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Influence of weather parameters on the population of *Bactrocera* spp. (Diptera, Tephritidae) in the mango orchards of Padanakkad, Kerala, India

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ABSTRACT: An investigation was conducted to study the seasonal occurrence of *Bactrocera* spp. (Diptera, Tephritidae) in the mango orchards of College of Agriculture, Kerala Agricultural University, Padannakkad. Surveillance of fruit flies was conducted using bottle traps with methyl eugenol lure. A total of 10,546 fruit flies were trapped with the predominant species being *Bactrocera dorsalis*. Four species *viz*., *B. dorsalis*, *Zeugodacus tau, B. zonata* and *Z. cucurbitae* were identified from the population collected in that order of dominance. Out of fruit flies captured, *B. dorsalis*, accounted for 97.97 per cent. The highest weekly population of fruit flies was recorded in the 14th standard meteorological week (SMW) of 2022 from April 2 to 8, 2022, with 793 fruit flies, while the lowest population in 50th SMW from December 10 to 16, 2021 with only one fruit fly. The monthly average population was highest in May with 667.5 flies per month and lowest in December with 16 flies per month. During the period of host availability (April to June), the population of fruit flies exhibited significant positive correlation with minimum temperature (0.805), and a significant negative correlation with soil temperature (-0.512). There was a negative correlation with maximum temperature (-0.329) and wind speed (-0.192) while a positive correlation was observed with rainfall (+0.204). © 2024 Association for Advancement of Entomology

KEY WORDS: Surveillance, *Bactrocera dorsalis, B. zonata*, *Zeugodacus tau* and *Z. cucurbitae*, weather parameter, population dynamics

INTRODUCTION

Mango (*Mangifera indica* L.) holds immense commercial importance as the foremost fruit crop in India, contributing to over 54 per cent of global mango production (Tharanathan *et al*., 2006). India, the world's largest producer, producing around 21 million metric tons of mango in 2022 (Statista, 2023), accounting for 44 per cent of worldwide production. The productivity of mango in Kerala in the year 2020-21 was reported to be 6206 kg ha^{-1} (FIB, 2023). However, India's global market share is limited to just 15 per cent (Sahithi, 2022), due to various insect pests, especially fruit flies (Diptera,

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Tephritidae), which infest both ripe and unripe fruits (Choudhary *et al*., 2018). The Oriental fruit fly, *Bactrocera dorsalis* (Hendel) is a major pest of mango causing both quantitative and qualitative losses as well as export barriers (Hossain *et al*., 2020). It is widely recognized as a highly invasive species, with documented populations in over 60 countries, primarily concentrated in Asia and Africa. Fruit flies have been identified as one among the ten most severe threat to crop production due to their polyphagous nature and severity in infestation that causes 2.5 to 100 per cent of damage and significant economic loss (Verghese *et al*., 2004). Apart from the immediate harm caused to the fruit, such as its softening, rotting, decay, and subsequent premature dropping to the ground before harvesting, there are also trade-related concerns and trade relationship issues arising from quarantine restrictions imposed because of fruit fly infestations. These are considered as high priority quarantine pests. Being polyphagous pests with high reproductive potential, wide host range, adaptability to climate and overlapping of generations, their management is rather difficult (Agarwal and Kumar, 1999). The key to successful control is effective monitoring. Prior to creating an insect pest management plan tailored to a particular agro-ecosystem, it is vital to possess fundamental data about pest prevalence in relation to weather parameters. This information aids in determining the right timing for intervention and selecting the most effective control methods. Monitoring the pest population throughout the year stands as a crucial foundational element in implementing the Integrated Pest Management (IPM) approach for management of fruit flies in mango ecosystem.

