

## Research Article

---

# Monitoring and management of fruitfly (*Bactrocera zonata*) population on peach (*Pronus persica*) Quetta Balochistan-Pakistan

Mitha Khan<sup>1\*</sup>, Shafique Ahmed Memon<sup>3</sup>, Bhai Khan Solangi<sup>2</sup>, Ghulam Jillani<sup>3</sup>, Ameer Uddin<sup>1</sup>, Syed Jahangeer Shah<sup>4</sup>, Enayat Aziz<sup>4</sup>, Kamran Jamil<sup>4</sup>, Naveed Ahmed<sup>4</sup>, Aeman Afzal<sup>5</sup> and Abdul Raziq<sup>6</sup>

1. Research officer Agriculture Research Institute Baluchistan-Pakistan
2. Department of Entomology, Sindh Agriculture University, Tandojam-Pakistan
3. Department of Entomology, LUAWMS at uthal Baluchistan-Pakistan
4. Agriculture Officer Agriculture Extension Department Baluchistan-Pakistan
5. Agriculture Research fruit and Post-Harvest Quetta Baluchistan-Pakistan
6. Agriculture officer Directorate of Procurement of Supplies (Extension wing) Baluchistan-Pakistan

\*Corresponding author's email: [mithakhan86.mk@gmail.com](mailto:mithakhan86.mk@gmail.com)

### Citation

Mitha Khan, Shafique Ahmed Memon, Bhai Khan Solangi, Ghulam Jillani, Ameer Uddin, Syed Jahangeer Shah, Enayat Aziz, Kamran Jamil, Naveed Ahmed, Aeman Afzal and Abdul Raziq. Monitoring and management of fruitfly (*Bactrocera zonata*) population on peach (*Pronus persica*) Quetta Balochistan-Pakistan. Pure and Applied Biology. Vol. 9, Issue 4, pp2425-2434. <http://dx.doi.org/10.19045/bspab.2020.90257>

---

Received: 04/04/2020

Revised: 17/07/2020

Accepted: 19/07/2020

Online First: 24/07/2020

---

### Abstract

Present investigation was conducted on the monitoring and management of fruit fly (*Bactrocera zonata*) population on peach in different locations of Quetta region (Hanna Orak) during 2017. The experiment consists of following IPM treatments (Sanitation + Methyl-Eugenol, without sanitation + Methyl-Eugenol, Sanitation + Protein hydrolysis baits, without sanitation + Protein hydrolysis baits, Neem Extract + Methyl-Eugenol and Neem Extract + Protein hydrolysis baits). The results of current finding showed that peak population of *Bactrocera zonata* ( $1223.2 \pm 66.74$  larvae/trap) was trapped under Methyl eugenol with sanitation Neem extract followed by Neem Extract + Methyl-Eugenol ( $1187.6 \pm 64.80$  larvae/trap), Sanitation + Methyl-Eugenol ( $1153 \pm 62.84$  larvae/trap), Sanitation + Protein hydrolysis baits ( $1064 \pm 31.40$  larvae/trap), Neem Extract + Protein hydrolysis baits ( $959.8 \pm 43.50$  larvae/trap), without sanitation + Methyl-Eugenol ( $932 \pm 42.26$  larvae/trap), without sanitation ( $870.97 \pm 76.76$  larvae) and Without sanitation + Protein hydrolysis baits ( $724 \pm 80.59$  larvae/trap) on 30<sup>th</sup> September. Similar trend was observed for minimum population of *Bactrocera zonata* trapped under different IPM treatments. Analysis of variance (ANOVA) depicted highly significant difference ( $p < 0.05$ ) in population of *Bactrocera zonata* trapped under different IPM treatments in all fortnight observations. On the basis of present investigation, it was observed that *Bactrocera zonata* highly attracted to Methyl eugenol with sanitation Neem extract followed by Neem Extract +

Methyl-Eugenol, Sanitation + Methyl-Eugenol, Sanitation + Protein hydrolysis baits, Neem Extract + Protein hydrolysis baits, Without sanitation + Methyl-Eugenol and Without sanitation + Protein hydrolysis baits. Maximum population abundance of *Bactrocera zonata* were recorded at the end of September afterwards the population simultaneously declined upto end of October.

