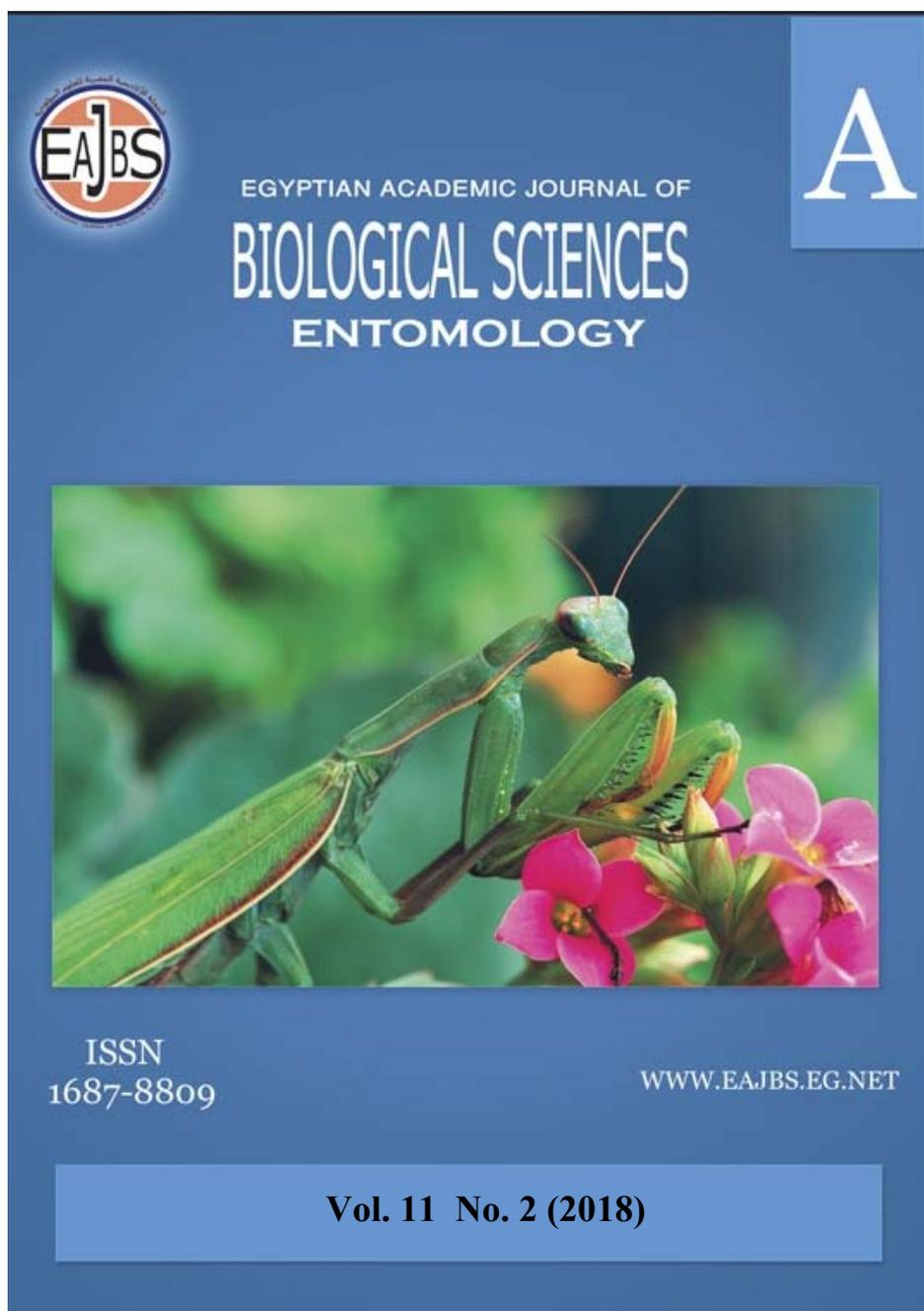


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**Seasonal Occurrence of Fruit Flies and Their Infestation Rates on Pomegranate Fruits at Assuit and Fayoum Governorates**

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**ABSTRACT**

The peach fruit fly, *Bactrocera zonata* (Saunders), and the Mediterranean fruit fly, *Ceratitis capitata* (Wiedmann) are harmful tephritid insects that infesting the Egyptian fruits. This study was conducted to determine the occurrence and damage rates of these fruit flies on pomegranate fruits at Assuit and Fayoum governorates under various cultivated types of mixed-host or aggregated orchards. Moreover, the study extended to estimate some biological aspects of *B. zonata* rearing on pomegranate fruits under laboratory conditions. At Assuit governorate, the highest peak of *B. zonata* and *C. capitata* populations were observed during the 3<sup>rd</sup> week of October and 4<sup>th</sup> week of October with means of 2.33 and 9.13 flies/trap/week on the mixed-host orchards, respectively, while, on the pomegranate aggregated orchards, the highest peak of *B. zonata* and *C. capitata* populations were observed during the 4<sup>th</sup> week of October and 3<sup>rd</sup> week of November with means of 3.42 and 3.17 flies/trap/week, respectively. At Fayoum governorate, the highest peak of *B. zonata* and *C. capitata* populations were observed during the 2<sup>nd</sup> and 4<sup>th</sup> weeks of October with means of 10.17 and 8.17 flies/trap/week on the mixed-host orchards, respectively, while, on the pomegranate aggregated orchards, the highest peak of *B. zonata* and *C. capitata* populations were observed during the 4<sup>th</sup> week of September with means of 7.67 and 1.83 flies/trap/week, respectively. At the mixed-host orchards of Assuit, the infestation percentages averaged 7.39, 9.15 and 5.65% for Manfaloti, Baladi and Nab Al-Jaml varieties, respectively, while, on the aggregated orchards, the infestation percentages averaged 2.17, 5.45 and 6.04%, respectively for the same varieties. At Fayoum, the infestation percentages averaged 6.40, 7.96 and 6.25% for Manfaloti, Baladi and Wonderful varieties, respectively on the mixed-host orchards, while, on the aggregated orchards, Baladi variety fruits were only infested with a mean percentage of 6.42%. Under laboratory conditions, *B. zonata* females were capable to attack pomegranate fruits that were in healthy state or that were wounded, while, *C. capitata* females failed to attack the healthy fruits and succeeded to infest only the wounded fruits of both two tested varieties. Also, a significant difference was observed among the mean no. of obtained pupae/ infested fruits of various pomegranate varieties after exposing to fertile females of *B. zonata* which may due to the significant difference among their fruit firmness. The shortest and

longest duration of total immature stages averaged 21.17 and 23.36 days on the Baladi and Taefi fruits, respectively. Despite the limited occurrence of both fruit flies and the low infestation rates, the study suggested that attention should be paid against pomegranate orchards by application of control procedures for avoiding rebuilding new generations of both fruit flies that could attack the successive ripe crops.