MATERIALS AND METHODS

Surveillance of population: Surveillance was conducted in the mango orchards of Instructional Farm I (IF I) at College of Agriculture, Padanakkad of Kerala Agricultural University within the district of Kasaragod (Kerala, India) (12.25°N; 75.11°E), at an altitude of 8.73m above sea level. The mango orchard spans 6.64 ha and consists diverse range of mango varieties, including Alphonso, Bennet Alphonso, Bangalora, Banganappalli, Neelum, Himayuddin X Neelum, Kalapady, Gomanga, Mundappa, Prior, Phirangiladuva, Karpooram, and more. Notably, no insecticidal sprays were applied during the entire observation period. Surveillance was carried out from September 2021 to September 2022, *i.e*., from 38th standard meteorological week (SMW) of 2021 to 37th SMW of 2022. Four standardised Methyl Eugenol (ME) baited bottle traps were installed in the Instructional Farm - 1 of College of Agriculture, Padannakkad at a height of 1.5m from the ground in a shady place in the mango orchard. The lure blocks were replaced at monthly interval and the trapped flies were removed and counted on a weekly basis. Weekly population of fruit flies were monitored and average monthly population was computed for the surveillance period.

Dominance of fruit fly species: Dominance of fruit fly species was assessed by counting the number of each species. The fruit flies were identified based on the keys specified by David and Ramani (2011). The calculation of the diversity of fruit fly species was carried out for each species using the Shannon-Wiener diversity, Simpson dominance index and Margalef's Species richness index and Species evenness was also assessed.

➢ The Shannon Weiner index (H') is a quantitative measure that reflects how many different species are there in a dataset, and accounts how evenly the basic entities (such as individuals) are distributed among those types.

$$H^1 = -\sum_{i=0}^{s} Pi \ln Pi$$

where: s = number of species in the community

p_i = proportion of total abundance represented by ith species

➢ Simpson's Dominance Index (D) is a measure of diversity which takes into account both richness (the number of species per sample) and evenness (abundance of the different species making up the richness of an area).

$$D = 1 - (\sum(pi)^2)$$

➢ Margalef's Species Richness Index (d)-

Simplest measure of biodiversity and is a count of the number of different species in a given area calculated using the formula:

$$d = \frac{S-1}{\ln N}$$

Where: S = number of species, N = total number

➢ Species evenness - Indicate the measure of how similar the abundance of different species, species evenness was calculated to estimate the equitability component of diversity.

$$J = H' / \ln s$$

Influence of weather parameters with population of fruit flies: Weekly population data of fruit flies was correlated (Pearson's simple correlation) with weather parameters like minimum temperature, maximum temperature, relative humidity, rainfall, wind speed and soil temperature. These meteorological observations were collected from the records of the Regional Agricultural Research Station, Pilicode, Kasaragod, Kerala.

RESULTS AND DISCUSSION

Surveillance of population: Fruit fly populations monitored throughout showed that the weekly catch in trap varied from 1.00 to 793.00 fruit flies. In total, 10546 adult fruit flies were trapped during the year from September, 2021 to September, 2022. Maximum population was recorded in the 14th SMW of 2022, while the lowest population was recorded during 50th SMW (Fig. 1). A sudden increase in the population of fruit flies was observed in the first week of April after the summer showers in late March. Conversely, a gradual decline in the population of fruit flies was noticed from the first week of July as the season of mangoes came to an end and also coincided with the heavy rainfall.

The average monthly population recorded was highest in May followed by June, while lowest monthly population was noted in December. A higher population of fruit flies was mainly reported from April to June which coincided with host availability and suitable weather parameters since the population of fruit flies is mainly influenced by host availability and suitable weather parameters.

The population of fruit flies trapped was significantly lower when mango was unavailable since the study area is deprived of other suitable hosts like guava and banana.

The seasonal pattern of population fluctuation was similar to that of the reports of Akhila (2015) that population build-up was noticed from April and attained a peak in May to June in Kerala. Begam *et al*. (2021) also reported a similar trend from Tamil Nadu where the population was found to gradually increase from the first fortnight of April and reached its first peak during first fortnight of July. Vignesh *et al*. (2020) observed the peak incidence of fruit flies in August and least in December in Tamil Nadu and Sumathi *et al*. (2019) reported less fruit fly population in traps from January to April in Tamil Nadu.

