The population of mealybugs increased during the month of March and April. The increase in population also strongly depends upon prevailing weather factors. Suresh *et al.* (2010) showed that the population of mealybugs in Tamil Nadu was highest in the month

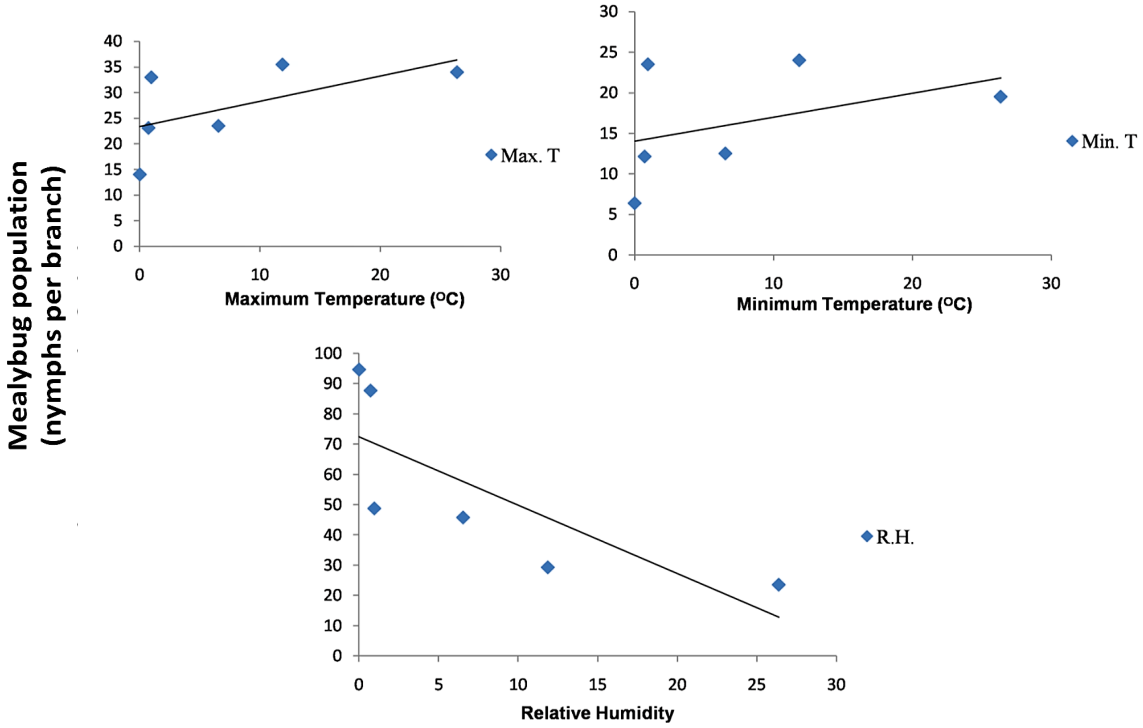

Figure 3: Relationship of nymphal population of mealybug *Drosicha mangiferae* with the prevailing maximum temperature (°C), minimum temperature (°C) and relative humidity (%).

