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Population Fluctuations of the Mediterranean Fruit Fly, *Ceratitis capitata* (Wied.) with Respect to some Ecological Factors in Peach Orchards

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ABSTRACT

The Mediterranean fruit fly (MFF), *Ceratitis capitata* (Wied.) (Diptera: Tephritidae) is an important economic pest worldwide. The present work aimed to study the effect of peach fruit ripening and certain weather factors on population fluctuations of MFF on peach orchards during two successive seasons (2015 and 2016). An area of about 25 feddans was selected for the present study at Aga district, El-Dakahlia governorate, Egypt. The MFF showed two peaks of seasonal activity at the period of fruit ripening during the first season, whereas it recorded four peaks of abundance during the second season. Generally, these peaks of activity were confined between June and September. Population of MFF positively responded to fruit ripening. Among the weather factors, temperature has the highest effect on MFF population; relative humidity has the lowest, and wind speed has a moderate effect. The MFF population responded positively to both temperature and humidity, whereas it responded inversely to wind speed. Although weather factors had effects on MFF population, fruit ripening exhibited an extrusive effect on its population. Updating the information regarding factors that affect population dynamics of an insect under various ecological situations might lead to provide insights into pest control.

Keywords: Jackson traps, sex pheromone, temperature, relative humidity, wind, trimedlure

INTRODUCTION

The peach, *Prunus persica* (L.) (Family: Rosaceae) is one of the most important contributors to stone fruit production. It is a deciduous tree native to the region of Northwest China (Faust and Timon, 2010). According to Hashem *et al*. (2001), Ghanim (2009), Ghanim and Moustafa (2009) and Hull *et al*. (2009), many arthropod pests were recorded attacking peach trees. Some of these pests cause serious damage, hence affecting quantity and quality of the peach fruits and cause economic loss in the crop. However, tephritid fruit flies are among the major pests attacking peach fruits in Egypt and worldwide. The infestation by these flies indirectly cause secondary infestations with fungal and bacterial diseases that mostly exist from the same place of penetration by neonate maggots, resulting in fruits drop down (White and Elson-Harris, 1994).

The Mediterranean fruit fly (MFF), *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae), is one of the world's most destructive fruit pests and is recognized by some as the worst pest of fruit trees (Enkerlin and Mamford, 1997; Teresa *et al.,* 2002). It is a species of Afrotropical origin which has adapted to the climatic conditions of the Mediterranean basin (Franco *et al*., 2006). It attacking over 350 species of fruits, nuts and vegetables round the world (Liquido *et al*., 1991). Infestations by fruit flies have been annually estimated at thousands of millions of US dollars of crop losses worldwide each year (Sarwar, 2006). The variability in host range is influenced mainly by the habitat, environment factors and by chemical and physical characteristics of the fruits (Harris, 1975; Eskafi and Kolbe, 1990; Perry and Yuva, 1997; Ghanim, 2009). In Egypt, the existence of hosts for MFF is the important reason to build up its generations; so, its population occurred all over the year and increased during the fruiting seasons of the orchards (Hashem *et al*., 2001; Ghanim, 2009; Ghanim, 2012; Moutafa *et al*., 2014). This pest invades many kinds of fruits causing a serious decline in both quantity and quality of fruit yield (Hassanein *et al*., 1995). Fruit production is extremely affected by MFF and its damage increasing annual, however the fruit infestation is as high as 80% (Hafez *et al.*, 1973).

The effect of fruit ripening presence on MFF population was explained by Hashem *et al*. (2001), Ghanim (2012) and Moustafa *et al*. (2014). They mentioned that the presence of host fruit ripening is significantly increased fruit fly's population. Further, Saafan *et al*. (2005), Saafan *et al*. (2006), Ghanim and Moustafa (2009) and Moustafa *et al*. (2014) mentioned that MFF population is significantly affected by some weather factors especially temperature degrees. Population of MFF therefore is highly affected by host fruit ripening and climatic conditions. Although there were several studies examined the effects of different weather factors on different fruit fly species on the same or different host plants such as rainfall, rainy days and night land surface temperature (Mahmood *et al.*, 2002; Hasyim *et al.*, 2008; Robert *et al.*, 2013 and Ordano *et al.*, 2015). Continuous investigations and updating the information for its populations at various situations would generate the information regarding its biology and ecology that is critical to foresee with its status.

