# OCCURRENCE AND COMPETITION BETWEEN MALES OF *BACTROCERA ZONATA* (SAUNDERS) AND *CERATITIS CAPITATA* WIEDEMANN (DIPTERA: TEPHRITIDAE) ON GRAPES AND GUAVA AT DAKAHLIA GOVERNORATE, EGYPT

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(Manuscript received 8 June 2016)

***Abstract***

Seasonal activities of the peach fruit fly, *Bactrocera zonata* (Saunders) and the Mediterranean fruit fly, *Ceratitis capitata* Wiedemann were studied on grapes and guava orchards during the two successive fruiting seasons of 2014 and 2015 using white Jackson traps. The obtained data revealed that *B. zonata* showed differently three slight peaks of activity on grapes orchard during the first and second seasons; while on guava orchard it exhibited three to four distinct peaks of activity yearly. *C. capitata* showed two annual peaks of activity on grapes and guava orchards. *B. zonata* and *C. capitata* populations were significantly higher on guava orchard than that on grapes one during the two seasons of investigation. On other hand, *B. zonata* population was significantly higher than that of *C. capitata* on the two crops during the first and second seasons. Also, there were inversely correlations between *B. zonata* and *C. capitata* populations on grapes and guava orchards during the first and second seasons; however, the correlation coefficient values (r) between their populations were negative. According to the competition equations of Lotka-Volterra, there was a comparative co-existence between *B. zonata* and *C. capitata* on grapes and guava orchards at the area of study.

## INTRODUCTION

Fruit trees are considered as one of the most important crops in the whole world because of their nutritional and economical importance as well as for local consumption or exportation. The peach fruit fly, *Bactrocera zonata* (Saunders) and the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Order: Diptera, Family: Tephritidae) are the most dominant and serious pests on fruit orchards. They severely infest many fruit species such as; guava, peach, mangoes, citrus, apricot, figs, persimmon and apple, in addition to some vegetables such as tomato, pepper and egg-plants as secondary hosts (Saafan and Korashy, 2001; Amro and Abdel-Galil, 2008; Ghanim and Moustafa, 2009; Ghanim, 2012; Rauf *et al.*, 2013; Moustafa *et al.*, 2014 and Ghanim *et al.*, 2015). The females of *B. zonata* and *C. capitata* lay their eggs inside fruits and the hatching maggots devour into the pulp. Subsequently, secondary infestations with bacterial and fungal diseases mostly exist and the infested

fruits drop down and make fruits unfavorable for marketing and exportation (White and Elson-Harris, 1994 and Borge and Basedow, 1997).

According to Hashem *et al.* (2001), Saafan and Korashy (2001), Ghanim and Moustafa (2009), Ghanim (2012), Moustafa *et al.* (2014) and Ghanim *et al.* (2015) the existence of *B. zonata* and *C. capitata* hosts is one of the most important reasons to build up their generations in Egypt; so, their populations occurred all over the year and increased during the fruiting seasons of the hosts.

Varley *et al.* (1973) reported that when two species compete for the same resource in a culture usually only one survives and the other became extinct, but on occasion co-existence of both species has observed. Ghanim (2009, 2012) and Moustafa *et al.* (2014) reported that there was a comparative co-existence between *B. zonata* and *C. capitata* in peach, guava, mandarin, persimmon and apple orchards.

In spite of studying the population fluctuations of *B. zonata* and *C. capitata* in several crop orchards such as peach, mangoes, citrus, guava, apricot, figs, apple, persimmon and others (Hashem *et al*., 2001; Saafan and Korashy, 2001; Saafan *et al*., 2006; Ghanim and Moustafa, 2009; El-Metwally and Amin, 2010; Ghanim, 2012; Moustafa *et al*., 2014 and Ghanim *et al*., 2015); there is a shortage about the population fluctuations of them on grapes orchards. So, the present study aimed to shed additional light on the occurrence of *B. zonata* and *C. capitata* males in a grapes orchard in comparison with a guava orchard as a preferable host plant to *B. zonata* and *C. capitata*. Moreover, the competitive interactions between *B. zonata* and *C. capitata* populations on grapes and guava orchards were explained.

