www.ajlifesciences.com / ISSN: 2663-1040 *AJ Life Sci. 2024, 7 (1): 32-39* Research Article

AJLS

Abasyn Journal of Life Sciences

Open Access

DOI: 10.34091/AJLS.7.1.4

Performance of Static Spinosad Traps against *Bactrocera* Spp. at Different Heights in Guava Orchard

Jawad Hyder Soomro[1], Bhai Khan Solangi[1], Din Muhammad Soomro[1*], Ariz Muhammad Pirzado[1], Faiza Abbasi[2], Noman Khalid Randhawa[3], Shafee Muhammad[1] and Syed Muzafar Ali Shah Rashdi[1,4]

[1]*Department of Entomology, FCPT, Sindh Agriculture University, Tandojam, 70050, Sindh, Pakistan.*
[2]*Department of Statistics, FASS, Sindh Agriculture University Tando Jam, 70050, Sindh, Pakistan.*
[3]*PARC-Arid Zone Reseach Center, Umarkot, 69100, Sindh, Pakistan*
[4]*Center of Agriculture and Bioscience International, Rawalpindi, 46000, Pakistan.*

Abstract

Fruit flies (*Bactrocera* spp.) are considered serious insect pests of fruits and vegetables globally. This study aimed to evaluate the efficacy of pheromone traps containing Static Spinosad + Methyl eugenol in controlling *B. zonata* and *B. dorsalis* fruit flies. Traps were positioned at different heights (0, 1, 2, and 3 meters) to assess catch rates. Weekly monitoring of male fruit fly populations revealed fluctuations over time and across heights, with peak populations of both species (460.2 and 103.0 flies) observed at 2 meters and lowest populations (48.6 and 7.0 flies) at ground level (0 meters). Similarly, maximum populations for both species occurred in late October, with declines observed in February. Population fluctuations correlated positively with temperature and negatively with relative humidity. Traps utilizing Spinosad + Methyl eugenol were effective, particularly at 2 meters, suggesting this height is optimal for guava orchards. The study emphasizes the need for further research to refine fruit fly control strategies, focusing on trap placement and effectiveness across different orchards and vegetable crops.

Keywords: *Bactrocera* spp, Guava orchard, Methyl eugenol, Static Spinosad

Article Info:
Received:
January 01, 2024
Received Revised:
April 24, 2024
Accepted:
April 24, 2024
Available online:
April 26, 2024

Corresponding Author:
dinmuhammad1177@gmail.com

1. INTRODUCTION

Guava (*Psidium guajava* L.), belonging to the Myrtaceae family, is a tropical fruit native to South America. Popularly, it is known as "Amrood" in some regions and is widely cultivated in tropical and subtropical areas of the world[1,2]. Mango, guava, and peach are fruits that are beneficial to human health and pleasant to consume[3]. Besides, guava seeds, leaves, and pulp are used to treat hypertension, obesity, and diabetes, as well as respiratory and gastrointestinal problems, anti-inflammatory, cough-suppressant, and anti-diarrheal properties[4,5].

Guava demonstrates remarkable adaptability to propagate through various methods including budding, layering, and stem/ root cuttings. Their trees may be grown in a variety of soils, but prefer sandy soils, and can begin producing fruit as early as the third year after cultivation[6]. In Pakistan, guava is grown on 65.600

hectares, with an annual yield of approximately 489.100 tonnes in 2014-15 seasons[7]. Micropropagation is one of the most effective biotechnology methods for plant regeneration and genetic resource conservation[6]. Guava is a rich source of calcium, phosphorus, vitamin C, pectin, and other essential nutrients[1,8].

Globally, insect pests caused significant losses in quality and agricultural productivity, including in Pakistan[9]. Among these pests, fruit flies (*Bactrocera* spp.) are one of the most harmful pests to fruits and vegetables[5]. Belonging to the order Diptera due to their two wings, these flies can cause significant yield losses ranging from 20 to 100 percent. *Bactrocera* spp. attack a broad range of fruit crops, guava is particularly susceptible to damage by different fruit fly species[10].

Fruit flies are pale yellow with blackish markings in appearance; posing a significant threat to global quarantine security and international trade of vegetables and fruits [11]. Their destructive behavior involves laying eggs within the skin of fruit by injecting their ovipositor. Once hatched, the larvae feed on the fruit pulp, ultimately burrowing out to pupate in the soil before emerging as adult flies to continue the life cycle. In Pakistan, *B. dorsalis* and *B. zonata* are identified as the most severe species; causing 5-100 percent fruit losses[12]. These losses are exacerbated by factors such as a higher infestation rate (25-50 percent more attacks than the rest of the globe) in southern Pakistan; leading to roughly 80% of the fruit is destroyed in the market. Furthermore, the concealed nature of fruit fly damage makes traditional pesticide application ineffective[3].