To obtain a success integrated pest management, different methods used to control insect population must be integrated by a strategy addressed towards greater protection of the cultures with respect to ecological, toxicological and economic principles (Neuenschwander and Paraskakis, 1980). Ecological studies about the target pest are of great important for building-up an efficient integrated pest management. So, the present work aimed to study the seasonal population activity of MFF under some ecological factors (i.e., fruit ripening, temperature, relative humidity and wind speed).

MATERIALS AND METHODS

An area of about 25 feddans cultivated with fruiting peach trees was selected for the present study at Aga district, El-Dakahlia governorate, Egypt. Five white Jackson traps (Harris *et al*., 1971) were hanged in the shaded side of the fruit trees at height of two meters (with a rate of one trap per five feddans) from the 30th of May (the start of fruit ripening) till the 5th of September

2015 during the first season and from the 29th of May (the start of fruit ripening) till the 4th of September 2016 during the second season. All traps were provided with the sex attractant of MFF (trimedlure) which renewed every four weeks. The traps were inspected weekly and number of flies captured on each sticky cardboard inside trap was counted with renewal cardboard strips. The number of captured flies per trap and day (FTD) was counted as a measure of fly population.

The accumulative passed time after fruit ripening was calculated and grouped in a weekly ascending order according to sampling dates. The mean weekly FTDs were correlated with the accumulative passed time after fruit ripening and the simple regression in addition to explained variance were analyzed by using the computer program of CoHort Software (2004).

Using the meteorological data, daily averaged temperatures, relative humidity and wind speed were obtained from the Agrometeorological Station at El-Dakahlia region during the period of investigations of 2015 and 2016 seasons. The weekly means of each weather factor were calculated. The mean weekly FTDs were correlated with each weather factor and the Person simple regression coefficient and the explained variances were analyzed using CoHort Software (2004).

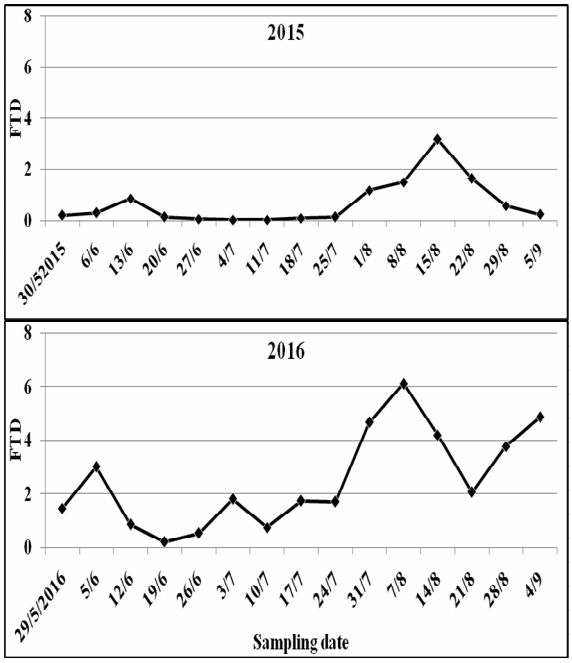

Fig. 1. Seasonal activity of MFF during peach fruit ripening seasons of 2015 and 2016 at El-Dakahlia governorate.

RESULTS

1. Seasonal activity of MFF

The population of MFF was recorded, all over the fruit ripening season of peach orchards, during the two seasons of investigation. The MFF population showed two peaks of seasonal activity during the first season (2015). The lowest peak of the number of captured flies per trap per day (FTD) was recorded on 13th of June (FTD = 0.86); while, the highest peak was recorded on 15th of August (FTD = 3.17). The MFF population exhibited four peaks of seasonal abundance during the second season (2016). These peaks were recorded on 5th of June, 3rd of July, 7th of August and 4th of September with FTD-values of 3.00, 1.80, 6.11 and 4.86 flies, respectively (Fig. 1). The mean of male flies captured per trap and day was 0.67 and 2.51 flies during the first and second season, respectively.

2. Effect of fruit ripening

The correlation coefficient between fruit ripening and MFF population was positive. Linear regression between fruit ripening and MFF population showed that the FTD of MFF increased each day after peach fruit ripening by 0.03 flies during the two seasons (Fig.2). The fruit ripening showed relatively high effects on MFF population with a determination coefficient (R^2) of 19.9 (during 2015), 42.3 (during 2016) and 21.0% (during 2015 and 2016).

