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FACTORS REGULATING THE POPULATION TRENDS OF THE PEACH FRUIT FLY BACTROCERA ZONATA (SAUNDERS) (DIPTERA: TEPHRITIDAE) ATTACKING GUAVA AND MANDARIN TREES IN ASSIUT, UPPER EGYPT

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ABSTRACT

Determination of the factors responsible for regulating the population trends of the peach fruit fly (PFF) Bactrocera zonata (Saunders) attacking guava and mandarin trees in three mixed orchards (Manfalut, Hawatka and Hawatka-Gazera) in Assiut, Northern Upper Egypt, was the cornerstone of this investigation. Regardless of the examined sites, the highest populations (peaks) of B. zonata were recorded in October during both of 2010 and 2011 guava and mandarin fruiting seasons. Peak average of 58.06 and 108.92 individuals/1 lure trap were found to be constituted 42.82 and 50.74% of the total attracted males to lure traps hanging on guava trees throughout both seasons. The peak of the pest during 2011 is equal 1.88 fold of this recorded in 2010 guava fruiting season. Appearance of the pest in high numbers at Hawatka orchards is due to the presence of guava trees in high numbers in this site than the other examined sites. Similar trends were recorded in mandarin. In general, numbers of B. zonata males attracted to lure traps hanging on mandarin trees recorded high values than those attracted to lure traps hanging on guava trees. It is clear that, peaks of B. zonata were coincided with guava ripening period and mandarin coloration period. Relative efficiency of fruit age and the ambient weather factors on variability of B. zonata population trends revealed that, fruit age ranked as the first between factors responsible for regulating the pest populations. However, maximum air temperature ranked as the second factor. Maximum relative humidity reveals some sort of responsibility in regulating the pest populations. The rest of the variables combined together had less efficiency. The coefficient of determination values refer to the responsibility of 76.10 and 88.60% of the examined variables for males attractant to lure traps hanging on guava trees during both of 2010 and 2011seasons, respectively. Unknown factors were predicted to responsible for 23.90 and 11.40% of the coefficient of determination. The same trend was detected on the pest behavior attracted to lure traps hanging on mandarin trees.

Keywords: *Bactrocera zonata, population trends, guava, mandarin, plant age and abiotic factors.*

INTRODUCTION

The peach fruit fly (PFF), Bactrocera zonata (Saunders) originates in South and South-East Asia, where it attacks many fruit species (more than 50 host plants), including guavas, mangoes, peach, apricots,

figs and citrus. In 1924, B. zonata was declared present in Egypt (White & Elson-Harris, 1992). Recently, this insect pest has spread to other parts of the world, in particular several countries of the Near East (Solangi et al., 2014). It is one of the most dominant and destructive key pests in fruit orchards in different agro-ecosystems. So, monitoring adult's population fluctuations in orchards has been considered as the main way to forecasting or management the pest (Draz et al., 2016). In Upper Egypt, attempts are being made to determine its population trend (Abdel-Galil, 2007; Abdel-Galil et al., 2010; Sayed, 2012). In the same area, its control by a regional integrated management approach was studied by Mohamed, 1993, 2002; Darwish, 2013; Darwish et al., 2014 and 2015. Many authors are interested in monitoring and studying population fluctuation of PFF males worldwide by using methyl eugenol, such as: Rai et al. (2008), Deepa et al. (2009), Dale & Patel (2010), Venkatachalam et al. (2014) and Sundar et al. (2015). This manuscript aimed to determine the population trends of B. zonata attacking guava and mandarin trees in mixed orchards in Assiut, Upper Egypt. Also, it aimed to through a beam of light on factors responsible for regulating the population trends of this insect pest.

MATERIALS AND METHODS

1- Population trends of B. zonata invading guava and mandarin mixed orchards

1.1. The experimental sites

Field experiments are carried out in three mixed orchards located at Manfalut district, Assiut Governorate, Northern Upper Egypt (360 Km, South of Cairo), during 2010-2011 seasons. The three orchards squares were 9, 7.5 and 3 feddans for Manfalut, Hawatka and Hawatka-Gazera, respectively. These sites are selected because they harbored the major cultivated fruit hosts grown in this region and they commonly infested by the native and invading fruit flies.

