Volume 3, Issue 4, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

DETERMINATION OF DYNAMICS OF FRUIT FLY BACTROCERA ZONATA INFESTATION IN GUAVA ORCHARD AT DISTRICT KOHAT, KHYBER PAKHTUNKHWA, PAKISTAN

Muhammad Luqman Khan[*1,2], Safdar Ayub[1], Atazaz Ahmad[1], Muhammad Adeel[1], Mushtaq Sarwar[2], Muhammad Hasnat[1], Muhammad Luqman[1], Muhammad Faizan[1], Arif Ullah[1], Abdul Ahad[1]

[1]*Department of Zoology, University of Lakki Marwat, Lakki Marwat, Khyber Pakhtunkhwa, Pakistan*
[2]*Department of Zoology, Kohat University of Science and Technology, Kohat-26000, Khyber Pakhtunkhwa, Pakistan*

DOI: https://doi.org/10.5281/zenodo.15737019

Keywords
Guava, Fruit fly, infestation, Methyl eugenol, Meteorological factors, Bactrocera zonatus

Article History
Received on 15 May 2025
Accepted on 15 June 2025
Published on 23 June 2025

Corresponding Author: *
Muhammad Luqman Khan
luqman@ulm.edu.pk

Abstract

Bectrocera zonata *(Saunders) is recognized as a polyphagous species and one of the most destructive fruit pests, prevalent in various regions globally. B. zonata has been documented to cause complete losses in diverse fruits, with an estimated 50-55% infestation specifically in guava fruits in Pakistan. Guava is often called the "apple of the poor" due to its affordability, widespread availability, and high nutritional value. Given its significant nutritional importance, guava is frequently marketed as a "super-fruit." In terms of production, it ranks fourth after Citrus, Mango, and Bananas in Pakistan. The primary objectives of this study were to ascertain the percentage of guava fruit infestation and to monitor the population dynamics of the fruit fly, B. zonata, under the influence of meteorological factors such as temperature, relative humidity, and sunshine. The experiment was conducted in a guava orchard from November to April in District Kohat, Khyber Pakhtunkhwa. The percentage of fruit infestation was recorded as 43.7%, 33.75%, 25%, 46.25%, 52.5%, and 60% for November, December, January, February, March, and April, respectively. The highest infestation rate (60%) was observed in April, while the lowest (25%) was recorded in January. The population of B. zonata was monitored using methyl eugenol traps from November to April. The dynamics of Bactrocera zonata infestation were compared with meteorological factors, such as temperature, relative humidity, and sunshine. The lowest fruit fly population was 148 at 18°C in January, which subsequently increased to 480 at 29.4°C in April. The fruit fly population exhibited a positive correlation with temperature and a slightly negative correlation with relative humidity. Based on our current study, there is a need to employ insecticides judiciously and in accordance with expert recommendations, integrating them into an Integrated Pest Management program.*

INTRODUCTION

Fruit flies belonging to the family Tephritidae represent the most diverse group of insects and are recognized as significant pests of horticultural crops worldwide [1,2]. Within the Dacinae subfamily, the genus Bactrocera is especially noteworthy due to its inclusion of economically important species, particularly B. zonata. This species has been reported to potentially infest over 173 varieties of fruits and vegetables, including mango, banana, peach, guava, citrus spp., apricot, cucurbits, and other vegetables

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

[3, 4]. *B. zonata* is considered a polyphagous species that attacks a wide range of crops and is one of the most destructive fruit pests, spreading across various regions globally [5]. In Pakistan, 11 species of fruit flies cause damage to fruits and vegetables, with B. zonata, B. cucurbitae, and B. dorsalis being the most prominent. Among these, *B. zonata* is a particularly serious pest, especially on guava [6].

Among the various species of fruit flies, *Bactrocera zonata* is a significant pest affecting fruit production and quality in Pakistan [7]. This species has been documented to cause losses ranging from 3% to 100% in different fruits, with an estimated infestation rate of 50-555 specifically in guava fruits in Pakistan [8]. The majority of the damage is attributed to the larvae, which consume the interior of the fruit during their growth and development [9]. Given that the damage to fruits and vegetables is internal, it is challenging to manage with a single control measure [10]. Therefore, the implementation of integrated pest management (IPM) is crucial due to its effectiveness and benefits for both the environment and human health; otherwise, the reliance on pesticides will continue to escalate [11].

