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ROLE OF THE OLIVE FLY, *BACTROCERA OLEAE* (ROSSI) TRAPS IN INTEGRATED PEST MANAGEMENT ON OLIVE TREES UNDER CLIMATIC CHANGE CONDITIONS IN EGYPT

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Abstract

Yellow sticky and plastic McPhail-type traps were tested in integrated pest program for controlling the olive fruit fly, *Bactrocera oleae* in Egyptian olive trees. El-Behera and El-Fayoum Governorate were selected for these evaluations. The Yellow sticky traps captured significantly more flies than McPhail traps. The capturing numbers by both catches clearly indicate the importance of using these traps in Egyptian olive groves. Climatic changes effect on the olive fly population during two seasons was studied.

Keywords: Climatic change; the olive fly, *Bactrocera oleae;* traps; integrated pest management; olive trees.

Introduction

The olive tree (*Olea europaea*) is historic and classical feature of the Mediterranean landscape (Garantonakis *et al*., 2017). It has been cultivated since the late prehistory, in the early Bronze Age, where it has been grown for its oil-rich fruit (Carrion-Flores *et al.,* 2010). The olive tree is susceptible to pests, including the olive fruit fly, *B. oleae* (Rossi) (Diptera: Tephritidae). It is considered the foremost pest of olives around the world for more than 2000 years (Raspi and Viggiani 2008; Hepdurgun *et al.,* 2009; Garantonakis *et al*., 2017). Olive fruit fly preferred the humid climates and the dry regions. According to Kapatos and Fletcher (1986) the olive fruit fly survives best in cooler coastal and hot climate. The optimum temperature for the insect development is between 20.0 and 30.0ºC. A few of the factors related to fruit qualities that possibly play a role in sensitivity of fruits for infestation include size, colour , exocarp hardness, aliphatic waxes surface and chemical composition of olive fruits (Daane and Johnson, 2010; Malheiro *et al*., 2015a). Recently, Malheiro et al. (2016) observed relationship between infestation level and the aromatic hydrocarbons (α-copaene) during olive ripen that it leads to an oviposition promoter for *B. oleae*. Also, positive association found between *B. oleae* infestation and potassium, iron content in olive fruits (Garantonakis *et al*., 2016). The broad uses of traditional insecticides lead to environmental contamination (Abd El-Salam *et al*., 2018).

In recent years, mass trapping had become a significant management means in controlling *B. oleae* and protecting the beneficial fauna in the ecosystem (Roessler, 1989; Mazomenos *et al*., 2002; Dimou *et al*., 2003). Mass trapping was a preventive control measure and it depends on attraction and killing of olive fruit fly adults to avoid infestation. The traps could be filled by attractant materials for example, proteins, ammonia and pheromone and mixed by insecticide, or they could be filled with an attractant-insecticide solution (Economopoulos, 1977; Haniotakis *et al*., 1987 & 1991; Bjeliš, 2006).

The use of attractive traps within the integrated pest control list had become an urgent necessity. Numerous researches contributed in developing bait sprays or mass trapping (Broumas *et al*., 1998), with lower costs of application. McPhail traps baited with a solution of protein hydrolyzate and visual (yellow color) sticky traps have also been used to control the fly (Economopoulos *et al*., 1977). Many authors had confirmed that might be attracted the beneficial insects to traps. (Broumas *et al.,* 1983; Kapatos and Fletcher, 1986).

Climate changes impact on agricultural and other ecosystems had omitted trophic interactions (Van der Putten et al. 2010). In the main time, the effects of climate change on the population dynamic of *B. oleae* to be study as urgent need .The thermal limits of olive and the fly were differed and affect the trophic interactions crucial to estimating the bioeconomic impact of climate change in olive across the Basin (Gutierrez *et al*., 2009).

In this study, the efficacy of two traps in controlling the olive fruit fly populations in olive orchards in two different regions and the climatic changes effect on the population of fly was studied.

