Evaluation of the efficiency of some pheromone traps in attracting adults of the peach fruit fly *Bactrocera zonota* (Saunder) (Diptera: Tephretidae) in an orchard in Karbala Province, Iraq

Alaa Abbas Gaduaa [1] , Ali Abdulhusien Kareem [1*]

[1]Plant Protection Department, Agriculture College, University of Kerbala, Karbala, Iraq
***Corresponding author e-mail: ali.kareem@uokerbala.edu.iq**

Received:

Jan. 25, 2023

Accepted:

Feb. 23, 2023

Published:

Mar. 23, 2023

Abstract

A study was conducted to evaluate the efficiency of the integrated control program for the peach fruit fly. Different attractant pheromone traps and treatments of fungi, biocides and some agricultural operations to attract and catch adult insects in citrus orchards in Karbala during the fall season 2021-2022. The fungi *Beuveria bassiana*, *Metarhizum anisopliae* and the pesticide Balizin S165% were used with different pheromone traps Delta trap (Jackson red trap), Tefrey yellow trap, Spanish Olipe trap, and the local trap. Also, within the integrated control program, a study was conducted on the efficiency of attractant pheromone traps with the pesticides Tondexir EC80%, Success 0.02CB, and some agricultural operations such as wrapping the fruits in paper bags, tilling the soil, cleaning the weeds, and covering the soil with polyethene. The treatment of *M. anisoplia* with the two traps of Jackson (fruit fly pheromone) and Tefrey trap (a new peach fly pheromone) gave 95.8 % of effect through attraction within 6 days. As for the two treatments of the *B. bassiana* fungus and the pesticide Balizin with the two traps of Jackson and the Trap of Tefrey, the pheromone traps were almost identical in the same effect in attraction and entrapment reached 74.5 and 73.09, respectively. There were significant differences in the number of adults attracted to the traps in the study site, where the efficiency of pheromone traps was characterized by the agricultural operations of covering the soil with polyethene, soil ploughing and cleaning weeds with two Jackson traps (fruit fly pheromone) and the local trap gave the highest rate of effect by trapping the most significant number of adults over 6 days. In a study of the efficiency of all the treatments used in the integrated insect control program in reducing the infection rate on citrus trees, it was noted that all the treatments used caused a decrease in the average number of infected fruits during the first, second, and third weeks. The statistical analysis proved that the rate of infected fruits of citrus trees in the different treatments did not differ statistically among them. Based on the study's results, attractive pheromone traps can target adult insects as one of the components of integrated control programs for the peach fruit fly.

Keywords: *Bactrocera zonota*, peach fruit fly, Karbala

Introduction

Iraq is famous for planting many fruit trees of nutritional and economic importance, whether at domestic consumption or export level. Among the essential fruit trees are the peach, *Prunus persica*, and Mango *Mangifera indica*, which are widely cultivated in cold regions of the country [1]. These trees are grown in large areas, but these crops are infested with many insect pests that negatively affect their productivity [2]. These crops are infested with several pests; the most important of these pests is the termite, *Microcerotermes diversus*, a red-scale insect *Anoidiella aurantii*, mango bud mite *Aceria mangifera*, fruit fly *Bactrocera zonata* on peaches and mangoes, and the soft scale insect *Parasaisstia nigra*, a white scale insect *Peudolacaspis pentagona*, and the common red spider *Tetranychus telarius* on peaches [3, 4,5]. Major pests have appeared on mango and peach trees, especially in the last five years, the most important of which is the black peach on peach and boll trees, *Pterochloroides persicae*, and the peach/mango fly, *B. zonata*, on peach and mango trees [6].

