Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v2023i1.525
*Biol. Clin. Sci. Res. J., Volume, **2023**: 525*
Original Research Article

EMPLOYING MALE ANNIHILATION OR BAIT APPLICATION TECHNIQUES TO SUPPRESS THE PEACH FRUIT FLY, *BACTROCERA ZONATA* (DIPTERA: TEPHRITIDAE)

MUNIR H[1], AHMAD S[1*], CHATTHA MB[2], MAHMOOD R[3], TARIQ MR[4], IQBAL M[1], ASHRAF S[1]

[1]*Department of Entomology, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan*
[2]*Department of Agronomy, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan*
[3]*Department of Soil Science, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan*
[4]*Department of Food Sciences, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan*
**Corresponding author email address: shahbaz.iags@pu.edu.pk*

(Received, 27th May 2023, Revised 26th November 2023, Published 27th November 2023)

Abstract *Guava (Psidium guajava) is one of the important crops of tropical regions and a major source of antioxidants and fibers. Peach fruit fly (PFF) Bactrocera zonata is a pest of many fruit crops like guava. The purpose was to extract the most efficient method among MAT, BAT, or Botanicals by considering their mortality in 24, 48, 72, and 96-hour intervals. In both BAT and Botanicals, the efficiency of extracts of Neem (A. indica), Moringa (Moringa oleifera), Citrus, and Parthenium (Parthenium hysterophorus) at concentrations (100%, 50%, and 25%) was observed. We placed 39 traps in the field with 4 different treatments, 3 concentrations having 3 replicates along with control. Maximum mortality after 24 hours at 100% concentration of Neem was 69.91% and minimum mortality (13.91%) was observed at 25% concentration of Parthenium. While mortality ranged for A. indica (58.12% - 31.78%), M. oleifera (44.01 - 22.68), Citrus (40.21 - 19.67) and P. hysterophorus (34.11 - 13.91). Citrus and moringa showed moderate mortality. In the present study, the percentage of mortality was much higher at the highest concentration of neem when compared with the control treatment. The study revealed that all the measures gave satisfactory results and proved to be more efficient, while botanicals were least significant*.

Keywords: Botanicals, Parthenium, mortality, Management

Introduction

Guava is a very nutritious and common fruit in Pakistan. It is a winter fruit containing soluble fiber, calcium, and phosphorous. Scientifically it is known as *Psidium guajava* and belongs to the family Myrtaceae. It is a tropical fruit containing antioxidants and is widely used as fresh and processed food. Its pulp and peel also have antioxidants and dietary fibers (Jiménez-Escrig et al., 2001). Guava is a very common tropical fruit in Pakistan. It is a very popular fruit due to its taste and fragrance. In Pakistan, it is consumed as fresh, but there are a lot of other products for which guava is utilized e.g. jams and jellies, etc. Guavas are quite nutritious as they contain vitamins A, B, and C, minerals, a high amount of pectin, 82% water, and 11% carbohydrates. Guava provides 25 calories per guava desirable for its nutritional value (Bhatti et al., 2023; Khushk et al., 2009). In Pakistan, guava is cultivated in Sindh and Punjab and holds third place among major fruits after citrus and mango. Guava is cultivated in an area of 61608 hectares with an average yield of 549599 tons. It can be grown in dry subtropical with little average rain. The main flowering period lasts between June-July, with a harvesting period in Autumn- Winter between (Oct-Dec)(Ishtiaq et al., 2019). Meanwhile, for the spring-summer harvesting period, flowering occurs from February to March (Mercado-Silva et al., 1998). Mature fruits, leaves, roots, and bark are used to treat gastroenteritis, high blood pressure, obesity, and diarrhea due to their medicinal properties (Fatima et al., 2023; Joseph and Priya, 2011).

Among these pests, peach Fruit fly *B. zonata* is the most damage-causing pest of guava fields. Guava fruit fly *B. zonata* is innate to South Africa, and it attacks various soft fruits like mango, guava, and peach majorly (White and Elson-Harris, 1992). About 500 species are included in the genus Bactrocera, most of which are found in Asia and Australasian areas. Africa has only 10 indigenous species, the best identified is Olive fly, *B. oleae* (Rossi). The peach fruit fly is called *Dacus zonata* in older kinds of literature. However, according to the authors of the new era, the name Dacus is restricted to use in the family Dacini. (Dacus and Bactrocera) having a single sclerotized plate into their abdominal terga fused. It can infest many hosts major host attacks are peach, mango, and guava. Infestation of

[Citation Munir, H., Ahmad, S., Chattha, M.B., Mahmood, R., Tariq, M.R., Iqbal, M., Ashraf, S. (2023). Employing male annihilation or bait application techniques to suppress the peach fruit fly, *Bactrocera zonata* (diptera: tephritidae). *Biol. Clin. Sci. Res. J.*, **2023***:* 525. doi: https://doi.org/10.54112/bcsrj.v2023i1.525]

50 to 80% by this pest has been recorded in West Pakistan in many fruits like pear, peach apricot and fig.

