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Research Article

# Suppression Program of the Peach Fruit Fly, *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) Depend on Male Annihilation and Bait Application Techniques in Northern Coast of Egypt

**Al-Eryan MAS[1]*, El-Minshawy AM[1] and Awad AI[2]**

[1]*Department of Applied Entomology, Faculty of Agriculture, Alexandria University, Egypt*

[2]*Plant Protection Research Institute, Agricultural Research Centre, Dokki, Giza, Egypt*

***Corresponding Author:** Al-Eryan MAS, Department of Applied Entomology, Faculty of Agriculture, Alexandria University, Egypt.

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## Abstract

The Peach Fruit Fly, *Bactrocera zonata* (Saunders), is considered one of the aggressive fruit flies in Egypt. It is a polyphagous insect, particularly on peach, mango and guava. *B. zonata* was recorded as a new pest in north western coast of Egypt in 1998. The aim of the present work is to evaluate the application of both male annihilation technique (MAT) and bait application technique (BAT) on suppression of *B. zonata* through four successive years in Northern coast of Egypt.

The present study was carried out in four areas, two areas (Agamy and Borg El-Arab) in the north-western coast of Alexandria province, and the other two areas (Mamoura and Abees) in the north-eastern coast of Alexandria. The population density of peach fruit fly, *B. zonata* was estimated in the season 2005 before application of National Area-Wide Fruit Flies Extermination Program for *B. zonata* in Egypt. The suppression programme of *B. zonata* depend on BAT and MAT applied in a total area of 13721 and 9779 feddan for outdoor cultivations and backyards (feddan = 4200 m2), respectively. The programme was applied for four successive years from 2012 - 2015. Jackson sticky traps baited with methyl eugenol were used to evaluate the reduction of flies.

Results showed that before application of the programme in 2005, mean numbers of captured flies per trap per day (CTD) were 45.24, 4.01, 3.87 and 12.44 at Agamy, borg El-Arab, Mamoura and Abees, respectively. According to the matrix of the different trapping scenarios of fruit flies designed by IAEA (2003), suppression is considered to be success when the delimiting survey show 0.1 - 1.0 CTD after application. In the current study, CTD was reduced to 0.49, 0.43 and 0.24 for Borg El-Arab, Mamoura and Abis, respectively after four years of application (from 2012 to 2015). With exception Agamy area, CTD (1.806) is still more than 1.0 because occurrence of fruit diversity in house backyards. This location still needs more applications of suppression programmes in the future.

**Keywords:** *Bactrocera zonata*; Methyl Eugenol; Bait; Alexandria; Egypt

## Introduction

The Peach Fruit Fly, *Bactrocera zonata,* is the most important insect pest of fruit flies in Egypt. It attaks peach, mango and guava as preferable host plants. The insect was detected for the first time in Egypt in 1924 in Port-Said as a quarantine insect pest [1]. In 1995, it was recorded again attacking a wide range of fruits but it was misidentified as *B. pallidus* (Perkins and May) [2]. In 1997 the insect was recorded as *B. zonata* and the identification was corrected and reported as a serious pest on many fruit crops particularly Guava in north western coast of Alexandria [3]. In many countries, this pest was reported to out-compete other fruit flies such as *Ceratitis capitata* (Wied). It is a significant pest in India and Pakistan. Publications from Pakistan showed that it is possibly more importation in that country than *B. dorsalis* [4].

*B. zonata* has been presented in several Middle Eastern countries like Libya and the Arabian Peninsula, including Oman, Saudi Arabia, United Arab Emirates and Yemen. Recently, it has been reported from Gezira region in the Sudan [6]. Current annual costs of damage in the Near East are estimated of 320 million EUR and 190 million EUR in Egypt [6]. An application of National Area-Wide Fruit Flies Extermination Program for PFF, *B. zonata* in Egypt began in the year of 2008 by the Plant Protection Research Institute, Agricultural Research Centre, Egypt. The main methods used were the bait application technique (BAT) and male annihilation technique (MAT). BAT are usually directed at both male and female adult flies whereas, MAT attracts and kills male adult flies using para-pheromones accompanied by an insecticide. Hashem., *et al.* [7], studied the diversity and abundance of the Mediterranean fruit fly and peach fruit fly in different horticultural orchards. Furthermore,both methods were also used in the area wide pro-

gramme to control *B. dorsalis* in the North and the North East of Mauritius [8,9]. MAT has been successfully used to control and eradicate *B. dorsalis* in a number of cases [10]. Eradication with MAT was first achieved in Rota Islands in 1963 [11], and later in the Okinawa Islands in 1982 [12].