Guava (Psidium guajava L.), colloquially referred to as the "poor man's apple" due to its widespread availability and substantial nutritional value, is a significant source of vitamin C, dietary fiber, folic acid, and essential minerals such as potassium, copper, and manganese [12]. Among the principal fruits cultivated in Pakistan, guava ranks fourth in production, following oranges, mangoes, and bananas [13]. In Pakistan, the total annual production amounts to 5,123 thousand tons, with a yield of 8,223 kg per hectare cultivated over an area of 62.3 thousand hectares [14]. Data indicates that during 2004-2005, an area of 1,557 hectares was dedicated to guava cultivation in KPK, yielding 18,570 tons of fruit, with Kohat alone contributing 33 percent of this production [15]. The agricultural sector faces significant fruit damage, resulting in an estimated annual loss of USD 200 million in Pakistan [16]. Recently, *B. zonata* has been documented in Egypt, where it has proliferated nationwide, prompting the initiation of control trials.

Fruit flies represent significant threats to fruits and vegetables, contributing to substantial global economic losses [17]. Various methods exist for controlling fruit flies, including mechanical, natural, and chemical approaches. The Male Annihilation Technique (MAT) is recognized as the most effective method, utilizing methyl eugenol and cue-lure as attractants and lethal agents in fruit fly management [18]. In Pakistan, the regulation of fruit flies predominantly relies on insecticides. However, the use of additives for insect control poses considerable environmental risks. The male *B. zonata* is attracted to the phenyl propanoides compound methyl eugenol, which occurs naturally in numerous plant species [19]. Given the importance of fruit fly infestation in Khyber Pakhtunkhwa, this study was conducted to determine the percentage of guava fruit infestation and to monitor the *B. zonata* population, which is influenced by climate variables such as temperature, humidity, and sunlight in guava orchards in the Kohat district.

Materials and Methods

The study was conducted to assess the prevalence of fruit flies in guava orchards in Kohat from November to April. This research was carried out in the guava orchards located in Jarma, situated in the northwestern part of District Kohat. This area is approximately 1.7 km from the Kohat University of Science and Technology (KUST). The region possesses favorable climatic conditions for the cultivation of guava trees.

Trap preparation and sample collection

Fruit fly traps serve as a crucial method for mitigating fruit fly populations. The trap design features a cone-shaped plastic cup with two openings, each with a diameter of 2.3 cm, positioned 5.4 cm apart along the bottle's surface area. The total length of the trap is 11.00 cm. A cover is situated across the middle of the trap, secured with a stretchable copper wire. The wire's outer segment, measuring 20 cm, is intended for suspension in trees, while the inner segment, measuring 6 cm, is designed to accommodate the use of cotton buds as needed. The trap utilizes a mixture comprising 85% Methyl-Eugenol, 10% sugar solution, and 5% insecticides, with Dipterex (Trichlorophon) employed as the insecticide to exterminate trapped insects [20]. This study was conducted to evaluate the percentage of fruit fly epidemics affecting guava within specific ecological

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

zones. Infestation rates were determined by counting both healthy and infested or dropped fruits.

Number of fruit flies

Total of fruit flies reported by calculating the number of flies trapping the din trap.

Species determination

Species were determined through analysis of captured flies' morphological characteristics/ characters. Using taxonomic keys, the collected specimen of fruit flies was identified [21].

Metrological Data collection Meteorological data concerning maximum, minimum temperature, humidity level, and sunlight were taken from the Meteorological section correlated with the fruit fly population.

Statistical Analysis The overall number of fruits and the number of infested fruits were enumerated, and the following formula became infestation percentage.

$$\text{Fruits infestation (\%)} = \frac{\text{No. of infested fruits}}{\text{Total number of fruits}} \times 1$$

Results

Overall fruit fly infestation in Guava orchards at District Kohat

The data pertaining to fruit infestation in guava orchards located in District Kohat are presented. Monthly assessments of fruit infestation were conducted in the guava orchard. The recorded percentages of fruit infestation were 43.7%, 33.75%, 25%, 46.25%, 52.5%, and 60% for the months of November through April, respectively. The highest infestation rate, 60%, was observed in April, while the lowest rate, 25%, was recorded in January (Table 1).