**Keywords:** Monitoring; Management; Fruitfly

### Introduction

Every people every time demand healthy and safe nutritious fruit. In Pakistan there is a greater demand of fruit. That can only met by fruit management from insect pests. Fruit flies are the most important pests because of their quarantine importance. Different insect pest species attacking on delicious fruit but fruit fly (Tephritidae, Diptera) cause greater economic losses to fruit in Pakistan [1]. Fruit fly reduces both quality and quantity of fruit when female lay their eggs inside the fruit after that hatched maggots feed pulp and render them unfit for human consumption. At the puncture point fruit start rotting. The losses caused due to various species of fruit fly. In scientific literature reported oriental fruit fly (*B. dorsalis*) is the serious pest which caused 5 – 100 percent loss of various fruit [2]. Highest loss 80 Percent in guava fruit was reported by Kafi [3]. Guava fruit fly (*B. correcta*) is the serious pest of guava and another various fruit [4] reported 60 to 80 percent loss due to guava fruit fly. Peach fruit fly (*B. zonata*) is the another serious pest of various fruit which found abundantly in all climatic region of Pakistan and cause 3 to 100 percent loss in different fruit [2]. A loss to the tune of 25 to 50 percent occurred in mango fruit every year by *B. zonata* and *B. dorsalis* [2]. The fruit flies [*Bactrocera dorsalis* (Hendle), *B. zonata*(Saunders)] damage was observed on fruits from October to January with maximum infestation during s second fortnight of December. This is in agreement with the findings of Kumar *et al.* [5].

Export of mango and other soft fruits from Pakistan is under threat due to fruit fly infestations. A fruit fly management model

was developed, demonstrated on 500 acres mango orchards successfully achieving 95% control and published by PARC scientists under a National Coordinated Project on Integrated Pest Management of Fruit flies in Pakistan. The model consisted of the application of MAT, BAT, Sanitation and neem seed extract [6]. It was successfully demonstrated in guava plantations at large scale.

Peach belongs to the genus: *Persica*. Scientific name: *Persicadominica*. Peach thought to have originated in the Central American rain forests, probably in Mexico and Belize and bear fruit twice a year. Today, its cultivation has spread all over the tropical belt and is being grown as a major commercial crop in India, Sri Lanka, Indonesia and Malaysia. Peach is another popular sub-tropical fruit in line with Apple almond, etc .It is composes of soft easily digestible pulp made of simple sugars like fructose and sucrose. Peach is delicious fruit crop of tropical and sub-tropical countries and grown commercially for making chewing gum. The consumption of peach is recommended in herbal medicine as it has an uncountable number of medicinal uses. In Pakistan, the mature fruits are also used for making jams as these provide a valuable source of raw material for the manufacture of industrial glucose, pectin and natural fruit jellies. They are also canned as slices. Peach is a tropical and subtropical fruit of Pakistan and can be grown from sea level up to 1600-2000 meters. The mountainous climate is best suited to this plant. This fruit crop was introduced in Pakistan from India about thirty year ago .This crop cultivated in Balochistan distract (Mastung, Pishin, Loralai Kanmahtorzai) are exceptionally

suited to its growing on the basis of soil and climatic requirements [7]. High quantity and quality losses caused due to the insect pests and disease. Including insect pest larvae of twig borer, scales, mealy bug, aphid and fruit flies. Fruit flies (Diptera: Tephritidae) incur most of the damage fruit of peach.

### **Materials and methods**

The research work was undertaken in peach orchards in and around Quetta. Monitoring of fruit fly population was done in various farm around Quetta whereas its management studies was undertaken in Achakzai Peach form Hanna lake. Monitoring of the peach fruit fly population was done through fortnight sampling in two orchard 30 km away from each other. For this purpose five plastic traps having methyl Eugenol and 5% malathion or available insecticide were installed in each orchard at fortnightly interval and population of trapped fruit fly adults counted during August to September and until the harvest of the fruit.

### **Management of peach fruit fly**

Following treatment was applied in the peach form for management of fruit fly during August to September and until the harvest of fruit.

1. Methyl eugenol traps with Sanitation
2. Methyl eugenol without Sanitation.
3. Protein hydrolysate baits with Sanitation.
4. Protein hydrolysate baits without Sanitation.
5. Methyl eugenol with Neem extract.
6. Protein hydrolysate baits with Neem extract.
7. Methyl eugenol with Sanitation and Neem extract.