In the present work, Both MAT and BAT were applied in four locations. The first two locations are Agamy and Borg El-Arab in the north-western coast of Alexandria, the second two locations are Mamoura and Abees in the north-eastern coast of Alexandria.

## Aim of the Study

The aim of the present work is to evaluate the application of both MAT and BAT techniques on the suppression of *B. zonata* through four successive years in the Northern coast of Egypt.

## Materials and Methods

### Application sites

Four locations were selected for the present study, two in the north-western coast of Alexandria (Agamy and Borg El-Arab) in which scattered smallholder orchards and house backyards are found. The other two locations (Mamoura and Abees) were in the north-eastern coast of Alexandria which is characterized by occurrence of commercial orchards of guava, citrus, peach, mango and apple (Figure 1). Irrigation relies on rain in north-western coast while it was surface irrigation from water canals in north eastern coast of Alexandria. The suppression programme was applied on a total area of 13721 and 9779 feddan for both outdoor cultivations and backyards (feddan = 4200m) at the abovementioned sites, respectively.

**Figure 1:** Map of Northern coast of Egypt (Alexandria province) showing application sites of suppression programme by BAT and MAT techniques.

### Bait Application Technique (BAT)

Partial spray at week intervals using BAT performed using the Emulsifiable Concentrate (EC) insecticide, Malathion 57%, which provided a high fruit fly control percentage. BAT solutions consisted of a mixture of water (carrier), hydrolysed protein (food attractant), and Malathion 57 EC in the ratio of (18.5:1:0.5), respectively. This method is relatively safer for non-target insects and has less impact on the environment than complete cover sprays. It also generates very less drift and very little chemical residue. The solution is applied at the rate of 40 ml as a partially spray to the tree trunk of foliage using knapsack-sprayer in orchards. The treatment began during the time of fruit ripping at 7 day intervals.

### Male Annihilation Technique (MAT)

MAT was implemented using methyl eugenol (4-allyl-1,2-dimethoxybenzene-carboxylate) (Elan Chemical, Newark, NJ) blocks to mass-trap adult males, thereby disturbing the mating success. During the MAT phase, plywood blocks (50 mm x 50 mm x 12 mm) were impregnated with solution of 9 parts Methyl eugenol (67%), and 1 part Malathion (technical 95% EC). Blocks were nailed on fruit tree trunks and were distributed at 50 meters distances in outdoor areas and at 33 meters in house backyard areas; this is equivalent to one block per feddan and two blocks per feddan, respectively. The toxic lure blocks were replaced every 1 - 1.5 month intervals.

### Monitoring and statistical analysis

Jackson sticky traps were used to evaluate the reduction of flies [13]. Traps were baited with strips of cotton saturated with methyl eugenol hanged on fruit trees (one trap per 5 feddans), and the traps were hanged between the branches of the trees at a height of 1.5 m. Captured male flies were counted weekly. Cotton strips were monthly replaced by new ones saturated with fresh methyl eugenol. Number of captured flies per trap per day (CTD) was determined by the following formula according to IAEA [14]:

C.T.D. = C/TxD

where:

C = Total number of captured flies

T = Number of serviced traps

D = Average number of days traps were exposed in the field

Results were statistically analysed using ANOVA according to Steel and Torrie [15].

## Results and Discussion

The mean captured numbers of flies/trap/day (CTD) of *B. zonata* using Delta traps lured with methyl eugenol in the north western coast of Alexandria (Agamy and Borg El-Arab) before and after application are listed in figure 2 and 3 and table 1. In Agamy location, the CTD values during 2005, began with low numbers of flies, 1.75 in January and sharply increased to 86.76 flies in September, and then decreased to 13.47 in December. The average CTD values in the same area after application of both BAT and MAT throughout the years of 2012, 2013, 2014 and 2015, showed major reduction in all four seasons with values of 5.17, 3.03, 2.25 and 1.81, respectively (Table 1). In Borg El-Arab district, the values of trapped insects in 2005 before application showed no trapped flies in January and February, the flies trapped in March with the low value of 0.04 then increased to 19.57 in September, after that it decreased to 0.48 in December. After application of both BAT and MAT in the seasons of 2012, 2013, 2014 and 2015, the population density of *B. zonata* were suppressed to 0.41, 0.69, 0.96 and 0.49 CTD, respectively (Figure 3 and Table 1).

