Seasonal Activity of *Bactrocera zonata* (Saunders) and *Ceratitis capitata* in a Navel Orange Orchard in Dakahlia, Egypt

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Abstract

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The peach fruit fly (PFF), *Bactrocera zonata* (Saunders) and the Mediterranean fruit fly (MFF), *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) are of the most major pests infesting citrus orchards in Egypt as well as several countries of the world. The present study was carried out to study the seasonal activity of PFF and MFF in navel orange orchards located in Dakahlia governorate, Egypt during two successive fruiting seasons of 2019/2020 and 2020/2021 by using sex attractants and fruit samples. The results obtained showed that, by using sex attractants, PFF males had two peaks each season, whereas MFF showed one to two peaks. By monitoring fruit samples, PFF exhibited one to two peaks of activity seasonally in the non-fallen and fallen fruits; whereas MFF exhibited two to three peaks on the non-fallen and fallen fruits. Both PFF and MFF were more abundant in the fallen fruits than in the non-fallen fruits. The relationships between flies trapped per day (FTD) of PFF and MFF males in Jackson traps and infestation rate of these pests showed that these traps can be used to predict infestation rates of PFF and MFF in their host fruits.

Keywords: *Bactrocera zonata*, *Ceratitis capitata*, navel orange, Jackson traps, sex attractants.

Introduction

Navel orange crop is one of the most important citrus crops in in the world. Egypt is ranked the sixth biggest producer of orange throughout the world after Brazil, China, US, EU, and Mexico (Abobatta, 2018). The peach fruit fly (PFF), *Bactrocera zonata* (Saunders) and the Mediterranean fruit fly (MFF), *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) are of the most major pests infesting citrus orchards in Egypt as well as several countries of the world. The economic importance of these pests is due to their large distribution, dominance and number of known hosts. According to several workers (Darwish, 2016; Ghanim & Moustafa, 2009; Hafez *et al*., 1973; Syed *et al*., 1970), PFF and MFF cause direct damage to fruits and vegetables which can cause up to 90–100% yield loss. Besides yield loss, the incidence of both species provides specific restrictions to export fruit trade to several countries around the world (Ahmad *et al*., 2010).

The peach fruit fly (PFF) is among the most destructive *Bactrocera* fruit fly species in Asia and Africa (Qin *et al*., 2021). It is a serious polyphagous pest originated in the South and South-East Asia where it attacks more than 50 host plants, including citrus, guava, mango, peach, apricot and fig (Ghanim & Moustafa, 2009; White & Elson-Harris, 1992). Extra labor and material are needed for controlling PFF in infested areas which increases production costs (Alzubaidy, 2000). In Egypt, PFF became a serious pest attacking a wide range of fruits that differ in their ripening time around the year (Ghanim & Moustafa, 2009).

The Mediterranean fruit fly (MFF) infests and reproduces on plants in the Mediterranean basin. It is a key pest of major fruit crops in many mild temperate, subtropical, and tropical regions (Sciarretta *et al*., 2018) including countries in Central America and Caribbean, Australia, Africa, Asia, Europe, and South America (Thomas *et al*., 2019). MFF is known to infest the fruits of more than 300 plant species (Malavasi, 2014). In Egypt, MFF is the main pest not only of citrus but also of many other fruit crops. The most economically significant and preferred MFF hosts in Egypt are citrus (*Citrus sinensis* L. Osbeck) of various varieties including navel orange.

To achieve a successful pest control in any region, ecological characteristics of the pest should be well studied. Accordingly, the present investigation aimed to study seasonal activity of PFF and MFF on navel orange trees by using two methods, sex attractants and monitoring fruit samples.

Materials and Methods

Seasonal activity of PFF and MFF were carried out in navel orange orchards located in the Experimental Farm of the Faculty of Agriculture, Mansoura University, Dakahlia governorate, Egypt. This study spanned over two successive fruiting seasons of 2019/2020 and 2020/2021 by using sex attractants and monitoring fruit samples.