The peach fly, *B. zonata*, is considered one of the most dangerous pests that have spread in recent years and have become a threat to many fruit trees in Iraq, especially mangoes and peaches, in addition to infecting figs, dates, and secondary fruits of cucurbits and tomatoes [7]. It causes 25-100% losses in peach and apricot fruits and 25-50% in figs and many other fruits. It is one of the main destructive insects that threaten the commercial production of these fruits [2]. The peach fruit fly causes damage by laying eggs on the fruits, which causes deformation and evident depressions on the fruit surface, in addition to the exit of some waxy secretions from the egg-laying areas that quickly dry up and cause an undesirable appearance on the fruits [1]. It infects the fruits produced by adults and larvae on the fruits in their different stages, as the damages are caused by adults, represented by the effects of laying eggs on the fruits [7]. The place of laying the eggs is a brown point lower than the surface of the fruit, and thus causes a lack of marketing value, especially if the females lay eggs several times on the same fruit, which causes rotting and damage. Insecticides are often used to combat this pest, and other methods can be used, such as yellow pheromone traps, which recorded the highest number of male peach flies attracting and catching [8]. There were significant differences between the yellow, green and white traps. In contrast, the blue and black traps recorded the lowest number of males [9]. The best height for placing traps is 10 feet, and some research also mentioned the preference for white, yellow, and black [10].

Likewise, food traps are among the methods used to monitor the appearance of adults in the field, as insects are usually attracted to chemicals emitted in the environment, such as food odours. Insects can sense very small amounts of them when they rise into the air through the organs of smell, as insects receive odours through chemical receptors. Especially often found on antennae and sensory hairs [9].

The attraction of adult fruit flies is high for protein-baited traps. Research has indicated decomposing yeast as a food attractant in mango orchards. The most attractive flies are the peach fruit fly and the cucurbit fly [9]. As a result of the widespread and dangerous spread of this insect in most of the country's governorates

in recent years, which caused severe damage to citrus fruits due to the lack of studies on the insect, our study aimed to evaluate the efficiency of some attractive materials and different colours for the possibility of using them within integrated control programs to limit the spread of the insect and reduce its damage [11, 7].

Materials and Methods

Evaluation of the efficiency of some attractant pheromone traps:

The study was conducted in one of the Karbala orchard sites during the fall agricultural season of 2021-2022. It included a citrus orchard (grapefruit trees) with 5 dunums in the Al-Bubayyat area in Karbala Governorate. The following pheromone attractant traps were used in the study:

A- Delta Trap (Jackson Red Trap): A pyramidal trap with rectangular base dimensions 20 x 12.5 cm, height 8 cm, made of cardboard, red in colour, and an adhesive substance is placed in the base part of the trap that helps catch insects. The trap is suspended using a metal wire fixed at the top of the trap (Figure 1).

Figure (1): The Delta pheromone trap (Jackson's Red Trap) in a grapefruit tree to estimate the population density of the insect.

B- The yellow Tefrey trap: a cylindrical container made of plastic, 15 cm high and 12 cm in diameter. The lower part of the trap is yellow and contains three openings that allow insects to enter. The upper part of the trap is a transparent cover to facilitate monitoring of the trap without opening it. A metal wire is attached to the top of the trap to hang it in the trees (Figure 2).

Figure (2):The pheromone trap secretes bile in one of the grapefruit trees to estimate the insect's population density.

C- The Spanish Olipe Trap: It is a cylindrical, elongated, transparent plastic bowl to facilitate monitoring of the trap. It has a capacity of 1.5 liters. It contains three alternating holes in the upper part of the bowl. The diameter of the hole is 3 cm. The bowl is filled with 20 gm of yeast + 100 gm of Dap fertilizer + 1 liter of water. And a rope fixed at the top of the trap to hang trap in the tree. This model was chosen for its ease of manufacture by the researcher and its low price (Figure 3).

Figure (3): The Spanish Olipe trap to estimate the insect population density in a grapefruit tree.

Integrated control program on *B. zonota* on citrus trees

Experiments were conducted on citrus trees (Grapefruit) at the study site. The tree spacing was 5 x 5 m with a density of 27 trees. Various pheromone traps were attached to the trees at 180-200 cm height. A knapsack sprinkler was used to spray pesticides and biological preparations (fungal plants). The examination is done

every week by emptying the contents of each bottle of attractive baits and insects, counting the numbers of the caught peach fruit fly, and returning the bottles and traps to hang in the trees after adding the different baits solution inside them and closing them after each reading. Experiments were conducted with 9 treatments and three replications with comparison. The transactions are set out as follows:

1- The Delta trap (Jackson's red trap) contains the sex pheromone analogue of the insect, the Jackson trap for the Mediterranean fruit fly contains the sex pheromone of the insect, 10 Serranoc traps distributed on 3 trees, and the soil is treated with the fungus *B. bassiana* one spray.