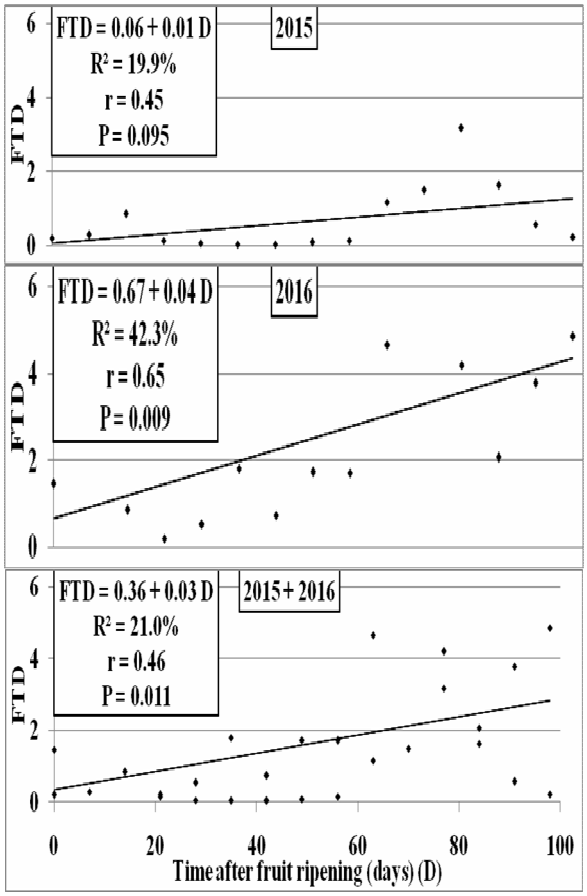

Fig. 2. Effect of passed time after host fruit ripening on MFF population in peach orchards at El-Dakahlia governorate during 2015 and 2016 seasons.

3. Effect of weather factors

Temperature

Temperature showed an extrusive effect on MFF population. The increase in temperature by one degree led to an increase in FTD of MFF by 0.41 flies during the two seasons. The determination coefficient (R^2) of temperature was 10.2, 16.5 and 12.1% during 2015, 2016 and both (2015 and 2016) seasons, respectively (Fig. 3).

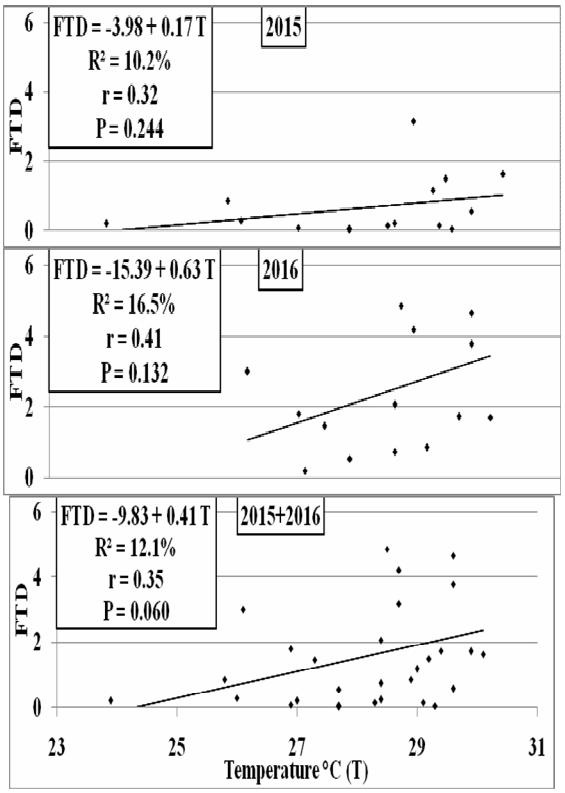

Fig. 3. Effect of temperature degrees on MFF population in peach orchards at El-Dakahlia governorate during 2015 and 2016 seasons.

Relative humidity

There was a non-significant positive correlation between relative humidity and FTD of MFF during both seasons together (2015 and 2016). However, each increase in the relative humidity by one percent led to an increase in FTD by 0.25 flies during both seasons (2015 and 2016) (Fig. 4). The determination coefficient for relative humidity was 10.3 (during 2015), 18.3 (during 2016) and 2.3% (during 2015 and 2016 together).