Using sex attractants

To estimate the activity of both PFF and MFF males in the fruit orchard, Jackson traps (Harris *et al*., 1971) were used. Traps baited with methyl eugenol (for PFF) and trimedlure (for MFF) were distributed in the experimental farm. During the fruiting seasons of navel orange, five traps were hanged randomly in the shaded side of the fruit trees at around two meters height for every sexual attractant. Traps of the same attractant were 60 meters apart. The traps were inspected weekly and numbers of attracted flies on each sticky cardboard inside traps were counted and cardboard strips were replaced. The number of captured flies per trap per day

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(FTD) was used as a measure of flies abundance. The sex attractants were renewed every two weeks for PFF and every four weeks for MFF.

Monitoring fruit samples

To estimate the seasonal abundance of PFF and MFF populations, five trees of navel orange uniform in age and size were selected and marked. In the beginning of fruit maturing stages (Hashem *et al*., 2007), samples were collected weekly during two successive fruiting seasons. Each sample consisted of 25 fruits/host plant (5 fruits/tree) randomly collected from the different orchard directions (north, south, east and west) from the center of the tree (one fruit/direction) in addition to 25 fruits were collected from the fallen fruits under the selected trees. The collected fruits were transferred to the laboratory for investigation. Each fruit was put on a small plastic dish (5 cm in diameter) inside a plastic container (10 cm in diameter and 15 cm high) covered with a piece of muslin. A 2 cm thin layer of sand was placed in each container under the dishes to receive the emerged larvae for pupation.

The incubated fruits were inspected two weeks later and the resulted pupae from each infested fruit were re-incubated for another two weeks inside a glass tube until adult emergence under laboratory conditions. The resulted adult flies were classified as PFF and MFF and the number of each species was counted and recorded.

The infestation rate with each fruit fly species was calculated as follows:

$$\text{Infestation rate (\%)} = \frac{\text{No. of infested fruits with PFF or MFF}}{\text{Total number of the collected fruits}} \times 100$$

Statistical analysis

Data obtained was analyzed using SAS Software, Release 9.1 (SAS, 2003).

Results

Using sex attractants

During the first season, males of PFF started the first season with its first peak of activity (FTD = 28.9 flies) on the 10th of October and the second peak (FTD = 15.5 flies) on the 7th of November. The MFF males appeared in few numbers at the beginning of the season (FTD = 0.33 flies) and increased gradually until they reached the first peak (FTD = 5.3 flies) on the 7th of November; whereas, its second peak (FTD = 12.7 flies) was recorded on the 28th of November. After the second peak of the two pests, their populations decreased gradually until the end of the season (Figure 1). Generally, PFF males were more abundant than MFF males, and the general mean of captured male flies per trap per day all over the season reached 7.07 for PFF and 3.50 for MFF.

During the second season, males of PFF exhibited two peaks of activity; the first one (FTD = 18.5 flies) was recorded on the 10th of October, and the second one (FTD = 2.70 flies) was recorded on the 16th of January. Males of MFF increased gradually from the beginning of the season (FTD = 0.86 flies) until it reached its only distinct peak of activity (FTD = 10.4 flies) on the 26th of December. After reaching the peaks, PFF and MFF populations decreased until the end of the season (Figure 1). The general mean of captured flies per trap per day all over the season reached 4.14 flies for PFF males and 4.67 flies for MFF males.

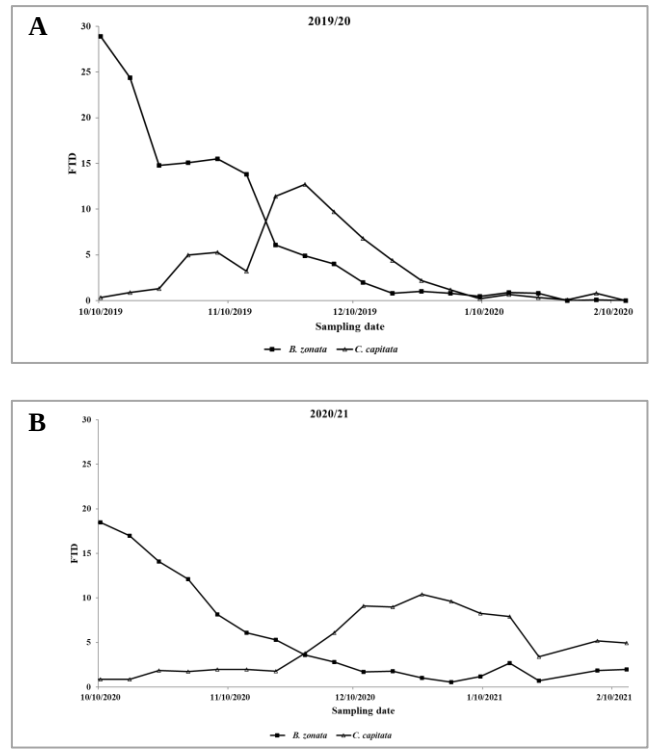

Figure 1. Seasonal activity of PFF and MFF males (flies trapped per day in Jackson traps) in navel orange orchard during (A) 2019/2020 and (B) 2020/21 fruiting seasons in Dakahlia governorate, Egypt.