2- Jackson trap containing similar sex pheromone of the insect, Jackson trap for the Mediterranean fruit fly containing the sexual pheromone of the insect, Serranoc traps number 10, distributed on 3 trees, and treating the soil with the fungus *M. anisopliae* one spray.

3- Jackson trap containing the sex pheromone of the insect, Jackson trap for the Mediterranean fruit fly containing the sex pheromone of the insect, Siranuk traps number 10, distributed on 3 trees, and the soil is treated with the fungus pesticide, one spray.

4- Jackson trap containing the sexual pheromone of the insect, Jackson trap for the Mediterranean fruit fly containing the sexual pheromone of the insect, Siwanok traps 10 pcs distributed over 3 trees, and the soil is treated with the fungicide Tondexir one spray.

5- Jackson trap containing sexual pheromone similar to the insect, Jackson trap for the Mediterranean fruit fly containing sexual pheromone of the insect, and 10 Sranook traps distributed over 3 trees with good soil ploughing.

6- Jackson trap containing similar sex pheromone of the insect, Jackson trap for the Mediterranean fruit fly containing the sexual pheromone of the insect, Siwanok traps number 10 distributed on 3 trees with fruits wrapped in paper bags

7- Jackson trap containing sexual pheromone similar to the insect, Jackson trap for the Mediterranean fruit fly containing sexual pheromone of the insect, Siwanok traps number 10 distributed on 3 trees with fruits wrapped in white salt.

8- The comparison leaves three trees without any parameters.

The study was conducted for two months from the beginning of the fruit contract, and the results were calculated six weeks after the transactions. The rate of the number of fruits infested with the insect was recorded for all treatments before starting the program by taking 25 fruits/trees randomly.

The efficiency of the program was determined based on the following:

1- The number of males of the caught insect

2- The infection rate of infected fruits

The examination was carried out weekly, as the number of adults caught and the percentage of fruit infestation were calculated, the stickers were replaced weekly, and the pheromone analogue was replaced every two weeks.

Statistical analysis

The results of the research were analysed statistically according to the randomized complete block design (RCBD). The results were analysed using the

variance table according to the design used. The averages were compared using L.S.D at 0.05 [12] and the statistical program GenStat for data analysis.

Results and Discussion

Efficiency of attractant pheromone traps with *M. anisopliae* and *B. bassiana* treatments and Balizin in attracting adult insects of *B. zonota* on grapefruit trees

The statistical analysis showed that the attractive pheromone traps differed significantly in the treatments in attracting and catching the peach fruit fly insect adults during the different periods and in the study site. The *M. anisopliae* fungus treatment with two traps of Jackson (fruit fly pheromone) and Tefrey trap (new peach fly pheromone) gave the highest rate of effect by attracting and trapping the largest number of adults during 6 days, and the average effect was 95.8 for the caught adults. As for the treatment of the fungus *B. bassiana* with two Jackson traps (fruit fly pheromone, and Tefrey trap (a new peach fly pheromone) And the treatment of the pesticide Balizin with a trap (a new peach fly pheromone), the pheromone traps were almost identical in the effect of attraction and catching, and it was observed through statistical analysis that there were no significant differences between the two treatments, as the average effect of attraction and capture was 74.5 and 73.09, respectively. Comparing none of the insects was attracted to the control treatment.

This superiority is attributed to the use of fungicides *M. anisopliae* and *B. bassiana* with sprays in the soil. It leads to the death of many pupae, which is reflected in the number of adults emerging and its association with the infection rate. In addition, the statistical analysis showed a significant difference between the mean numbers of captured per trap per day (CTD) in Jackson trap and the Tefrey traps [9]. El-Gendy [13] showed that Jackson traps proved highly effective in capturing peach fly *B. zonata*. However,[14] indicated no significant effect between Jackson and Tefrey traps in capturing the number of male peach fly fruit. Draz *et al*. [10] showed that using traps with different pheromones for fruit flies is one of the most important methods for determining and monitoring the population density.