The damage caused by adults of fruit flies is observed by the presence of eggs in fruit flesh or with the signs of oviposition rupture. Maggots cause severe damage as they start feeding on fruit. Damage caused by fruit flies can be of two types: direct and indirect damage. Direct damage includes the deterioration of fruit quality as eggs are laid inside fruit pulp, so maggots, after hatching, start feeding on food pulp, thus making fruit unfit for human consumption. Larvae make galleries inside the fruit. Therefore, the present situation warrants an eco-friendly pest management strategy. The food source used in the bait application technique and male annihilation technique is as attractive as that of methyl eugenol. Currently, malathion is used as the only insecticide in the BAT and MAT (Stonehouse et al., 2002). The government of Kerala has also decided to declare it as the state in Organizational 2016. In this context, malathion, a conventional organophosphate in BAT and MAT may create great concern.

Hence, botanicals, biocontrol BAT, and MAT are needed in agents and safer new-generation insecticides. Newer Chemicals are more target-specific and require smaller quantities. Identifying newer chemicals that are safe and effective in reducing pesticide load environment and can be used in organic farming. It is noticed that most plants have toxic compounds that repel the insect pest, because of which plants are being used to manage pest population in the field to enhance yield by safe means. These plants are used to make biopesticides. Botanicals are products obtained from different plants with toxic compounds that can be used against pests. These are considered safer and least hazardous to the environment with good efficacy. *Azadirachta indica,* commonly known as neem, is a native plant of India. It is a large evergreen plant that is found in about 80 countries. Neem contains different biologically active chemicals like steroids, ketone, carotenoids, alkaloids, levonoids, and phenolic compounds, and the most active is azadirachtin. Azadirachtin is a mixture of seven isomeric compounds. In 1992 US National Academy published a report that revealed that neem is a plant for resolving global issues (Atif et al., 2019; Hashmat et al., 2012). Neem gave noteworthy results in managing the Colorado potato beetle. Moringa oleifera is a high-value plant that is distributed in many countries of the world. It contains proteins, amino acids, phenolics, and vitamins in it. Moringa has great industrial and medicinal value (Moyo et al., 2011). The bait application technique (BAT) is a major part of integrated pest management (IPM), consisting of a food source to attract a pest and a poison to kill it instantly. Insecticide alone cannot give much operational control in the case of fruit flies as larvae reside inside the fruit under protection, and pesticides cannot penetrate deep into the fruit, so it could decline the fruit quality and injure human health. The male annihilation technique (MAT) is another active technique for controlling fruit flies. This technique, which consists of a male lure (an attractant for males) and any lethal compound, is used against the male population to reduce pest population. Reduction in the male population ultimately reduces the overall production of fruit flies.

Materials and methods

The present study aims to study the management of fruit flies with different methods, including the male annihilation technique MAT and bait application technique BAT mixed with botanicals. The field experiments were conducted in the Punjab University research area.

Preparation of Mango Pulp

To conduct the trial 4 mangoes were taken and washed properly. These mangoes were peeled off and cut into small pieces leaving behind their seeds. These mango pieces were poured into a grinder machine for about half a minute to make fine pulp. This pulp was then poured into a clean container. The pulp was weighed, and 30 grams were taken and mixed with 10 grams of sugar and protein.

Preparation of traps

A total of 6 plastic bottles were taken to make traps for this experiment. Two holes of equal size were made that were parallel to each other with the help of scissors. A piece of rope was taken, which was tied on both ends of the traps to make it hang on trees in the fields.

Mango pulp, sugar, and casein protein were mixed well in a container. To apply the mixture, cotton bolls made from cotton roll were taken. Cotton bolls were poured into the mixture and were placed in traps. These traps were hanging about 6 feet above the ground level on the tree with the help of the rope. All 6 traps were hung on the same level and at equal distance.

