

Field Evaluation of Different Chemical Compounds in Attracting the Mediterranean Fruit Fly, *Ceratitis capitata* Wied: (Diptera, Tephritidae) Using Makkar and El-Abbassi Plastic Trap

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ABSTRACT

Field experiments were conducted to evaluate the efficiency of Makkar and El-Abbassi plastic trap loaded with four attractant sachets against the Mediterranean fruit fly *Ceratitis capitata* (Wied). Trials were carried out in two different locations, at El-Santa, Gharbia Governorate within the period from November 24th 2015 till January 17th 2016, and at Aga, Dakahlia Governorate within the period from February 29th 2016 till April 26th 2016. The two locations were cultivated with citrus tress. Results revealed that, Makkar and El-Abbassi trap loaded with sachets mounted with the three component lures (Ammonium acetate + Putrescine + Trimethylamine), treatment (D) captured more flies where compared with the other treatments throughout the period of experiment (16 weeks), meanwhile, the lowest cumulated number of captured flies was in traps baited with treatment (A), (Ammonium acetate). Treatment (C) (Ammonium acetate + Diammonium phosphate + Trimethylamine) captured reasonable high number of flies when compared with the other treatments (A and B). Data showed also that the highest percentages of captured females throughout four periods were in treatment (D) (92.2 %). Statistical analysis showed non significant differences between treatment (D) and treatment (C). Results obtained from this study revealed that *C. capitata* could be controlled by applying mass trapping technique, treatment (D) a better option for mass trapping.

Keywords: Mediterranean Fruit Fly, Ammonium acetate, Diammonium phosphate, Putrescine and Trimethylamine

INTRODUCTION

The Mediterranean Fruit Fly, *Ceratitis capitata* (Wied) is one of the world's most destructive and injurious fruit pests. It is widely distributed and the list of its host range is long and diverse (White and Elson-Harris 1994). Cohen and Yuval (2000) pointed out that *Ceratitis capitata* is polyphagous and as such uses the various hosts in its environment as stepping stones, moving from one to another as fruit mature throughout the season. It is high priority quarantine pest, therefore intensive control applications against this pest in the fruit growing areas are applied. Recently, research and development of effective control methods as alternative to chemical control are needed. These methods could include the use of traps baited with the female targeted and male targeted lures (Papadopoulas *et al.*, 2001; Broughton and De Lima, 2002; Heath *et al.*, 2004 and Tóth *et al.*, 2004).

Tephritids use both visual and chemical signals to locate and access habitat, adult food, oviposition sites and mating resources. Plant chemical cues play a crucial role in mediating host finding and oviposition (Fletcher and Prokopy, 1991). Epsky and Heath (1998) and Hull and Cribb (2001) revealed that, ammonia releasing substances play an important role in fruit fly attraction to food sources. Piñero *et al.*, (2015) showed that ammonia and its derivatives are used by female fruit flies (Diptera: Tephritidae) as volatile cues to locate protein-rich food needed to produce their eggs. Heath *et al.*, (1997) stated that addition of trimethylamine to traps baited with ammonium acetate and putrescine increased capture of *C. capitata*. Ros, *et al.*, (1997) found that combination of the three components putrescine, ammonium acetate and trimethylamine slow release membranes glued inside the tephri fly catcher was Mosquero mixing and more attractive to *C. capitata* females. Leblance *et al.*, (2010) stated that Biolure, a synthetic food attractant for *C. capitata* which composed of three chemicals (ammonium acetate, trimethylamine hydrochloride and putrescine) attracted very few predators, parasitoids or pollinators. Makkar, *et al.*, (2015) evaluated Makkar and El-Abbassi trap and its modifications for attracting adult males of peach fruit fly. In

the same trend, Makkar, *et al.*, (2016) evaluated Makkar and El-Abbassi trap in attracting the (MFF) *C. capitata* as an alternative to standard traps. So, the objective of the present work was the evaluation of fruit fly attractants for *C. capitata* under Egyptian condition, and assessment of the cost effectiveness of the various products.

MATERIALS AND METHODS

Experimental locations:

The present experiment was carried out in two different locations. First location was at El-Santa district, Gharbia governorate, where about 25 feddans were cultivated with novel orange. Second location was carried out at Aga district, Dakahlia Governorate, where about 20 feddans were planted with valencia orange (*Citrus sinensis* var. Valencia).

Duration and conditions of trials:

Evaluation of four tested attractant materials started from date of hanging traps in of November 24th 2015 till April 26th 2016 and divided into four periods (A, B, C, D). Maximum, minimum and average of temperature and relative humidity in each period, were recorded.

A- First period: from November 24th till December 22th 2015

Avg. Temp. (Min-Max) = 16.6 (12.9-20.4).