Table (1): Efficiency of using attractant pheromone traps with fungus treatments, *M. anisopliae*, *B. bassiana*, and Balizin against *B. zonota*

Treatment	Trap	Average number of insects per week						Trap rate	Treat. rate
		1	2	3	4	5	6		
M.anisopliae	Jackson trap (fruit fly pheromone)	0	0	0	1	1	0	0.33	95.8
	Tefrey trap (new peach fly pheromone)	229.6	220	301.6	292	59.6	46	191.4	
B. bassiana	Jackson trap (fruit fly pheromone)	0	0	0.33	0	0	0	0.055	74.5
	Tefrey trap (new peach fly pheromone)	157.3	174.6	239.6	242.6	42.3	38.3	149.1	
Balizin	Jackson trap (fruit fly pheromone)	0	0	3.3	1.6	1	0	0.98	73.09
	Tefrey trap (new peach fly pheromone)	167	181.6	228.3	228	35.6	31.3	145.2	
Rate per week		92.3	96.03	128.8	127.5	23.25	19.2		
L.S.D$_{0.05}$	T= 12.2, Trap= 12.45,				Weeks= 21.57 , Interaction= 52.82				

Efficiency of attractant pheromone traps with different treatments of the pesticides Tondexir, Success, and some agricultural operations (wrapping the fruits with paper bags, tilling the soil, cleaning the bushes, and covering the ground with polyethene) in attracting adult insects of *B. zonota* on grapefruit trees

The statistical analysis showed that the attractive pheromone traps differed significantly in the treatments in attracting and catching adults of the peach fruit fly *B.zonota* during the different periods and in the study site. Its efficiency with some agricultural operations (wrapping the fruits with paper bags, ploughing the soil, cleaning the bushes, and covering the soil with polyethene) in attracting adult insects. There were significant differences in the numbers of adults attracted to the traps at the study site, where the efficiency of the pheromone traps was distinguished with the agricultural operations of wrapping the fruits in paper bags, tilling the soil and cleaning the bushes, and covering the soil with polyethene with the two traps of Jackson (fruit fly pheromone) and the local trap giving the highest average effect by attracting and trapping the most significant number of adults

over 6 days. Where the average effect was 59.1, 52.6 for adults caught when the two treatments (Jackson's Trap (fruit fly Pheromone), the local trap) with the agricultural operations of covering the soil with polyethene, soil ploughing and brush cleaning, respectively, as for the efficiency of attractive pheromone traps (Jackson's trap and the local trap) with some agricultural operations such as wrapping the fruits in paper bags, tilling the soil and cleaning the bushes, covering the soil with polyethene and its role in attracting adult insects, the pheromone traps had almost the same effect on attraction and catching. None of the insects is to be treated for comparison. Many studies used pesticides and exact plants to affect insects in the field and storage [15].

Table (2): Efficiency of using pheromone attractant traps with different treatments of Tondexir, Success and some agricultural operations (wrapping fruits with paper bags, tilling the soil and clearing the bushes, and mulching the soil with polyethene) against *B. zonota*

Treatment	Trap	Average number of insects per week						Trap rate	Treat. rate
		1	2	3	4	5	6		
Tondexir	Local trap	2.6	3	3.3	4.6	1.6	1	2.7	32.8
	Jackson trap (fruit fly pheromone)	62.3	71	78.6	97	41.6	27.6	63.01	
Success	Local trap	3.3	2.6	6.6	5.6	2.3	1.6	3.6	33.2
	Jackson trap (fruit fly pheromone)	60	61	92	85	45	34.3	62.8	
Wrapping the fruits with paper bags	Local trap	3.6	3	7.3	6.3	2.3	1.3	3.9	47.49
	Jackson trap (fruit fly pheromone)	75	85.3	206.6	98.3	46	35.3	91.08	
Tilling the soil and clearing weeds	Local trap	3	3.6	4.6	5	2.6	1.3	3.35	52.6
	Jackson trap (fruit fly pheromone)	78.6	87	172.3	186.3	47.3	40	101.9	
Mulching the soil with polyethene	Local trap	4	3	5.3	7	2.6	2.3	4.03	59.1
	Jackson trap (fruit fly pheromone)	79	78.3	169	215.3	80.6	63.6	114.3	
Rate per week		37.14	39.78	74.56	71.04	27.19	20.83		
L.S.D$_{0.05}$	T= 5.592, Trap= 3.537,				Weeks= 6.126 , Interaction= 19.371				

3- Efficiency of all treatments used in the integrated control program for *B. zonota* insect in reducing the infection rate on grapefruit trees during 6 weeks of treatment.