By using fruit samples

Data presented in Figure 2 indicated that PFF started to infest navel orange fruits on the 24th of October of the first season and then it increased gradually to reach its only distinct peak on the 21st of November in the non-fallen fruits (6.1 flies per fruit and 28.0% infestation rate) and on the 14th of November in the fallen fruits (12.0 flies per fruit and 52.0% infestation rate). After that, PFF activity decreased gradually until the end of the season. MFF exhibited two peaks in the non-fallen and fallen fruits. The first peak (the lowest) was recorded on the 31st of October when mean number of flies per non-fallen and fallen infested fruit was 0.7 and 1.8 flies (infestation percentages were 12.0 and 20.0%). The second peak (the highest) was recorded on the 19th of December (6.3 and 7.1 flies per non-fallen and fallen infested fruits, respectively). The second peak of infestation rate was recorded in the non-fallen fruits on the 5th of December (infestation rate= 40.0%) and on the 19th of December in the fallen fruits (infestation rate= 44.0%). Both PFF and MFF were found in higher numbers in the fallen fruits than in the non-fallen fruits. The general mean of emerged flies per one non-fallen and fallen infested fruit recorded was 2.49 (with a mean infestation rate of 16.0%) and 3.28 flies (mean infestation rate of 23.6%), respectively, of PFF and 2.59 (mean infestation rate of 22.7%) and 3.42 flies (mean infestation rate of 32.9%) of MFF, respectively.

During the second season (Figure 3), PFF had only one distinct peak of activity in the non-fallen fruits. This peak was recorded as 5.3 flies infested fruit on the 24th of October with 36.0% infestation rate on the 31st of October. After this peak, activity of PFF decreased gradually until the end of the season. In the fallen fruits, PFF showed two peaks of abundance (7.4 and 10.5 flies per fruit) and two peaks of infestation rate (44.0 and 56.0%) on the 31st of October and 21st of November. On another hand, MFF exhibited three peaks of activity in the non-fallen fruits. These peaks were recorded on the 14th of November (6.1 flies/infested fruit and 40.0% infestation rate), 12th of December (10.1 flies and 40.0%) and 2nd of January (10.7 flies and 48.0%). In the fallen fruits under the trees, MFF showed two peaks of activity on the 5th of December (14.3 flies and 56.0%) and 9th of January (15.1 flies and 56%). The general mean of emerged flies per one non-fallen and fallen infested fruits recorded was 1.81 and 3.28 flies of PFF (with mean infestation rate of 13.4 and 22.3%) and 5.10 and 6.61 flies of MFF (with mean infestation rate of 27.1 and 35.4%).

The relation between captured males by Jackson traps and infestation rate in fruits

The relationships between FTDs of MFF males in Jackson traps and its infestation rate showed that each increase of FTD by one fly increased infestation rate by 2.42 and 2.86% in non-fallen and fallen fruits, during the first season, respectively. During the second season, each increase of FTD by one fly increased infestation rate by 3.33 and 4.15% in non-fallen and fallen fruits, respectively. With respect to PFF, each increase of FTD by one fly decreased infestation rate by 0.20 and 0.07% in non-fallen and fallen fruits, respectively, during the first season. In addition, during the second season, each increase of FTD by one fly increased infestation rate of PFF by 1.08 and 1.28% in non-fallen and fallen fruits, respectively (Figure 4).