Fortunately, fruit flies may be controlled by a variety of methods, including Chemical, Mechanical, cultural, and Biological approaches. Integrated Pest Management (IPM) has proven to be more effective in reducing insect infestations. Attractive methods play a critical role for reducing pest infestations and monitoring insect numbers. The use of sexual pheromones is a great method to capture male fruit flies[13]. The goal of the present study investigates the performance of Static Spinosad traps against *Bactrocera* spp. at different heights in the Guava orchard.

2. MATERIALS AND METHODS

2.1 Place of work

The research work was conducted at the guava orchard farm, Agriculture Research Institute (ARI), Tandojam, Pakistan for monitoring the population of two *Bactrocera* spp. (*B. zonata* and *B. dorsalis*) during 2021-22 Seasons. The size of the orchard was 8 acres.

2.2 Experimental set-up

The experiment was designed in RCBD (Randomized Complete Block Design). Four treatments, representing different trap placement heights and each treatment was replicated five times.

2.3 Procedure of experiment and data collection

This study aimed to identify the optimal height of pheromone traps replacement to capture the maximum number of male fruit flies (B. zonata and B. dorsalis) in guava orchard. Pheromone traps were cylindrical shape and size (36 x 11 x 16 cm) with a top cover and two opposing openings for fly entry. Each trap contained a lure of 3g Static Spinosad + Methyl eugenol. The traps were hanged at four different heights from ground level: 0 meters (T1), 1 meter (T2), 2 meters (T3), and 3 meters (T4) in a guava orchard to catch the male *B. zonata* and *B. dorsalis* fruit flies. The wicks of cotton were used to absorb Static Spinosad cure and enfolded in wire to attach to the trap at all tested heights. After 35 days, the pheromone traps were replaced to make sure the chemical used to attract fruit flies was fresh. The species was recognized, and the number of attracted male fruit flies was checked at weekly intervals. The data was observed every week, and the population of male fruit flies was counted from each pheromone trap at all tested heights.

2.4 Statistical analysis

The collected data were subjected to analysis of variance (ANOVA) using Statistix 8.1 software. Least significant difference (lSD) analysis at P≤0.05 was used to determine the significant differences among the treatments.

3. RESULTS AND DISCUSSIONS

In this study, it was found that the pheromone trap, baited with Static Spinosad + Methyl eugenol, was positioned at a height of 2 meters in the guava orchard, capturing the highest number of male *B. zonata* and *B. dorsalis* fruit flies. However, during the seasonal fruit fly infestation, the *B. zonata* population consistently exceeded the population of *B. dorsalis* observed throughout the season. [14]Also observed that the highest population of *B. zonata* was trapped at the 2-meter height as compared to *B. dorsalis* in the jujube orchard. In addition, as reported by[15] the guava fruit fly was highly trapped when traps of methyl eugenol were positioned at heights of 1, and 2 meters. Moreover,[16] also reported that the Methyl eugenol traps caught the highest population of fruit flies such as *B. zonata*, *B. dorsalis,* and *C. vesuviana*, during seasonal fruit fly infestation.

Our results represented that all pheromone traps were effective against both fruit flies at different heights with significant differences (P <0.05) between all treatment. The weekly mean population of *B. zonata* fluctuated throughout the season (Table 1), reaching the maximum capture of flies (460.2) at 2 meters on 22nd October, 2020, and the lowest number (243.6) on 21st January, 2021. At the height of 1 and 3 meters, the highest population of *B. zonata* was noted (320.2 and 401.2, respectively) than (289.6 flies) at ground level (0 meter) on 22nd October, 2020, and the lowest (133.4 and 243.6, respectively) on 21st January 2021.

Table 1. Weekly mean population of *Bactrocera zonata* (males) at different heights during guava seasons 2021-2022.