## INTRODUCTION

Pomegranate (*Punica granatum* L.) is the most important fruit that grows in Assiut, Sohag and Sinai governorates and considered the main source of many farmers' income and it is accepted to grow after it became one of the important exporting crops (Bekheit and Latif, 2009). Pomegranate fruits were reported to attack by many species of fruit flies (Diptera: Tephritidae), their larvae feed on the pulp of ripe fruits forming tunnels inside them causing a great damage and make fruits unfavorable for marketing and exportation (White and Elson-Harris, 1992). Liquido *et al.*, (1990) reported that the collected pomegranate fruits were with no infestation of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) on the island of Hawaii (1949-1985 survey). However, *C. capitata* was reported as pomegranate pest causing reduction of its marketing quality in Spain and in Turkey (Juan *et al.*, 2000 and Ozturk *et al.*, 2005). It is thought that the damages were caused by a secondary attack of the fly after the initial fruit penetration by *Deudorix (Virachola) livia* Klug (Holland *et al.*, 2009). Also, Alzubaidy, 2000 listed pomegranate as one of host plants known to support peach fruit fly, *Bactrocera zonata* (Saunders) larval development.

Moreover, pomegranate fruits are attacked by the Mexican fruit fly, *Anastrepha ludens* (Loew), the Caribbean fruit fly, *A. suspense* (Loew), the Oriental fruit fly *B. dorsalis* (Hendel), *B. kandiensis* (Drew and Hancock), Jarvis' fruit fly, *B. jarvisi* Tryon (White and Elson-Harris, 1992), the invasive fruit fly *B. invadens* Drew, Tsuruta and White (José *et al.*, 2000), *B. passiflorae* Fiji, the Queensland fruit fly *B. tryoni* (Froggatt) (Leblanc *et al.*, 2013) and Carambola fruit fly, *B. carambolae* (Drew & Hancock) (Sauers-Muller, 2005).

In Egypt, information concerning the occurrence of fruit flies and their infestation rates on pomegranate orchards is still in lack; therefore, this study was conducted to determine the population fluctuations and estimate the damage rates of fruit flies on pomegranate at Assiut and Fayoum governorates under various cultivated types of mixed-host and aggregated orchards. Moreover, the study extended to estimate some biological aspects of *B. zonata* rearing on pomegranate fruits under laboratory conditions.

## MATERIALS AND METHODS

### A-Field studies:

The experiments were carried out on the peach fruit fly, *B. zonata*, and the Mediterranean fruit fly, *C. capitata* at the period from the 3<sup>rd</sup> week of July till end of December at Assiut governorate and from the 1<sup>st</sup> week of August till the end of November at Fayoum governorate throughout the season of 2017 in two types of pomegranate cultivations. The studies started for 4 weeks previously to fruit maturity and continued after fruits harvesting completion for 4 weeks.

### 1-The Selected Experimental Orchards:

#### a-Assiut Governorate :

Two sites of the mixed-host orchards were selected, the 1<sup>st</sup> selected site is located at Al-Badari district with the total area of 60 feddans (1 feddan = 4200m<sup>2</sup>)

cultivated with mango as the main crop, Valencia orange, mandarin, guava and date palm trees. The total area of pomegranate trees occupied about 15 feddans of the total area, where, the Manfaloti variety were the most cultivated commercial variety (about 8 feddans) followed by Nab Al-Jaml (4 feddans) and Baladi (3 feddans). The 2<sup>nd</sup> site is located at Manfalot district and cultivated with 50 feddans including mainly citrus crops (orange and mandarin), guava and date palm. Manfaloti trees occupied about 9 feddans of pomegranate trees followed by Nab Al-Jaml (3 feddans) and Baladi varieties (2 feddans).

Also, two selected sites of aggregated orchards were selected at Al-Badari and Manfalot districts with an area of 100 feddans for each of them. Manfaloti was the most cultivated variety occupying about 60 feddans of the total area followed by Nab Al-Jaml variety which occupying about 30 feddans, while Baladi variety presenting the rest percentage (10 feddans).

#### **b-Fayoum Governorate :**

Two of the mixed-host orchards were selected, the 1<sup>st</sup> selected site is located at Fayoum district with the total area of 40 feddans cultivated with mango, navel orange, Valencia orange, mandarin and lemon. The pomegranate trees occupied about 8 feddans of the total area, where, the Baladi and Manfaloti varieties were the cultivated commercial variety. The 2<sup>nd</sup> site is located at Ibshway district and cultivated with 5 feddans of Wonderful variety surrounding by mango (the main crop), apple, olive and pear trees.

The experimental site of pomegranate aggregated orchards is located at the desert extension of Fayoum governorate (Fayoum district). The total area was about 20 feddans cultivated with Wonderful, Baladi, Manfaloti and varieties with respective approximated areas of 7, 5 and 3 Feddans.

#### **2-Monitoring of *B. zonata* and *C. capitata* Populations:**

For monitoring the two flies, three Jackson sticky traps (Harris *et al.*, 1971) were used for each experimental site. The traps were baited with methyl eugenol as a male lure of *B. zonata* males and malathion as a toxicant agent in the ratio of (8:2), respectively. Also, an equivalent number of the same trap was baited with trimedlure as male lure of *C. capitata* males. The traps were hanged at a height approx., 1.75-2.50 m. and distributed alternatively in the orchards. Traps were inspected weekly with replacing the sheets and replenished with the mentioned attractant by injection the cotton wick by medical syringe. The attracted males of both fruit flies were counted and the mean catch per trap per week was calculated.

#### **3-Sampling of Pomegranate Fruits:**

Samples of pomegranate fruits that thought to be infested by fruit flies either on trees or fallen were weekly collected in plastic bags and transferred to laboratory starting from the 1<sup>st</sup> week of August during the season of 2017. The fruits were placed above a layer of sterilized sand (5 cm) in plastic containers. The collected fruits were incubated until popping of larvae out of the fruits. After 5-10 days, the fruits were inspected by observing larvae or pupae for assessing infestation percentage. The infestation percentage was determined as the ratio of the number of infested fruits per total number of inspected fruits. Pupae were separated from sand by sieving, counted, and kept in Petri dishes. The emerged adult fruit flies were counted and identified to peach fruit fly or Mediterranean fruit fly.