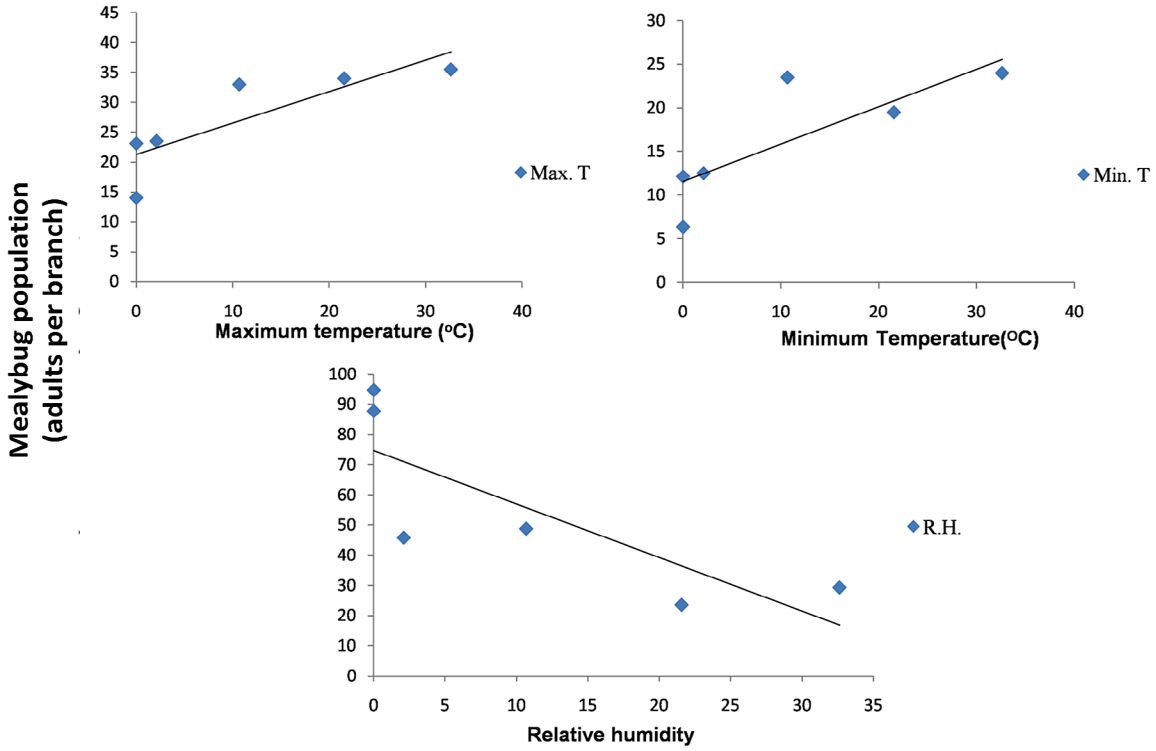

Figure 4: Relationship of adult population of mealybug *Drosicha mangiferae* with the prevailing maximum temperature (˚C), minimum temperature (˚C) and relative humidity (%).

of June and after June the population gradually decreased. Some previous studies showed a significant positive correlation of temperature and a negative correlation of relative humidity with the prevailing population dynamics of mealybugs (Suresh *et al.*, 2010; Chakraborty *et al.*, 2015; Ghafoor, 2021). Ghafoor (2021) showed that the first instar of mealybug (*D. mangiferae*) started to move up on the citrus plants during the first week of February and there was an increase in nymphal population on the plant canopies in the month of March.

Table 1: Correlation coefficients (r) among the mealybug population and prevailing abiotic (weather) factors.

Weather factors	Mealybug nymphs	Mealybug adults
Maximum temperature(˚C)	r = 0.599	r = 0.838*
Minimum temperature (˚C)	r = 0.423	r = 0.813*
Relative humidity (%)	r = -0.775*	r = -0.802*

* Significant at P < 0.05.

The population of nymphs started to appear when the maximum temperature was less than 20˚C. It increased with the increase in temperature and the maximum nymphal population was observed when the temperature was above 25˚C but the increase in population was up to a certain temperature. The mealybug population started to decrease at 30˚C. In case of minimum temperature, the population of nymphs started at about 10˚C and gradually increased along with the temperature. The nymphal population of mealybugs had a significant and negative correlation with the prevailing relative humidity. The population increased with the decrease in relative humidity. The nymphal population was started to appear when relative humidity was about 50% and reached its maximum when relative humidity was about 30% or lower than 30%. The adult population was observed when the temperature was about 10 to 25˚C. There was an increasing trend in the adult mealybug population with the increase in temperature and the maximum population was observed when the temperature was above 35˚C but this increase in population was up to a certain temperature. The population started to decrease when the temperature rose above 35˚C. Adult population of *D. mangiferae* exhibited similar behavior towards relative humidity. According to Cid *et al.* (2010), the active period of citrus mealybug (*Planococcus citri*) in northwestern Spain starts from June and peaks in August when the prevailing mean temperature is about 20˚C and remains until December. Similarly, Chakraborty *et al.* (2015) showed that the population of mealybugs had a significant positive correlation with high relative humidity, low temperature, and temperature gradient.