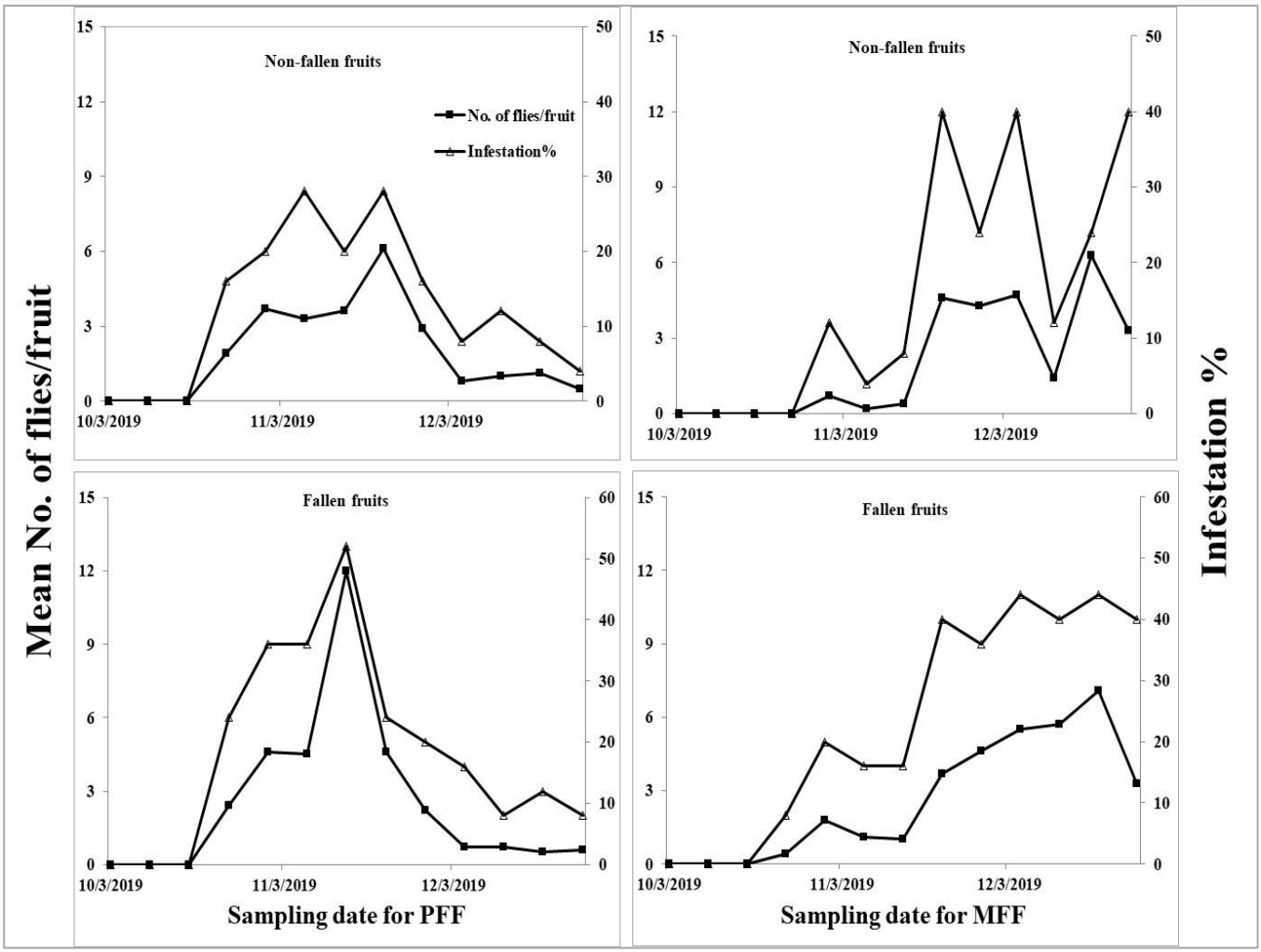

Figure 2. Seasonal abundance of PFF and MFF in navel orange fruits (non-fallen and fallen fruits) during 2019/2020 fruiting season in Dakahlia governorate, Egypt.