## **B: Laboratory Studies:**

### **1- The Propensity Evaluation of *B. zonata* and *C. capitata* Females to Oviposit into Healthy and Wounded Pomegranate Fruits:**

This test was carried out to determine the role of fruits wounds that may be resulting by pomegranate moth *D. livia* infestation or that were physiological splatted affecting by misapplication of cultural practice. Health and wounded fruits of Manfaloti and Wonderful were fields collected. Fruits of each tested variety (including health and wounded fruits) were exposed to 200 fertile females of *B. zonata* and *C. capitata* reared in two independent cages (60 X 40 X 40 cm). This test was replicated 5 times. Hence, the exposed fruits were removed and individually placed in plastic containers supplied with a layer of sand to receive pupae and kept under laboratory conditions. The infestation percentages and mean no. of pupae / infested fruit were calculated.

### **1- The Propensity Evaluation of *B. zonata* Females to Oviposit into Some Pomegranate Fruit Varieties:**

During the 1<sup>st</sup> week of October, ripe pomegranate fruits of various varieties (Manfaloti, Baladi, Taefi, Nab Al-Jaml and Wonderful) were tree collected, bagged, and fruit firmness was determined by using Penetrometer (fruit pressure tester). The fruits were inspected to avoid any field infestation, for oviposition choice test, five fruits of the desired varieties (in the rate of one fruit of each variety) were exposed for 2 hrs to 200 fertile females of *B. zonata* reared in the cage (60 X 40 X 40 cm). This test was replicated 5 times. Hence, the exposed fruits were removed and individually placed in plastic containers supplied with a layer of sand to receive pupae and kept under laboratory conditions. The infestation, pupation and emergence percentages were calculated. Also, durations of egg-larval, pupal and total immature stage were estimated for the individuals that obtained from infested exposed fruits.

The statistical analysis was done as one way ANOVA and means separated was conducted by using L.S.D. for the three treatments, while, the independent variables t-test at the probability of 5% for paired treatments comparison (Costat, 1990).

## **RESULTS AND DISCUSSION**

### **A-Field studies**

#### **- Population Fluctuations of *B. zonata* and *C. capitata*:**

##### **a – Assuit Governorate:**

Illustrated data in Fig. (1) shows the seasonal occurrence of *B. zonata* and *C. capitata* on the mixed-host orchards that including pomegranate and the aggregated pomegranate orchards in Assuit governorate during the season of 2017.

On the mixed-host orchards, *B. zonata* males were firstly observed on the 1<sup>st</sup> week of August with a mean of 0.17 fly / trap / week, hence, the males fluctuated relatively in low numbers to record 2.17 flies / trap / week on the ultimate week of September. The population decreased during the successive two weeks to increase again during the 3<sup>rd</sup> week of October with a mean of 2.33 flies / trap / week following by remarkable decline to end their existence with a mean of 0.17 fly / tap / week on the 1<sup>st</sup> week of December. Concerning *C. capitata* population, the flies appeared during the 3<sup>rd</sup> week of July with a mean of 0.17 fly / trap / week and fluctuated in low number until the 4<sup>th</sup> week of August, thereafter, the males disappeared during the last week of August and the 1<sup>st</sup> and 2<sup>nd</sup> week of September. During the 3<sup>rd</sup> week of September, *C. capitata* males were observed again with a mean of 1.75 flies / trap / week to increase sharply recording the its highest peak with a mean of 9.13 flies / trap / week on the 4<sup>th</sup> week of October followed by a relative decline for the successive two weeks. The males increased in their density recording 18.42 flies / trap / week on the 1<sup>st</sup>

week of December following by slight decline to end the experimental period with a mean of 15.08 flies / trap / week.

On the other side, on the pomegranate aggregated orchards, *B. zonata* males started their fluctuations with a mean of 0.83 fly / trap / week on the 3<sup>rd</sup> week of July. Despite the early existence of *B. zonata*, the traps recorded their occurrence in low numbers during the months of August, September and October. The highest density of *B. zonata* males was recorded during the 4<sup>th</sup> week of October with a mean of 3.42 flies / trap / week, hence, the flies declined gradually to be finally observed during the ultimate week of November with a mean of 0.75 fly / trap / week.

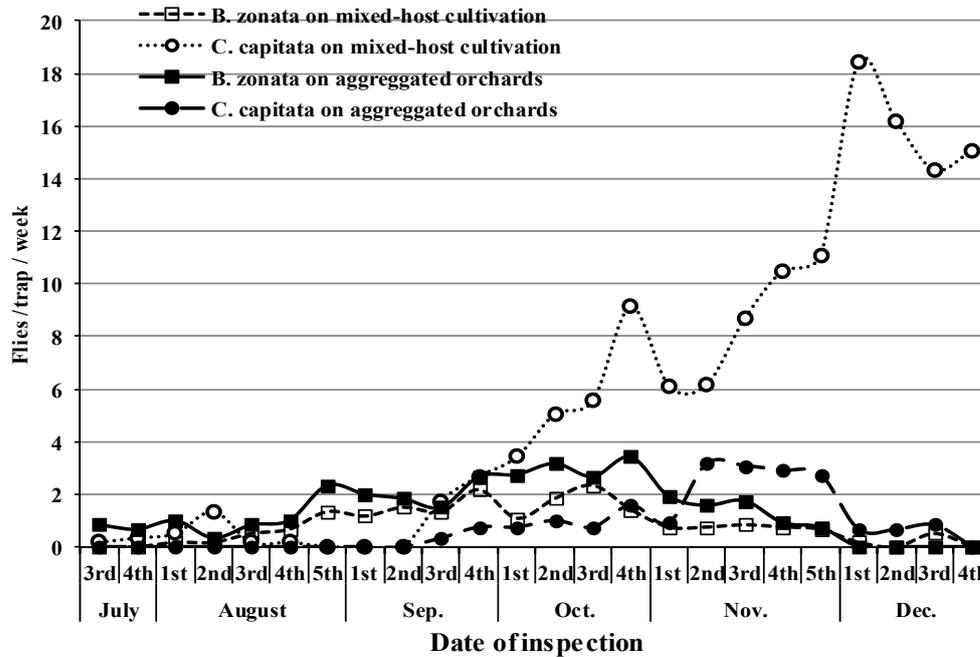


Fig. (1) : Mean number of captured flies/trap/week of *B. zonata* and *C. capitata* in two types of pomegranate orchards cultivation at Assuit governorate during the season 2017