[Citation Munir, H., Ahmad, S., Chattha, M.B., Mahmood, R., Tariq, M.R., Iqbal, M., Ashraf, S. (2023). Employing male annihilation or bait application techniques to suppress the peach fruit fly, *Bactrocera zonata* (diptera: tephritidae). *Biol. Clin. Sci. Res. J.,* **2023***:* 525. doi: https://doi.org/10.54112/bcsrj.v2023i1.525]

Botanicals

This study was conducted to check the efficiency of different botanicals i.e. neem, citrus, moringa, and parthenium. The leaves of these plants were collected from the fields of IAGS to conduct this experiment. These were washed and kept to sundry for two days. Dried leaves were ground to powder form. Methanol was used to prepare leaf extract; 10 grams of powder was mixed with 90 ml of methanol. Three replications of each plant 25%, 50%, and 100% were prepared and stored in beakers, and beakers were tagged with their names and percentages. These plant extracts were taken to the fields, and a cotton ball was dipped. That cotton ball was placed into a jar and the jar was hung on the tree. Reading was taken daily for three days from these jars to check the mortality rate of fruit flies, and the collected data was saved to find the result.

Preparation of Trap

12 jars were taken to apply botanicals in the field. Two rectangular windows were made on traps parallel to each other. Threads were being used to make them tie with guava plants. All traps were placed in a field with a specific distance.

Efficiency of BAT

The bait application technique normally consisted of traps baited with a liquid solution (El-Gendy, 2017), (Silva et al., 2011) reported that setting up a banana or starch-jaggery trap showed zero percent fruit fly infestation. A study conducted in Pakistan (Stonehouse et al., 2002) observed that a meat-based bait (beef meat broth) was found to be 68.7 percent more effective than commercial protein hydrolysate. Bait application is a technique applied to control pests without harming the environment. The bait used in this experiment is different botanicals. All the botanicals used are the same, as mentioned earlier, but the results of both experiments are different.

Preparation of bait

Selection of most effective treatments in BAT

Field evaluation was conducted to select the most promising treatments for managing guava fruit flies. The following were the treatments used for the study.

Treatments	Description
T_1	Neem 100%
T_2	Neem 50%
T_3	Neem 25%
T_4	Moringa 100%
T_5	Moringa 50%
T_6	Moringa 25%
T_7	Citrus 100%
T_8	Citrus 50%
T_9	Citrus 25%
T_{10}	Parthenium 100%
T_{11}	Parthenium 50%
T_{12}	Parthenium 25%

Statistical Analysis

After calculating the percentage mortality, the data for different concentrations were subjected to the Analysis of variance technique. ANOVA was performed using Statistica 10.0 for Windows. The means were separated through Tukey's HSD (Honest Significant Difference) test at a significance level 0.05. A value of $P < 0.05$ was considered statistically significant.

Results

Plants were selected randomly, upon which treatments were applied. The percentage mortality of *Bactrocera zonata* was recorded from selected plants from different treatments, concentrations, and combinations. Data showed that all the treatments ($F = 68469.30$; d.f. = 4; $P = 0.000$), concentrations ($F = 15231.52$; d.f. = 2; $P = 0.000$), time ($F = 6115.76$; d.f. = 3; $P = 0.000$), treatments × concentrations ($F = 1073.97$; d.f. = 8; $P = 0.0000$), treatments × time ($F = 647.38$; d.f. = 12; $P = 0.0000$), concentrations × time ($F = 601.06$; d.f. = 6; $P = 0.0001$) and treatments × concentrations × time ($F = 145.14$; d.f. = 24; $P = 0.0000$) are highly significant after different post-treatment intervals on different concentration of different plant extracts (Table 1). Results of mean percent mortality *B. zonata* of all treatments showed that maximum mortality (43.24% ± 1.90) was

[Citation Munir, H., Ahmad, S., Chattha, M.B., Mahmood, R., Tariq, M.R., Iqbal, M., Ashraf, S. (2023). Employing male annihilation or bait application techniques to suppress the peach fruit fly, *Bactrocera zonata* (diptera: tephritidae). *Biol. Clin. Sci. Res. J.*, **2023***:* 525. doi: https://doi.org/10.54112/bcsrj.v2023i1.525]

observed on treatment treated with *A. indica* followed by (31.53% ± 1.10), (28.36% ± 1.05), (22.65% ± 1.09) percent mortality rate was counted on *Moringa oleifera*, Citrus sps and *Parthenium hysterophorus* respectively while least or no mortality was found in control treatment (Table 2). Mortality at concentrations of 100%, 50%, and 25% was found (30.99% ± 2.34), (25.63% ± 1.88) and (19.79% ± 1.43) respectively (Table 3). Maximum mortality (30.27% ± 2.75) of *B. zonata* was observed after 96 hours of post-treatment application of different plant extracts, followed by (21.35% ± 1.78), (22.88% ± 1.95) and (27.38% ± 2.45) mortality rate was recorded after 24 hours, 48 hours and 72 hours respectively (Table 4).