### **Male annihilation through pheromone (methyl Eugenol + contact insecticide) baited wooden blocks re-charged after every 10 days**

Plywood blocks measuring (3x3 inch) soaked in the mixture of (methyl eugenol+5% Malathion/available contact

insecticide) which was fixed on the tree at 4.5ft height. For population monitoring 5 traps was used. These was recharged after 10 days.

### **Female flies controlled by bait application technique through regular sprays of the bait (protein hydrolysate mixed with 10% available stomach poison) during fruit fly season at 10 days interval**

Bait spray is a preparation of 3 ml stomach poison and 30 ml commercial protein hydrolysate in 1 L water. The mixtures 7.6 liter was used with knapsack sprayer weekly from the start of fruit formation till harvest. Four blocks with 5 traps was used. In each block 1 trap was used at the height of 4.5 feet. Bait sprays was applied at the underside of the tree canopy.

### **Application of 2% Neem seed extract on the most susceptible varieties at 10 days interval during fruit ripening.**

Neem seed is abundantly available in Jaffarabad district. Two percent of Neem seed extract was prepared from 2Kg Neem seed powder along with 30gm detergent. The powder of Neem seed was wrapped in a muslin cloth and dipped in 4-5L hot water. After 15-20 hours, the concentrate was squeezed out and diluted by adding water. Only 3 sprays of Neem seed extract at an interval of 10 days was applied in order to repel fruit fly from ripening peach. This material is an effective repellent against fruit flies.

### **Results**

#### **Population of *Bactrocera zonata* trapped by Methyl-Eugenol with and without sanitation**

Results (Table 1) indicates that on 15<sup>th</sup> August the population of *Bactrocera zonata* trapped by without Sanitation + Methyl-Eugenol was 728±67.55 larvae/trap which was further increased upto 790±87.75 and 990±78.10 larvae/trap on 30<sup>th</sup> August and 15<sup>th</sup> September and the population reached at peak level of 1153±62.84 larvae/trap on 30<sup>th</sup> September, afterwards the population linearly dropped and reached at 660±54.31

and  $546.6 \pm 55.06$  larvae/trap on 15<sup>th</sup> October and 30<sup>th</sup> October, respectively. However, the population of *Bactrocera zonata* trapped by Sanitation + Methyl-Eugenol was  $576 \pm 53.72$  larvae/trap on 15<sup>th</sup> August which was further increased upto  $638 \pm 87.20$  and  $821 \pm 72.32$  larvae/trap on 30<sup>th</sup> August and 15<sup>th</sup> September and the population reached at peak level of  $932 \pm 42.26$  larvae/trap on 30<sup>th</sup> September, afterwards the population linearly dropped and reached at  $462 \pm 51.71$  and  $386.6 \pm 73.76$  larvae/trap on 15<sup>th</sup> October

and 30<sup>th</sup> October, respectively. On the basis of statistical analysis of the data, there was highly significant difference in population of *Bactrocera zonata* trapped by Sanitation + Methyl-Eugenol and without sanitation + Methyl-Eugenol in all fortnight observations. Furthermore, significantly higher population of *Bactrocera zonata* was observed under without Sanitation + Methyl-Eugenol as compared to Sanitation + Methyl-Eugenol on 30<sup>th</sup> September.

**Table 1. Mean $\pm$ SE population of *Bactrocera zonata* trapped by Methyl-Eugenol with and without sanitation**

Date	Plot-1 (Sanitation + Methyl-Eugenol)	Plot-2 (Without sanitation+Methyl-Eugenol)
15 <sup>th</sup> August	$576 \pm 53.72$ ef	$728 \pm 67.55$ de
30 <sup>th</sup> August	$638 \pm 87.20$ f	$790 \pm 87.75$ cd
15 <sup>th</sup> September	$821 \pm 72.32$ c	$990 \pm 78.10$ b
30 <sup>th</sup> September	$932 \pm 42.26$ b	$1153 \pm 62.84$ a
15 <sup>th</sup> October	$462 \pm 51.71$ hi	$660 \pm 54.31$ ef
30 <sup>th</sup> October	$386.6 \pm 73.76$ i	$546.6 \pm 55.06$ gh