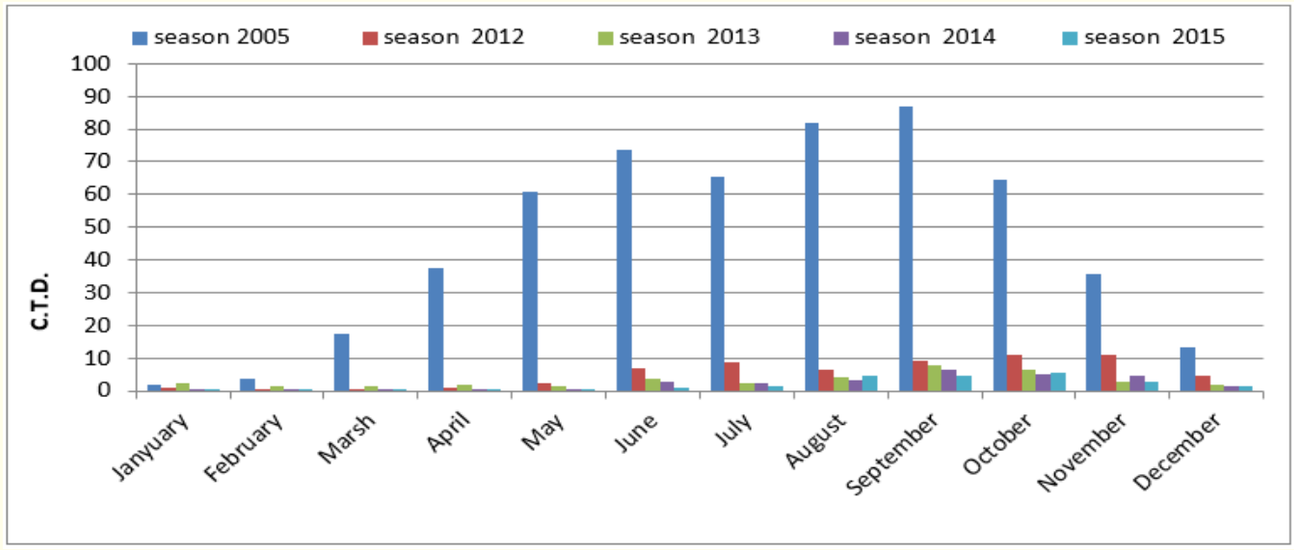


**Figure 2:** Average CTD of *B. zonata* in Agamy, north-western coast of Alexandria, before (season 2005) and after application of both BAT and MAT.