## MATERIALS AND METHODS

### 1. Occurrence of *B. zonata* and *C. capitata* males on grapes and guava:

An area of about five feddans (feddan = 4200m$^2$) cultivated with grapes (variety: Roomy) in addition to other five feddans cultivated with guava (variety: Balady) at Dakahlia governorate were selected for the present study during the two fruiting seasons of 2014 and 2015. The distance between grapes and guava orchards was about three kilometres.

The population fluctuation of males of both the peach fruit fly, *B. zonata* and the Mediterranean fruit fly, *C. capitata* in each orchard were estimated by using white Jackson traps (Harris *et al*., 1971) from August 29$^{th}$ and 28$^{th}$ (the beginning of fruit ripening) till December 5$^{th}$ and 4$^{th}$ during 2014 and 2015 seasons, respectively.

The sex attractant of *B. zonata* (methyl eugenol) was used for powering ten traps; in addition to other ten traps were powered with trimedlure (the sex attractant

of *C. capitata*). Five traps of each attractant were distributed on grapes orchard and the other fives were distributed on guava orchard. Traps were hung in a shady site within the canopy of the fruit trees at a rate of two traps/feddan (one trap for each insect species). The traps were weekly inspected and number of captured males on each sticky cardboard inside traps was counted and recorded. The sticky cardboards were renewed every week. Methyl eugenol was renewed biweekly; while, trimedlure was renewed every four weeks. The number of captured flies per trap per day (FTD) was used as a measure of fly abundance.

**2. Evaluating the competitive interaction between *B. zonata* and *C. capitata*:**

To determine the presence of competitive behavior of *B. zonata* in response to *C. capitata* population, correlation analysis was carried out between FTDs for both species. The competition equations of Lotka-Voltera (Lotka, 1932) were employed to predict either co-existence or the dominance of one species on the other.

**3. Statistical analysis:**

Statistical analysis was done by using one way ANOVA; the explained variance were analyzed using the computer program of CoStat (1990).

## RESULTS

**1. Occurrence of *B. zonata* and *C. capitata* males on grapes and guava:**

Seasonal activities of *B. zonata* and *C. capitata* males on grapes and guava orchards during two the successive fruiting seasons of 2014 and 2015 are illustrated in Figures (1 and 2).

As shown in Figure (1), *B. zonata* males showed three slight peaks of activity on grapes orchard during the first season (2014), these peaks were recorded as FTD = 0.11, 0.83 and 0.71 at August 29$^{th}$, October 24$^{th}$) and November 7$^{th}$, respectively; while on guava orchard it exhibited four distinct peaks of activity recorded at September 9$^{th}$ (FTD = 2.23), October 3$^{rd}$ (FTD = 5.54), October 17$^{th}$ (FTD = 4.80) and November 14$^{th}$ (FTD = 4.66).

During the second season (2015), *B. zonata* males exhibited three slight peaks of activity on grapes orchard which recorded at September 11$^{th}$ (FTD = 0.60), October 9$^{th}$ (FTD = 0.86) and November 20$^{th}$ (FTD = 1.00); while, on guava orchard it showed three distinct peaks of activity that recorded on September 25$^{th}$ (FTD = 5.09), October 9$^{th}$ (FTD = 6.49) and November 13$^{th}$ (FTD = 6.89) (Figure, 1).

With respect to *C. capitata* (Figure, 2), it showed two annual peaks of activity on grapes orchard. These peaks were recorded during 2014 season as 0.40 and 0.17 males/trap/day on September 12th and November 14th, while during 2015 season these peaks was recorded as 0.80 and 0.29 males at August 28th and October 30th, respectively.

On guava orchard, *C. capitata* males exhibited also two annual peaks of seasonal activity. The first peak was recorded as 0.89 and 1.43 males/trap/day at September 26th and August 28th (during the first and second seasons); while, the second peak was recorded as 0.46 and 1.60 at December 5th 2014 and September 25th 2015, respectively.