Understanding the incidence and prevailing dynamics of insect pests can provide baseline information helpful in the management of these pests. Different factors may affect the population of insect pests and their spatial abundance. Hence, the information about the population dynamics of mealybugs in citrus orchards would be helpful in the effective control of mealybugs' infestation on citrus plantations in district Sargodha.

Conclusions and Recommendations

In brief, overall study results show that the population of *D. mangiferae* mealybugs appears in mid-February and remains higher during the months of April and May in citrus orchards of district Sargodha. Keeping in view the appearance and peak population trends of mealybugs in the study area, this study could aid in devising timely and effective control strategies for an effective management of this insect pest in citrus orchards and nurseries.

Acknowledgements

The authors are thankful to Department of Horticulture, College of Agriculture, University of Sargodha and to the Pakistan Meteorological Department, Sargodha for providing the research facilities and weather data.

Conflict of interest

The authors have declared no conflict of interest.

References

Afzal, M.B.S., Sikandar, Z., Banazeer, A., Khan, M.N., Aziz, A., Salik, M.R. and Nawaz, S., 2018. Efficacy of different insecticides under laboratory conditions against *Drosicha mangiferae* Green (Homoptera: Margarodidae) collected from citrus orchards of Sargodha, Pakistan. *J. Entomol. Zool. Stud.,* **6:** 2855–2858.

Ahmad, B., Mehdi, M., Ghafoor, A. and Anwar, H., 2018. Value chain assessment and measuring export determinants of citrus fruits in Pakistan: an analysis of primary data. *Pak. J. Agric. Sci.*, **55:** 691–698. https://doi.org/10.21162/PAKJAS/18.6056

Barretto, J.W., Cultid-Medina, C.A. and Escobar, F., 2019. Annual abundance and population structure of two dung beetle species in a human-modified landscape. *Insects,* **10:** 2. https://doi.org/10.3390/insects10010002

Chakraborty, K., Sarkar, A. and Nandi, P., 2015. Incidence of mango mealy bug *Droschia mangiferae* (Pesudococcidae: Hemiptera) in the Agro-climatic conditions of upper gangetic plain of West Bengal, India. *Int. J. Sci. Nat.,* **6:** 568–575.

Cid, M., Pereira, S., Cabaleiro, C. and Segura, A., 2010. Citrus mealybug (Homoptera: Pseudococcidae) movement and population dynamics in an arbor-trained vineyard. *J. Econ. Entomol.,* **103:** 619–630. https://doi.org/10.1603/EC09234

Danks, H.V., 2007. The elements of seasonal adaptations in insects. *Can. Entomol.,* **139:** 1–44. https://doi.org/10.4039/n06-048

Downie, D.A. and Gullan, P.J., 2004. Phylogenetic analysis of mealybugs (Hemiptera: Coccoidea: Pseudococcidae) based on DNA sequences from three nuclear genes, and a review of the higher classification. *Syst. Entomol.*, **29:** 238–260. https://doi.org/10.1111/j.0307-6970.2004.00241.x

Finlay-doney, M. and Walter, G.H., 2012. The conceptual and practical implications of interpreting diet breadth mechanistically in generalist predatory insects. *Biol. J. Linnean Soc.,* **107:** 737–763. https://doi.org/10.1111/j.1095-8312.2012.01991.x

Ghafoor, H.A., 2021. *Integrated management of mealybug (Hemiptera: Pseudococcidae) infestation on citrus in district Sargodha*. PhD Dissertation. University of Sargodha, Punjab, Pakistan.