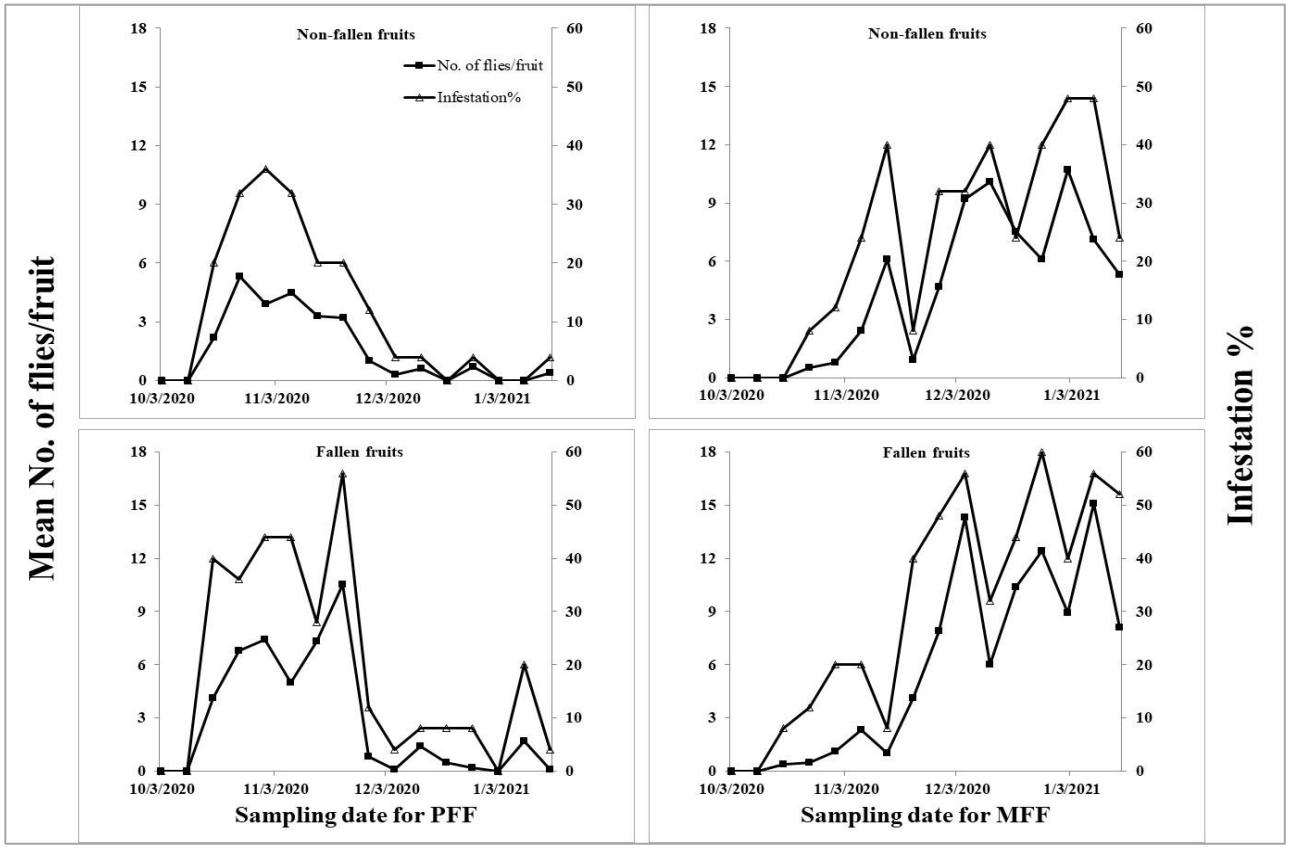

Figure 3. Seasonal abundance of PFF and MFF in navel orange fruits (non-fallen and fallen fruits) during 2020/2021 fruiting season in Dakahlia governorate, Egypt.