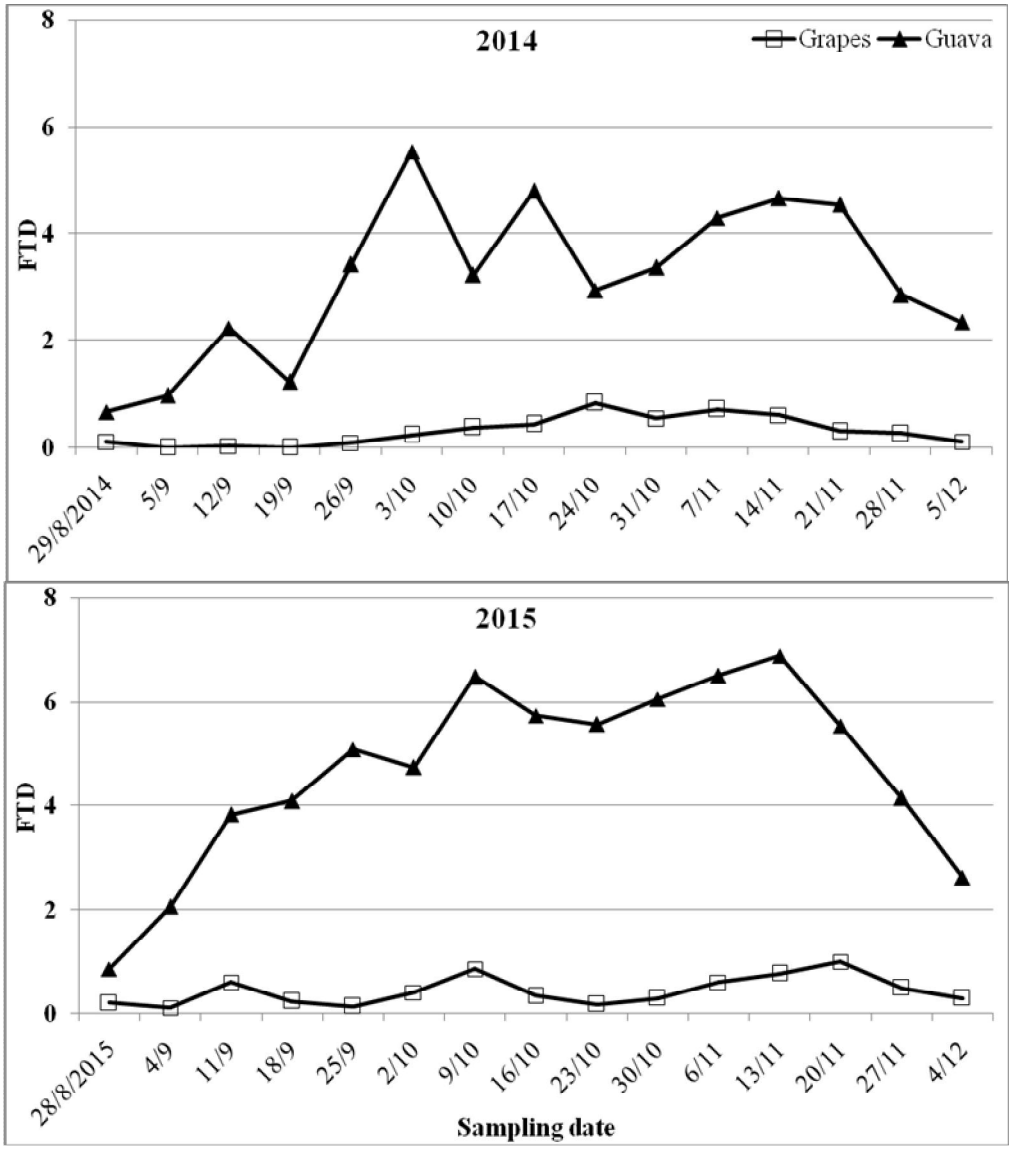



Figure 1. Occurrence of *B. zonata* males on grapes and guava at Dakahlia governorate during 2014 and 2015 fruiting seasons. (FTD = captured flies/trap/day)