1.2. Fly trapping and population trends

Abdel-Kawi trap (Abdel-Galil, 2007) was used (Figure 1) to collect the peach fruit fly. Traps were provided by 0.5 ml Methyl eugenol as a synthetic insect lure which has been used for the male specific para pheromone (1-2-dimethoxy-4-(2-propenyl) benzene) (Hee & Tan, 2004). The traps were provided with poisoned solution. Three traps (replicates) were distributed in each orchard randomly and hanged on guava and mandarin trees at height of 1.5-2 meters from the ground surface. Traps were left on the selected trees and provided with the pheromone twice weekly. Traps were changed weekly all over the study period (July-November). The numbers of caught males were counted. Mean numbers of males/trap were statistically analyzed by F- test and means were compared by Duncan's multiple range tests, according to Snedecor & Cochran (1971).

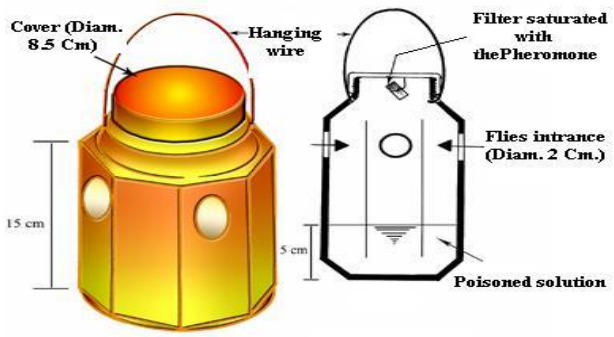

Figure (1): Abdel-Kawi Trap

2. Impact of plant age and the ambient weather factors on B. zonata population trends

The relationship between the populations of B. zonata and fruits age (days) as well as some weather factors were estimated. Temperature (max. and min.), relative humidity (max. and min.) and the soil temperature (5 and 10cm) under the soil surface were obtained from the meteorological station located at Assiut University experimental farm. Co-efficient of determination was also estimated.

RESULTS AND DISCUSSION

1- Population trends of B. zonata invading guava and mandarin mixed orchards

Monthly population trends of B. zonata males attracted to lure traps hanging on guava trees was clarified in Table (1). Throughout the first season of study (2010), gradual increase of the pest numbers was recorded until the appearance of its peak in October with an average of 58.06 individuals/trap. Suddenly decrease in the pest populations was recorded in November. It is clear that Hawatka location harbored the highest numbers of the pest and constituted 1.73 and 5.22 fold of those recorded in Hawatka-Gazera and Manfalut locations, respectively. Variations between inspection months and/or the tested locations showed highly significant values during 2010 season (f=537.5 and 702.9**) as well as 2011(f=3951.6** and 2711.3**) respectively. This finding could be attributed to the presence of guava trees in high densities (40 trees) in the first location than the latters (35 and 10 trees, respectively). Similar trend was recorded during the second season of study, 2011. It is important to note that, the insect pest peak recorded in 2011 was found to be equal 1.88 fold of this recorded in 2010 season. Changes of the ambient weather factors could be responsible for this justification increase.**

Concerning the monthly population trends of B. zonata males attracted to lure traps hanging on mandarin trees, data in Table (2) revealed that the pest attack mandarin trees all over the study period. Also, gradual increase of the pest numbers was recorded until the appearance of its peak with an average of 69.16 and 171.68 individuals/trap in October 2010 and 2011, respectively. Variations between inspection months and/or the tested locations showed highly significant values during both years of study. In holding a comparison between the results recorded in Tables (1, 2 &3), peaks of B. zonata were coincided with guava ripening periods and mandarin coloration periods. Determination of the pest peak appearance in the examined areas should be led to the suitable time for its control.

The current study results are in accordance with those obtained by Mohamed (1993), who reported that the high score of fruit flies in the same area of study was caught throughout October, November and December, while a moderate numbers were obtained during February and May. In different environmental circumstances, in Fayoum governorate, results obtained by Amin (2003) indicated that B. zonata adults were active all over the year except the periods of cold weather whereas no attracted flies were recorded. In semi-tropical circumstances, in the new valley oases, Abdel-Galil et al. (2010) recorded two annual peaks of B. zonata in Kharga oases throughout May and September and coincided with the ripening periods of apricot, mango and guava. Therefore, fruits ripening period could be play an important role in regulating B. zonata population trends. Also, the examined location meridians and latitudes could be responsible for regulating B. zonata populations.