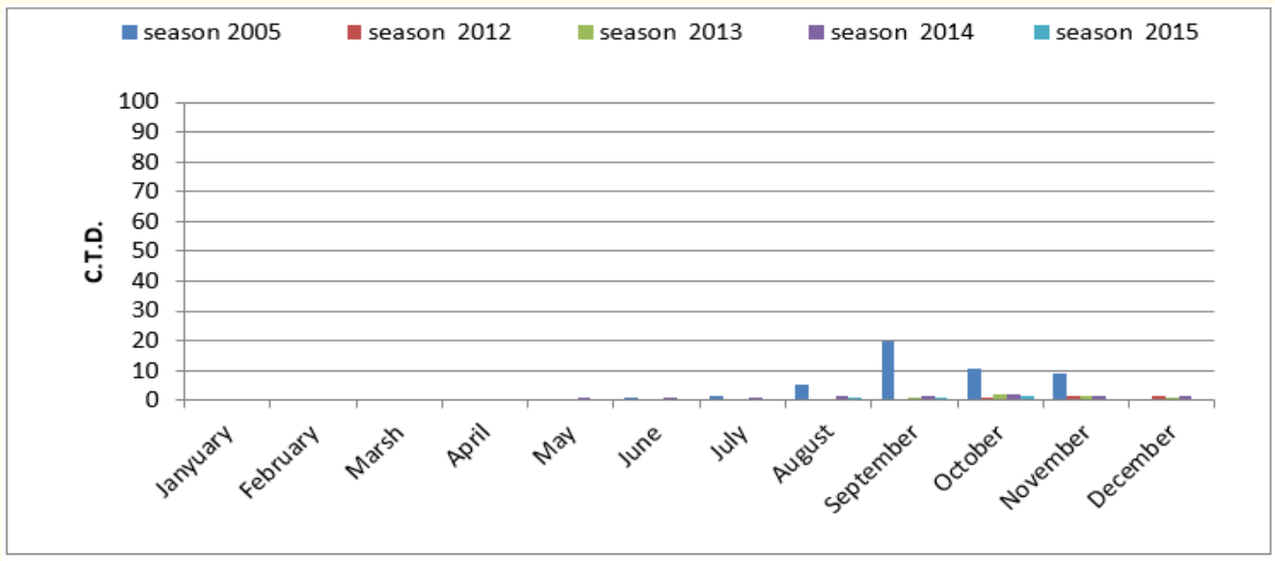


**Figure 3:** Average CTD of *B. zonata* in Borg El-Arab, north-western coast of Alexandria, before (season 2005) and after application of both BAT and MAT.

| Location | CTD | | | | |
|---|---|---|---|---|---|
| | Before application | After application | | | |
| | 2005 | 2012 | 2013 | 2014 | 2015 |
| Agamy | 45.24$^{c}$ | 05.17$^{b}$ | 03.03$^{a}$ | 02.25$^{a}$ | 01.81$^{a}$ |
| Borg El-Arab | 04.01$^{d}$ | 00.41$^{a}$ | 00.69$^{b}$ | 00.96$^{c}$ | 00.49$^{a}$ |
| Mamoura | 03.87$^{e}$ | 01.90$^{d}$ | 01.29$^{c}$ | 00.74$^{b}$ | 00.44$^{a}$ |
| Abees | 12.44$^{c}$ | 00.92$^{b}$ | 00.52$^{ab}$ | 00.34$^{a}$ | 00.24$^{a}$ |

**Table 1:** Mean numbers of captured *B. zonata* per trap per day (CTD) in four locations of Alexandria before and after application of both BAT and MAT.

L.S.D. 0.05= 1.60

In the north-eastern coast of Alexandria (Mamoura and Abees), the average CTD values of *B. zonata* are listed in figure 4 and 5 and table 1. In Mamoura location, the CTD values during 2005, began with low numbers of flies, 0.08 in April then increased to 14.42 flies in October, and then decreased to 1.2 in December. The average CTD values in the same area after application of both BAT and MAT throughout the seasons of 2012, 2013, 2014 and 2015, showed major reduction through the four years with mean values of 1.91, 1.29, 0.74 and 0.44, respectively (Figure 4 and Table 1). Results presented in table 1 and figure 5 indicated that the values of CTD in north-eastern coast of Alexandria, (Abees) throughout the year of 2005 began with low numbers of flies, through January to July. Average high numbers of 54.98 was in September then decreased gradually through October, November and December. The average CTD values in the same area after application of both BAT and MAT throughout the seasons of 2012, 2013, 2014 and 2015, showed significant reduction through the four years where the CTD was 0.92, 0.52, 0.34 and 0.24, respectively.