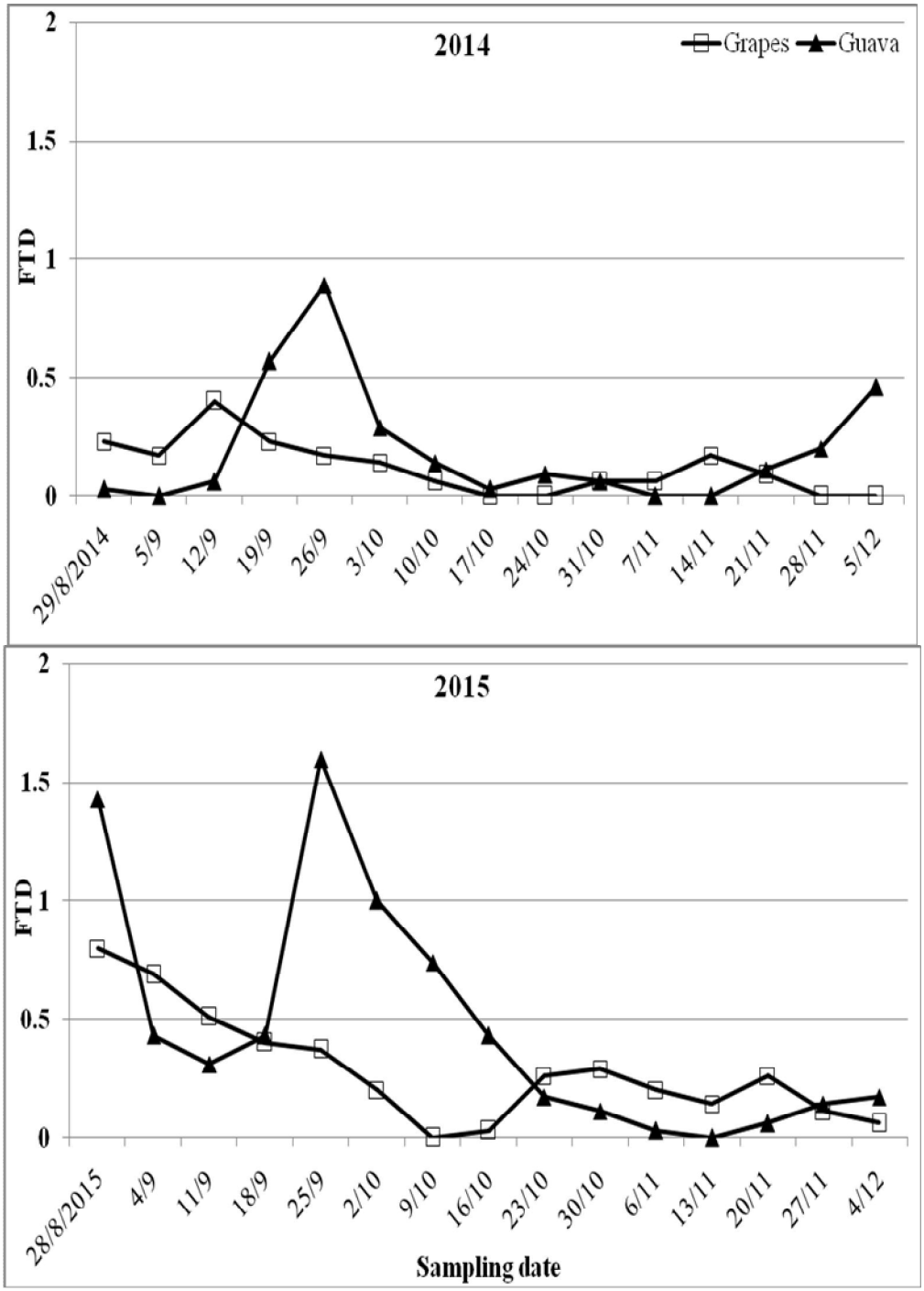



Figure 2. Occurrence of *C. capitata* males on grapes and guava at Dakahlia governorate during 2014 and 2015 fruiting seasons. (FTD = captured flies/trap/day).

As shown in Figures (1 and 2), *B. zonata* and *C. capitata* populations were higher on guava than that on grapes during the two seasons of investigation. On the

other hand, data compiled in Table (1) show that the mean FTD values of *B. zonata* males all over the season were significantly higher on guava (3.14±0.38 and 4.68±0.44) compared to those recorded on grapes (0.31±0.04 and 0.43±0.05) during the first and second season, respectively.