Weeks	Trapping Height			
	0-Meter (Surface)	1-Meter	2-Meter	3-Meter
15/10/2021	270.4± 13.8^{m-y}	311.4±13.7^{h-r}	451.6±21.9^{ab}	403.2±23.4^{a-e}
22/10/2021	289.6 ± 19.7^{k-u}	320.2±18.1^{h-p}	460.2±31.1^{a}	401.2±28.6^{a-f}
29/10/2021	282.0 ± 13.8^{k-v}	313.8±18.8^{h-q}	450.6±28.3^{ab}	397.2±28.9^{a-f}
05/11/2021	270.0 ±18.3^{m-v}	296.2±4.0^{j-t}	425.4±34.2^{a-c}	387.6±24.6^{b-g}
12/11/2021	245.6 ±18.5^{r-d}	287.4±13.9^{k-u}	412.6±30.2^{a-d}	362.8±30.4^{c-i}
19/11/2021	237.4 ± 8.2^{t-h}	252.4±19.2^{p-c}	376.6±21.2^{c-h}	340.8±31.3^{e-l}
26/11/2021	215.2 ± 6.7^{w-l}	230.0±17.4^{u-j}	358.6±42.9^{d-j}	314.4±37.1^{h-p}
03/12/2021	173.6±10.2^{h-q}	211.4±9.0^{x-i}	335.8±40.6^{f-m}	297.2±17.7^{i-t}
10/12/2021	164.0 ± 18.1^{j-q}	190.2±14.4^{b-o}	325.4±46.8^{g-n}	278.8±17.7^{l-w}
17/12/2021	141.8 ±11.1^{m-s}	179.4±14.5^{e-q}	308.2±36.6^{i-s}	257.2±15.7^{o-a}
24/12/2021	127.6± 9.6^{o-t}	169.8±16.7^{i-q}	263.0±41.5^{n-z}	244.4±17.8^{s-e}
31/12/2021	128.2 ± 10.3^{o-t}	162.6±11.4^{k-r}	276.6±61.1^{l-x}	174.8±5.8^{g-q}
07/01/2022	82.4 ± 12.2^{s-w}	134.2±9.6^{n-t}	247.8±36.1^{q-c}	187.6±18.2^{c-p}
14/01/2022	75.6 ± 11.1^{t-w}	140.2±10.7^{m-t}	254.6±47.8^{p-b}	167.6±31.7^{i-q}
21/01/2022	60.8±10.2^{u-w}	133.4±7.0^{n-t}	243.6±41.7^{s-f}	124.0±14.8^{p-u}
28/01/2022	52.8±10.0^{vw}	135.8±7.3^{n-t}	255.2±28.9^{p-b}	180.8±26.8^{d-q}
04/02/2022	48.6±8.2^{w}	142.8±8.5^{m-s}	261.8±37.6^{n-z}	194.8±21.8^{a-n}
11/02/2022	57.2±7.4^{vw}	160.6±8.4^{k-r}	292.4±36.9^{k-u}	205.6±20.1^{y-m}
18/02/2022	56.6±7.4^{vw}	150.6±11.3^{l-r}	277.2±18.3^{l-x}	219.6±12.9^{v-k}
25/02/2022	52.4±6.2^{vw}	157.8±16.4^{k-r}	292.2±45.1^{k-u}	233.6±20.4^{t-i}
04/03/2022	77.4±14.3^{s-w}	178.2±15.1^{f-q}	295.4±35.9^{j-u}	240.8±16.5^{t-g}
11/03/2022	78.6±8.9^{s-w}	192.2±10.3^{a-o}	299.0±37.7^{i-t}	253.2±30.0^{p-c}
18/03/2022	97.8±10.3^{r-w}	193.4±11.6^{a-o}	321.8±32.2^{g-o}	245.6±19.7^{r-d}
25/03/2022	115.2±6.8^{q-v}	202.6±12.2^{z-m}	340.6±38.3^{e-l}	247.2±22.6^{r-c}
01/04/2022	170±14.7^{i-q}	220.0±10.3^{v-k}	346.2±42.0^{e-k}	270.0±23.5^{m-y}

Interestingly, the lowest population at all tested trap heights (48.6 flies) was recorded on 4th February 2021 at ground level. Our findings of methyl eugenol traps in guava orchards are consistent with that conducted by11 that the maximum number of *B. zonata* (1428.4 flies) were at 2-meter height but the minimum numbers (1177.3 flies) at the ground level, followed by (1340.5 and 1185.4 flies) at the 1 and 3 meters, respectively. According to the findings of17 that recorded *B. zonata* flies were 61.38 at 2 meters height, followed by 51.35, 43.03, and 38.09 when traps hanged at 3, 1, and 0-meters, respectively. These differences in population numbers of fruit flies compared to our results may be related to different factors such as geographical location, environmental conditions, and fruit variety.

The overall mean population of male *B. zonata* at different heights revealed the higher population (326.9) was caught at 2-meter height and the lower (142.8) at ground level (Fig. 1). Similarly,[18] noted that the highest male population of *B. zonata* was trapped at 12 feet height and the lowest was at 4 feet.