With *A. indica*, (51.90%) mortality was recorded at 100% concentration, while (38.30%), (34.26%) and (28.84%) were observed at the same concentration for *Moringa oleifera*, citrus sps, and *Parthenium hysterophorus*, respectively. Similarly, the mortality percentage was (43.66%, 31.37%, 28.96%, and 22.72%) for *A. indica*, *Moringa oleifera*, citrus sps, and *Parthenium hysterophorus*, respectively, when applied at a concentration of 50%. Other concentrations of *all tested plant extracts* have a mortality range (34.16% - 16.38%) (Figure 1). *A. indica* showed (53.44%) at 96 hours, which is higher than mortality after 72 hours, 48 hours, and 24 hours (37.16%, 47.16%, and 35.22%) respectively. Similarly, *M. oleifera* showed mortality (35.89%) which was statistically non-significant, with mortality caused by *A. indica* after 24 hours, while statistically significant mortality rates (33.36%, 29.15%, and 27.72%) with 72 hours, 48 hours, and 24 hours respectively. On the other hand, citrus sps and *P. hysterophorus* showed mortality rates in the range (32.61% - 18.06%) (Figure 2). Mortality at 100%, 50% and 25% concentration was significant and ranged (38.18% and 17.92%) at 96 hours to 24 hours for different plant extracts (Figure 3). After an exposure of 96 hours, *A. indica was* found to be the most effective plant extract at 100% contrition by causing (69.91%) mortality of *B. zonata* while the mortality range for the rest of the concentrations and time intervals for *A. indica* was (58.12% - 31.78). Similarly, *M. oleifera* showed mortality ranges (44.01% - 22.68%) while citrus sps and *P. hysterophorus* showed the lowest mortality range (34.1% - 13.91%) (Figure 4).

Table 1: ANOVA for adult mortality of *Bactrocera zonata*

SOV	d.f.		*F*	*P* < 0.05)
Treatments	4		68469.30	0.00
Concentrations	2		15231.52	0.00
Time	3		6115.76	0.00
Treatments × Concentrations	8		1073.97	0.00
Treatments × Time	12		647.38	0.00
Concentrations × Time	6		601.06	0.00
Treatments × Concentrations × Time	24		145.14	0.00

Table 2: Mean percent mortality of *B. zonata* to different plant extracts

Treatments	Percent Mortality ± S.E.
Azadirachta indica	43.24 ± 1.90^{A}
Moringa oleifera	31.53 ± 1.10^{B}
Citrus sps.	28.36 ± 1.05^{C}
Parthenium hysterophorus	22.65 ± 1.09^{D}
Control	1.57 ± 0.08^{E}

Table 3: Mean percent mortality of *B. zonata* to different concentrations of different plant extracts

Concentrations	Percent Mortality ± S.E.
25%	19.79 ± 1.43^{C}
50%	25.63 ± 1.88^{B}
100%	30.99 ± 2.34^{A}

Table 4: Mean percent mortality of *B. zonata* at different exposure time

Time	Percent Mortality ± S.E.
24 Hours	21.35 ± 1.78^{C}
48 Hours	22.88 ± 1.95^{C}
72 Hours	27.38 ± 2.45^{B}
96 Hours	30.27 ± 2.75^{A}

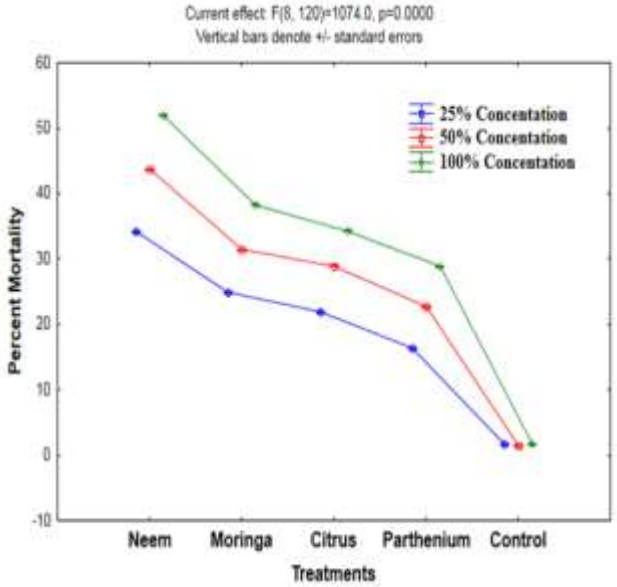

Figure 1: Mean percent mortality of *B. zonata* against different concentrations against different plants extracts