Table 1. Mean number of captured males/trap/day (FTD) of *B. zonata* and *C. capitata* during 2014 and 2015 fruiting seasons of grapes and guava orchards at Dakahlia governorate.

| Season | Crop | *B. zonata* | *C. capitata* | $LSD_{P=5\%}$ | F | P |
|---|---|---|---|---|---|---|
| 2014 | Grapes | 0.31±0.04 | 0.12±0.03 | 0.06 | 18.3 | 0.0027 |
| | Guava | 3.14±0.38 | 0.20±0.04 | 0.60 | 41.9 | 0.0002 |
| | $LSD_{P=5\%}$ | 0.39 | 0.04 | ---- | ---- | ---- |
| | F | 264.8 | 19.4 | ---- | ---- | ---- |
| | P | 0.0000 | 0.0023 | ---- | ---- | ---- |
| 2015 | Grapes | 0.43±0.05 | 0.29±0.03 | 0.04 | 87.6 | 0.0000 |
| | Guava | 4.68±0.44 | 0.47±0.05 | 0.06 | 112.2 | 0.0000 |
| | $LSD_{P=5\%}$ | 0.46 | 0.06 | ---- | ---- | ---- |
| | F | 463.8 | 49.8 | ---- | ---- | ---- |
| | P | 0.0000 | 0.0001 | ---- | ---- | ---- |

Notice: df = 1, 8

The same trend was observed in case of *C. capitata* males; however, the mean FTDs all over the season were significantly higher on guava (0.20±0.04 and 0.47±0.05) compared to those of grapes (0.12±0.03 and 0.29±0.05) during the first and second seasons, respectively (Table, 1).

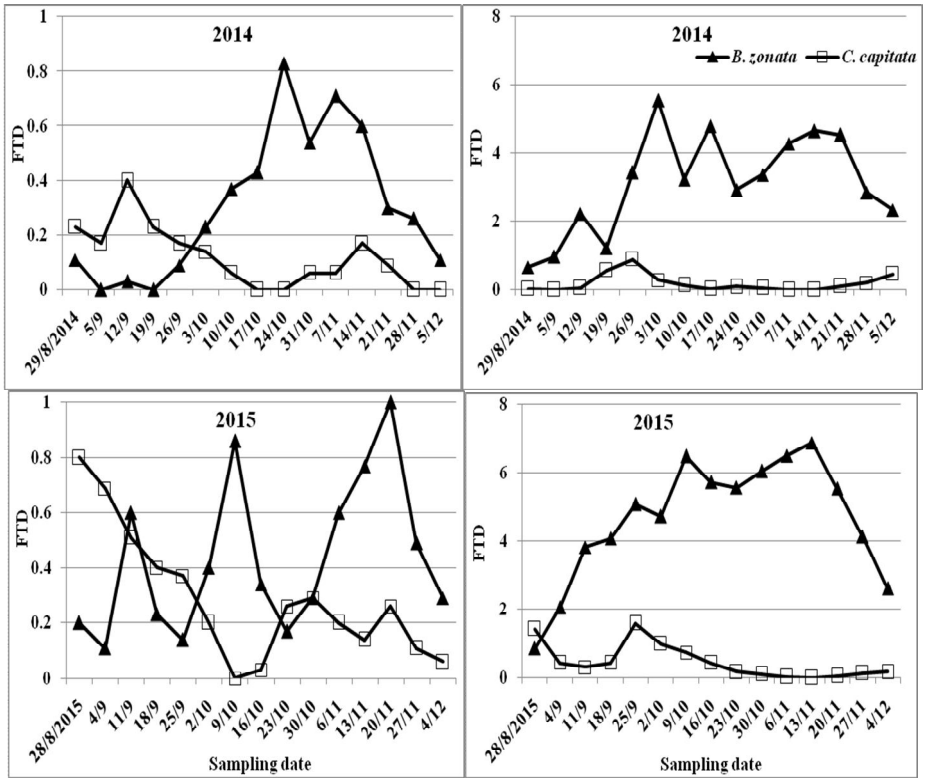
Also, data in Table (1) show that the mean number of captured flies per trap per day (FTD) of *B. zonata* all over the season were significantly higher than those of *C. capitata* on the two orchards during the first and second seasons. So, *B. zonata* was more dominant on grapes and guava orchards than *C. capitata*.