S. No	Month	Total no of fruits collected	Infested fruits	Fruit infestation%
1.	November	80	35	43.75%
2.	December	80	27	33.75%
3.	January	80	20	25%
4.	February	80	37	46.25%
5.	March	80	42	52.5%
6.	April	80	48	60%

Table:1 Fruit infestation (%) in Guava orchards at District Kohat

Volume 3, Issue 4, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

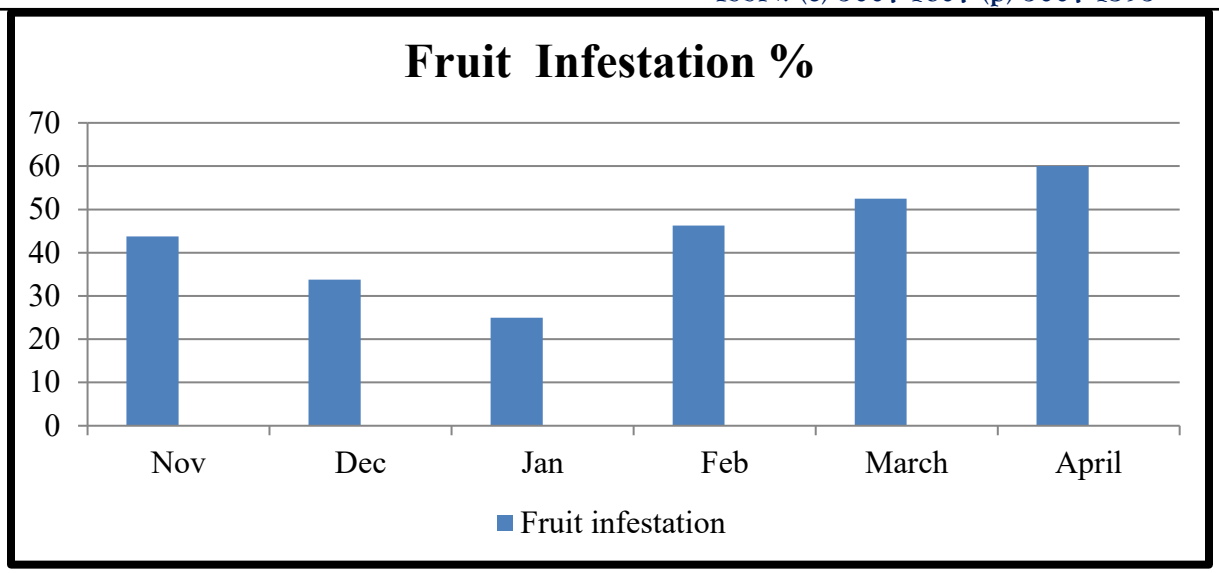

Fig: 3.1. Fruit fly infestation (%) in Guava orchards at District Kohat

Data regarding Fruit fly population in different months under using chemical

Data related to fruit fly population in Guava orchards at District Kohat are given. Highest possible number was reported in April (480), and the lowest population was recorded in January (148).

S. No	Month	Chemical Methyl Eugnol, Dipteryx, and Sugar	Fruit fly Population
1.	November	=	225
2.	December	=	180
3.	January	=	148
4.	February	=	260
5.	March	=	345
6.	April	=	480

Table: 2 Table1 Use of chemicals and population of fruit fly

Fluctuation in the fruit fly population in relation to metrological data in Kohat

The population of fruit flies exhibits a fluctuating trend, with the highest recorded catch being 480 in April and the lowest at 148 in January. The figure illustrates the impact of temperature on the population dynamics of male fruit flies. It demonstrates that a decrease in temperature correlates with a reduction in the male fruit fly population, whereas an increase in temperature results in a population rise. According to the figure, the highest number of male fruit flies was observed at 29.4°C, while the lowest was reported in January at 18°C. Figure 3.5 depicts the effects of relative humidity on the fruit fly population.