Dominance of fruit fly species: *Bactrocera dorsalis* was found to be the predominant species. Out of the total fruit flies captured (10,546), an over whelming majority were *B. dorsalis* (10,332), accounting for 97.97 per cent. Other species constituted only a small proportion *viz.*, *Zeugodacus cucurbitae* (Coquillett) (199 fruit flies, sharing1.89%), *B. zonata* (Saunders) (9 fruit flies, accounting 0.09%) and *Z. tau* (Walker) (six fruit flies, accounting 0.06%).

The species richness value determined was 0.32 at IF I of CoA, directly indicating fruit fly species composition responding to methyl eugenol in ME traps. The Simpson Dominance Index (D) showed a value of 0.04 in the overall range of 1 to 4. The low value indicates a low species diversity in the community with a few dominant species. From the surveillance study, only four species of fruit flies were captured, with *B. dorsalis* being the most

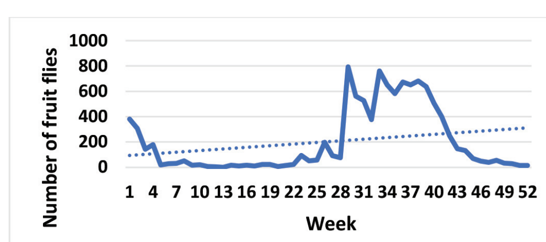

Fig. 1 The weekly population of fruit flies collected in Instructional Farm 1, CoA Padannakkad

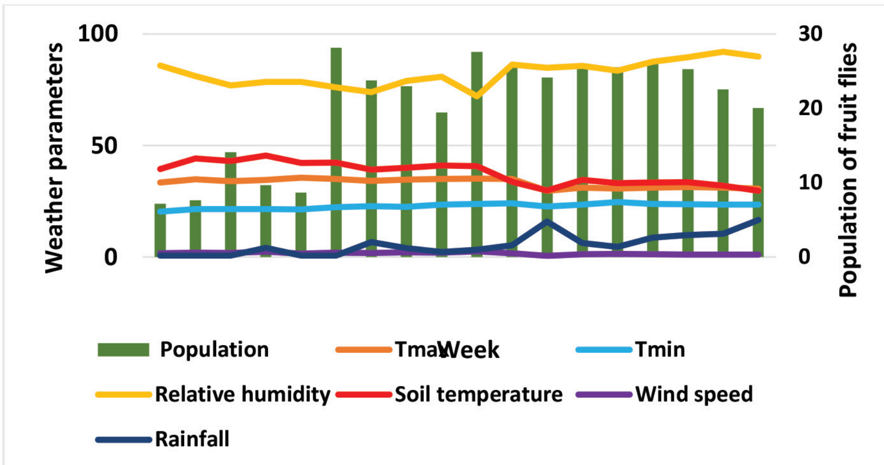

Fig. 2 Influence of weekly weather parameters on population of fruit flies during host availability period