2. Impact of plant age and the ambient weather factors on B. zonata population trends

Data presented in Table (4) exhibited the relative efficiency (re) of fruit age (days) and the ambient weather factors [temperature (max. and min.), relative humidity (max. and min.) and the soil temperature (5

and 10cm) under the soil surface] on variability of B. zonata males attracted to lure traps hanged on guava trees during 2010 and 2011 fruiting seasons. Coefficient of determination was also estimated. Fruit age ranked as the first factor responsible for regulating B. zonata populations with (re=52.219 and 60.420) during 2010 and 2011 seasons, respectively. It followed by maximum air temperature (C°) with (re=13.373 and 13.066) and maximum relative humidity with (re=7.358 and 11.570) during both fruiting seasons, respectively. The rest of the tested factors showed less relative efficiency values. The coefficient of determination value of all dependent variables under investigation was 0.761 in 2010 and 0.886 in 2011 seasons. This finding refers to the responsibility of 76.1 and 88.6 % of the variables for male attracted to lure traps. So, other dependent variables can be responsible for 23.9 and 11.4% for male attractant to lure traps hanging on guava trees.

Data presented in Table (5) exhibited the relative efficiency of fruit age (days) and the same weather factors on variability of B. zonata males attracted to lure traps hanging on mandarin trees during 2010 and 2011 fruiting seasons. Fruits age (days) also, appeared as the first factor responsible for regulating B. zonata populations with (re=42.612 and 30.555) and followed by the maximum air temperature (C°) with (re=10.611and 30.299), while the maximum relative humidity ranked as the third factor with (re=8.228and 17.209) during both fruiting seasons, respectively. The rest of the tested factors showed less relative efficiency values. The coefficient of determination values of all dependent variables revealed similar impact on B. zonata male's attractant to lure traps hanging on mandarin trees.

Fletcher (1989) had agreement results with those obtained in this manuscript. He mentioned that temperature plays a dominant role in the rate of development of immature stages of B. zonata and consequently determines the timing of population increase. In the tropical region (India), Agarwal et al. (1999) supported the current study to some extent where B. zonata population had a positive correlation with maximum temperature. In a temperate region (Thessaloniki - Greece), Papadopoulos et al. (2001) indicated that the drop of temperature could be the main factor determining the end of adult activity of Ceratitis capitata.

In the Egyptian western desert (Fayoum Governorate), Amin (2003) found that the maximum temperature was only the significant factor affecting B. zonata populations. In Assiut (Upper Egypt), results obtained by Sayed (2012), indicated a highly significant correlation between B. zonata populations and both maximum and minimum temperature. So, results confirm that temperature seems to be an important factor affecting the fly population activities. Also, insignificant correlation is shown between relative humidity and the pest population. Conversely, the results obtained by Darwish (2013) **explained that because of immature stages (larvae and pupae) of PFF are not exposed to the direct effects of climatic factors as they are protected either inside the fruits in case of larvae or inside the soil in case of pupae, results pointed to that temperature and other weather factors are not the main factors affecting PFF population and there might be another factor affecting its population. On the other hand, the results obtained by El-Gendy & Nassar (2014), revealed that abiotic factors (max- and min- temperature and relative humidity) are correlated significantly with the number of fruit flies of PFF. So, the above-mentioned discussion emphasized the importance of more advanced studies on the biotic and abiotic factors responsible for the population dynamics of fruit flies.**

Table (1): **Monthly population trends of Bactrocera zonata males attracted to lure traps hanging on guava trees at three localities of Assiut Governorate during 2010 and 2011 fruiting seasons.**