SE $\pm$  = 43.190, LSD 0.05 = 87.044, P-value = 0.0000\*\*, \*\*\*= highly significant

Different alphabets among the mean values shows significant difference at <0.05 probability level

#### **Population of *Bactrocera zonata* trapped by protein hydrolysis baits with and without sanitation**

Results (Table 2) indicates that on 15<sup>th</sup> August the population of *Bactrocera zonata* trapped by without sanitation + Protein hydrolysis baits was  $629 \pm 31.24$  larvae/trap which was further increased upto  $752 \pm 27.82$  and  $972 \pm 39.16$  larvae/trap on 30<sup>th</sup> August and 15<sup>th</sup> September and the population reached at peak level of  $1064 \pm 31.40$  larvae/trap on 30<sup>th</sup> September, afterwards the population linearly dropped and reached at  $540 \pm 20.73$  and  $415.8 \pm 33.56$  larvae/trap on 15<sup>th</sup> October and 30<sup>th</sup> October, respectively. However, the population of *Bactrocera zonata* trapped by sanitation + Protein hydrolysis baits was  $416 \pm 33.55$  larvae/trap on 15<sup>th</sup> August which was further

increased upto  $476 \pm 55.10$  and  $558 \pm 57.56$  larvae/trap on 30<sup>th</sup> August and 15<sup>th</sup> September and the population reached at peak level of  $724 \pm 80.59$  larvae/trap on 30<sup>th</sup> September, afterwards the population linearly dropped and reached at  $298 \pm 41.76$  and  $232 \pm 33.37$  larvae/trap on 15<sup>th</sup> October and 30<sup>th</sup> October, respectively. On the basis of statistical analysis of the data, there was highly significant difference in population of *Bactrocera zonata* trapped by sanitation + Protein hydrolysis baits and without sanitation + Protein hydrolysis baits in all fortnight observations. Furthermore, significantly higher population of *Bactrocera zonata* was observed under without sanitation + Protein hydrolysis baits as compared to sanitation + Protein hydrolysis baits on 30<sup>th</sup> September.

**Table 2. Mean±SE population of *Bactrocera zonata* trapped by Protein hydrolysis baits with and without sanitation**

Date	Plot-1 (Sanitation + Protein hydrolysis baits)	Plot-2 (Without sanitation+ Protein hydrolysis baits)
15 <sup>th</sup> August	416±33.55g	629±31.24d
30 <sup>th</sup> August	476±55.10f	752±27.82c
15 <sup>th</sup> September	558±57.56e	972±39.16b
30 <sup>th</sup> September	724±80.59c	1064±31.40a
15 <sup>th</sup> October	298±41.76h	540±20.73e
30 <sup>th</sup> October	232±33.37i	415.8±33.56g

SE± = 25.232, LSD 0.05 = 50.852, P-value = 0.0000\*\*, \*\*= highly significant

Different alphabets among the mean values shows significant difference at <0.05 probability level

**Population of *Bactrocera zonata* trapped by Neem extract + Methyl-Eugenol and Neem extract + protein hydrolysis baits**

Results (Table 3) indicates that on 15<sup>th</sup> August the population of *Bactrocera zonata* trapped by Neem Extract + Methyl-Eugenol was 749.8±69.48 larvae/trap which was further increased upto 813.6±90.42 and 1019.6±80.39 larvae/trap on 30<sup>th</sup> August and 15<sup>th</sup> September and the population reached at peak level of 1187.6±64.80 larvae/trap on 30<sup>th</sup> September, afterwards the population linearly dropped and reached at 679.8±55.96 and 563±56.78 larvae/trap on 15<sup>th</sup> October and 30<sup>th</sup> October, respectively. However, the population of *Bactrocera zonata* trapped by Neem Extract + Protein hydrolysis baits was 593.2±55.34 larvae/trap on 15<sup>th</sup> August which was further increased upto 657±89.74

and 845.6±74.52 larvae/trap on 30<sup>th</sup> August and 15<sup>th</sup> September and the population reached at peak level of 959.8±43.50 larvae/trap on 30<sup>th</sup> September, afterwards the population linearly dropped and reached at 475.6±53.21 and 398.2±75.91 larvae/trap on 15<sup>th</sup> October and 30<sup>th</sup> October, respectively. On the basis of statistical analysis of the data, there was highly significant in population of *Bactrocera zonata* trapped by Neem Extract + Methyl-Eugenol and Neem Extract + Protein hydrolysis baits in all fortnight observations. Furthermore, significantly higher population of *Bactrocera zonata* was observed under Neem Extract + Methyl-Eugenol as compared to Neem Extract + Protein hydrolysis baits on 30<sup>th</sup> September.