[Citation Munir, H., Ahmad, S., Chattha, M.B., Mahmood, R., Tariq, M.R., Iqbal, M., Ashraf, S. (2023). Employing male annihilation or bait application techniques to suppress the peach fruit fly, *Bactrocera zonata* (diptera: tephritidae). *Biol. Clin. Sci. Res. J.*, **2023***:* 525. doi: https://doi.org/10.54112/bcsrj.v2023i1.525]

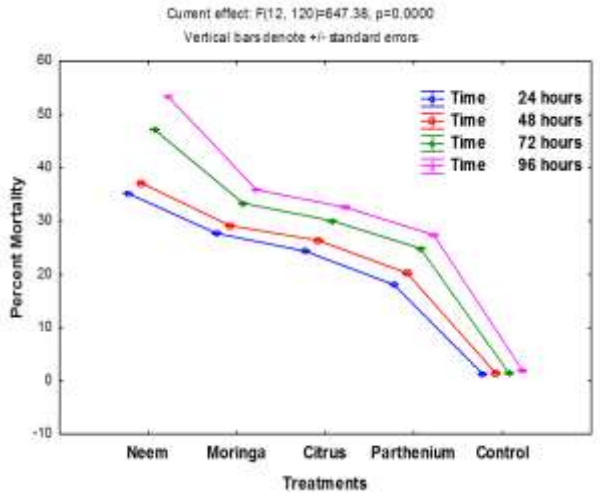

Figure 2: Mean percent mortality of *B. zonata* at different exposure time against different plants extracts

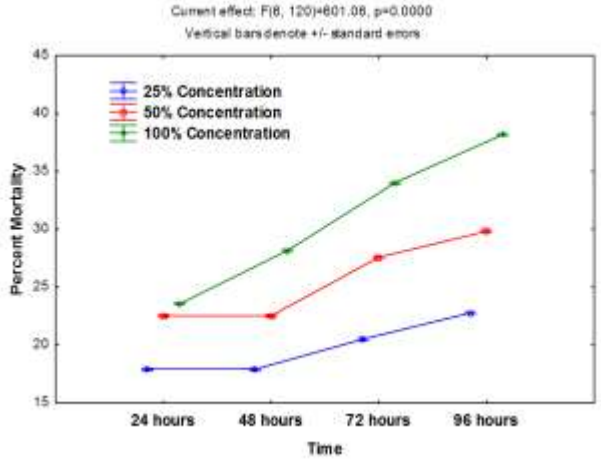

Figure 3: Mean percent mortality of *B. zonata* for different time intervals against different concentrations of plants extracts

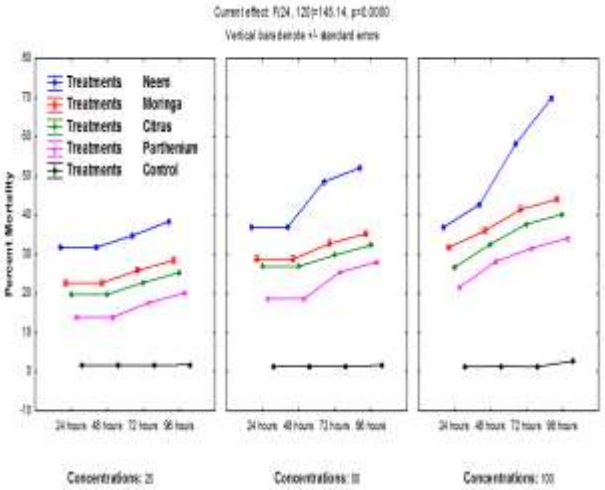

Figure 4: Mean percent mortality of *B. zonata* for different time intervals on different concentrations of different plants extracts