**2. Competition between *B. zonata* and *C. capitata*:**

The population is arithmetically shown in Figure (3) and illustrates that during the first season of grapes, *C. capitata* was the dominant within the period from August 29$^{th}$ till September 26$^{th}$, while *B. zonata* was the dominant within the period from October 3$^{rd}$ till the end of season (December 5$^{th}$). During the second season, the population of *C. capitata* surpassed that of *B. zonata* for three times (at the periods

from August 28th till September 4th, September 18th till September 25th and October 23rd); while, *B. zonata* was the dominant at September 11th and at the periods from October 2nd till October 16th and from November 6th till December 4th (the end of season). With respect to guava, *B. zonata* was the prevailing species all over the two studied seasons, except for August 28th of 2015 which *C. capitata* was the dominant one (Figure, 3).

Also, Figure (3) showed that there were inverse visual correlation between *B. zonata* and *C. capitata* populations on grapes and guava orchards during the first and second seasons. However, the periods of high activities for *B. zonata* were coincided with the periods of low activities for *C. capitata*.




**Grapes** **Guava**

Figure 3. Synchronization between *B. zonata* and *C. capitata* males on grapes and guava at Dakahlia governorate during 2014 and 2015 fruiting seasons. (FTD = captured flies/trap/day)

Data represented in Table (2) explained that the correlation coefficient values (r) between *B. zonata* and *C. capitata* male populations were negative on grapes during the first and second seasons (r = -0.559 and -0.446). Also, on guava the same

trend was observed, where negative correlations between *B. zonata* and *C. capitata* male populations during the first and second seasons were recorded; however, r-values were -0.089 and -0.372, respectively.

Table 2. Correlation coefficient (r) between *B. zonata* and *C. capitata* populations on grapes and guava orchards at Dakahlia governorate during 2014 and 2015 fruiting seasons.

| Crop | 2014 | | 2015 | |
|---|---|---|---|---|
| | R | P | r | P |
| Grapes | -0.559 | 0.030 | -0.446 | 0.095 |
| Guava | -0.089 | 0.752 | -0.372 | 0.172 |

The competition equation of Lotka-Volterra (Lotka, 1932) may predict co-existence or the dominance of one species on the other. The outcome of competition could be predicted from the relative position of the regression lines of *B. zonata* and *C. capitata* populations.

The obtained results illustrated in Figure (4) cleared that the two lines of *B. zonata* and *C. capitata* cross each other at a point which is an equilibrium position where neither species changes in the numbers (according to Varley *et al.*, 1973).

According to Lotka-Volterra equations (Figure, 4), the key component to this model is the competition coefficient, where it was higher on grapes orchard for *C. capitata* population during the first season (a = 1.31) compared to *B. zonata* (b = 0.24). It means that every increase of *C. capitata* population by one individual (as FTD) would reduce the growth rate of *B. zonata* population by 1.31 individuals; while, every increase of *B. zonata* population by one individual would reduce the growth rate of *C. capitata* population by 0.24 individuals. Also, on guava orchard, the higher competition coefficient was that for *C. capitata* during the second season (a = 1.29) compared to *B. zonata* during the first one (b = 0.02).