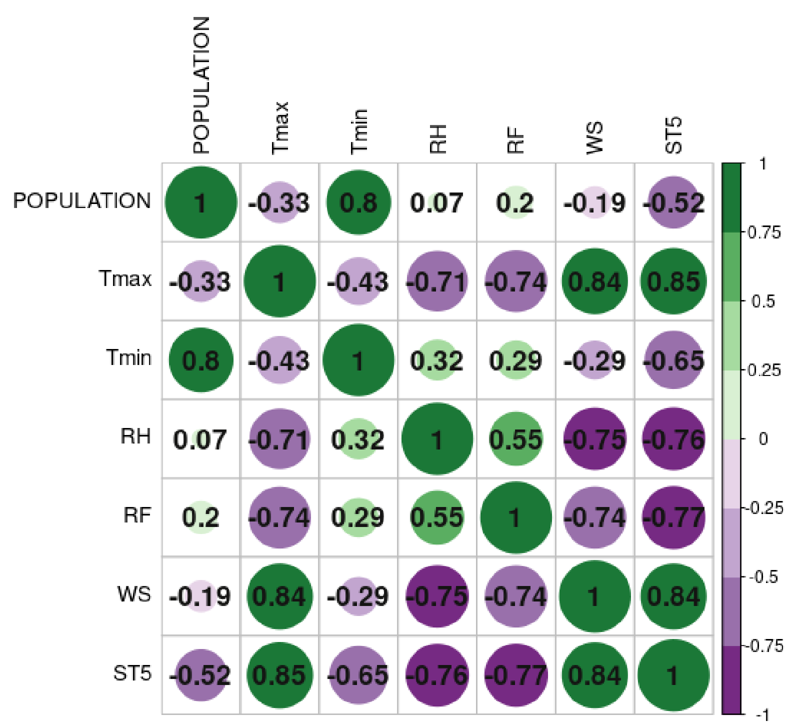

Fig. 3 Correlogram presentation of influence of weather parameters on population of fruit flies

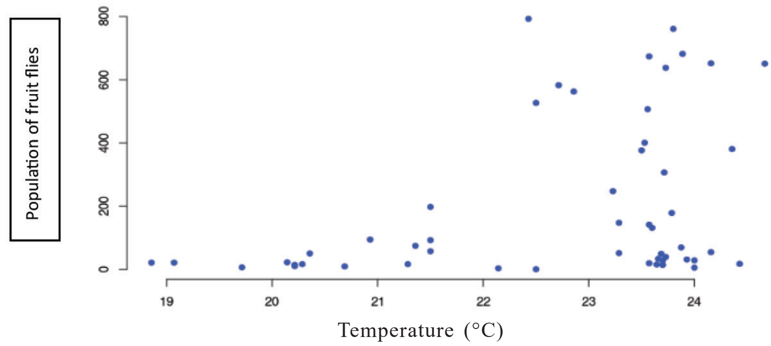

Fig. 4a Influence of minimum temperature on population (r=+0.81)

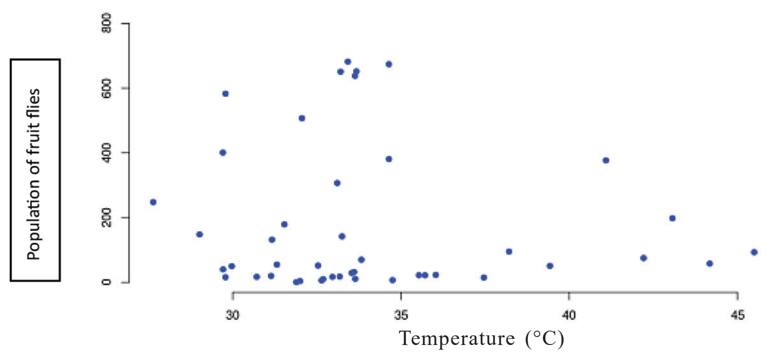

Fig. 4b Influence of soil temperature on population (r= -0.52)

prevalent and dominant species. Shannon-Wiener Diversity Index (H) determined was 0.11 in the range of 0 to 1.38. The low value of *H,* indicates a lower diversity of species in the community. Additionally, the Evenness Index (J) estimated was 0.42, within its range of 0 to 1. The low value suggests that there is an unequal distribution of individuals among the species within the community.

A similar dominance trend was also reported from the field experiments of Mariadoss *et al*. (2020) from the surveillance study in Telangana during 2018 and 2019. Ebi *et al*. (2020) also trapped fruit flies where more than 90 per cent were *B. dorsalis*. Among the three species of *Bactrocera*, the highest population trapped was *B. dorsalis* followed by *B. zonata* and *B. correcta* (Kumar *et al*., 2021). Roy *et al*. (2022) also trapped a higher population of *B. dorsalis* (85.41%) from the surveillance from April to June 2020 in Bangladesh.