Government of Pakistan (GOP), 2018. *Economics Survey of Pakistan, 2017–18*. Economic advisory wing, finance division, Islamabad, Pakistan.

Gundappa, T.A. and Shukla, P., 2018. Population dynamics of mango mealybug, *Drosicha mangiferae* (Margorididae: Hemiptera) and its relation with weather parameters in subtropical climatic conditions. *Ind. J. Agric. Sci.*, **88:** 865–870.

Karl, I., Stoks, R., De Block, M. and Janowitz, S.A., 2011. Temperature extremes and butterfly fitness: Conflicting evidence from life history and immune function. *Glob. Chang. Biol.,* **17:** 676–687. https://doi.org/10.1111/j.1365-2486.2010.02277.x

Konopka, J.K., Hanyu, K., Macfie, S.M. and Mcneil, J.N., 2013. Does the response of insect herbivores to cadmium depend on their feeding strategy? *J. Chem. Ecol.,* **39:** 546–554. https://doi.org/10.1007/s10886-013-0273-4

Kumar, A., 2016. Nymph's population of mango mealy bug *Drosicha mangiferae* (Green) on different parts of mango trees, *J. Glob. Biosci.,* **5:** 4320–4328.

Milosavljevic, I., Esser, A.D. and Crowder, D.W., 2016. Seasonal population dynamics of wireworms in wheat crops in the Pacific Northwestern United States. *J. Pest. Sci.,* **90:** 77–86. https://doi.org/10.1007/s10340-016-0750-y

Nyamukondiwa, C., Weldon, C.W., Chown, S.L., Le Roux, P.C. and Terblanche, J.S., 2013. Thermal biology, population fluctuations and implications of temperature extremes for the management of two globally significant insect pests. *J. Insect Physiol.,* **59:** 1199–1211. https://doi.org/10.1016/j.jinsphys.2013.09.004

Régnière, J., St-Amant, R. and Duval, P., 2012. Predicting insect distributions under climate change from physiological responses: Spruce budworm as an example. *Biol. Invasions,* **14:** 1571–1586. https://doi.org/10.1007/s10530-010-9918-1

Sirisena, U.G.A.I., Watson, G.W., Hemachandra, K.S. and Wijayagunasekara, H.N.P., 2013. Mealybugs (Hemiptera: Pseudococcidae) species on economically important fruit crops in Sri Lanka. *Trop. Agric. Res.,* **25:** 69–82. https://doi.org/10.4038/

tar.v25i1.8031

Suresh, S., Jothimani, R., Sivasubrmanian, P., Karuppuchamy, R., Samiyappan, A. and Jonathan, I., 2010. Invasive mealybugs of Tamil Nadu and their management. *Karnataka J. Agric. Sci.,* **23:** 6–9.

Tahir, H.M., Nazarat, I., Naseem, S., Butt, A., Yaqoob, R., Mukhtar, M.K. and Samiullah, K., 2015. Seasonal dynamics of spiders and insect pests in citrus orchards of district Sargodha, Pakistan. *Pakistan J. Zool*., **47:** 1673–1681.

Tetsuo, T., Nakajo, M., Furuki, T., Umamoto, N., Moku, M., Sekimoto, T. and Katagiri, C., 2018. Seasonal change in distribution and heat coma temperature of oceanic skaters, Halobates (Insecta, Heteroptera: Gerridae). *Insects,* **9:** 133. https://doi.org/10.3390/insects9040133

Waheed, A., Abdul, S., Lanjar, G., Anwar, M., Sajjad, R., Khuhro, A. and Rais, N., 2014. Population trend and vartical preference of mango mealybug *Drosicha mangiferae* (Green). *Sci. Int.,* **26:** 1617–1622.

Williams, D.J. and DE Willink, M.C.G., 1992. *Mealybugs of central and South America*. CAB Int. Wallingford, U.K., pp. 635. ISBN: 0851987915.