**Table 3. Mean±SE population of *Bactrocera zonata* trapped by Neem Extract+Methyl-Eugenol and Neem Extract + Protein hydrolysis baits**

Date	Plot-1 (Neem Extract + Methyl-Eugenol)	Plot-2 (Neem Extract + Protein hydrolysis baits)
15 <sup>th</sup> August	749.8±69.48de	593.2±55.34fg
30 <sup>th</sup> August	813.6±90.42cd	657±89.74f
15 <sup>th</sup> September	1019.6±80.39b	845.6±74.52c
30 <sup>th</sup> September	1187.6±64.80a	959.8±43.50b
15 <sup>th</sup> October	679.8±55.96ef	475.6±53.21hi
30 <sup>th</sup> October	563±56.78gh	398.2±75.91i

SE± = 44.469, LSD 0.05 = 89.621, P-value = 0.0000\*\*, \*\* = highly significant

Different alphabets among the mean values shows significant difference at <0.05 probability level

### Population of *Bactrocera zonata* trapped by Methyl-Eugenol with sanitation Neem extract

Results (Table 4) indicates that on 15<sup>th</sup> August the population of *Bactrocera zonata* trapped by without sanitation was 772.29±71.57 larvae/trap which was further increased upto 838.01±93.13 and 1050.2±82.80 larvae/trap on 30<sup>th</sup> August and 15<sup>th</sup> September and the population reached at peak level of 1223.2±66.74 larvae/trap on 30<sup>th</sup> September, afterwards the population linearly dropped and reached at 700.19±57.64 and 579.89±58.49 larvae/trap on 15<sup>th</sup> October and 30<sup>th</sup> October, respectively. However, the population of *Bactrocera zonata* trapped by without sanitation was 611.00±57.00 larvae/trap on 15<sup>th</sup> August which was further increased

upto 676.71±92.43 and 870.97±76.76 larvae/trap on 30<sup>th</sup> August and 15<sup>th</sup> September and the population reached at peak level of 988.59±44.81 larvae/trap on 30<sup>th</sup> September, afterwards the population linearly dropped and reached at 489.87±54.81 and 410.15±78.19 larvae/trap on 15<sup>th</sup> October and 30<sup>th</sup> October, respectively. On the basis of statistical analysis of the data, there was highly significant difference in population of *Bactrocera zonata* trapped by Methyl-Eugenol with sanitation Neem Extract in all fortnight observations. Furthermore, significantly higher population of *Bactrocera zonata* was observed under without sanitation as compared to sanitation with Methyl-Eugenol on 30<sup>th</sup> September.

**Table 4. Mean±SE population of *Bactrocera zonata* trapped by Methyl-Eugenol with sanitation Neem Extract**

Date	Plot-1 (Methyl-Eugenol with sanitation Neem Extract)	Plot-2 (without sanitation)
15 <sup>th</sup> August	611.00±57.00cd	772.29±71.57cd
30 <sup>th</sup> August	676.71±92.43bc	838.01±93.13bc
15 <sup>th</sup> September	870.97±76.76ab	1050.2±82.80ab
30 <sup>th</sup> September	988.59±44.81a	1223.2±66.74a
15 <sup>th</sup> October	489.87±54.81cd	700.19±57.64cd
30 <sup>th</sup> October	410.15±78.19d	579.89±58.49d

SE± = 33.851, LSD 0.05 = 64.554, P-value = 0.0000\*\*, \*\* = highly significant

Different alphabets among the mean values shows significant difference at <0.05 probability level

### Comparative population of *Bactrocera zonata* trapped under different IPM treatments

Results (Table 5) indicated that maximum population of *Bactrocera zonata* (1223.2±66.74 larvae/trap) was trapped under Methyl eugenol with sanitation Neem extract followed by Neem Extract + Methyl-Eugenol (1187.6±64.80 larvae/trap), Sanitation + Methyl-Eugenol (1153±62.84 larvae/trap), Sanitation + Protein hydrolysis baits (1064±31.40 larvae/trap), Neem Extract + Protein hydrolysis baits