Materials and Methods

Study Position

The study was conducted in two different regions; El-Fayoum Governorate is located on 100 km in the southwest of Cairo, the city in Middle Egypt. El-Behera Governorate is coastal Governorate, the city is located160 km in the northwest of Cairo in Lower Egypt, the city is located in the middle of the western Nile Delta). The selected area was about one Feddan (4200 m^2) in each farm. Both farms are olive cultivar (*Olea europaea* L.) planted with Toffahi variety , the age of trees is 5 years and the high trees is about 3-4 m. The distance between each two trees about 5.0 m^2. This variety is use as Olives pickled (less than 15% oil content, large volume and thick pulp). The density of trees is about of 175 trees/ feddan. The yard has very good climatic conditions for growing olive trees. The chosen area has a high degree of isolation from other orchards and not received any chemical insecticides applied or pruning processes two years before treatments. The soil of the experimental zone is sandy; the dripping irrigation system is applied.

Adult Traps

Two different types of traps were used in each farm. The experimental study was divided into 5 blocks (total 175 trees) and each block contained 35 trees. Five trees were randomly selected from each block (total 35 trees).

Yellow sticky traps (15x20 Cm, diameter) were installed containing adhesive material and equipped with aluminum bicarbonate to attract the adult fly. The second trap

(McPhail trap) is makes from plastic containing yeast tablets. Five traps were used either plastic or yellow paper at a rate of one trap/5 trees. One tree was selected from each block and the yellow trap was hanged (one trap / five trees). McPhail trap was hanged on another tree at 20 meters from the yellow trap tree to avoid interaction between lures. All traps were hanged at a height of 2.0 meter above ground in a shaded place of trees. Weekly, the adults captured are counted and recorded for each trap, at the same time the new traps were replaced the oldest one. Five traps represented 5 replicates. Daily records of temperature degrees and percentage of relative humilities were obtained from the Agro Meteorological Station at El-Fayoum and El- Behera regions during period of studies (Figs. 1 & 2). Efficacy % of traps was calculating as follow:

$$\text{Efficacy\%} = \frac{T_1 \text{ or } T_2}{T_1 + T_2} \times 100$$

T_1 = number of captured adults by McPhail trap & T_2= number of captured adults by yellow trap.

Also, the relationship between the climatic changes and the population density of the olive fly was studied.

The experimental studies were begun from 1st Jun. 2016 to 15th Dec. 2017 (two production seasons).

Statistics Analysis

SPSS, 16 program will be used for analysis the results, correlation between the number of insects and the mean daily temperature degree and the relative humidity percentage will be conducted.

Results

Role of the olive fly, *B. oleae* (Rossi) traps in integrated pest management

Data in Table (1) revealed that the activity of adult in the two Governorates was spread throughout the year, the period from January to May is almost zero, but the numbers were begun during June, the number of adults captured per trap significantly increasing in El-Behera farm. The dynamics of adult flights showed that three (2016) or five peaks (2017) were recorded in Table (1) annually during the activation period. The results are relatively important in El-Behera than in El-Fayoum farm. Generally, the number of fly captured fluctuations significantly in El-Behera compared to the other Governorate. Table (1) showed that there is some differentiation between the two tested trap types for its efficiency for attracting fly. El-Fayoum farm, 2016 season, the peak was 95.0 fly/trap, while in 2017 season, there was 424.2 fly/ trap (McPhail trap). Further, the second type (sticky yellow trap) at the same farm, the trap gave a highly efficacy, for example at 2016 season, there was 122.0 fly/trap, 2017 season the data recorded 482.8 fly /trap. In the coasted farm (El-Behera), the trap McPhail-type clarify that there was one peak in 2016 season, the peak was recorded 139.0 fly / trap, while at 2017 season, the peak was recorded 566.0 fly / trap. Otherwise, the yellow sticky trap more efficacy than the McPhail-trap, in 2016 season, the peak was 166.0 fly / trap, while in 2017 season, the number of peak reached to 788.6 fly / trap.

Effect of climatic changes on population dynamic of the olive fly

The statistical analysis of the data in Table (2) indicated that effect temperature and relative humidity % on the numbers of olive fly in the dry region (El-Fayoum) were positive correlation during 2016/2017 season with McPhail and yellow traps. Except for season 2016, the correlation was negative between relative humidity % and the numbers of the numbers of olive fly in each trap. There are significant to found between temperature and the numbers of olive flies.