Avg. RH. (Min-Max) = 53.7 (33.6-73.7).

B- Second period: from December 22th 2015 till January 17th 2016

Avg. Temp. (Min-Max) = 13.8 (9.2-18.4).

Avg. RH. (Min-Max) = 54.9 (36.4-73.5).

C- Third period: from February 29th 2016 till March 28th 2016

Avg. Temp. (Min-Max) = 17.3 (12.1-22.4).

Avg. RH. (Min-Max) = 61.5 (42.8-80.2).

D- Fourth period: from March 30th till April 26th 2016

Avg. Temp. (Min-Max) = 20.1 (13.9-26.3).

Avg. RH. (Min-Max) = 63.2 (43.8-82.6).

Evaluation extended for four weeks per each period.

Description of experimental plot:

The experimental area in each location was divided into four blocks, each of 4 feddans and about 0.5 feddan was left between every two blocks. Each block was

devoted for Makkar & El-Abbassi trap (4 traps (replicates) were prepared with four treatments. These traps were arranged in complete randomized block design, and hanged at a height of 150- 170 cm above ground on the southern external branches of trees. The distance between each two successive traps was 40 meters. Traps were checked and rotated per week. Dead and captured males and/or females were counted and removed after each trap check.

Trap type was used to catch medfly:

The second modified shape of Makkar & El-Abbassi trap was used (Makkar et al., (2015). A film of insecticide Deltamthrine (0.2 mg.) was smeared on the lower side of trap lid which acted as a killing agent (retention system), El- Abbassi et al., (2017) in press.

Tested attractant materials:

- 1- Ammonium acetate (AA)
- 2- Diammonium phosphate (DAP)
- 3- Putrescine (PT)
- 4- Trimethylamine (TMA)

Each treatments was used as follows:

All treatments were prepared as a new wetted lure bag.

- A- (AA)
- B- (AA) + (DAP) + (PT)
- C- (AA) + (DAP) + (TMA)
- D- (AA) + (PT) + (TMA)

These traps and lures were innovated by Research & Development Department- National Area- wide Fruit Flies Extermination Program.

Statistical analysis:

Number of captured males and/or females were recorded; values of captured flies per trap per day (CTD) and

percentages of males and/or females were calculated. Statistical analysis was fulfilled using a completely randomized design.

RESULTS

Data in the first location show response of Mediterranean fruit fly, *C. capitata* to different attractant materials when inspected under field conditions in navel orange at El-Santa district, Gharbia governorate. Data represented in Table (1) show cumulated mean number of medflies (males and/or females) captured/trap/week; at the first period (November 24th till December 22th 2015). Results showed that, Makkar & El-Abbassi trap with three component lure Ammonium acetate (AA) + Putrescine (PT) + Trimethylamine (TMA), treatment (D) captured (538 flies) with mean (134 ± 72.96) more than the other treatments within this period. Treatment (C) ((AA) + Diammonium phosphate (DAP) + (TMA)) captured higher number of flies when compared with two treatments (A) and (B). In all treatments females were highly attracted than males. Also data presented in Table (1) clearly show that the highest percentage of captured females at the first period in treatment (D) was 82.3% while, the highest percentage of captured males in treatment (A) was 20%. In the same time, data clearly showed that there was non significant differences between treatment (D) and treatment (C), while, there was significant difference in mean number of captured flies between treatment (D,C) and treatments (A,B), where the computed (F) values was 7.5 and L.S.D. = 69.2. The climatic conditions recorded in this period, characterized by Avg, daily temperature (16.6 °C), and Avg. relative humidity (RH) 53.7%.

Table 1. Mean number, CTD values and percentages of captured medfly adults (Males and/or females) inside Makkar & El-Abbassi traps throughout a period of four weeks in navel orange at the first period (November 24th till December 22th) 2015

Treatments	Means ± SD	CTD	% of captured medfly adults		Total of males and females
			♂	♀	
A-(AA)	8.75 ± 7.6 a	0.31	20.0	80.0	35
B- (AA) + (DAP) + (PT)	7.75 ± 2.9 a	0.28	19.4	80.6	31
C- (AA) + (DAP) + (TMA)	81.25 ± 25.6 b	2.9	17.8	82.2	325
D-(AA) + (PT) + (TMA)	134 ± 72.96 b	4.8	17.7	82.3	538
Computed (F)	7.5				929
Tabulated (F) at level 5% of 3.12			3.49		
L.S.D.			69.2		

Means followed by the same letters are not significantly different at 5% level.