(959.8±43.50 larvae/trap), Without sanitation + Methyl-Eugenol (932±42.26 larvae/trap), without sanitation (870.97±76.76 larvae) and Without sanitation + Protein hydrolysis baits (724±80.59 larvae/trap) on 30<sup>th</sup> September. Similar trend was observed for minimum population of *Bactrocera zonata* trapped under different IPM treatments. Analysis of variance (ANOVA) depicted highly significant difference (p<0.05) in population of *Bactrocera zonata* trapped under different IPM treatments in all fortnight observations.

**Table 5. Comparative (Mean±SE) population of *Bactrocera zonata* trapped under different IPM treatments**

Date	Plot-1 (Sanitation + Methyl- Eugenol)	Plot-2 (Without sanitation+ Methyl- Eugenol)	Plot-1 (Sanitation + Protein hydrolysis baits)	Plot-2 (Without sanitation+ Protein hydrolysis baits)	Plot-1 (Neem Extract + Methyl- Eugenol)	Plot-2 (Neem Extract + Protein hydrolysis baits)	Plot-1 (Methyl- Eugenol with sanitation Neem Extract)	Plot-2 (without sanitation)
15 <sup>th</sup> August	576±53.72ef	728±67.55de	416±33.55g	629±31.24d	593.2±55.34fg	749.8±69.48de	611.00±57.00cd	772.29±71.57cd
30 <sup>th</sup> August	638±87.20f	790±87.75cd	476±55.10f	752±27.82c	657±89.74f	813.6±90.42cd	676.71±92.43bc	838.01±93.13bc
15 <sup>th</sup> September	821±72.32c	990±78.10b	558±57.56e	972±39.16b	845.6±74.52c	1019.6±80.39b	870.97±76.76ab	1050.2±82.80ab
30 <sup>th</sup> September	932±42.26b	1153±62.84a	724±80.59c	1064±31.40a	959.8±43.50b	1187.6±64.80a	988.59±44.81a	1223.2±66.74a
15 <sup>th</sup> October	462±51.71hi	660±54.31ef	298±41.76h	540±20.73e	475.6±53.21hi	679.8±55.96ef	489.87±54.81cd	700.19±57.64cd
30 <sup>th</sup> October	386.6±73.76i	546.6±55.06gh	232±33.37i	415.8±33.56g	398.2±75.91i	563±56.78gh	410.15±78.19d	579.89±58.49d
SE±	43.190		25.232		44.469		33.851	
LSD 0.05	87.044		50.852		89.621		64.554	
P-value	0.0000**		0.0000**		0.0000**		0.0000**	
**	highly significant		highly significant		highly significant		highly significant	

Different alphabets among the mean values shows significant difference at <0.05 probability level

**Overall population and percentage of *Bactrocera zonata* trapped by Methyl-Eugenol with and without sanitation**

Results in (Table 6) showed that maximum population and percentage of *Bactrocera*

*zonata* was recorded in plot-2 (without sanitation + methyl-eugenol) as compared to plot-1 (sanitation + methyl eugenol).

**Table 6. Overall population and percentage of *Bactrocera zonata* trapped by Methyl-Eugenol with and without sanitation**

Variables	Plot-1 (Sanitation + Methyl-Eugenol)	Plot-2 (Without sanitation+Methyl-Eugenol)
Total population	3815.6	4867.6
Percentage	44.04%	56.18%

**Overall population and percentage of *Bactrocera zonata* trapped by Protein hydrolysis baits with and without sanitation**

Results in (Table 7) showed that maximum population and percentage of *Bactrocera*

*zonata* was recorded in plot-2 (without sanitation + protein hydrolysis baits) as compared to plot-1 (sanitation + protein hydrolysis baits).

**Table 7. Overall population and percentage of *Bactrocera zonata* trapped by Protein hydrolysis baits with and without sanitation**

Variables	Plot-1 (Sanitation + Protein hydrolysis baits)	Plot-2 (Without sanitation+ Protein hydrolysis baits)
Total population	2704	4372.8
Percentage	38.20%	61.79%

**Overall population and percentage of *Bactrocera zonata* trapped by Neem extract+Methyl-Eugenol and Neem extract + Protein hydrolysis baits**

Results in (Table 8) showed that maximum population and percentage of *Bactrocera zonata* was recorded in plot-1 (neem extract + methyl-eugenol) as compared to plot-2 (neem extract + protein hydrolysis baits).