The results of the study shown in tables (3-4-5) proved that all treatments used in the integrated pest control program caused a decrease in the average number of infected grapefruits during the first, second, and third weeks. Furthermore, the statistical analysis proved that the rate of infected fruits of grapefruit trees in the different treatments did not differ statistically but significantly from the comparison treatment. It is also clear that all the treatments caused a gradual, sequential decrease in the rate of the number of infected fruits during the different periods from the treatment to the end of the experiment, which lasted for 6 weeks after it was high before the treatments. This result was similar to [16].

Table (3): Efficiency of integration using different control methods in the percentage of peach fruit fly infection in grapefruit trees for the first week

Treatment	No. of uninfected fruits	Infected fruits %	Total No. of fruits
M.anisopliae	40.6	14	47.6
B. bassiana	46.6	15	55
Balizin	34.6	18	42.3
Tondexir	26.3	15	31.3
Success	25.3	22	32.6
Wrapping fruits with paper bags	24.6	18	30.3
Tilling soil and clearing weeds	22.3	17	27
Mulching soil with polyethene	29.6	20	37.3
Control	37	16	2044.3
L.S.D$_{0.05}$	22.48	3.494	23.49

Table (4): Efficiency of integration using different control methods in the percentage of peach fruit fly infection in grapefruit trees for the second week

Treatment	No. of uninfected fruits	Infected fruits %	Total No. of fruits
M.anisopliae	39.6	16	47.6
B. bassiana	45	18	55
Balizin	32.6	22	42.3
Tondexir	25.6	18	31.3
Success	24.6	24	32.6
Wrapping fruits with paper bags	24.3	19	30.3
Tilling soil and clearing weeds	22.3	17	27
Mulching soil with polyethene	28	25	37.3
Control	36.3	18	44.3
L.S.D$_{0.05}$	21.52	3.646	23.49

Table (5): Efficiency of integration using different control methods in the percentage of peach fruit fly infection in grapefruit trees for the third week

Treatment	No. of uninfected fruits	Infected fruits %	Total No. of fruits
M.anisopliae	36.3	23	47.6
B. bassiana	43	21	55
Balizin	32	24	42.3
Tondexir	24.3	22	31.3
Success	24.3	25	32.6
Wrapping fruits with paper bags	24	20	30.3
Tilling soil and clearing weeds	21.6	19	27
Mulching soil with polyethene	26.6	28	37.3
Control	36.3	21	44.3
L.S.D$_{0.05}$	20.99	4.016	23.49

Table (6): Efficiency of integration using different control methods in the percentage of peach fruit fly infection in grapefruit trees for the four weeks

Treatment	No. of uninfected fruits	Infected fruits %	Total No. of fruits
M.anisopliae	35.3	25	47.6
B. bassiana	42.3	23	55
Balizin	31	26	42.3
Tondexir	23.6	24	31.3
Success	23.3	28	32.6
Wrapping fruits with paper bags	23.3	23	30.3
Tilling soil and clearing weeds	20.6	23	27
Mulching soil with polyethene	25.6	31	37.3
Control	32	27	44.3
L.S.D$_{0.05}$	20.35	4.454	23.49

Table (7): Efficiency of integration using different control methods in the five-week percentage of peach fruit fly infection in grapefruit trees

Treatment	No. of uninfected fruits	Infected fruits %	Total No. of fruits
M.anisopliae	34	30	47.6
B. bassiana	39.3	28	55
Balizin	29.3	30	42.3
Tondexir	22.6	27	31.3
Success	22.6	30	32.6
Wrapping fruits with paper bags	23.3	23	30.3
Tilling soil and clearing weeds	19	28	27
Mulching soil with polyethene	25	33	37.3
Control	29.6	30	44.3
L.S.D$_{0.05}$	19.72	3.494	23.49

Table (8): Efficiency of integration using different control methods in the percentage of peach fruit fly infection in grapefruit trees for the six weeks