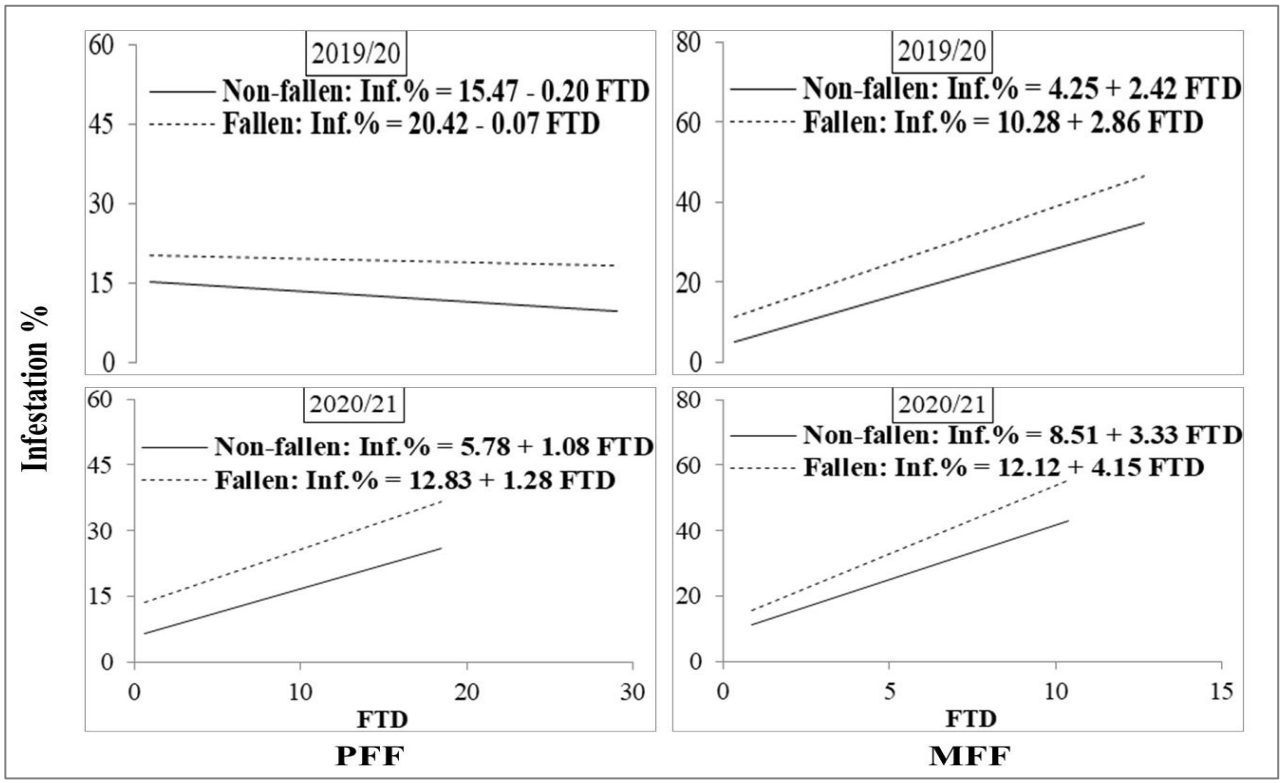

Figure 4. Relationship between FTD of PFF and MFF males in Jackson traps and infestation percentages (Inf.%) of non-fallen and fallen fruits in navel orange orchard during 2019/2020 and 2020/2021 fruiting seasons in Dakahlia governorate, Egypt.

Discussion

The results obtained showed that PFF and MFF were recorded in navel orange orchard approximately all over the fruiting seasons. Similar findings were reported earlier (Amin, 2003, 2008; Bayoumy *et al*., 2021; Ghanim, 2012, 2016, 2017; Ghanim & Moustafa, 2009; Ghanim *et al*., 2018; Moustafa *et al*., 2014). These workers reported that PFF and MFF were observed during the whole fruiting seasons of several fruit host plants. The results obtained in this study indicated that both of PFF and MFF exhibited one to three seasonal peaks of activity in the navel orange orchard. These results are in agreement with what has been reported by El-Metwally & Amin (2010) who indicated that PFF and MFF exhibited one to three peaks of seasonal activity in orange orchard at Dakahlia and Fayoum governorates. Also, in Dakahlia governorate, Ghanim (2016) reported earlier that PFF exhibited one to three peaks of seasonal activity in grapes orchard and exhibited two peaks in guava orchard. The same author reported that MFF showed two peaks of activity in guava and grape orchards. On another hand, the activity of MFF recorded two to three peaks in peach orchard at Dakahlia governorate (Ghanim, 2017). In El-Beheira governorate, Draz *et al*. (2002) reported that PFF showed one to two peaks of seasonal activity. According to Saafan & Korashy (2001) and Saafan *et al*. (2006), PFF and MFF exhibited one to two peaks of activity in guava orchard at Kalubia and Fayoum governorates. Hashem *et al*. (2001) and Ghanim *et al*. (2015) reported two peaks of abundance for MFF and two to three peaks for PFF in guava and mango orchards located in Kalubia and Dakahlia governorates. In addition, Bayoumy *et al*. (2021) reported that PFF exhibited three peaks of activity in guava orchard at Dakahlia governorate. Furthermore, Hashem *et al*. (2001) (in North Sinai governorate) and Amin (2003) (in Fayoum governorate), PFF had four peaks of seasonal activity. In addition, Bayoumy *et al*. (2021) reported that MFF had four peaks of activity in guava orchard at Dakahlia governorate. Ghanim & Moustafa (2009) reported four to five annual peaks of activity for MFF in Dakahlia governorate. Both of MFF and MFF exhibited four peaks of activity in persimmon orchard located in Dakahlia governorate (Ghanim, 2012). The variation between the present results and others may be attributed to the variations of weather factors, the tested host plants and/or the cultivated plants around the tested host plant.