Influence of weather parameters on fruit fly population: The fluctuation in fruit fly population may be attributed to prevalence of congenial environmental conditions and/or fruiting and flowering time of the hosts as suggested by Laskar and Chatterjee (2010). Weekly weather parameters during mango fruit availability *i.e*., from 26-02-2022 to 01-07-2022, which coincided with fruit maturing and ripening stage, were analysed and correlated with the population of fruit flies during the same period (Fig. 2). The maximum temperature ranged from 29.66 to 35.64°C and the minimum temperature ranged from 20.36 to 24.67°C, indicating warm to hot climate during this period. Relative humidity fluctuated between 72.07 to 92.07 per cent, suggesting a moderate to high moisture level in the air. There are periods with no recorded rainfall and some weeks with varying amounts, ranging from 4.50 to 274.60mm. This indicates a mix of dry and wet periods, with some weeks experiencing significant rainfall. Wind speed varied from 0.57 to 2.61 km h^{-1}, suggesting generally calm to light breezes during this period. The soil temperature ranged from 29.71 to 45.50°C indicating consistently warm soil conditions throughout the period.

Population of fruit flies showed significant positive correlation (+0.81) with the minimum temperature, significant negative correlation (-0.52) with soil temperature at a depth of 5cm, negative correlation (-0.33) with the maximum temperature, minute positive correlation (0.07) with relative humidity, positive correlation (0.20) with rainfall and a negative correlation (-0.19) with wind speed (Figs. 3, 4a, b).

Cai *et al*. (2023) stated that development and reproduction of fruit flies is in the range of 15 to 34°C with an optimum range of 20 to 28°C. Minimum temperature recorded during the study period lies in the optimum range for development and reproduction of fruit flies. Positive and highly significant correlation of *B. dorsalis* incidence with minimum temperature was recorded earlier by Bana *et al*. (2017) in Gujarat, Abro *et al*. (2021) in Hyderabad and Larkana, Kumar *et al*. (2021) in Meerut, Kumar *et al*. (2022) in Ayodhya, and Amur *et al*. (2022) in Pakistan.

Fruit flies pupate in the soil at a depth of one to five centimetres (Dimou *et al*., 2003). Soil temperature is a crucial determinant to ensure successful pupation and for the subsequent emergence of adult fruit flies. Unfavourable soil temperatures, such as being too high or too low, can negatively impact pupal survival and reduce the overall population size. In a surveillance study by Barma *et al*. (2013) in West Bengal, they reported a higher population of fruit flies in an optimum range of 27 to 30°C. Since the soil temperature recorded during the present study period was mostly in the range of 30 to 45°C, which was beyond the threshold limit of optimum temperature for the lifecycle of fruit flies, surveillance data recorded a negative correlation of population with soil temperature. A similar negative correlation of population with maximum temperature is also reported by Ganie *et al.* (2013) in Kashmir and Dale and Patel (2010) in Gujarat.

While relative humidity contributes to the overall suitability of the environment for fruit fly survival and reproduction, its minute-scale fluctuations alone may not be the primary determinant of population abundance. So, a similar correlation has been reported by Konyak *et al*. (2023), Kumar *et al*. (2021) and Bana *et al*. (2017), where pest population was not influenced by relative humidity.

Population build-up evidently happens after the receipt of summer showers which favours the emergence of fruit flies from the soil. Moist environments created by rain and increased relative humidity may enhance larval survival rates and accelerate their growth, potentially increasing the population size. Bateman (1968) cited by Drew *et al*. (1984) suggested that ample moisture has a significant impact on the abundance of fruit flies. This influence might be attributed to the fact that the availability of moisture in the air and soil promotes the emergence of pupae. And this might be the reason for the higher population of fruit flies followed by the receipt of summer showers. Similar reports of positive correlation between rainfall and fruit fly population were reported by Mouly *et al*. (2017) in Karnataka, Jena *et al*. (2022) in Gujarat, and Amur *et al*. (2022) in Pakistan. Higher wind speed can make it more challenging for fruit flies to locate and assess suitable host plants. Similar negative correlation of population of flies with wind speed was reported by Draz (2016).

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REFERENCES

Abro Z.A., Baloch N., Memon R.M. and Khuhro N. (2021) Population fluctuation of *Bactrocera zonata* and *Bactrocera dorsalis* in guava orchard agro-ecosystem in Sindh Region. Pakistan Journal of Zoology 53(5): 1969–1972.