Treatment	No. of uninfected fruits	Infected fruits %	Total No. of fruits
M.anisopliae	33.3	30	47.6
B. bassiana	38.6	29	55
Balizin	28.6	32	42.3
Tondexir	18.3	30	31.3
Success	22.3	30	32.6
Wrapping fruits with paper bags	23	24	30.3
Tilling soil and clearing weeds	18	32	27
Mulching soil with polyethene	24	35	37.3
Control	28.3	36	44.3
L.S.D$_{0.05}$	19.7	5.415	23.49

References

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

2) EPPO .2013. Bactrocera zonata. European and Mediterranean Plant Protection Organization (EPPO). Accessed 30 January 2023.

3) Khlaywi, S.A., et al. (2017). Identification of Peach Fruit Fly, Bactrocera Zonata (Saunders) in Iraq.

4) El-Minshawy, A.M., El-Eryan, M.A. and Awad, A.I., (1999). Biological and morphological studies on the guava fruit fly, Bactrocera zonata Saunders) (Diptera: Tefreytidae) found recently in Egypt. 8th Nat. Conf. Pests & Dis. of Veg. & Fruits in Ismailia, Egypt, pp. 71-82.

5) Ismail R. (2013). Response of the Peach Fruit Fly, Bactrocera zonata (Saunders) (Diptera: Tefreytidae), to Synthetic Food-Odor Lures and Extent the Effect of pH on Attracting the Fly. Journal of Entomology, 10: 136-146.

6) Shehata, N.F., Younes, M.W.F. and Mahmoud, Y.A. (2008). Biological studies on the peach fruit fly, Bactrocera zonata (Saunders) in Egypt. Journal of Applied Sciences Research, 4(9), pp.1103-1106.

7) Abu-Ragheef, A.H., Hamdan, F.Q. and Al-Hussainawy, K.J. (2020). Evaluation of type, color of traps and different attractants in attracting and capturing of Mediterranean fruit fly Ceratitis capitata (WIED.). Plant Archives, 20(1), pp.52-55.

8) Vargas, R.I.; Miller, N.W. and Prokopy, R.J. (2002). Attraction and feeding responses of Mediterranean fruit fly a natural enemy to protein baits laced with two novel toxins, Phloxin B. and spinosad. Entom. Exp. Appl. 102(3): 273-282.

9) El-Shiblawi, L.A. (2012). Evaluation of some types of traps, baits and controlling methods for Mediterranean fruit fly Ceratitis capitata (Wied.) (Diptera: Tephritidae) on pomegranates. Master Thesis, College of Agriculture, Baghdad University. 116.

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

11) Aljaafari, R. K. (2022) New report of Mesostenus transfuga Gravenhorst, 1829 (Ichneumoni-dae - Hymenoptera) from Karbala Province in Iraq", Journal of Kerbala for Agricultural Sciences 9(2): 135–138.

12) Al-Sahoki M. and Waheeb K. M. .(1990). Applications in the design and analysis of experiments (Iraq: University of Baghdad. Ministry of Higher Education and Scientific Research.

13) El-Gendy, I.R. (2012). Elevation of attraction efficiency of Jacson trap peach fruit fly Bactrocera zonata (Saunders). International Journal of Agricultural Research, 7(4): 223-230.

14) Abu-Ragheef, A.H. and Al-Jassany, R.F. (2018). Effect of type trap, height and color in attracting and capture of peach fruit fly Bactrocera zonata. Journal of Biodiversity and Environmental Sciences (JBES). 12(6): 96-101.

15) Abbas, M. A., Ibrahim, A. H., Fawaz, S. F., & Jassim, M. I. (2019). Efficacy of the alcoholic extracts of eucalyptus (Eucalyptus camldulenis L.) leaves and barks against adults of cowpea beetle Callosobruchus maculatus (Fab.) (Coleoptera: Bruchidae). Journal of Kerbala for Agricultural Sciences, 6(2), 20–28.

16) Iwahashi, O. and W. Routhier. (2001). Aedeagal length and its variation of the peach fruit fly, Bactrocera zonata (Saunders) (Diptera: Tefreytidae), which recently invaded Egypt. Applied Entomology and Zoology; 36: 13-17.