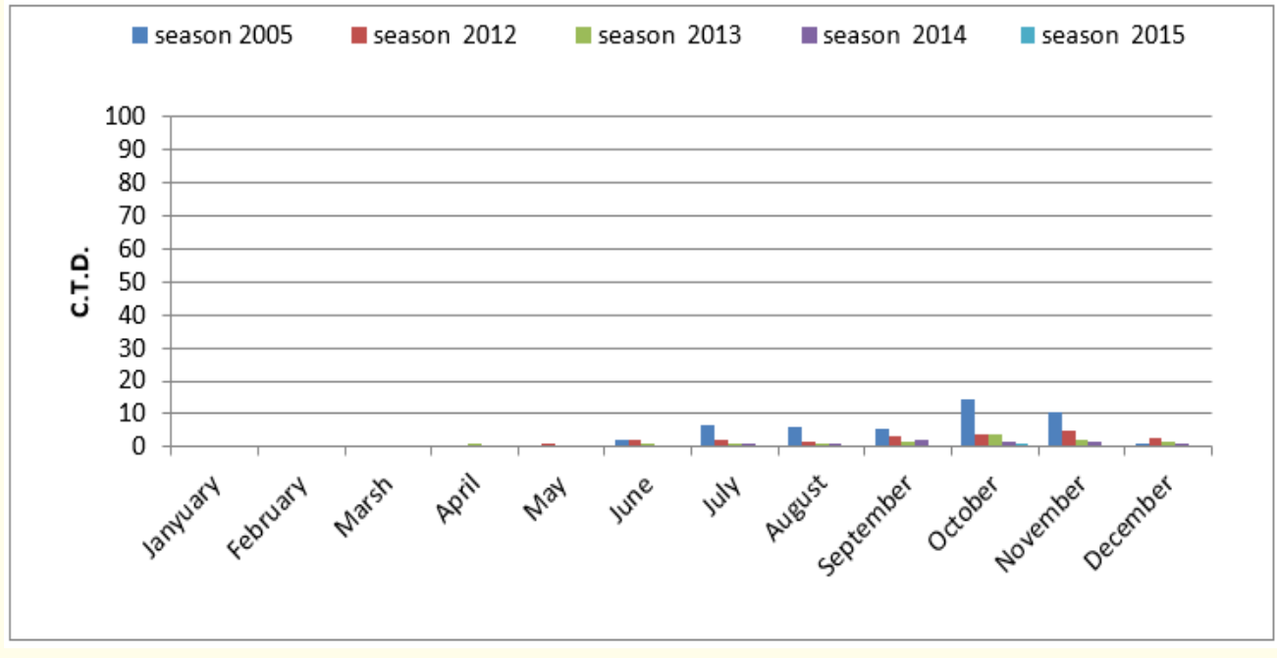


**Figure 4:** Average CTD of *B. zonata* in Mamoura, north-eastern coast of Alexandria, before (season 2005) and after application of both BAT and MAT.

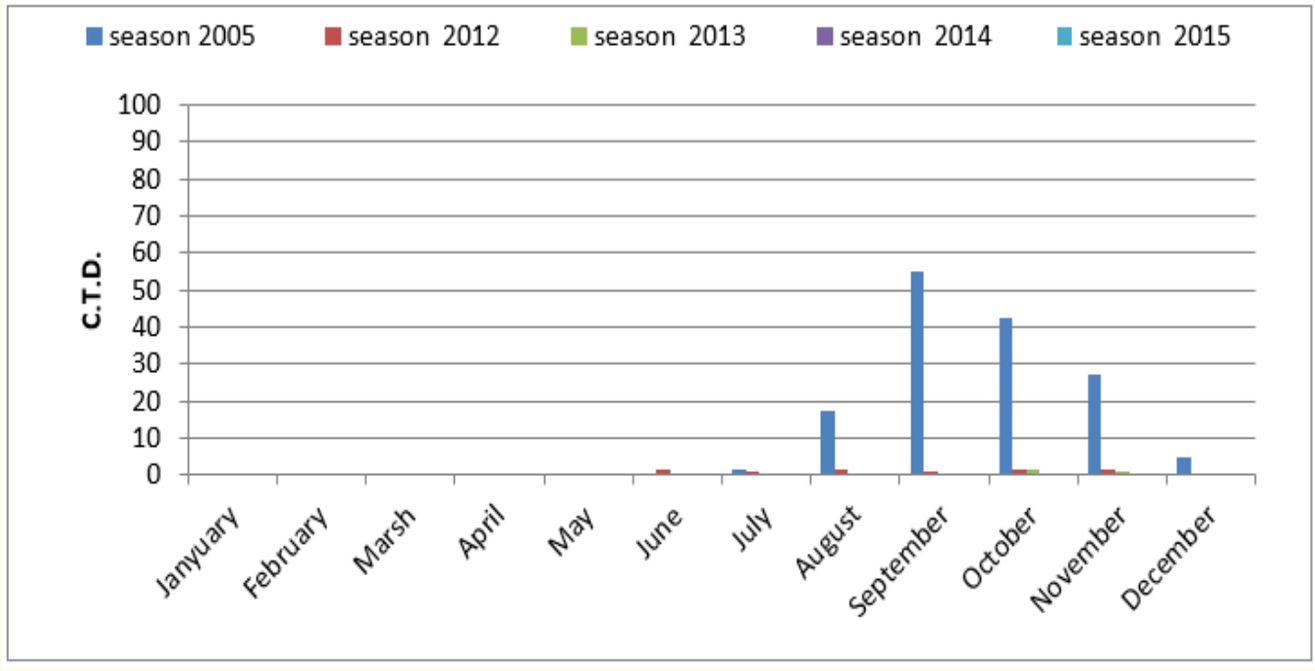


**Figure 5:** Average CTD of *B. zonata* in Abees, north-eastern coast of Alexandria, before (season 2005) and after application of both BAT and MAT.