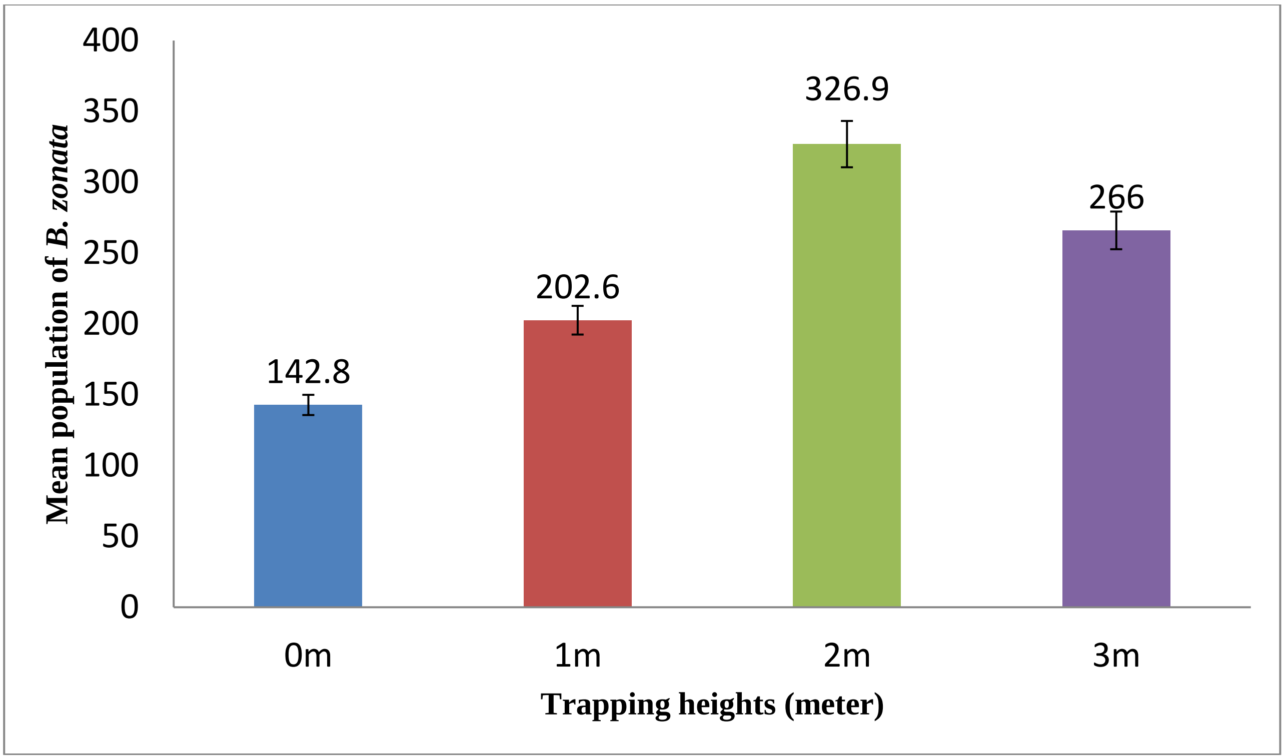

Fig. 1. Overall mean population of *Bactrocera zonata* (males) at different heights during guava seasons 2021-2022.

Similar to *B. zonata*, *B. dorsalis* captures followed a trend of higher population numbers at 2-meter height (103.0) on 29th October, 2020, while the lowest capture (74.2 flies) was on 18th February, 2021 (Table 2). At the 3-meter height, the maximum population catches of fruit flies (56.4) were on 05th October, 2020, and the minimum (33.6 flies) was on 11th February, 2021. Similarly, the highest population of (37.4 flies) was trapped at 1-meter height on 22nd October, 2020, then (19.4 flies) on 14th January, 2021. At ground level, the maximum population (11.4 flies) was caught on 26th November, 2020, and the minimum (7.0 flies) was on 4th February, 2021. Our findings were confirmed by those reported previously by[17], who reported that the highest weekly captures of *B. dorsalis* (0.49 flies) were noted at 2 metres, and the minimum (0.29 flies) were at ground level. Similarly,[11] also observed that the highest *B. dorsalis* male (7.34 flies) at 2-meter height, followed by (4.67 flies) at 3 meters, and the trap captures decreasing at lower heights.

The overall mean population of male *B. dorsalis* flies at different heights showed the 2-meter height captured the most with (89.01 flies) than (9.11 flies) at the ground level (0 m height) (Fig. 2). However, as noted by [13] that reported the highest population of *Bactrocera* spp. capture (515 flies) at 5-feet height (approximately 1.5 meters), whereas the lowest (315 flies) were at the ground level.

Table 2. Weekly mean population of *Bactrocera dorsalis* (males) at different heights during guava seasons 2021-2022.