**Overall population and percentage of *Bactrocera zonata* trapped by Methyl-Eugenol with sanitation Neem extract**

Results in (Table 9) showed that maximum population and percentage of *Bactrocera zonata* was recorded in plot-2 (without sanitation) as compared to plot-1 (methyl-eugenol with sanitation neem extract).

**Table 8. Overall population and percentage of *Bactrocera zonata* trapped by Neem Extract+Methyl-Eugenol and Neem Extract + Protein hydrolysis baits**

Variables	Plot-1 (Neem Extract + Methyl-Eugenol)	Plot-2 (Neem Extract + Protein hydrolysis baits)
Total population	5013.4	3929.4
Percentage	56.06%	43.93%

**Table 9. Overall population and percentage of *Bactrocera zonata* trapped by Methyl-Eugenol with sanitation Neem extract**

Variables	Plot-1 (Methyl-Eugenol with sanitation Neem Extract)	Plot-2 (without sanitation)
Total population	4047.29	5163.78
Percentage	43.93%	56.06%

### Discussion

The finding of the present study showed that *Bactrocera zonata* highly attracted to Methyl eugenol with sanitation Neem extract followed by Neem Extract + Methyl-Eugenol, Sanitation + Methyl-Eugenol, Sanitation + Protein hydrolysis baits, Neem Extract + Protein hydrolysis baits, Without sanitation + Methyl-Eugenol and Without sanitation + Protein hydrolysis baits. Maximum population abundance of *Bactrocera zonata* were recorded at the end of September afterwards the population simultaneously declined upto end of October. Solangi [8] reported that methyl eugenol pheromone traps installed at 2m height resulted in highest *B. zonata* and *B. dorsalis* catches at Hyderabad (1428.4±260.04), at Larkana (2208.4±327.44) as well as at Mirpurkhas 1595.6±264.41, followed by surface installed, and 1 meter or 3 meter trap heights. Under Hyderabad ecological conditions, the *B. zonata* starts its rapid development from the month of May and sustains upto the month of September with certain fluctuation at Tandojam. The fruit fly population sharply decreased in October. According to the findings of Bateman [9] reported that tephritid fruit flies are serious pests in Mauritius, of which *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) is one. One of the pathogens of fruit flies is *Beauveria bassiana* (Balsamo) Vuillemin; the introduction of this entomopathogen into the wild fly population would be beneficial for suppression of fruit fly populations. Five releases were made to study the dispersal behaviour and survival of sterile *B. zonata* males either treated or untreated with dry conidia of *B. bassiana*, in vegetable plantations bordered with papaya and mango trees in northern Mauritius from April 2010 to

December 2012. The flies used were reared for ≈172 generations in the laboratory. Results showed that the dispersal behaviour and post-release survival were different for the two types of sterile males. Recapture rates of *B. bassiana*-treated sterile males ( $2.0 \pm 1.4$  %) were significantly lower than those of untreated flies ( $6.2 \pm 5.5$  %). However, the recapture rates for both types of males were within acceptable limits for release—recapture studies with mass-reared and irradiated fruit flies. Up to day 4 after release the percentage recovery of sterile *B. zonata* males untreated and treated with *B. bassiana* was 76 % and 81 %, respectively; 90 % of the recovered sterile flies from both groups were recovered up to 100 m from the release point, and only 4 % at a distance between 150 m and 200 m from the release point. Our results suggest that sterile *B. zonata* males could potentially be used as vectors of *B. bassiana* to supplement suppression of this pest in a sterile insect release programme. Patel and Patel (1995) tested the efficacy of modified trap (Methyl eugenol alone) with conventional bait trap (Methyl eugenol + DDVP) for trapping fruit flies in a sapota (Manilkarazapota) orchard and reported that new designed trap “Patel fruit fly trap” proved equally effective. Liu and chen (1992)[10] reported that 10% Cue lure was the most attractive mixture for luring males of both *B. cucurbitae* and *Bactrocera dorsalis* as compared to methyl eugenol. Sookar *et al.* [10] studied attractiveness of the three proteinaceous substance (protein hydrolysate, Nu-lure and PIB-7 to *Bactrocera dorsalis* and reported that protein hydrolysate was the most effective bait attracting 45.4% of adult females and 35.6% of males. Liu and Chen [11] determined the population dynamic of *B. dorsalis* and *B.*