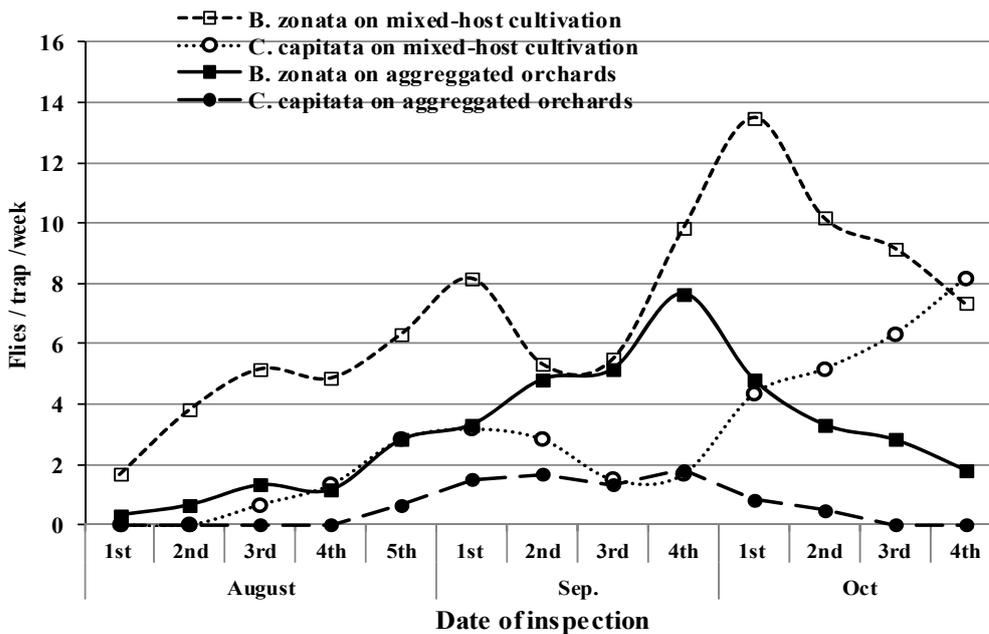


Fig. (2) : Mean number of captured flies/trap/week of *B. zonata* and *C. capitata* in two types of pomegranate orchards cultivation at Fayoum governorate during the season 2017

Regarding the *C. capitata* population, the flies were firstly recorded on the pomegranate aggregated orchards on the 3<sup>rd</sup> week of September with a mean of 0.33 fly / trap / week. The flies fluctuated to record the highest peak on the 2<sup>nd</sup> week of November with a mean of 3.17 flies / trap / week. Gradually, the population declined to be observed ultimately during the 3<sup>rd</sup> week of September with a mean of 0.83 fly / trap / week.

#### **b-Fayoum Governorate :**

Data represented in Fig. (2) shows the population fluctuations of *B.zonata* and *C. capitata* on the mixed-host orchards that including pomegranate and the aggregated pomegranate orchards in Fayoum governorate during the season of 2017. On the mixed-host orchards, *B. zonata* males appeared during the 1<sup>st</sup> week of August with a mean of 1.67 flies/trap/week, then, the flies increased to record its 1<sup>st</sup> peak on the 1<sup>st</sup> week of September with a mean of 8.17 flies/trap/week followed decline to increased sharply to record the 2<sup>nd</sup> and highest peak with a mean of 13.50 flies/trap/week on the 1<sup>st</sup> week of October. Concerning *C. capitata* population, the males were firstly observed during the 3<sup>rd</sup> week of August with a mean of 0.67 fly/trap/week. The population of *C. capitata* fluctuated to record the highest two peaks on the 1<sup>st</sup> week of August and the 4<sup>th</sup> week of October with means of 3.17 and 8.17 flies/trap/week, respectively.

On the other side, on the pomegranate aggregated orchards, *B. zonata* males were present during all experimentation period. Illustrated data in Fig. (2) showed that the *B. zonata* flies started its activity during the 1<sup>st</sup> week of August with a mean of 0.33 fly/trap/week and fluctuated during the experimentation period to record 1.83 flies/trap/week during the last week of October. The highest density of population was observed during the 4<sup>th</sup> week of September with a mean of 7.67 flies/trap/week. Regarding *C. capitata* population, the males were firstly observed during the last week of August with a mean of 0.67 fly/trap/week. The population increased gradually to record the highest density during the 4<sup>th</sup> week of August with 1.83 fly/trap/week, meanwhile, the population remarkably decreased to be observed ultimately during the 1<sup>st</sup> week of October with a mean of 0.50 fly/trap/week.

#### **Infestation Percentages of Pomegranate by Fruit Flies:**

Data presented in Table (1) shows the infestation percentages by *B. zonata* and *C. capitata* for some pomegranate fruit varieties in Assuit and Fayoum governorates on the mixed-host orchards and pomegranate aggregated orchards.

#### **a-Assuit Governorate:**

On the mixed-host orchards, Baladi fruits were the most infested fruits with a mean % of 9.15 followed by Manfaloti and Nab Al-jaml fruits with respective percentages of 7.39 and 5.65%. The highest mean no. of obtained pupae were from Baladi fruits with a mean of 9.15 pupae/ infested fruit, while Nab Al-Jaml was the lowest one for obtaining pupae with a mean of 6.65 pupae infested fruit. It could be notable that adults of *B. zonata* and *C. capitata* were emerged from both of Manfaloti and Baladi fruits, while, only *B. zonata* have emerged of Nab Al-Jaml fruits (Table 1).

Regarding the aggregated orchards, Nab Al-Jaml and Baladi fruits were the highest infested fruits with respective percentages of 6.04 and 5.45%, while, the Manfaloti fruits were the lowest infested fruits with a mean percentage of 2.17%, however, the highest mean no. of obtained pupae was from Manfaloti fruits with a mean of 6.80 pupa/ infested fruit. All the emerged adult flies were belonging to *B. zonata* which indicting the absolute infestation by *B. zonata* only.

Table (1): Infestation %, mean no. of obtained pupae/infested fruit and mean no. of emerged adult fruit flies / infested fruit at Assuit and Fayoum governorates during season 2017 on two types of pomegranate cultivations.