Volume 3, Issue 4, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

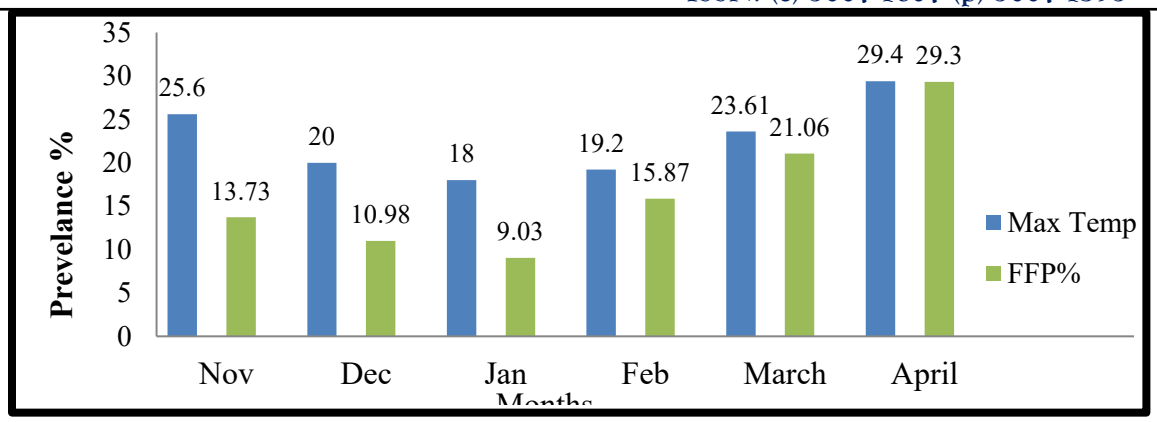

Fig No: 3.2 Fluctuation in the fruit fly population in relation to Maximum temperature

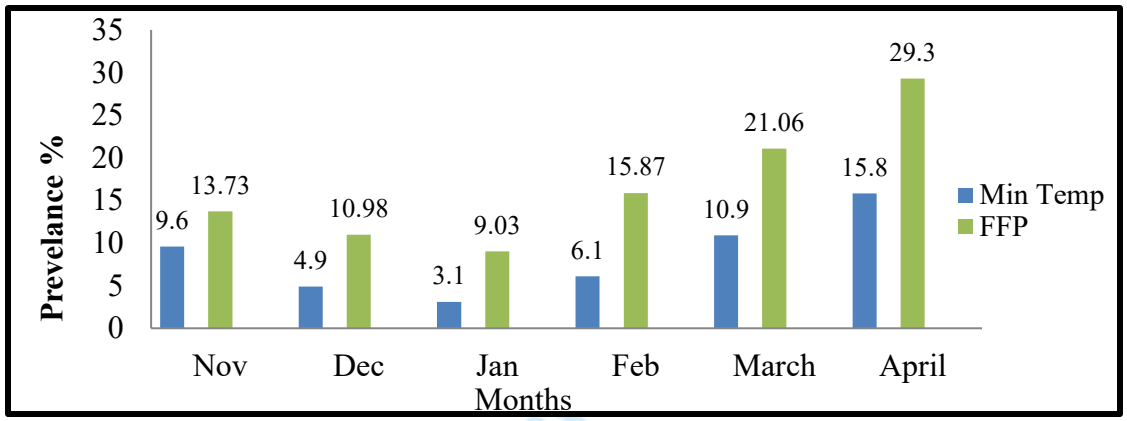

Fig No :3.3 Fluctuation in the fruit fly population in relation to Minimum temperature