Agarwal M.L. and Kumar P. (1999) Effect of weather parameters on population of peach fruit fly, *Bactrocera zonata* (Saunders). ENTOMON 24: 81–84.

Akhila M.U. (2015) Population dynamics and management of mango fruit fly, *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae). M.Sc. (Ag.) thesis. Kerala Agricultural University, Thrissur. 200p.

Amur A., Memon N., Khan P. and Gull F. (2022) The Relationship among the ecological factors and population of *Bactrocera dorsalis* in mango orchards of district Mirpur Khas, Sindh, Pakistan. Sarhad Journal of Agriculture 38(1): 60–67.

Bana J.K., Sharma H., Kumar S. and Singh P. (2017) Impact of weather parameters on population dynamics of oriental fruit fly, *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) under south Gujarat mango ecosystem. Journal of Agrometeorology 19(1): 78-80.

Barma P., Jha S. and Banerjee S. (2013) Prediction of population development of melon fruit fly (*Bactrocera cucurbitae* Coq.) on pointed gourd (*Trichosanthes dioica* Roxb.). African Journal of Agricultural Research 8(38): 4740–4747.

Begam N., Jalaluddin S.M., Sithanantham S., Shanthi M., Thiruvudainambi S. and Beaulah A. (2021) Population dynamics and seasonal incidence of two Tephritid fruit fly species in mango ecosystem under off-season fruiting in Tamil Nadu. The Pharma Innovation Journal 10(2): 126–130.

Cai P., Song Y., Meng L., Lin J., Zhao M., Wu Q., Nie C., Li Y. and Ji Q. (2023) Phenological responses of *Bactrocera dorsalis* (Hendel) to climate warming in China based on long-term historical data. International Journal of Tropical Insect Science 43: 881–894.

Choudhary J. S., Dhakar M. K., Mukherjee D., Das B., Singh A.K., and Bhatt B.P. (2018) Influence of some fruit traits of mango, *Mangifera indica* L. varieties against maggot development and infestation of mango fruit fly, *Bactrocera dorsalis* (Hendel). Journal of Entomology and Zoology Studies 6(2): 2621–2627.

Dale N.S. and Patel R.K. (2010) Population dynamics of fruit flies (*Bactrocera* spp.) on guava and its correlation with weather parameters. Current Biotica 4(2): 245–248.

David K.J. and Ramani S. (2011) An illustrated key to fruit flies (Diptera: Tephritidae) from Peninsular India and the Andaman and Nicobar Islands. Zootaxa 3021(1): 1–31.

Dimou I., Koutsikopoulos C., Economopoulos A.P. and Lykakis J. (2003) Depth of pupation of the wild olive fruit fly, *Bactrocera* (*Dacus*) *oleae* (Diptera: Tephritidae), as affected by soil abiotic factors. Journal of Applied Entomology 127(1): 12–17.

Draz K.A. (2016) Population activity of peach fruit fly *Bactrocera zonata* (Saunders) (Diptera: Tephiritidae) at fruits orchards in Kafer El-Shikh Governorate, Egypt. Arthropods 5(1): 28–43.

Drew R.A.I., Zalucki M.P. and Hooper G.H.S. (1984) Ecological studies of Eastern Australian fruit flies (Diptera: Tephritidae) in their endemic habitat: I. Temporal variation in abundance. Oecologia 64: 267–272.

Ebi C., Asawalam E.F. and Ogunfunmilayo A.O. (2020) Effectiveness of selected parapheromones for mass trapping of Mango fruit fly, *Ceratitis cosyra* Walker and Oriental fruit fly, *Bactrocera dorsalis* Hendel (Diptera: Tephritidae) on Mango. Nigerian Journal of Entomology 36: 118–129.

FIB (2023) Farm Information Bureau, Farm guide, Agriculture development and farmer's welfare department, Thiruvananthapuram. 307pp.