Discussion

Role of the olive fly, *B. oleae* (Rossi) traps in integrated pest management

The olive fruit fly was attacked the olive fruits and quality and quantity loss in the world (Rice, 2000) as well as in Egypt. Sticky yellow traps have been shown to be fine for monitoring the fly and correlate with fruit infestation levels (Gonçalves & Torres, 2013; Varikou *et al*., 2014). Unlike the traps that utilize pheromone or food attractants, sticky traps are not affected by ambient conditions. Hence, they can more exactly evaluate the magnitude of adult populations throughout the year. So, they are widely used in the Eastern Mediterranean region and, based on our systematic monitoring. Topuz & Durmusoglu (2008) showed that population densities of *B. oleae* adults were at low level during summer months. At high temperatures and low humidity had prevented the female maturation in summer months (Fletcher *et al*., 1978; Katsoyannos 1992; Tzanakakis 2003). An amazing the adults number was low in July and August and increased starting from September and reached the highest level at the end of October. it remained high after the peak formation (in October and November). It was observed that *B. oleae* population survived to the end of December.

Hence, it can be concluded that the trap types used have an important role in predicting the dates of the pest and the extent of its spread on the olive trees. Varikou *et al*. (2014) tested McPhail traps for captured of *B. oleae* fly by use various attractant solutions mixed with registered plant protection products and it gave good resulting during three summer year periods.

Effect of climatic changes on population dynamic of the olive fly

In the present century, insect scientists have become aware of the changes in the climate and have negative and possibly positive effects that cause more damage to agricultural crops.

Girolami *et al*. (1983) stated that the development insect populations of each stage and the generations number depend on climatic factors (temperature and humidity) and harvest dates. Ordano *et al*. (2015) indicated that the olive fly populations are expected to fluctuate and to be highly seasonal in cold areas with nice summer temperatures such as ,at high elevations or the northern latitudes of the Mediterranean region,. These meteorological conditions, olive fly populations are optimum to develop throughout the summer and autumn, but exhibit a slower rate of development during eggs, larvae, pupae stages in the winter. The rate of population change was positively affected by temperature. At this high-altitude location, fly-trapping increased during the summer and no fly were caught during the winter and spring (Kounatidis *et al*., 2008; Burrack *et al*., 2011).

In the moistly region, El-Behera (2017 season), the positive correlation and significant were found between the temperature and the numbers of olive fly. While, the negative correlation was found between relative humidity % and the numbers of olive fly with traps . This result gives an indication that there is a climate change that occurred from 2016 to 2017.

Burrack *et al.* (2011) found that weather conditions significantly affect the growing season of the olive and consequently the bio-ecology of *B. oleae*. Indeed, the high relative humidity and temperatures softened even in summer (near the coast), cause an early start of the phenological olive tree stages and lead to attracted the adults female for oviposition and the development of the larval stages. Several previous studies indicated that a relatively large infestation of olives by the larvae of *B. oleae* in wetter areas, *i.e.*, areas of high altitudes, irrigated orchards and coastal areas (Zaoug, 1993; Belhamdounia, 1993; Afellah *et al*., 1997; Weems *et al*., 1999; Ordano *et al*., 2015; Mansour *et al*., 2015).

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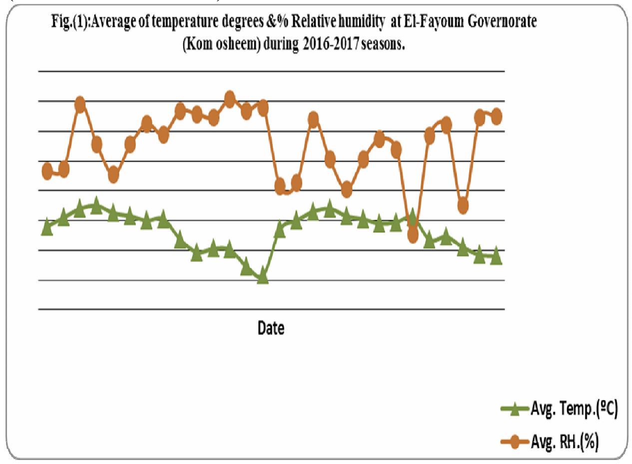

Table 1 : Efficacy of two mass-trapping devices for surveying of numbers the olive fly, *B. oleae* during two seasons at two regions.