Sampling date (month)	Fruits age (day)	Mean number of individuals/1 lure trap 2010			Mean	Mean number of individuals/1 lure trap 2011			Mean
		Manfalut	Hawatka	Hawatka - Gazera		Manfalut	Hawatka	Hawatka - Gazera	
July	30	2.40	3.20	1.40	2.33 E	2.33	2.42	3.92	2.89 E
Aug.	60	4.92	12.42	27.84	15.06 D	7.27	11.07	7.40	8.58 D
Sept.	90	18.33	58.33	24.47	33.71 B	6.50	63.58	61.75	43.94 C
Oct.	120	15.33	90.08	68.75	58.06 A	19.08	167.30	140.37	108.92 A
Nov.	150	3.00	65.75	10.50	26.42 C	25.27	73.33	52.40	50.33 B
Mean		8.80 C	45.96 A	26.59 B		12.09 C	63.54 A	53.17 B	
F value		702.9**			537.5**	2711.3**			3951.6**

Means followed by the same letter in each column are not significantly different at 0.05 level of probability by Duncan's multiple range tests.

Table (2): **Monthly population trends of Bactrocera zonata males attracted to lure traps hanging on mandarin trees at three localities of Assiut Governorate during 2010 and 2011 fruiting seasons.**

Sampling date (month)	Fruits age (day)	Mean number of individuals/1 lure trap 2010			Mean	Mean number of individuals/1 lure trap 2011			Mean
		Manfalut	Hawatka	Hawatka - Gazera		Manfalut	Hawatka	Hawatka - Gazera	
July	70	0.00	3.50	0.00	1.17 E	0.00	5.53	5.40	3.64 E
Aug.	100	0.58	18.92	28.08	15.86 D	5.50	59.83	44.00	36.44 C
Sept.	130	13.13	30.93	29.53	24.53 C	46.83	196.47	178.93	140.74 B
Oct.	150	61.67	114.63	31.17	69.16 A	24.75	235.03	255.27	171.68 A
Nov.	180	11.08	66.58	26.17	34.61 B	15.13	15.58	22.50	17.74 D
Mean		17.29 C	46.91 A	22.99 B		18.44 B	102.49 A	101.22 A	
F value		1513.8**			6862.4**	2400.4**			10438.6**

Means followed by the same letter in each column are not significantly different at 0.05 level of probability by Duncan's multiple range tests.

Table (3): Coloration and ripening periods of guava and mandarin fruits during 2010 and 2011 fruiting seasons.

Host plant	Season	Site	Coloration period	Ripening period
Guava	2010	Manfalut	4th week of July-3rd week of Aug.	4th week of Aug. - 3rd week of Oct.
		Hawatka	Mid July-mid Aug.	3rd week of Aug. - 3rd week of Oct.
		Hawatka-Gazera	Mid July -3rd week of Aug.	4th week of Sept. - 4th week of Oct.
	2011	Manfalut	3rd week of Aug -1st week of Sept.	2nd week of Sept. - 2nd week of Oct.
		Hawatka	1st week of Aug-4th week of Aug.	4st week of Sept. - 4th week of Nov.
		Hawatka-Gazera	1st week of Aug-4th week of Aug.	4st week of Sept. - 4rd week of Oct.
Mandarin	2010	Manfalut	4th week of Oct. - 4th week of Nov.	1st week - 4th week of Dec.
		Hawatka	3rd week of Oct. - 4th week of Oct.	1st week - 4th week of Nov.
		Hawatka-Gazera	4th week of Oct. - 3rd week of Nov.	4th week of Nov. - 1st week of Dec.
	2011	Manfalut	1st week of Oct. - 4th week of Oct	1st week of Nov. - 4th week of Dec.
		Hawatka	3rd week of Oct. - 4th week of Nov.	1st week - 2nd week of Dec.
		Hawatka-Gazera	1st week of Oct. - 4th week of Nov.	1st week of Dec.

Table (4): Relative efficiency of fruits age and ambient weather factors on variability of Bactrocera zonata males attracted to lure traps hanging on guava trees during 2010 and 2011 fruiting seasons.

Climatic factors		Relative efficiency	
		2010	2011
Fruits Age(day)		52.219(1)	60.420(1)
Air Temperature (C°)	Max.	13.373(2)	13.066(2)
	Min.	0.089(8)	0.846(6)
Relative humidity	Max.	7.385(3)	11.570(3)
	Min.	0.002(9)	0.960(5)
Soil temp. (C°) 5 cm	Max.	0.787(5)	0.261(7)
	Min.	0.620(6)	0.248(8)
Soil temp. (C°) 10 cm	Max.	1.530(4)	0.161(9)
	Min.	0.090(7)	1.069(4)
Co-efficient of determination		0.761	0.886

Numbers between parentheses= ranking order

Table (5): Relative efficiency of fruits age and ambient weather factors on variability of Bactrocera zonata males attracted to lure traps hanging on mandarin trees during 2010 and 2011 fruiting seasons.