Wind speed

As wind speed increased the population of MFF decreased, but this relation was non-significant. The increase of wind speed by on kilometer per hour decreased the FTD of MFF by 0.21 males during the two seasons. Statistical analysis showed that wind speed had the lowest effect on MFF population compared to the other factors. It contributed with 0.4, 2.3 and 7.9% of the total factors affecting on MFF population during the first, second and both seasons, respectively (Fig., 5).

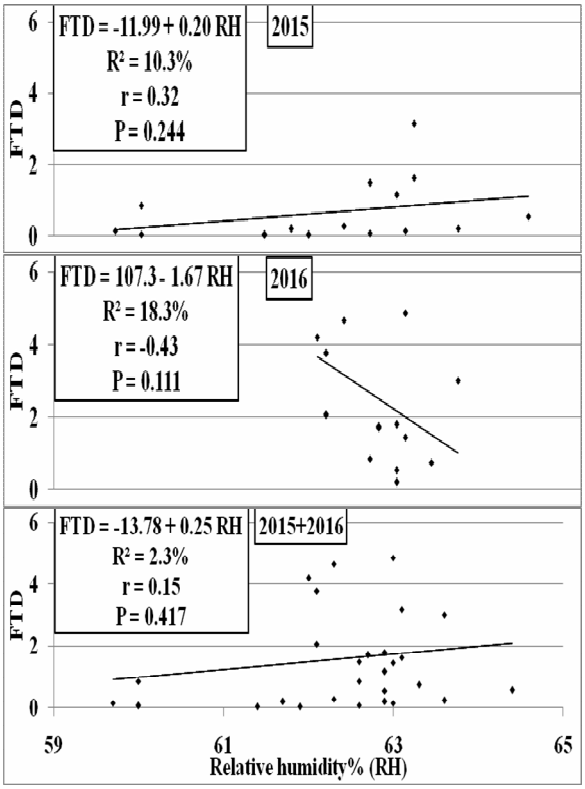

Fig. 4. Effect of relative humidity on MFF population in peach orchards at El-Dakahlia governorate during 2015 and 2016 seasons.

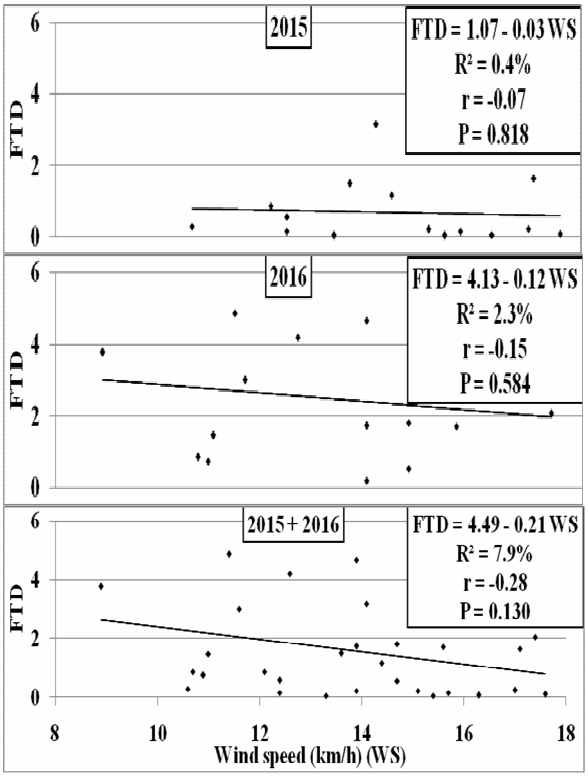

Fig. 5. Effect of wind speed on MFF population in peach orchards at El-Dakahlia governorate during 2015 and 2016 seasons.

DISCUSSION

The present results showed that the MFF population exhibited two to four peaks of seasonal activity during fruit ripening period of peach orchards at El-Dakahlia governorate. These results are previously confirmed by Ghanim (2012) and Moustafa *et al.* (2014) in persimmon and apple orchards at El- Dakahlia governorate. In addition, Ghanim and Moustafa (2009) mentioned that MFF showed four peaks of abundance during the entire year in an orchard cultivated with successive ripening of different fruit species at El-Dakahlia governorate. The current results are partially consistent with those of Hashem *et al.* (2001) who recorded one to two peaks of abundance for MFF in Qualyobia governorate on different horticultural orchards. The host plant and weather factor may explain the partial difference with the current study.