Governorate	Type of cultivation	The variety	Total no. of collected fruits	No. of infested fruits	Infestation %	Mean no. of obtained pupae / infested fruit	Emerged flies / infested fruit	
							<i>B. zonata</i>	<i>C. capitata</i>
Assuit	Mixed-host cultivations	Manfaloti	284	21	7.39	6.86	2.48	3.67
		Baladi	142	13	9.15	8.23	4.54	2.85
		Nab Al-Jaml	177	10	5.65	6.60	5.90	0.00
	Aggregated cultivations	Manfaloti	230	5	2.17	6.80	6.20	0.00
		Baladi	165	9	5.45	5.78	5.11	0.00
		Nab Al-Jaml	182	11	6.04	5.82	5.36	0.00
Fayoum	Mixed-host cultivations	Manfaloti	157	10	6.40	5.40	4.80	0.00
		Baladi	201	16	7.96	8.44	7.44	0.00
		Wonderful	144	9	6.25	6.11	4.33	1.33
	Aggregated cultivations	Manfaloti	150	0	0.00	0.00	0.00	0.00
		Baladi	187	12	6.42	6.42	5.75	0.00
		Wonderful	118	0	0.00	0.00	0.00	0.00

#### Fayoum Governorate:

Concerning the mixed-host orchard in Fayoum governorate, Baladi fruits had the highest infestation % (7.96%), followed by Manfaloti fruits (6.40%) and Wonderful (6.25%). However, the highest mean no. of obtained pupae was from Baladi fruits (8.44 pupae/infested fruit) followed by Wonderful fruits (6.11 pupae/infested fruit) and Manfaloti fruits (5.40 pupae/infested fruit). Adult flies of both *B. zonata* and *C. capitata* were emerged from the infested fruits of Wonderful, while, Manfaloti and Baladi fruits were attacked only by *B. zonata* females indicating by the absolute emerged flies of their sampled fruits.

On the aggregated orchards, only Baladi fruits were infested with a mean percentage of 6.42%. The absolute emergence of *B. zonata* flies only from the pupae that obtained of pomegranate infested sampled fruits indicated the infestation occurrence by *B. zonata* females only during experimentation period.

Generally, laboratory observations indicated that most of the sampled fruits either that of the mixed-host or aggregated orchards at both two governorates were infested by pomegranate moth, *D. livia* indicating by larvae observation, obtaining pupae and their adult emergence of collected fruits, thus, maybe support fruit flies infestation, particularly *C. capitata*. Also, the relative emergence both of *B. zonata* and *C. capitata* adult flies from fruits of Manfaloti and Baladi fruits on the mixed

#### Dates of Infestation:

Data presented in Table (2) shows the infestation dates of pomegranate fruits of some varieties in the mixed-host orchards and pomegranate aggregated orchards at Assuit and Fayoum governorates during season 2017. At Assuit governorate, the 1<sup>st</sup> infestation of pomegranate fruits was observed on Manfaloti fruits during the 3<sup>rd</sup> and 5<sup>th</sup> weeks of August on the mixed-host orchards and aggregated orchards, respectively, and continued till the 4<sup>th</sup> week of November. While, the infestation of Baladi and Nab Al-Jaml fruits were firstly observed during the 3<sup>rd</sup> week of

September and 1<sup>st</sup> week of October, respectively, and extended until the end of October and November, respectively.

Concerning dates of pomegranate infestations in Fayoum governorate by *B. zonata* and *C. capitata*, on the mixed cultivation orchards, the obtained results indicated the infestation was firstly observed on the 1<sup>st</sup> week of September on Baladi fruits and continued till the last week of the same month, while, the Manfaloti and Wonderful fruits were infested laterally during the 2<sup>nd</sup> week and 3<sup>rd</sup> weeks of September, respectively. While, on the aggregated orchards, the Baladi fruits were firstly infested by *B. zonata* females during the 1<sup>st</sup> week of September until the 3<sup>rd</sup> week of the same month.

Table (2): Date of infestation of pomegranate fruits by fruit flies at Assuit and Fayoum governorates during season 2017 on two types of pomegranate cultivations.

Governorate	Type of cultivation	The variety	Date of infestation																	
			August				September				October				November					
			2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	
Assuit	Mixed-host cultivations	Manfaloti	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	X	
		Baladi	-	-	-	-	-	-	+	+	+	+	+	+	X					
		Nab Al-Jaml	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	X
	Aggregated cultivations	Manfaloti	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	X
		Baladi	-	-	-	-	-	-	+	+	+	+	+	+	X					
		Nab Al-Jaml	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	X
Fayoum	Mixed-host cultivations	Manfaloti						+	+	+	X									
		Baladi					+	+	+	+	X									
		Wonderful					-	-	+	+	+	X								
	Aggregated cultivations	Manfaloti					-	-	-	-	-	X								
		Baladi					+	+	+	X										
		Wonderful					-	-	-	X										

(+) Fruit infestation (-) Non- infestation of fruits (X) End of fruit harvesting

The obtained results revealed availability of *B. zonata* and *C. capitata* populations at various densities, such variations may be affected by host availability and weather factors suitability during this period of the year in both two studied governorates. On the mixed-host orchards, the emerged fruit flies of the previously infested fruits (Valencia orange, mango, guava and pear) would be supposed to attack pomegranate fruits. Availability of successive matured host fruits on the mixed-host orchards enable both of *B. zonata* and *C. capitata* flies to rebuild new generations during this period of the year (Amin, 2008). Females with mature ovaries tend to remain or very near from fruiting host plants so long as the fruit is suitable for egg laying (Drew and Hooper, 1983).

While, on the aggregated pomegranate orchards, both of the mentioned two fruit flies were observed in remarkable lower numbers of density compared to that of the mixed-host orchards, these lower numbers may be due to the adults that resulted of other nearby orchards. If the plants are non-host or hosts with low quality fruit, the mature females arrive in low numbers and/or emigrate rather rapidly, and in some species may fly considerable distance before finding host plants with suitable fruits (Prokopy and Roitberg, 1989). Presence of tephritids on the field searching for a host for egg deposition is affected by some factors; fruit volatiles during ripening stage have been found to elicit positive responses of gravid females in *C. capitata*,

and *B. oleae* (Guerin *et al.*, 1983).

Availability of pomegranate in larger cultivated areas at Assuit governorate compared to that of Fayoum governorate explains the extending periods of infestation weeks by fruit flies. Absence of primary and favorable hosts during this period of the year or its lack in the mentioned cultivated areas may be the responsible for pomegranate fruits infestation, specially, availability of matured adult flies on large numbers after their emergence of previously infested fruits like mango, guava and date palm. These obtained results are in agreement with (Saafan *et al.*, 2006 and Amin, 2008) who indicated the important role availability of host diversity coinciding with weather factors improvement.