Published by Abasyn University

Weeks	Trapping heights			
	0-Meter (Surface)	1-Meter	2-Meter	3-Meter
15/10/2021	10.4±1.5$^{y\text{-}c}$	31.0±2.8$^{p\text{-}w}$	97.0±7.3$^{a\text{-}d}$	50.0±5.8$^{h\text{-}k}$
22/10/2021	9.8±1.1$^{y\text{-}c}$	37.4±6.2$^{j\text{-}u}$	99.2±8.5$^{a\text{-}c}$	52.8±5.4^{hi}
29/10/2021	9.8±1.3$^{y\text{-}c}$	35.6±3.9$^{k\text{-}v}$	103.0±6.5^{a}	54.4±6.2^{hi}
05/11/2021	10.0±1.1$^{y\text{-}c}$	32.6±3.7$^{m\text{-}w}$	100.4±9.8^{ab}	56.4±5.2^{h}
12/11/2021	9.8±0.6$^{y\text{-}c}$	26.6±2.4$^{s\text{-}w}$	93.4±9.2$^{a\text{-}f}$	53.6±5.7^{hi}
19/11/2021	10.6±1.1$^{y\text{-}c}$	32.2±3.9$^{n\text{-}w}$	95.2±12.$^{a\text{-}e}$	52.4±5.5$^{h\text{-}j}$
26/11/2021	11.4±0.6$^{x\text{-}c}$	31.2±5.6$^{o\text{-}w}$	91.0±9.2$^{a\text{-}f}$	50.4±4.5$^{h\text{-}k}$
03/12/2021	8.8±1.0$^{z\text{-}c}$	27.4±3.1$^{r\text{-}w}$	92.8±11.3$^{a\text{-}f}$	48.4±4.9$^{h\text{-}l}$
10/12/2021	8.4±0.7$^{z\text{-}c}$	26.6±2.4$^{s\text{-}w}$	91.8±9.9$^{a\text{-}f}$	47.2±4.4$^{h\text{-}n}$
17/12/2021	9.8±1.1$^{y\text{-}c}$	22.2±1.1$^{v\text{-}b}$	86.6±8.2$^{a\text{-}g}$	50.0±6.1$^{h\text{-}k}$
24/12/2021	10.0±0.6$^{y\text{-}c}$	30.0±5.1$^{q\text{-}w}$	83.2±10.1$^{d\text{-}g}$	42.4±7.0$^{h\text{-}r}$
31/12/2021	9.2±0.6$^{z\text{-}c}$	22.6±2.2$^{u\text{-}a}$	86.8±7.2$^{a\text{-}g}$	42.0±6.2$^{h\text{-}r}$
07/01/2022	7.8±0.8$^{a\text{-}c}$	24.6±1.9$^{t\text{-}y}$	84.4±8.7$^{c\text{-}g}$	47.6±5.2$^{h\text{-}m}$
14/01/2022	8.6±0.4$^{z\text{-}c}$	19.4±1.5$^{w\text{-}c}$	85.8±5.6$^{b\text{-}g}$	50.8±5.0$^{h\text{-}j}$
21/01/2022	7.4±0.7^{bc}	23.0±3.5$^{u\text{-}z}$	81.8±7.1$^{e\text{-}g}$	43.6±2.9$^{h\text{-}q}$
28/01/2022	7.8±0.2$^{a\text{-}c}$	21.8±2.2$^{v\text{-}c}$	79.2±7.9^{fg}	48.4±4.9$^{h\text{-}l}$
04/02/2022	7.0±0.4^{c}	26.6±1.1$^{s\text{-}w}$	82.6±6.0$^{d\text{-}g}$	50.0±6.7$^{h\text{-}k}$
11/02/2022	7.8±0.8$^{a\text{-}c}$	28.6±2.6$^{q\text{-}w}$	79.2±7.8$^{f\text{-}g}$	33.6±5.7$^{l\text{-}w}$
18/02/2022	7.8±0.7$^{a\text{-}c}$	23.2±2.2$^{u\text{-}z}$	74.2±7.9^{g}	39.6±4.8$^{i\text{-}t}$
25/02/2022	9.0±0.4$^{z\text{-}c}$	25.8±3.4$^{s\text{-}x}$	85.6±7.5$^{b\text{-}g}$	40.0±4.7$^{i\text{-}s}$
04/03/2022	8.8±0.6$^{z\text{-}c}$	29.8±2.4$^{q\text{-}w}$	88.6±5.2$^{a\text{-}g}$	40.4±6.4$^{i\text{-}s}$
11/03/2022	9.8±0.7$^{y\text{-}c}$	31.4±3.3$^{o\text{-}w}$	94.4±12.3$^{a\text{-}e}$	40.0±4.8$^{i\text{-}s}$
18/03/2022	9.4±0.7$^{z\text{-}c}$	34.4±4.9$^{l\text{-}w}$	84.0±8.3$^{d\text{-}g}$	46.2±3.8$^{h\text{-}o}$
25/03/2022	9.0±1.0$^{z\text{-}c}$	29.6±2.4$^{q\text{-}w}$	93.6±11.9$^{a\text{-}f}$	47.0±6.6$^{h\text{-}n}$
01/04/2022	9.6±0.9$^{y\text{-}c}$	33.2±2.3$^{m\text{-}w}$	91.4±5.2$^{a\text{-}f}$	45.2±8.1$^{h\text{-}p}$