Discussion

This study aimed to check the results of integrated pest management of *B. zonata*. In strategy bait application technique, male annihilation technique and botanicals like Neem, Moringa, Citrus, and Parthenium were included, and methyl eugenol was used as an attractant in both bait application technique and male annihilation technique. This experiment was conducted to get the maximum control of *B. zonata* in the field by any of these parameters and to get the most efficient plant extract for killing fruit flies. An experiment was conducted in the jujube (ber) field (Murugan et al., 2018). In which he used neem powder followed by tobacco extracts. Flies least infested plants treated with neem powder as compared to that treated with tobacco, and the efficiency of both decreased with time. The *B. zonata* occurs in maximum numbers of up to 80% in the field of jujube, while *B. dorsalis* sand *carpomyia vesuviana* occur at 12.3 and 7.6, respectively. Another trial was made (Alao and Adebayo, 2015), the results of which were the same as that of this experiment: botanicals effectively control the pest population in field trials. This experiment was to check the efficiency of plant extracts against watermelon insects. The extracts Moringa oleifera and Tephrosia vogelii were used randomized complete block design. These extracts were used in three different concentrations of 5, 10 and 20% v/v with three replicates. The conclusions revealed that the reduction of *Phyllotreta crucifera* was done more by Moringa oleifera, which was 62%, compared with Tephrosia vogelii, which was 45%. But when it comes to Diabrotica undecimpunctata and Bactrocera curcubitacea, *T. vogelii* is more effective than M. oleifera. This experiment concluded that plant extracts are effective in use against different pests. Results of this study also relate to (Razaq et al., 2019) who experimented in the wheat field. Still, this experiment was done against the management of aphids concerning yield losses. This study was based on managing wheat aphids using imidacloprid and botanicals like moringa leaf extracts MLE and neem seed extracts NSE. The study showed that the infestation of Aphid was significantly reduced when applied in the field, and maximum yield was gained. The wheat yield increased when Imidacloprid was applied with Moringa leaf extracts compared to control. The second most effective control was neem seed extract in suppressing the aphid population; on the other hand moringa leaf extracts was not that efficient in controlling aphid when compared with neem and imidacloprid. Experiments discovered that neem seed extracts can be used as a promising biopesticide and could be alternative to the imidacloprid but can harm non targeted insects. An experiment was conducted (Hussain et al., 2010; Taseen et al., 2023) in which the results were the

[Citation Munir, H., Ahmad, S., Chattha, M.B., Mahmood, R., Tariq, M.R., Iqbal, M., Ashraf, S. (2023). Employing male annihilation or bait application techniques to suppress the peach fruit fly, *Bactrocera zonata* (diptera: tephritidae). *Biol. Clin. Sci. Res. J.*, **2023***:* 525. doi: https://doi.org/10.54112/bcsrj.v2023i1.525]

same as those of the present research. Botanicals like Neem seed extracts, Parthenium hysterophorus L. extracts, eucalyptus leaves extracts, and Methomyl were used in that experiment. All the used botanicals showed significant results This experiment found that botanicals can be used instead of synthetic pesticide that are also hazardous to plants and the environment.

Findings of the study (Solangi et al., 2011) in which extracts of peel of Citrus aurantium was used in a bioassay to evaluate the toxicity of it against olive fruit fly (*Bactrocera oleae*) and *Ceratitis capitata*. The extract of citrus was formed in petroleum ether. Adults of both species were exposed to the extracts. Both these species respond differently in this experiment both sexes of *Bactrocera oleae* were susceptible equally, while against *Ceratitis capitata*, males were more susceptible than females. Results of this trial showed that *Citrus aurantium* effectively manages insect pests by killing them. Results of the present study correlate with (Ali et al., 2011), in which the study showed that Male annihilation technique is comparatively more efficient than Bait application technique when different control measures were evaluated in controlling oriental fruit fly *B. zonata*. This study was made based on the data collected from formers and was statistically analyzed. And the present study also showed that the male annihilation technique is much more important in the management of fruit fly in the field when compared with bait application technique. Both techniques are safe and environmental friendly. Another research conducted (Naeem et al., 2022; Shinwari et al., 2015) is similar to the present research. This research was conducted in field of peach fruit to monitor the population peach fruit fly *B. zonata* along with its infestation. In this experiment different pheromones traps were used containing methyl eugenol, cur-lure, and protein hydrolysate with mixture of sugar and poison. The result showed that methyl eugenol and cue-lure attract male population while protein hydrolysate attracts only female flies. So, in the male annihilation technique ,attract and kill works with mixture of methyl eugenol and poison to attain maximum control of peach fruit fly *B. zonata*. A field experiment was conducted in Hawaii to control melon flies using bait spray. The trial was established by (Prokopy et al., 2004) which is similar to this experiment. In this experiment, non-host plants of the melon fly were sprayed with bait spray (GF-120 bait spray), and these plants were sorghum and sugarcane. These plants surrounded the host plant t,hwhichs cuthe cumber. The melon flies were released on the border plants (sorghum and sugarcane) some of the flies were fed by proteins. The flies that were not badly fed by the proteins were more susceptible 23% were killed by spray, and 0% were observed on the host plant (cucumber), while flies that were on protein got killed only by 14%, and cucumber plants were attacked by 11% of the flies. The results of this study also coincide with the experiment (Stonehouse et al., 2002), where the application of BAT and MAT was evaluated to check the efficacy of killing points of food baits. The efficacy was checked by collecting the dead flies from the traps. It was also observed that the BAT spots were more effective when applied to natural foliage instead of cut wood, cloth or plastic (Stonehouse et al., 2002). MAT was also placed in the field by soaking wooden blocks in a mixture of lure and insecticides. It was observed that MAT killed four times more than BAT, similar to this study's results as the MAT was more efficient when applied with methyl eugenol and insecticide Polytrene C.