The peach fruit fly is a serious insect pest on many horticultural fruits in the Near East and the Mediterranean zone. Nowadays, it is considered a threat in many countries leading to great losses in fruit yields [3]. In Egypt, natural vegetation in wild environments and urban house backyards often include different species of fruit trees around the year such as, guava, peach, pomegranate, and citrus etc... This vegetative diversity serves as "natural reservoirs" harbouring fruit flies. The huge numbers of captured peach fruit flies from house backyards of Cairo city (30 flies/trap/hour) [16] and (1.85 - 1960 larvae/kg guava fruit) in Alexandria city [17] show notorious view of population status of *B. zonata* in urban places (Figure 6). Moreover, no action plans of schedule insecticide applications in these situations. National campaign of management fruit flies in Egypt needs more information and data about that agro ecosystem to adjust the suitable procedure of management of *B. zonata* [17]. Programmers and advisors should under taken finding economical and environmental safety procedures to suppress fruit fly populations in wild vegetation system to manageable levels. Similar studies on the Oriental Fruit Fly *Bactrocera dorsalis* by Bateman [18] and Tan and Serit [19] found that fruit fly populations were affected directly by host fruit availability.

**Figure 6:** *Bactrocera zonata* collected by methyl eugenol trap from house backyards in Agamy location during September, 2005 (yield of 30 days).

In 2008, Both MAT and BAT techniques were adopted for the control of this pest all over Egypt. The data presented here were obtained from two major areas in Northern coast of Egypt, to clarify the effect of MAT and BAT control methods in north western and north-eastern coasts. The programme showed significant results for the suppression of the peach fruit fly, *B. zonata* in both house backyards and commercials farms. On the other hand, the suspected reason behind low captured numbers of *B. zonata* in the north eastern areas is due to that the commercial horticultural orchards planted use the ground complete spray with insecticides to protect the fruit hosts from infestation with both *B. zonata* and the Med-fly *C. capitata.* Therefore, the CTD values before and after application of BAT and MAT techniques are lower in numbers than those of the north-western district. According to the matrix of the different trapping scenarios of fruit flies designed by IAEA [14] (Table 2), suppression is considered to be success when the delimiting survey show 0.1 - 1.0 CTD after application. In the current study CTD after application of BAT and MAT were declined to 1.806, 0.49, 0.43 and 0.24 for Agamy, Borg El-Arab, Mamoura and Abees, respectively at the end of 2015. In Agamy location, CTD still more than 1.0 because occurrence of house backyards. This location still needs more applications of suppression programmes in the future.

| Trapping survey | Trapping applications | | | |
|---|---|---|---|---|
| | **Infested area CTD > 1** | **Suppression CTD: 1 - 0.1** | **Eradication CTD: 0.1 - 0** | **Exclusion CTD: 0 - 0** |
| Monitoring | x | x | x | |
| Delimiting | | x | x | |
| Detection | | | | x |

**Table 2:** Matrix of the different trapping scenarios of fruit flies.

CTD (Captured flies/trap/day) (values used only as reference) [14].

Similar area-wide control programme was applied in Mauritius Island. The population of *B. zonata* which is the main fruit fly of fleshy fruits, showed a significant decline after applying the control measures. However, despite a reduction in infestation fruit levels in the treated areas, peach fruit fly still persistent throughout the year. Hence, the control measures were not effective enough to further lower down the peach fruit fly populations. Fallen fruits in the backyards act as a reservoir of the pest [20]. Both methods are being used in the area wide programme to control *B. dorsalis* in the North and North East of Mauritius [8,9]. MAT has been successfully used for control and eradication of *B. dorsalis* in a number of many countries [10]. Eradication with MAT was first achieved on Rota Islands in 1963 [11] and later in the Okinawa Islands in 1982 [12].

## Conclusion

In our investigation, results showed that MAT and BAT techniques were effective in suppression of *B. zonata* and could progressively replace the current use of insecticide control methods. For instance, MAT and BAT techniques must be used annually for the suppression of the population density of *B. zonata* and other fruit flies through the implementation of the National Area-Wide Fruit Flies Extermination Program in Egypt.

## Acknowledgement

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## Conflict of Interest

No Conflict of interest is present.

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