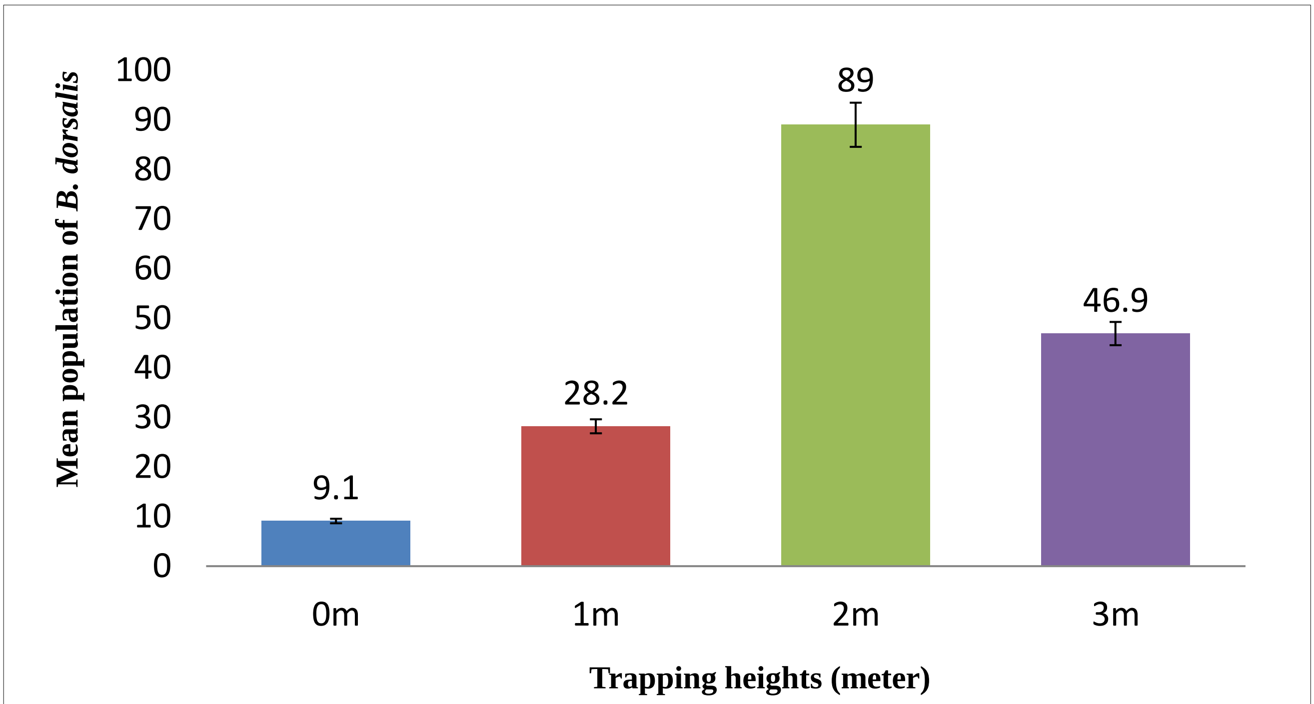

Fig. 2. Overall mean population of *Bactrocera dorsalis* (males) at different heights during guava seasons 2021-2022.

Fruit flies continued them actively throughout the year in various vegetables and orchards. In guava orchards specifically, the population of fly build-up started in July. Our results align with the previous observation that the highest population captures of both male *B. zonata* and *B. dorsalis* occurring in October. The lowest population of *B. zonata* was noted in January, while *B. dorsalis* captures in February. In this regard, as reported by [19] that the peak population of fruit flies was observed in July and the minimum was in January. Moreover,[13] observed that the highest population numbers of *Bactrocera* spp. in mango orchards during August and September, while [18]reported peak populations in June and July. These discrepancies may be due to fruit fly species composition, climatic conditions and geographical location.