#### **B: Laboratory Studies:**

##### **1- The Propensity Evaluation of *B. zonata* and *C. capitata* Females to Oviposit into Healthy and Wounded Pomegranate Fruits:**

Illustrated data in Fig. (3) shows the ability of *B. zonata* and *C. capitata* females to deposit eggs inside ripe pomegranate fruits either that are harvested in healthy status and that were wounded. The obtained data indicated that *B. zonata* females were capable to infest all exposed fruits of the two mentioned varieties in various rates. The wounded Wonderful fruits were significantly the most attacked by *B. zonata* females indicating by mean no. of obtained pupae. The mean no. of pupae obtained were 10.40 and 17.80 pupae/infested fruit from Manfaloti fruits, and 18.60 and 24.60 pupae/infested fruit of Wonderful fruits of healthy and wounded fruits, respectively.

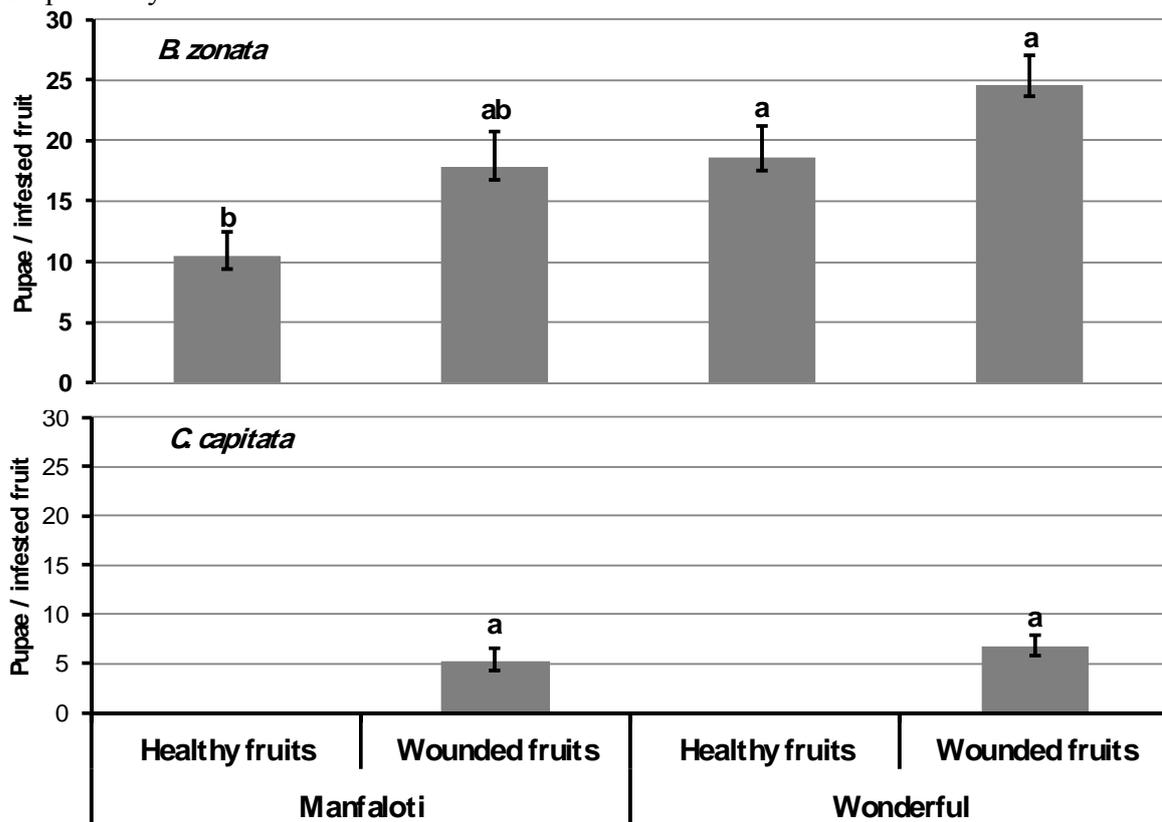


Fig. (3): Mean no. of obtained pupae/infested fruit of Manfaloti and Wonderful pomegranate varieties (healthy and wounded fruits) under laboratory conditions. Bars that has the same letter varied insignificantly. For *B. zonata*,  $df=3,16$   $F=5.17$   $p=0.0109$  and  $LSD=7.68$ . For *C. capitata*,  $t\text{-value}=-0.912$ ,  $p=0.3886$ .

Concerning *C. capitata*, the females were not able to infest or attack the healthy fruits of both varieties whereas no pupae were obtained from the exposed fruits, while, only the wounded fruits of both varieties were insignificantly infested indicating by obtaining a mean of 5.20 and 6.80 pupae/infested fruit of Manfaloti and Wonderful wounded fruits by *C. capitata*.

## 2-Effect of Pomegranate Fruits Firmness on Infestation Rate by *B. zonata*:

As shown in Fig. (4a) the mean no. of obtained *B. zonata* pupae from exposed fruits of different pomegranate varieties under laboratory conditions. Significantly, the mean no. of pupae that obtained from Baladi fruits was the highest averaging 28.40 pupa/infested fruit. Contrary to that, Taefi fruits were the lowest fruits for producing pupa (16.80 pupa/infested fruit). The mean no. of obtained pupa of other tested fruits were 19.20, 17.80 and 17.40 pupae /infested fruits for Manfaloti, Nab Al-Jaml and Wonderful fruits, respectively.

In order to understand the significant variations among the tested fruits, fruit firmness that could affect such female's ability was assessed. Data illustrated in Fig. (4b) revealed that the Baladi fruits were significantly the lowest fruits of fruit firmness (6.38Lb/inch<sup>2</sup>), while, Wonderful fruits were the highest one averaging 12.17 Lb/inch<sup>2</sup>. The fruit firmness of other varieties was 9.07, 9.17 and 10.10 Lb/inch<sup>2</sup> for Taefi, Nab Al-Jaml and Manfaloti. Data revealed that the highest no. of obtained pupae was belonged to Baladi fruits which had the lowest degree of firmness, on the same time, Wonderful fruits that having the highest degree of fruit firmness were the lowest one of fruit infestation, while, other fruit varieties were approximately similar for their infestation indicating by the obtaining pupa in relation to their levels of fruit firmness.