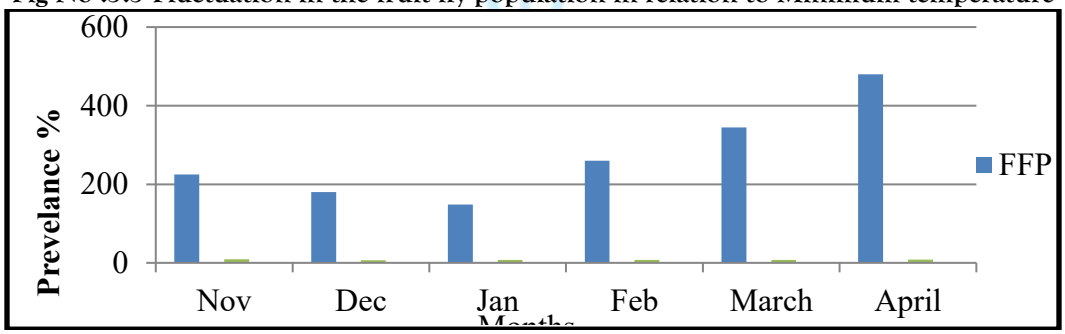

Fig.No: 3.4 Fluctuation in the fruit fly population in relation to sun shine

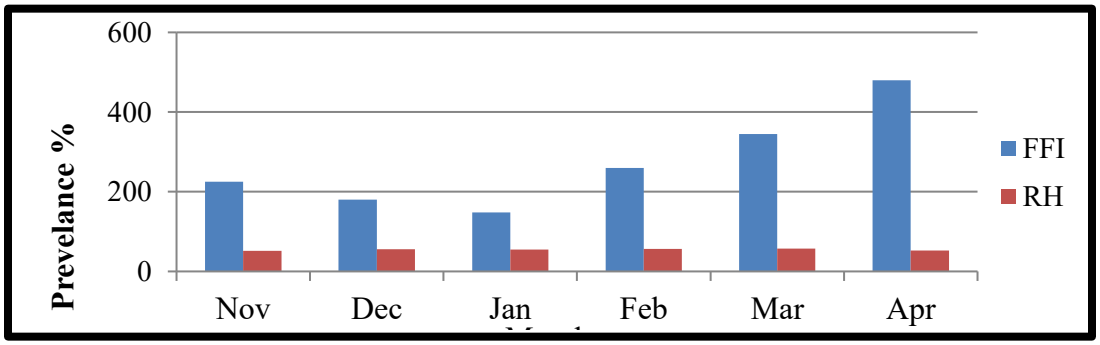

Fig No:3.5 Fluctuation in the fruit fly population in relation to Relative humidty

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ISSN: (e) 3007-1607 (p) 3007-1593

DISSCUSSION

Fruit flies represent significant agricultural pests in Pakistan, causing estimated farm-level losses of approximately USD 200 million annually [22]. These pests pose a substantial threat to the production of fruits and vegetables and the unrestricted global supply of these commodities [23]. The present study investigates the seasonal invasion of fruit flies, with data recorded monthly at a guava orchard. Our findings indicate that the highest infestation rate occurred in April, while the lowest was observed in January. These results align with the report by Muhammad Arif et al. (2011) [24]. Variations in fruit infestation rates during the data collection period may be attributed to weather fluctuations and, to some extent, the crop stage. Similar findings were published by Mehmood and Mishkat Ullah (2007), who reported the highest number of fruit fly outbreaks during the growing stage [25]. Additionally, Solangi et al. (2014) identified a significantly positive correlation between *B. zonata* infestation and temperature, suggesting that fruit fly infestation increases significantly with rising temperatures.

The present study utilized sexual attractants to mitigate the damage caused by fruit flies in guava and other tropical products. In certain Bactrocera species, methyl eugenol serves as a potent attractant for male insects. Our findings regarding methyleugenol align with the study by Ghanim et al. (2010), which demonstrated that methyleugenol is highly attractive to *B. zonata* [26, 27]. Methyl eugenol is recognized as a primary attractant for luring males of various species within the Tephritidae family (Shelly et al., 2010; Tan and Nishida, 2012), and according to Cunningham (1989), it can be integrated into male annihilation techniques alongside pesticides [28-30]. The Male Annihilation Technique (MAT) has been effectively employed in the suppression and management of numerous Bactrocera species (Fletcher and Prokopy, 1991) [31].

Abdullah and Latif (2001) have also identified similar trends. The findings of this study could be instrumental in enhancing the monitoring and management of fruit flies in Pakistan [6].

The dynamics of fruit fly populations are significantly influenced by abiotic conditions, with temperature being a primary factor affecting production rates [32]. A strong association exists between fruit fly populations and temperature. Our findings indicate that the highest number of fruit fly captures, 480, occurred in April, while the lowest, 148, were recorded in January. The elevated temperatures contributed to a substantial increase in fruit fly captures. The negative correlation between minimum temperature and population is likely due to the increase in fruit fly populations coinciding with fruit ripening. This demonstrates that temperature is correlated with fruit fly population numbers. Papadopoulos' observations (1999) align with our findings, as they recorded the lowest number of captures in December [33]. Host accessibility and the availability of harvested products, such as mangos and guavas, are important factors contributing to the demographic variability of the species Bactrocera. No correlation was observed between the number of insects trapped and sunshine hours or relative humidity.

CONCLUSION

At the farm level, fruit flies are significant pests in Pakistan, causing substantial damage. Among these, the peach fruit fly, Bactrocera zonata, has a particularly devastating impact on guava fruits. Observations of fruit infestation were conducted in Jurma, Kohat, near Kohat University of Science and Technology, from November to April. The data suggest that the highest infestation rate occurred in April, while the lowest was recorded in January. The application of chemical additives for fruit fly control poses considerable environmental risks, leading to atmospheric contamination and harm to non-target species. Additionally, fruit flies have developed significant resistance to chemical agents. The findings of this study indicate that integrated fruit fly management, utilizing sexual attractants, effectively mitigates the damage caused by fruit flies in guava orchards. Methyl eugenol, in particular, has proven to be highly attractive and yields improved outcomes.

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ISSN: (e) 3007-1607 (p) 3007-1593

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