The trapping population of *B. zonata* and *B. dorsalis* correlated with abiotic factors (temperature and relative humidity) (Table 3). Both fruit flies species populations are positively correlated with temperature (0.2943** and 0.0537**), but negatively non-significant (-0.0223NS and -0.0023NS) with relative humidity %. According to[20] showed that a positive correlation between wind velocity and temperature with the population of *B. zonata* and *B. dorsalis*, whereas a negative relationship with relative humidity. Additionally, [14] examine a positive significant relationship between temperature with *B. zonata* (r= 0.2939**) and non-significant with relative humidity (r= -0.0223^{NS}), while the correlation of the *B. dorsalis* population with temperature (r= 0.0261**) and relative humidity (r= 0.0091**) was positive. [21]Also reported that the temperature and population of fruit flies have a positive relationship, while the correlation with relative humidity has negative. [22]Observed that the population of *B. zonata* had a significant positive relationship with seasonal average temperature maximum (0.543) and minimum temperature (0.192), and rainfall (0.017), while the negative relationship with morning relative humidity (-0.241) and afternoon relative humidity (-0.215). In the same way, the population of *B. dorsalis* had a significant positive correlation with the seasonal average maximum temperature (0.187) and a significant negative correlation with the minimum temperature (-0.087), morning relative humidity (-0.257), afternoon relative humidity (-.511), and rainfall (-.329).

Table 3. Pearson's correlation among *Bactrocera zonata* and *Bactrocera dorssalis* (males) population with abiotic factors (Temperature and Relative Humidity).

Variable	*Bactrocera zonata*	*Bactrocera dorsalis*
Temperature (˚C)	r= 0.2943**	r=0.0537**
	p= 0.0000	p=0.2309
Relative Humidity (%)	r= -0.0223^{NS}	r= -0.0023^{NS}
	P= 0.6157	p= 0.9599

**Significant
NS= Non-significant

4. CONCLUSIONS AND RECOMMENDATIONS

This study investigated the effectiveness of pheromone trap at different heights containing static spinosad + methyl eugenol for capturing the fruit flies of (*B. zonata* and *B. dorsalis*) in guava orchard. The traps placed at 2 meters above the ground captured the highest numbers of both fruit flies. However, the numbers decreased at the heights of 3, 1, and 0 meters (ground level). Therefore, the study recommended installing pheromone traps at a height of 2 meters in guava orchard. Further studies are needed to determine the optimal trap placement heights in various fruit and vegetable crop ecosystems, regarding different fruit fly species and orchards layouts.

ACKNOWLEDGMENTS

We gratefully acknowledge the Agriculture Research Institute (ARI) Tandojam, Sindh, Pakistan, for providing the necessary platform and support to conduct this research.

NOVELTY STATEMENT

This study offers valuable insights into the effective use of pheromone traps (Spinosad + Methyl eugenol) at various heights in fruit orchards and vegetable fields for controlling male fruit flies.