Date of inspection	El-Fayoum Komoshem		El-Behera Wadi El-Natrun	
	McPhail –Type Trap/ 5 trees	Yellow sticky panels-Messy/ 5 trees	McPhail –Type Trap/ 5 trees	Yellow sticky panels-Messy/ 5 trees
	Avg. No. of *B. oleae* adults ± SE			
First season				
1/6/2016	27.0±1.92	32.0±3.56	62.0±4.25	59.0±4.18
15/6/2016	34.0±4.07	45.0±5.4	74.0±5.39	84.0±4.06
1/7/2016	48.0±6.17	69.0±6.0	98.0±5.27	98.0±5.2
15/7/2016	77.0±4.9	79.0±4.9	101.0±5.61	111.0±6.4
1/8/2016	78.0±6.22	85.0±4.7	112.0±6.47	122.0±5.88
15/8/2016	88.0±4.16	98.0±4.1	124.0±3.16	134.0±4.2
1/9/2016	95.0±5.37	101.0±5.61	136.0±3.96	139.0±5.32
15/9/2016	93.0±2.23	122.0±3.16	139.0±9.91	145.0±9.81
1/10/2016	65.0±5.28	85.0±6.73	88.0±3.39	166.0±11.35
15/10/2016	55.0±5.06	77.0±4.98	75.0±6.41	145.0±9.85
1/11/2016	42.0±5.48	72.0±5.06	61.0±3.88	132.0±5.43
15/11/2016	25.0±3.2	44.0±5.06	41.0±2.76	86.0±4.41
1/12/2016	12.0±2.21	20.0±1.31	31.0±3.37	42.0±5.26
15/12/016	3.0±0.5	14.0±3.2	17.0±5.6	35.0±4.2
Efficacy % of trap	44.0	56.0	43.6	56.4
Second season				
1/6/017	56.0±4.0	85±6.5	63.0±3.4	92.0±5.2
15/6/017	87.0±7.2	96.0±8.2	76.0±4.6	105.0±12.4
1/7/2017	122.0±9.07	155.0±10.66	220.0±24.37	310.0±32.88
15/7/2017	166.0±7.74	210.0±15.0	362.0±10.11	455.0±16.27
1/8/2017	186.2±5.43	255.6±10.18	466.4±12.44	522.4±14.22
15/8/2017	199.0±7.16	289.6±36.73	496.0±14.80	587.6±33.96
1/9/2017	318.6±23.68	366.0±8.84	512.6±18.30	645.4±35.25
15/9/2017	424.2±35.12	482.8±4.24	566.0±9.42	788.6±10.08
1/10/2017	96.2±3.12	75.0±9.88	79.2±7.09	180.0±6.80
15/10/2017	55.0±9.06	73.0±2.71	76.6±7.32	171.0±39.57
1/11/2017	47.0±9.32	69.0±5.42	65.4±6.25	150.2±6.38
15/11/2017	27.0±4.0	45.0±6.72	50.0±6.98	85.0±5.95
1/12/2017	13.0±2.12	15.0±1.64	25.0±2.56	35.6±3.34
15/12/2017	2.0±0.44	5.0±0.83	8.8±1.69	15.0±1.38
Efficacy % of trap	44.7	55.3	42.5	57.5

Table 2 : Correlation analysis between effect the Temperature and relative humidity % on Average number of *B. oleae* adults that capture with two traps in El- Fayoum & El-Behera Governorates.

Governorate		Temperature (ºc) & %Relative Humidity	Correlation	Avg. No. of *B. oleae* adults	
				McPhail Trap	Yellow Trap
El-Fayoum	2016	Temperature (ºc)	Pearson correlation	0.678**	0.599**
			Significant	0.000	0.000
		%Relative Humidity	Pearson correlation	-0.264*	-0.216
			Significant	0.027	0.298
	2017	Temperature (ºc)	Pearson correlation	0.562**	0.578**
			Significant	0.000	0.000
		%Relative Humidity	Pearson correlation	0.005	0.127
			Significant	0.970	0.824
El-Behera	2016	Temperature (ºc)	Pearson correlation	0.831**	0.273*
			Significant	0.000	0.022
		%Relative Humidity	Pearson correlation	-0.548**	0.103
			Significant	0.000	0.396
	2017	Temperature (ºc)	Pearson correlation	0.831**	0.546**
			Significant	0.000	0.000
		%Relative Humidity	Pearson correlation	-0.548**	0.078
			Significant	0.000	0. 522

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

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