Ganie S.A., Khan Z.H., Ahangar R.A., Bhat H.A. and Hussain B. (2013) Population dynamics, distribution, and species diversity of fruit flies on cucurbits in Kashmir Valley, India. Journal of Insect Science 13(1): 65; 1–7.

Hossain M.S., Sarkar B.C., Hossain M.M., Mian M.Y., Rajotte E.G., Muniappan R. and O'Rourke M.E. (2020) Comparison of biorational management approaches against mango fruit fly (*Bactrocera dorsalis* Hendel) in Bangladesh. Crop Protection 135: 104807.

Jena M.K., Patel S.R. and Mohapatra B. (2022) Population dynamics of *Bactrocera zonata* (Saunders) (Diptera: Tephretidae) on *Mangifera indica* (L.) (Anacardiaceae) and correlation with weather parameters. International Journal of Environment and Climate Change 12(12): 1708–714.

Konyak W.S., Devi H.S., Sahu A.K., Singh Y.S., Devi H.M. and Imtinaro L. (2023) Diversity and population dynamics of fruit fly in bottle gourd and its correlation with abiotic factors in Nagaland. Biological Forum an International Journal 15(3): 379–385.

Kumar P., Chandra U., Mishra R. and Kumar D. (2022) Impact of weather parameters on population dynamics of fruit fly (*Bactrocera* spp.) in cucurbits at different locations. The Pharma Innovation Journal 11(9): 704–707.

Kumar V., Singh R., Sachan S.K., Singh D.V., Singh G., Prakash S. and Singh B. (2021) Population dynamics of mango fruit fly species trapped through methyl eugenol traps in Western plain zone of Uttar Pradesh. Journal of Experimental Zoology 24(2): 1615–1620.

Laskar N. and Chatterjee H. (2010) The effect of meteorological factors on the population dynamics of melon fly, *Bactrocera cucurbitae* (Coq.) (Diptera: Tephritidae) in the foot hills of Himalaya. Journal of Applied Sciences and Environmental Managemnet 14(3): 53–58.

Mariadoss A., Samson David G., Vinay Teja and J Alice RP Sujeetha (2020) Species diversity of fruit flies in different varieties of mango in Ranga Reddy District of Telangana State, India. Journal of Entomology and Zoology Studies 8(4): 184–187.

Mouly R., Shivananda T.N. and Verghese A. (2017) Prediction models for *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) based on weather parameters in an organic mango orchard. Journal of Entomology and Zoology Studies 5(6): 345–351.

Roy J.K., Rahman M.M., Ali M.R. and Hossain M.E. (2022) Morphometric detection of Mango fruit fly collected from different mango growing regions of Bangladesh. Journal of Food, Agriculture and Environment 3(2): 23–28.

Sahithi D.G. (2022) Changing scenario of fruit fly incidence in mango fruit tree ecosystem. The Pharma Innovation Journal 11(9): 851–858.

Statista (2023) Production volume of mango across India from financial year 2012 to 2021, with an estimate for 2022 [on-line]. https://www.statista.com/statistics/ 1039683/india-production-volume-of-mango/ [accessed on 04 July 2023].

Sumathi E., Manimaran R., Nirmala D.M., Hamaran M. and Agila R. (2019) Population dynamics and management of mango fruit fly, *Bactrocera dorsalis* Hendel. International Journal of Current Microbiology and Applied Sciences 8(1): 2705–2710.

Tharanathan R.N., Yashoda H.M. and Prabha T.N. (2006) Mango (*Mangifera indica* L.), "The king of fruits"- An overview. Food Reviews International 22(2): 95–123.

Verghese A., Tandon P.L. and Stonehouse J.M. (2004) Economic evaluation of the integrated management of the Oriental fruit fly *Bactrocera dorsalis* (Diptera: Tephritidae) in mango in India. Crop Protection 23(1): 61–63.

Vignesh S., Chandrasekaran M. and Sithanantham S. (2020) Impact of climatic factors on seasonal occurrence and species diversity of fruit fly, *Bactrocera* spp. in mango orchards. Journal of Entomology and Zoology Studies 8(3): 1012–1015.

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