The present results showed that infestation rates of the non-fallen fruits by PFF and MFF reached 36.0 and 40.0% in the navel orange orchard investigated. On the other hand, infestation rates with PFF and MFF were higher in the fallen fruits under trees than in the non-fallen fruits. Approximately similar results were obtained in Dakahlia governorate by Ghanim & Moustafa (2009) who reported that the infestation rates with PFF and MFF reached around 90 and 20% on peach fruits, 80 and 90% on guava fruits and 80 and 60% on mandarin fruits.

According to Ghanim & Moustafa (2009), the potency and specificity of a good sex attractant made traps (such as Jackson traps) are a valuable tool in monitoring seasonal activities of PFF males. According to the captured flies in Jackson traps in the present study, it can be concluded that Jackson traps may be a good method for trapping males of PFF and MFF. The relationships between captured flies in Jackson traps and infestation rate indicated that these traps could be used to predict infestation rates with PFF and MFF in their host fruits. Similar conclusion was reported by Ghanim & Moustafa (2009).

الملخص

العفيفي، أحمد هـ.، ر.م. شريف، م.أ. هنداوي ونبيل م. غانم. 2023. النشاط الموسمي لحشرتي (Saunders) *Bactrocera zonata* و *Ceratitis capitata* في بستان برتقال أبو صرة في محافظة الدقهلية، مصر. مجلة وقاية النبات العربية، 41(2): 98–104.

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تعدّ ذبابة فاكهة الخوخ (Saunders) *Bactrocera zonata* وذبابة فاكهة البحر المتوسط (Wiedemann) *Ceratitis capitata* (Diptera: Tephritidae) من أكثر الآفات الرئيسة التي تصيب بساتين الحمضيات في مصر كما في العديد من بلدان العالم. أجريت الدراسة الحالية لمتابعة النشاط الموسمي لكلٍّ من ذبابة فاكهة الخوخ وذبابة فاكهة البحر المتوسط في بساتين البرتقال أبو صرّة الواقعة في محافظة الدقهلية بمصر خلال موسمي الإثمار المتتاليين 2020/2019 و2021/2020 باستخدام الجاذبات الجنسية وعينات من ثمار الفاكهة المتساقطة وغير المتساقطة. أظهرت النتائج التي تمّ الحصول عليها باستخدام الجاذبات الجنسية، أنّه كان لذكور ذبابة فاكهة الخوخ ذروتان في كلّ موسم، بينما أظهرت ذكور ذبابة فاكهة البحر المتوسط وجود ذروة إلى ذروتين في كل موسم. ومن خلال مراقبة عينات ثمار الفاكهة التي تمّ تحضينها، أظهرت ذبابة فاكهة الخوخ وجود ذروتين من النشاط الموسمي في ثمار الفاكهة غير المتساقطة والمتساقطة؛ بينما أظهرت ذبابة فاكهة البحر المتوسط وجود قمتين إلى ثلاث قمم على الثمار غير المتساقطة والمتساقطة. كان وجود كلٍّ من ذبابة فاكهة الخوخ وذبابة فاكهة البحر المتوسط أكثر وفرةً في الثمار المتساقطة منها في الثمار غير المتساقطة. أظهرت العلاقات بين ذكور الذباب الذي تم جذبه يومياً (FTD) بمصائد جاكسون (لكلٍّ من ذبابة فاكهة الخوخ وذبابة فاكهة البحر المتوسط) ومعدّل إصابة الثمار بهذه الآفات أنه يمكن استخدام هذه المصائد للتنبؤ بمعدّلات الإصابة بكلٍّ من الآفتين.

كلمات مفتاحية: برتقال أبو صرة، مصائد جاكسون، جاذبات جنسية، *Bactrocera zonata, Ceratitis capitata*.

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