AUTHOR'S CONTRIBUTION

J.H. Soomro conducted all research work during his post-graduation, B.K. Solangi and D.M. Soomro regarded the main research idea and management of the article, F. Abbasi prepared this manuscript, A.M. Pirzado and N. K. Randhawa helped in the collection and analysis of data, S. Muhammad and S. M. A. S. Rashdi helped in experimental layout and designing.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Abbas SQ, Niaz M, Iftakhar T, Perveen A, Abbas A, Riaz S. New fungal records on guava (*Psidium guajava*) from Pakistan. Pakistan Academy of Sciences. 2016; 51: 121–127.
2. Singh KK, Singh SP. A review: Micropropagation of guava (*Psidium* spp.). Journal of Pharmacognosy and Phytochemistry. 2018; 7: 145-150.
3. Siddiqui Q, Ahmad N, Rashdi SS, Niazi S. Effect of time of the day and trap height on the catches of peach/guava fruit flies, *Bactrocera zonata* (Saunders) through male annihilation technique. Asian Journal of Plant Sciences (Pakistan). 2003; 2: 228-232.
4. Ryu NH, Park KR, Kim SM, Yun HM, Nam D, Lee SG, Ahn KS. A hexane fraction of guava leaves (*Psidium guajava* L.) induces anticancer activity by suppressing AKT/mammalian target of rapamycin/ribosomal p70 S6 kinase in human prostate cancer cells. Journal of medicinal food. 2012; 15: 231-241.
5. Hussain B, Abbas A, Khan SU. First record of peach fruit fly in Gilgit-Baltistan (GB), Pakistan. Journal of Entomology and zoology studies. 2019; 7: 1451-1454.
6. Salih AM, Alaradi HJ, Ibrahim MA, Alhello AA. Effect of some methods of planting in guava (*Psidium guajava* L.) seed germination. Plant Archives (09725210). 2019; 19: 3057-3062.
7. Khan D, Ullah A, Bibi Z, Ullah I, Zulfiqar M, Khan ZU. Forecasting area and production of guava in Pakistan: An econometric analysis. Sarhad Journal of Agriculture. 2020; 36: 272-281.
8. Bansal M, Ranjan V. Phytochemical, therapeutic and ethnopharmacological overview for a traditionally important medicinal plant: *Psidium guajava* linn. International Journal of Innovative Pharmaceutical Sciences and Research. 2020; 8: 49-62.
9. Sarwar M. Occurrence of insect pests on guava (*Psidium guajava*) tree. Pakistan Journal of Zoology. 2006; 38: 197-200.
10. Mariadoss A, Alice J, Sujeetha RP, Jyothi P, Nikhileshwar P. Species diversity and identification of important fruit flies damaging Guava (*Psidium guajava* L.) in Ranga Reddy district, Telangana, India. Journal of Entomology and Zoology Studies. 2021; 9: 385-389.
11. Solangi BK, Sultana R, Wagan MS, Ahmed N. Seasonal monitoring of two *Bactrocera* species using methyl eugenol traps on guava orchards in Hyderabad district. Sindh University Research Journal-SURJ (Science Series). 2016; 47: 141-146.
12. Kakar MQ, Ullah FARMAN, Saljoqi AUR, Ahmad SAJJAD, Ali IJAZ. Determination of fruit flies (Diptera: Tephritidae) infestation in guava, peach and bitter gourd orchards in Khyber Pakhtunkhwa. Sarhad Journal of Agriculture. 2014; 30: 241-246.
13. Hasnain M, Babar TK, Karar H, Nadeem MK, Nadeem S, Ahmad SF, Ishfaq M. Changes in Height of Pheromone Traps Affect the Capture of Male Fruit fly, *Bactrocera* spp. (Diptera: Tephritidae). Journal of Environmental and Agricultural Science. (2017); 10: 33-39.
14. Pirzado AM, Solangi BK, Soomro DM, Ahmed AM, Wagan KH, Abbasi F, Razzaq N. Monitoring of the Fruit Flies (Bactrocera spp.) Infesting Jujube Orchard using Static Spinosad Traps: Monitoring of *Bactrocera* spp. by using static spinosad traps. Proceedings of the Pakistan Academy of Sciences: B. Life and Environmental Sciences. 2022; 59; 27-34.
15. Darwish DY, Rizk MMA, Abdel-Galil FA, Temerak SAH. Analysis of factors influencing population density of the peach fruit fly (PFF), *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) in Assiut, Northern Upper Egypt. Archives of phytopathology and Plant Protection. 2015; 48: 62-72.
16. Bugti NK, Bashir W, Baloch AQ, Sattar A, Ahmed M, Noor H, Ruk AS. Population dynamics of fruit flies on different varieties of Jujube. Journal of Biology, Agriculture and Healthcare. 2015; 5: 150-156.

17. Vistro JA, Solangi BK, Saleem M, Solangi I, Lashari MA, Khan AR, Alizai GH. Preference monitoring of Bactrocera spp. through installation of methyl eugenol traps at different heights in Jujube orchard. Pure and Applied Biology (PAB). 2021; 10: 1141-1147.
18. Murtaza G, Ramzan M, Bilal H, Ejaz A, Khan MAA, Riaz T, Waqas M. Monitoring of fruit fly, Bactrocera zonata (Diptera: Tephritidae) population by installing traps in mango orchard Bahawalnagar, Pakistan. Journal of Applied Research in Plant Sciences. 2021; 2: 148-151.
19. Wazir ZA, Singh AK, Ramana N. Seasonal incidence of fruit fly on Summer squash (Cucurbita pepo L.) and effect of weather parameters on population dynamics of fruit fly *Bactrocera cucurbitae* (Coquillett). Journal of Entomology and Zoology Studies. 2019; 7: 167-170.
20. Khoso FN, Gilal AA, Ahmed AM, Hajano JUD, Khatri I, Nizamani IA, Ahmad M. Improving Chemo Taxis Effects of Methyl Eugenol Bait against Two Fruit Fly Species in Jujube Orchards Located in Tandojam, Pakistan. Journal of the Kansas Entomological Society. 2019; 91: 229-237.
21. Khan RA, Naveed M. Occurrence and seasonal abundance of fruit fly, *Bactrocera zonata* Saunders (Diptera: Tephritidae) in relation to meteorological factors. Pakistan Journal of Zoology. 2017; 49: 999-1003.
22. Das U, Okram S, Jha SKKS. Species diversity and monitoring of population dynamics of two species of Bactrocera (*B. dorsalis, B. zonata*) through methyl eugenol traps at lower gangetic alluvium of West Bengal. Journal of Entomology and Zoology Studies. 2017; 5: 372-376.