Conclusions

Maximum mortality after 24 hours at 100% concentration of Neem was 55.83%, and minimum mortality was observed at 25% of Parthenium. Citrus and Moringa showed moderate mortality. For BAT results were calculated at intervals of 24, 48, 72, and 96 hours. Treatments, conc, and traps used were the same as in botanicals, but all these treatments were applied along with methyl eugenol as an attractant. In this case, the percentage of mortality was much higher when compared with botanicals only. Data collected after 24 hours showed a maximum mortality of 65.71 at 100% of Neem and a minimum mortality of 23.8%. at 25% Parthenium. Moringa and citrus gave moderate mortality. Results until 96 hours were the same, with different percentages of mortality. For MAT 9 traps were installed at three different concentrations (100%, 20%, and 10%) comprised of Polytrin-C and methyl eugenol (as male lure) with three replicates. 100% concentration gave maximum mortality after 24 hours, while minimum % mortality was observed at 10%. The study revealed that all the measures gave satisfactory results, but MAT produced more efficient results while botanicals were least significant.

References

Alao, F. O., and Adebayo, T. (2015). Comparative efficacy of Tephrosia vogelii and Moringa oleifera against insect pests of watermelon (Citrullus lanatus Thumb). *International letters of natural sciences* **35**, 71-78.

Ali, H., Ahmad, S., Hassan, G., Amin, A., Hussain, Z., and Naeem, M. (2011). Bioefficacy of different plant extracts against melon fruit fly in bitter gourd. *Pakistan Journal of Weed Science Research* **17**, 143-149.

Atif, M., Manzoor, M. T., Sarwar, M., and Rafaqat, N. (2019). Isolation and identification of fungi from rhizosphere in the vicinity of the institute of agricultural sciences university of the

[Citation Munir, H., Ahmad, S., Chattha, M.B., Mahmood, R., Tariq, M.R., Iqbal, M., Ashraf, S. (2023). Employing male annihilation or bait application techniques to suppress the peach fruit fly, *Bactrocera zonata* (diptera: tephritidae). *Biol. Clin. Sci. Res. J.*, **2023***:* 525. doi: https://doi.org/10.54112/bcsrj.v2023i1.525]

punjab, Lahore Pakistan. *Bulletin of Biological and Allied Sciences Research* **2019**, 30.

Bhatti, M. H. T., Ahmad, S., Bilal, S., and Iqbal, M. (2023). Evaluation of different strains of entmopathogenic fungi as potential agents for the management of *Tribolium castaneum*. *Bulletin of Biological and Allied Sciences Research* **2023**, 52.

El-Gendy, I. (2017). Host preference of the peach fruit fly, Bactrocera zonata (Saunders)(Diptera: Tephritidae), under laboratory conditions. *Journal of Entomology* **14**, 160-167.

Fatima, S., Cheema, K., Shafiq, M., Manzoor, M. T., Ali, Q., Haider, M. S., and Shahid, M. A. (2023). The genome-wide bioinformatics analysis of 1-aminocyclopropane-1-carboxylate synthase (acs), 1-aminocyclopropane-1-carboxylate oxidase (aco) and ethylene overproducer 1 (eto1) gene family of fragaria vesca (*Woodland strawberry*). *Bulletin of Biological and Allied Sciences Research* **2023**, 38.

Hashmat, I., Azad, H., and Ahmed, A. (2012). Neem (Azadirachta indica A. Juss)-A nature's drugstore: an overview. *Int Res J Biol Sci* **1**, 76-9.

Hussain, A., Sajjad, A., and Salim, J. (2010). Efficacy of different control methods against oriental fruit fly Bactrocera zonata (Saunders). *Journal of Agricultural and Biological Science* **5**, 1-3.

Ishtiaq, M., Atif, M., Manzoor, M. T., Sarwar, M., and Rafaqat, N. (2019). Analysis of different allelopathic plant extracts and fungal metabolites on rice to control rice grain discoloration. *Bulletin of Biological and Allied Sciences Research* **2019**, 28.