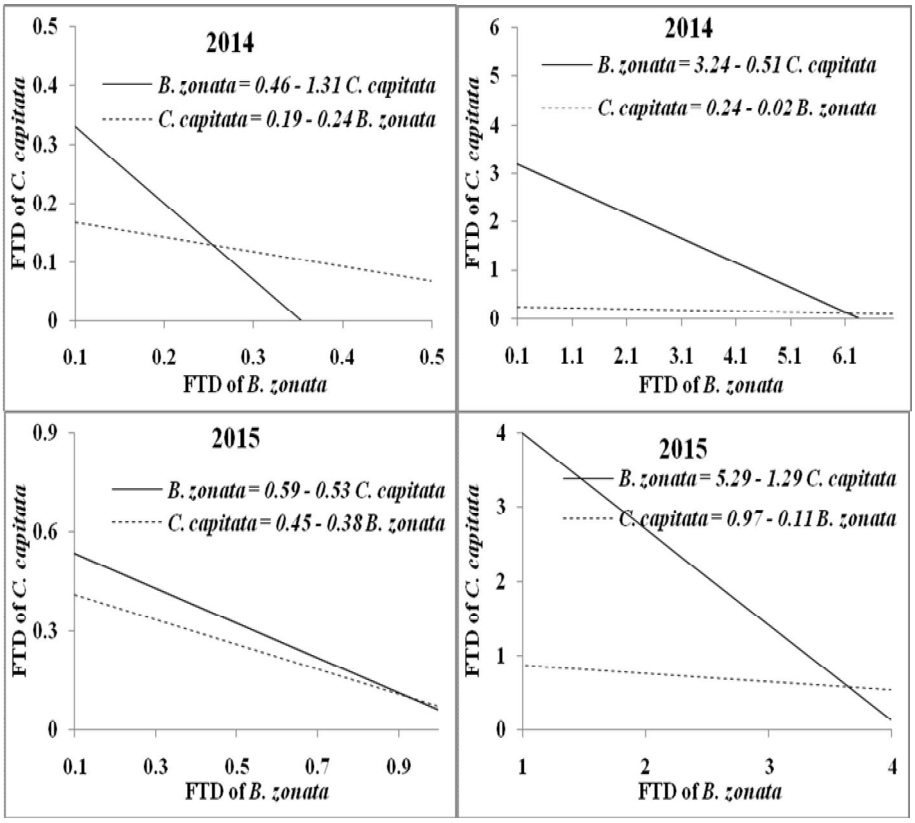



Figure 4. The relationships between *B. zonata* and *C. capitata* populations (as Lotka-Voltera equations) on grapes and guava orchards at Dakahlia governorate during 2014 and 2015 fruiting seasons. (FTD = captured flies/trap/day)

Results presented in Table (3) showed that on grapes orchard, $K_1/a$ (0.35) > $K_2$ (0.19) and $K_2/b$ (0.79) > $K_1$ (0.46) during the first season. The same results were obtained during the second season [$K_1/a$ (1.11) > $K_2$ (0.45) and $K_2/b$ (1.18) > $K_1$ (0.59)]. Also, during the first and second seasons of guava orchard, $K_1/a$ (6.35 and 4.10) > $K_2$ (0.24 and 0.97) & $K_2/b$ (12.00 and 8.82) > $K_1$ (3.24 and 5.29). So, according to the competition equations of Lotka-Volterra, there is a chance for the two species to survive together when the lines cross and the populations tend always converge on this points.

From the previously mentioned results, it can be concluded that *B. zonata* and *C. capitata* can coexist depends on more than their competitive interaction with each other at the area of this study.

Table 3. Competition coefficient (a & b) and the values of intercept ($K_1$ & $K_2$) for *B. zonata* and *C. capitata* male populations on each other on grapes and guava during 2014 and 2015 fruiting seasons.

| Season | Crop | *B. zonata* | | *C. capitata* | |
|---|---|---|---|---|---|
| | | a | $K_1$ | b | $K_2$ |
| Grapes | 2014 | 1.31 | 0.46 | 0.24 | 0.19 |
| | 2015 | 0.53 | 0.59 | 0.38 | 0.45 |
| Guava | 2014 | 0.51 | 3.24 | 0.02 | 0.24 |
| | 2015 | 1.29 | 5.29 | 0.11 | 0.97 |

## DISCUSSION

The obtained data revealed that, *B. zonata* males exhibited one to three peaks of seasonal activity on grapes orchard and exhibited two peaks on guava orchard at Dakahlia governorate. On the other hand, *C. capitata* showed two peaks of seasonal activity on grapes and guava orchards. These results are in agreement with those obtained by Saafan and Korashy (2001) and Saafan *et al.* (2006); they found that each of *B. zonata* and *C. capitata* exhibited one to two peaks on guava orchards at Kalubia and Fayoum governorates. Also, Hashem *et al.* (2001) and Ghanim *et al.* (2015) recorded two annual peaks of abundance for *C. capitata* and two to three peaks for *B. zonata* on guava and mango orchards at Kalubia and Dakahlia governorates. El-Metwally and Amin (2010) reported that *B. zonata* and *C. capitata* exhibited one to three peaks of seasonal activity in orange orchards at Dakahlia and Fayoum governorates. Also, Draz *et al.* (2002) reported that *B. zonata* had one to two peaks of seasonal activity at El-Beheira governorate.