cucurbitae from 1987 to 1989 by fruit collection and male trap captured. The found that major hosts of *B. dorsalis* were wild strawberry, guava and peach whereas major host of *B. cucurbitae* were cultivated truck crops on farms. They further reported that during period of peak guava abundant, number of *B. dorsalis* increased on farm. During period of peak crop production, increased in habitats surrounding farms [12].

### Conclusion

On the basis of present investigation, it was observed that *Bactrocera zonata* highly attracted to Methyl eugenol with sanitation Neem extract followed by Neem Extract + Methyl-Eugenol, Sanitation + Methyl-Eugenol, Sanitation + Protein hydrolysis baits, Neem Extract + Protein hydrolysis baits, Without sanitation + Methyl-Eugenol and Without sanitation + Protein hydrolysis baits. Maximum population abundance of *Bactrocera zonata* were recorded at the end of September afterwards the population simultaneously declined upto end of October.

### Authors' contributions

Conceived and designed the experiments: M Khan, SA Memon, BK Solangi & G Jillani, Performed the experiments: A Uddin, SJ Shah & E Aziz, Analyzed the data: M Khan, SA Memon & BK Solangi, Contributed materials/analysis/ tools: M Khan, K Jamil, N Ahmed, A Afzal & A Raziq, Wrote the paper: M Khan, SA Memon, BK Solangi & G Jillani.

### References

1. Fletcher, (1987). Population fluctuations and interspecific competition between Tephritid flies attacking fruit crops in the New Valley oases, Egypt. *Arch of Phytopathol and Plant Prot* 43(7/9): 647-659.
2. Syed *et al.* (1970). Population fluctuations and interspecific competition between Tephritid flies attacking fruit crops in the New Valley oases, Egypt. *Arch of Phytopathol and Plant Prot* 43(7/9): 647-659.
3. Kafi (1986). Final report for the project no PS-FAI-020-03 entitled "Study on biological means for controlling the Mediterranean fruit fly *Ceratitiscapitata* (Wiedemann) in New Valley Governorate" and submitted by the Academy of Scientific Research and Technology, Cairo, Egypt.
4. Jalaludin *et al.* (1999). Relative susceptibility of some fruits to the Mediterranean fruit fly, *Ceratitiscapitata* (Wiedemann) and peach fruit fly, *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) in Egypt. *J of Entomol and Zool Stu* 14(4): 42-48.
5. Kumar *et al.* (1997). Effect of weather parameters on population dynamics of peach fruit fly, *Bactrocera zonata* (Saunders). *Entomol* 24(1): 81-84.
6. Irshad and Jilani (2003). Oviposition stimulants of the peach fruit fly *Bactrocera zonata* (Saunders) (Diptera: tephritidae) under laboratory conditions. *J Egypt Soc Toxicol* 34(1): 1-4.
7. Bhatti (1968). *Agricultural Pests of India and Southeast Asia*. Kalyani Publishers, New Delhi.
8. Solangi (2017). Le piegeage du carpocapce sexual de syntheses: primers results utilisables pour L. estimation des populations conduite de la lutte. *Annales de Zoologie Ecologie Animale* 7(1): 6180.
9. Bateman MA (1972). The ecology of fruit flies. *Ann Rev Ent* 17: 493-578.
10. Sookar *et al.* (2014). Fruit fly control and monitoring in the Near East: shared concern in a regional trans boundary. Proceedings of the 6th International Symposium on fruit flies of economic importance. 155-171, Stellenbosch, South Africa.
11. Liu and Chen (1992). Fruit fly control and monitoring in the Near East: shared concern in a regional trans-boundary. Proceedings of the 6th International Symposium on fruit flies of economic importance. Stellenbosch, South Africa, 155-171.
12. Vargas *et al.* (1990). Invasive phytophagous pests arising through a recent tropical evolutionary radiation: the *Bactrocera dorsalis* complex of fruit flies. *Ann Rev of Entomol* 50: 293-319.