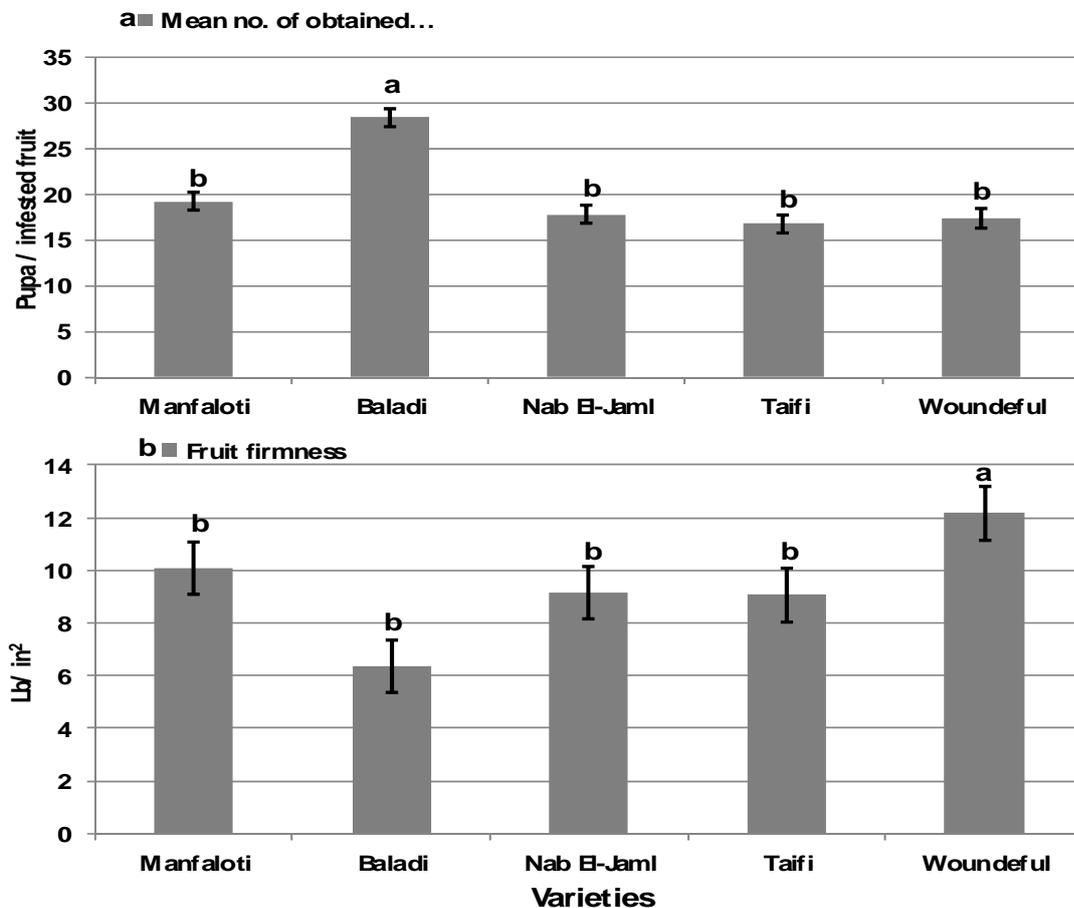


Fig. (4) : a- Mean no. of obtained pupae / infested of some pomegranate fruit varieties after 2 hours of exposure to 200 fertile females of *B. zonata*. b- Fruit firmness (Lb/ in<sup>2</sup>) of some pomegranate fruit varieties. Bars that have the same letters varied insignificant

### 3-Some Biological Aspects of *B. zonata* Immature Stages Rearing on some Pomegranate Varieties:

As shown in Table (3), under choice oviposition conditions, the egg and larval duration varied significantly in when rearing on the different stages of pomegranate fruit varieties under room temperature. Significantly, the shortest duration period was recorded to the individuals that obtained from Baladi variety fruits with mean of 10.88 day, while, the longest one was due the individuals that obtained of Taefi variety fruits with a mean of 12.30 days. Also, the pupal stage of the individuals that obtained from Taefi fruits had significantly the longest duration with a mean of 11.06 days. Subsequently, the shortest and longest duration significantly due to the individuals that obtained from Baladi and Taefi varieties, respectively with means of 21.17 and 23.36 days, respectively.

The pupation percentages were significantly differed, whereas the highest and lowest percentages were 96.34 and 92.90%, respectively to the larvae that reared on Baladi and Taefi fruits, respectively. While, the emergence percentages varied insignificantly for all individuals that obtained of various varieties fruits. Pupa that obtained from Nab Al-Jaml and Taefi fruits emerged with the highest and lowest rates averaging 96.91 and 94.54%, respectively.

Table (3): Some biological aspects of *B. zonata* immature stages rearing on some fruits of different pomegranate varieties with respect to larval development inside fruits under laboratory conditions.

Variety	Durations(Mean±S.E) days			Survival rate	
	Egg and Larval stages	Pupal stage	Total immature stages	Pupation %	Emergence %
Manfaloti	12.25±0.12a	10.30±0.06b	22.55±0.16b	94.39±0.73ab	95.70±1.22a
Baladi	10.88±0.35b	10.29±0.17b	21.17±0.36c	96.34±0.35a	96.20±0.38a
Nab Al-Jaml	11.71±0.34a	10.43±0.10b	22.14±0.32b	95.73±1.14ab	96.91±1.28a
Taefi	12.30±0.04a	11.06±0.17a	23.36±0.20a	92.90±0.83b	94.54±1.44a
Wonderful	11.74±0.02a	10.61±0.18b	22.35±0.17b	95.30±1.45ab	95.43±1.27a
L.S.D. <sub>.05</sub>	0.66	0.42	0.75	2.87	3.47
<i>P</i>	0.0015	0.0058	0.0002	0.1516	0.6936

Means with the same letter vertically within the same column not significantly different.

Generally, the obtained data pointed out that the *B. zonata* females were capable to attack pomegranate fruits that were in healthy state or that were wounded, while, *C. capitata* females failed to attack the healthy fruits and succeeded to infest only the wounded fruits of both two varieties. Previous studies indicated the role of pomegranate moth, *D.livia* through the their initial fruit penetration for facility the infestation by *C. capitata* as a secondary infestation(Juan *et al.*, 2000 and Ozturk *et al.*, 2005 and Hollandet *et al.*, 2009). In other words, *B. zonata* females have an advantage to attack directly fruits that belonging a higher level of fruit firmness compared to other soft fruits. Although the pomegranate fruit infestation was not effected by their firmness, a significant differences were shown among the tested fruits according to their fruit firmness values.

Regardless effects of temperature, *B. zonata* immature individuals complete their development, thus meaning the suitability of pomegranate fruits as host. The obtained data may agree somewhat with that previously reported by Mohamed, (2000) who reported that the total development period of egg, larvae and pupae of *B.*

*zonata* was 18.97 days under temperature of 25°C, respectively. While, Amin, 2008 estimated the total duration of immature stages of *B. zonata* with means of 20.53, 20.01 and 24.91 days on mango, guava and Navel orange fruits under laboratory conditions. Fruits differences in mature stages durations and recovery rates of *B. zonata* may be due to the variations in their content of nutritional requirements. The nutrition of tephritid in the larval stage is considered very important, qualitatively and quantitatively not only to provide energy and building material for survival, growth, development, but also storage material to be utilized in the pupal stage which required for metamorphosis to adult stage (Tsitsipis 1992). In same time, the obtained data indicated supporting of pomegranate fruits for larval development of *B. zonata* agreeing with Alzubaidy, 2000.