Jiménez-Escrig, A., Rincón, M., Pulido, R., and Saura-Calixto, F. (2001). Guava fruit (Psidium guajava L.) as a new source of antioxidant dietary fiber. *Journal of Agricultural and food Chemistry* **49**, 5489-5493.

Joseph, B., and Priya, M. (2011). Review on nutritional, medicinal and pharmacological properties of guava (Psidium guajava Linn.). *International Journal of pharma and bio sciences* **2**, 53-69.

Khushk, A. M., Memon, A., and Lashari, M. I. (2009). Factors affecting guava production in Pakistan. *Journal of Agricultural Research (03681157)* **47**.

Mercado-Silva, E., Benito-Bautista, P., and de los Angeles García-Velasco, M. (1998). Fruit development, harvest index and ripening changes of guavas produced in central Mexico. *Postharvest Biology and Technology* **13**, 143-150.

Moyo, B., Masika, P. J., Hugo, A., and Muchenje, V. (2011). Nutritional characterization of Moringa (Moringa oleifera Lam.) leaves. *African Journal of Biotechnology* **10**, 12925-12933.

Murugan, K., Suresh, U., Panneerselvam, C., Rajaganesh, R., Roni, M., Aziz, A. T., Hwang, J.-S., Sathishkumar, K., Rajasekar, A., and Kumar, S. (2018). Managing wastes as green resources: cigarette butt-synthesized pesticides are highly toxic to malaria vectors with little impact on predatory copepods. *Environmental Science and Pollution Research* **25**, 10456-10470.

Naeem, S., Sami, A., Haider, M. Z., and Meeran, M. W. (2022). Multivariate study of lilium lancifolium weed under different field conditions. *Journal of Physical, Biomedical and Biological Sciences* **2022**, 5.

Prokopy, R. J., Miller, N. W., Piñero, J. C., Oride, L., Chaney, N., Revis, H., and Vargas, R. I. (2004). How effective is GF-120 fruit fly bait spray applied to border area sorghum plants for control of melon flies (Diptera: Tephritidae)? *Florida Entomologist* **87**, 354-360.

Razaq, M., Shah, F. M., Ahmad, S., and Afzal, M. (2019). Pest management for agronomic crops. *Agronomic Crops: Volume 2: Management Practices*, 365-384.

Shinwari, I., Khan, S., Khan, M. A., Ahmad, S., Shah, S. F., Mashwani, M. A., and Khan, M. A. (2015). Evaluation of artificial larval diets for rearing of fruit fly Bactrocera zonata (Diptera: Tephritidae) under laboratory condition. *J. Entomol. Zool. Stud* **3**, 189-193.

Silva, M. A., Alvarenga, C. D., Bezerra-Silva, G. C., Mastrangelo, T., Lopes-Mielezrski, G. N., and Giustolin, T. (2011). Toxic effects of neem seed cake on the larval-pupal (prepupal) stage of Mediterranean fruit fly (Diptera: Tephritidae). *Fruits* **66**, 363-369.

Solangi, B. K., Sultana, R., Wagan, M. S., and Ahmed, N. (2011). Repellent action of botanical pesticides against fruit fly, Bactrocera zonata Saunders in laboratory. *Pakistan Journal of Entomology* **26**, 41-45.

Stonehouse, J., Afzal, M., Zia, Q., Mumford, J., Poswal, A., and Mahmood, R. (2002). "Single-killing-point" field assessment of bait and lure control of fruit flies (Diptera: Tephritidae) in Pakistan. *Crop Protection* **21**, 651-659.

Taseen, Z. A., Sami, A., Haider, M. Z., and Naeem, S. (2023). Molecular insights into plant hormone signaling unraveling the genetic foundations of growth, development, and stress responses under climate change. *Journal of Physical, Biomedical and Biological Sciences* **2023**, 6.

[Citation Munir, H., Ahmad, S., Chattha, M.B., Mahmood, R., Tariq, M.R., Iqbal, M., Ashraf, S. (2023). Employing male annihilation or bait application techniques to suppress the peach fruit fly, *Bactrocera zonata* (diptera: tephritidae). *Biol. Clin. Sci. Res. J.*, **2023***:* 525. doi: https://doi.org/10.54112/bcsrj.v2023i1.525]

White, I. M., and Elson-Harris, M. M. (1992). "Fruit flies of economic significance: their identification and bionomics," CAB international.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Funding

Not applicable

Conflict of Interest

Regarding conflicts of interest, the authors state that their research was carried out independently without any affiliations or financial ties that could raise concerns about biases.