Both Ghanim & Moustafa (2009) and Moustafa *et al.* (2014) mentioned that *C. capitata* exhibited three to four annual peaks of seasonal activity at Dakahlia governorate. While, Hashim *et al.* (2001) (at North Sinai governorate) mentioned that *B. zonata* showed four peaks of seasonal activity. The variation between the present results and others may be attributed to the variation of the cultivated host plant species in each district or the variation in weather factors.

The present results revealed that *B. zonata* and *C. capitata* populations were significantly high on guava compared to grapes orchard during the two studied seasons; which explain that guava was significantly more preferable to *B. zonata* and *C. capitata* than grapes. According to Bernays and Chapman (1994) preferences for

certain plant characteristics may modify insect behavior. On the other hand, oviposition in fruit flies depends upon their decision to select the proper host which must support the activities of their offspring (Joachim-Bravo *et al.*, 2001 and Fontellas-Brandalha and Zucoloto, 2004). Other factors that may affect the oviposition preference in fruit flies include odor, color and shape of host fruits (Li-Li *et al.*, 2008). The present results are in agreement with those obtained by Saafan and Korashy (2001) and Ghanim (2009); they mentioned that the captured *C. capitata* and *B. zonata* males by Jackson traps and infestation percentages was higher on guava orchards comparing to citrus and peach at Kalubia and Dakahlia governorates.

The present results revealed that *B. zonata* and *C. capitata* can coexist depends on more than their competitive interaction with each other. Similar conclusion was obtained by Ghanim (2009, 2012) and Moustafa *et al.* (2014); they mentioned that there was a comparative co-existence between *B. zonata* and *C. capitata* in peach, guava, mandarin, persimmon and apple orchards. Varley *et al.* (1973) added that closely related species which use the same food resource in the field often live together. While, Camargo *et al.* (1996) reported that *Anastrepha obliqua* successfully displaced *C. capitata* from mango fruits in Central America.

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# تواجد ذكور ذبابة ثمار الخوخ وذبابة فاكهة البحر المتوسط والتنافس بينهما على العنب والجوافة بمحافظة الدقهلية – مصر

**نبيل محمد غانم**

*معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الجيزة – مصر*

*تم دراسة تواجد ذكور ذبابة ثمار الخوخ وذبابة فاكهة البحر المتوسط بمزارع العنب والجوافة خلال موسمي إثمار متتاليين من عامي ٢٠١٤ و ٢٠١٥ باستخدام مصائد جاكسون البيضاء. وقد أوضحت النتائج أن لذبابة ثمار الخوخ على العنب ثلاث ذروات منخفضة من التعداد خلال الموسم الاول والثاني؛ بينما على محصول الجوافة فقد اظهرت هذه الحشرة ثلاثة الى اربعة ذروات للتعداد سنوياً. أما ذبابة فاكهة البحر المتوسط فقد اظهرت ذروتين للتعداد سنوياً على كلا المحصولين (العنب والجوافة). كما أوضحت النتائج أن تعداد ذكور كلا النوعين كان مرتفعاً على الجوافة مقارنة بالعنب خلال موسمي الدراسة. ومن ناحية أخرى فقد وجد أن تعداد ذكور ذبابة ثمار الخوخ كان مرتفعاً بدرجة معنوية عن تعداد ذكور ذبابة فاكهة البحر المتوسط على كلا المحصولين خلال موسمي الدراسة. لوحظ كذلك وجود ارتباط عكسي بين الحشرتين على محصولي العنب والجوافة خلال موسمي ٢٠١٤ و ٢٠١٥. وباستخدام معادلات Lotka-Volterra فقد تبين وجود تعايش بين ذبابة ثمار الخوخ وذبابة فاكهة البحر المتوسط على كلا المحصولين في منطقة الدراسة.*