Saxena & Pathak (1977) and Sogawa (1982) determined host suitability by parameters that including insect responses to the physical and chemical properties of the plants. These responses can be summarized as orientation response, feeding response, metabolic use of ingested food (nutrition), ovipositional response, egg hatch, growth of the immatures to the adult stage, survival of adults, and egg production.

Host suitability of pomegranate fruits is indicated by existence of *B. zonata* and *C. capitata* on pomegranate orchards either that available on the mixed-host cultivations or that existed on the pomegranate aggregated orchards. Furthermore, the emerged of both fruit flies of sampled and laboratory infested pomegranate fruits with respect to the lower number of obtained pupae compared to other favorable fruits indicated such suitability. Capability of *B. zonata* to infest the pomegranate healthy fruits that have a high level of fruit firmness, in same time, failure of *C. capitata* to attack healthy fruits, this giving an advantage for *B. zonata* to increase its population under field conditions. However, *C. capitata* infestation of pomegranate fruits by *C. capitata* is still related by pomegranate moth *D. livia* penetration. Determination of alternative fruit fly hosts in the production area and determination when these plants are fruiting is one of the key steps in managing fruit flies (Messing 1999), pomegranate trees maybe present as an alternative host of *B. zonata* under absence of favorable hosts or existence of low quality fruits.

In the conclusion, the obtained results indicated existence of both *B. zonata* and *C. capitata* on the different types of pomegranate cultivations, also, The infestation rate of pomegranate fruits by *B. zonata* is seemed to be affected by some factors including the availability of mixed-host orchards, and higher density of fly population. The mixed-host orchards especially those containing previously ripe fruits (mango, guava, pear and Valencia orange) present a favorable environment that can support strongly *B. zonata* fertile females to attack pomegranate fruits under absence of favourable hosts. Despite the limited occurrence of both fruit flies in aggregated pomegranate areas accompanied by low infestation rates, attention should be paid against pomegranate orchards, control procedures could be applied to minimize their population densities, also, removal of infested fruit becomes necessity for avoiding rebuilding a new generations could attack the next ripe crops, particularly, citrus fruits.

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### ARABIC SUMMARY

#### التواجد الموسمي لذباب الفاكهة ومعدلات الإصابة به على ثمار الرمان في محافظتي اسيوط والفيوم

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تُهاجم ثمار الفاكهة في مصر بذبابتي ثمار الخوخ وفاكهة البحر الابيض المتوسط وقد أجريت هذه الدراسة لتقدير تواجد ومعدلات الإصابة لهاتين الذبابتين على ثمار الرمان في بساتين الرمان سواء كانت مختلطة مع عوائل أخرى أو تلك في مساحات مجمعة في محافظتي اسيوط والفيوم وكذلك امتدت الدراسة لتقدير بعض المظاهر البيولوجية لهما على ثمار الرمان تحت ظروف المعمل. ففي محافظة أسيوط وفي البساتين المختلطة العوائل كانت أعلى قمة لتعدادي ذبابتي الخوخ والبحر المتوسط في الاسبوعين الثالث والرابع من أكتوبر بمتوسطي ٢.٣٣ و ٩.١٣ ذبابة/مصيدة /اسبوع على الترتيب بينما في بساتين الرمان المجمعة سجل أعلى تعداد في الاسبوعين الرابع من أكتوبر والثالث من نوفمبر بمتوسطي ٣.٤٢ و ٣.١٧ ذبابة/مصيدة /اسبوع على الترتيب. وفي محافظة الفيوم سجل أعلى مستوى من تعداد ذبابتي الخوخ والبحر المتوسط في البساتين مختلطة العوائل في الاسبوعين الثاني والرابع من أكتوبر بمتوسطي ١٠.١٧ و ٨.١٧ ذبابة/مصيدة /اسبوع على الترتيب بينما في بساتين الرمان المجمعة سجل أعلى قمة لتعداد الذبابتين خلال الاسبوع الرابع من سبتمبر بمتوسطي ٧.٦٧ و ١.٨٣ ذبابة/مصيدة /اسبوع على الترتيب. وفي بساتين الفاكهة مختلطة العوائل لمحافظة أسيوط كانت متوسطات النسبة المئوية للإصابة بذبابتي الفاكهة ٧.٣٩ و ٨.٣٩ و ٥.٦٥% للاصناف المنفلوطي والبلدي وناب الجمل على الترتيب بينما في بساتين الرمان المجمعة كانت متوسطات النسب المئوية ٢.٢١ و ٥.٤٥ و ٥.٠٤% لنفس الاصناف على الترتيب. وفي محافظة الفيوم كانت متوسطات النسب المئوية للإصابة بذبابتي الفاكهة في البساتين المختلطة العوائل ٦.٣٦ و ٧.٩٦ و ٥.٦٨% على ثمار أصناف المنفلوطي والبلدي والوندر فول على الترتيب بينما سجلت الإصابة على ثمار الصنف البلدي فقط في المساحات المجمعة بمتوسط نسبة ٦.٤٢%. وأكدت الدراسة المعملية قدرة اناث ذبابة الخوخ على إصابة ثمار الرمان السليمة والمجروحة لصنفي المنفلوطي والوندر فول بينما نجحت اناث ذبابة البحر المتوسط في إصابة ثمار الرمان المجروحة فقط و فشلت في إصابة الثمار السليمة لنفس الصنفين، وكانت هناك اختلافات معنوية بين متوسط عدد العذارى/ثمرة مصابة عند تعريض ثمار من أصناف الرمان لإناث ذبابة الخوخ والذي قد يعود للاختلاف المعنوي لمعامل صلابة هذه الثمار المختبرة وسجلت أقصر وأطول مدة لنمو الاطوار الغير كاملة لذبابة ثمار الخوخ بمتوسطي ٢١.١٧ و ٢٣.٣٦ يوم على ثمار صنف البلدي والطانفي على الترتيب، وبالرغم من التواجد المحدود لذباب الفاكهة في بساتين الرمان وانخفاض نسب الإصابة بهما الا أن الدراسة توصي بالاهتمام بتنفيذ تطبيقات مكافحة فيها لتفادي بناء جيل جديد من ذباب الفاكهة والذي قد يهاجم المحصول التالي في الناضج.