Fruit flies could not infest their hosts' fruits until the beginning of physiological fruit ripening. Thus, the abundance of fruit flies are highly affected by the availability of their hosts' fruit ripening which act as the source of their offspring's feeding (Hashem *et al.*, 2001; Afia, 2007; Ghanim, 2012; Ghanim *et al.*, 2015). These authors stated that the presence of host fruit ripening is one of the main drivers for MFF population in different horticultural orchards. This study confirmed the same finding, in which the host fruit ripening is the highest effective factor on MFF population compared to other weather factors. Thus, it could play an important positive role in the build-up of MFF population.

Extending to weather factors behind fruit ripening, both temperature and relative humidity had positive effect on the build-up of MFF population; while wind speed has a negative effect on the pest population increases. Among the three independent variables, temperature ranked the highest impact on MFF population. The present results are consistent with those obtained by Saafan *et al.* (2006) (at Fayoum governorate), Ghanim and Moustafa (2009) and Moustafa *et al.* (2014) (at El-Dakahlia governorate). According to Ghanim (2012), temperature increases from 16.4 to 19.3^{o}C at March to 29.1 to 29.3^{o}C at August positively affect the MFF population. Kounatidis *et al.* (2008) explained that geographic location and climate are also expected to have an important impact upon the ability of the population to reproduce and thrive.

The relative humidity insignificantly affected the MFF population during 2015 and 2016 seasons. Similarly, Afia (2007) and Ghanim (2012) mentioned that there was no significant effect for of relative humidity on MFF population. However, Saafan *et al.* (2006) and Ghanim and Moustafa (2009) found a negative effect for relative humidity of MFF population at Fayoum and El-Dakahlia governorates. The variation between the present results and others may be attributed to the variation of the cultivated host plant species in each district and/or the variation in weather factors. Specifically, Bayoumy and El-Metwally (2017) found that flight activities of MFF males were negatively, and females were positively, correlated with temperature, while MFF males were positively, and females were negatively correlated with relative humidity. This could be explained the variations in temperature and relative humidity among all previous studies.

The wind speed had insignificant negative effect on MFF population. This may attribute to the flight behaviour of fruit flies that fly oppositely to the direction of wind to reach the source of their attractants (which is trimedlure in the case of the present study). These results are in agreement with those obtained by Moustafa (2017); he found that wind speed had insignificant negative effect on *Bactrocera oleae* (Rossi) population in olive orchards.

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التذبذبات العددية لذبابة فاكهة البحر المتوسط وعلاقتها ببعض العوامل البيئية بمزارع الخوخ

نبيل محمد غانم

معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – الجيزة

تعتبر ذبابة فاكهة البحر المتوسط من أهم الآفات الاقتصادية على مستوى العالم. ويهدف هذا العمل إلى دراسة تأثير نضج الثمار وبعض العوامل المناخية على تعداد هذه الآفة في مزارع الخوخ خلال موسمين متتاليين (2015 و2016) وقد تم اختيار مساحة من الخوخ (25 فدان تقريباً) في منطقة أجا بمحافظة الدقهلية – مصر لهذه الدراسة. وقد أوضحت النتائج أن لهذه الآفة ذروتين للنشاط خلال موسم الإثمار في العام الأول وأربعة ذروات في العام الثاني، وقد سجلت هذه الذروات خلال الفترة من يونيه حتى سبتمبر. كما أوضحت النتائج ان تعداد هذه الآفة يستجيب ايجابياً لنضج الثمار. وكانت درجات الحرارة هي الأعلى تأثيراً على تعداد الآفة من بين الظروف الجوية يليها سرعة الرياح وأخيراً الرطوبة النسبية؛ حيث كان الارتباط إيجابياً بين تعداد الآفة وكل من درجات الحرارة والرطوبة النسبية أما الارتباط مع سرعة الرياح فقد كان سلبياً. كما كان لنضج الثمار تأثير طردي على تعداد الآفة. وربما يفيد تحديث المعلومات المتعلقة بالعوامل التي تؤثر على ديناميكية تعداد آفة ما تحت الظروف البيئية المختلفة في الرؤى المتعلقة بمكافحتها.