Climatic factors		Relative efficiency	
		2010	2011
Fruits Age(day)		42.612(1)	30.555(1)
Air Temperature (C°)	Max.	10.611(2)	30.299(2)
	Min.	0.002(9)	3.658(4)
Relative humidity	Max.	8.228(3)	17.209 (3)
	Min.	6.323(4)	0.566(8)
Soil temp. (C°) 5 cm	Max.	0.084(8)	2.026(6)
	Min.	0.110(7)	0.770(7)
Soil temp. (C°) 10 cm	Max.	0.536(6)	2.990(5)
	Min.	5.471 (5)	0.265(9)
Co-efficient of determination		0.740	0.884

Numbers between parentheses= ranking order

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العوامل المحددة لأتجاه مجاميع ذبابة الخوخ التي تهاجم أشجار الجوافة و اليوسفي في صعيد مصر

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الملخص :

تحديد العوامل المسئولة عن أتجاه مجاميع ذبابة الخوخ التي تهاجم أشجار الجوافة و اليوسفي في ٣ بساتين مختلطة (منفلوط و الحواتكة و جزيرة الحواتكة) بمحافظة أسيوط هي الهدف الرئيسي لهذه الدراسة. بغض النظر عن الموقع المختبر فقد تم تسجيل أعلي أعداد لذبابة الخوخ (القمة) في شهر اكتوبر لكل من موسمي أثمار الجوافة واليوسفي لعامي ٢٠١١ و ٢٠١٢م. سجل متوسط قمة الأفة ٥٨,٠٦ و ١٠٨,٩٢ فرد/ مصيدة مطعومة و التي مثلت ٤٢,٨٢% و ٥٠,٧٤% من المجموع الكلي للذكور المنجذبة للمصائد المطعومة المعلقة علي أشجار الجوافة خلال موسمي الدراسة ، علي التوالي. و قد سجلت قمة أعداد الأفة علي أشجار الجوافة ١,٨٨ مرة في الموسم ٢٠١١ قدر قيمتها في الموسم ٢٠١٠. ظهور الأفة بأعداد كبيرة في منطقة الحواتكة قد يعود لزيادة أعداد أشجار الجوافة في هذا الموقع عن الموقعين الأخرين. نفس الأتجاهات تم تسجيلها علي أشجار اليوسفي. بصفة عامة فقد وجد أن أعداد الذكور المنجذبة للمصائد المطعومة المعلقة علي أشجار اليوسفي تفوق مثيلتها المنجذبة للمصائد المطعومة المعلقة علي أشجارالجوافة. أوضحت النتائج أيضا أن قمة أعداد الأفة تزامنت مع فترة نضج الجوافة و فترة تلوين اليوسفي. أحصاء العلاقة بين أعداد الأفة و بين عمر الثمار و بعض العوامل غير الحيوية أظهر أن عمر الثمار أحتل المركز الأول فيما بين العوامل المسئولة عن أتجاه مجاميع الأفة. بينما أحتلت درجة الحرارة العظمي المركز الثاني. كما أظهرت درجة الرطوبة النسبية العظمي درجة من هذه المسئولية. أما باقي العوامل مجتمعة فقد أظهرت تاثير أقل علي أتجاه مجاميع الأفة. أشار معامل التحديد ألي مسئولية ٧٦,١ و ٨٨,٦ % من العوامل المختبرة عن أنجذاب ذكور الأفة الي المصائد المطعومة المعلقة علي أشجار الجوافة خلال موسمي ٢٠١٠ و ٢٠١١ ، علي التوالي. و بالتالي فأن مسئولية ٢٣,٩% و ١١,٤٠% عن أنجذاب الأفة لهذه المصائد يعزي ألي عوامل غير معروفة. أظهر معامل التحديد نفس الأتجاه علي أنجذاب ذكور الأفة الي المصائد المطعومة المعلقة علي أشجار اليوسفي.