Data presented in Table (2) show cumulated mean number of medflies (males and/or females) captured/trap/day; at the second period (December 22th 2015 – January 17th 2016). The climatic conditions recorded in this period, characterized by Avg, daily temperature (13.8°C), and Avg. relative humidity (RH) 54.9%. The medfly population during this period was very low (191). Table (2) indicate mean weekly captures of *C. capitata* for treatments A-D. Despite the extremely low fly capture rate, the three component lure treatment (D) (AA + PT + TMA) was significantly more efficient than other tested treatments A and B. Treatment (C) (AA + DAP + TMA) showed light increase in captured flies when compared with other treatments A and B. Also, all baits showed marked selectivity for females. In the same time, data represented in Table (2) clearly show that the highest percentage of captured females at the second period was recorded in treatment (D) 76.5%,

while the highest percentage of captured males in treatment (A) was 50%. Data show also there was non significant difference between treatment (D) and treatment (C), while there was significant difference in mean number of captured flies between treatment (D) and treatments (A and B), where the computed (F) value was 4.4 and L.S.D. = 21.9.

Data in the second location show response of Mediterranean fruit fly, *C. capitata* to different attractant materials when inspected under field conditions in valencia orange (citrus sinensis var. Valencia) at Aga district, Dakahlia Governorate. Data shown in Table (3) represent cumulated mean number of medflies (males and/or females) captured/trap/day; at the third period (February 29th – March 28th 2016). The climatic conditions recorded in this period, represented by Avg, daily temperature and Avg. relative humidity were 17.3°C and (RH) 61.5%, respectively. The medfly population during this period was low (456). Makkar

& El-Abbassi traps: attracted both sexes of *C. capitata* in all treatments. Also, traps attracted more females than males. The highest cumulated mean number of captured/trap/day was 60.5 ± 33.7 in case of treatment D (AA + PT + TMA).

Meanwhile, the lowest cumulated mean number of captured/trap/day were 8.5 ± 4.3 and 15.0 ± 6.7 in case of treatments (A and B) respectively.

Table 2. Mean number, CTD values and percentages of captured medfly adults (Males and/or females) inside Makkar & El-Abbassi traps throughout a period of four weeks in navel orange at the second period (December 22th 2015 – January 17th 2016)

Treatments	Means ± SD	CTD	% of captured medfly adults		Total of males and females
			♂	♀	
A-(AA)	1.0 ± 1.7 a	0.04	50.0	50.0	4
B- (AA) + (DAP) + (PT)	5.0 ± 1.2 a	0.18	35.0	65.0	20
C- (AA) + (DAP) + (TMA)	7.75 ± 3.6 ab	0.28	35.0	64.5	31
D-(AA) + (PT) + (TMA)	34.0 ± 24.3 b	1.20	23.5	76.5	136
Computed (F)	4.5				191
Tabulated (F) at level 5% of 3.12			3.49		
L.S.D.			21.9		

Means followed by the same letters are not significantly different at 5% level.

Data in table (3) clearly show that the highest percentage of captured females at this period in treatment (B) was 95%, while the highest percentage of captured males in treatment (D) was 10.3%. Data show also that there were non significant differences between

treatments (A, B and C) while, there was significant difference in mean number of captured flies between treatment (D) and treatments (A, B and C), where the computed (F) value was 3.8 and L.S.D. = 36.7.

Table 3. Mean number, CTD values and percentages of captured medfly adults (Males and/or females) inside Makkar & El-Abbassi traps throughout a period of four weeks in Valencia orange at the third period (February 29th – March 28th 2016).

Treatments	Means ± SD	CTD	% of captured medfly adults		Total of males and females
			♂	♀	
A-(AA)	8.5 ± 4.3 a	0.30	5.9	94.1	34
B- (AA) + (DAP) + (PT)	15.0 ± 6.7 a	0.54	5.0	95.0	60
C- (AA) + (DAP) + (TMA)	30.0 ± 22.5 a	1.07	12.5	87.5	120
D-(AA) + (PT) + (TMA)	60.5 ± 33.7 b	2.16	10.3	89.7	242
Computed (F)	3.8				456
Tabulated (F) at level 5% of 3.12			3.49		
L.S.D.			36.7		

Means followed by the same letters are not significantly different at 5% level.

Data presented in Table (4) show cumulated mean number of medflies (males and/or females) captured flies/trap/day; at the fourth period (March 30th – April 26th 2016). The climatic conditions recorded in this period, represented by Avg. daily temperature and Avg. relative humidity showed 20.1°C and (RH) 63.2%, respectively. The medfly population during this period was high (1697).

The highest cumulated mean number of captured/trap/day were (153.50 ± 58.4) and (152.25 ± 22.5) in case of treatments (D) (AA + PT + TMA) and (C) (AA + DAP + TMA), respectively. Meanwhile, the lowest cumulated mean number of captured flies/trap/day was (46.00 ± 30.3) in case of treatment (A) (AA).

Table 4. Mean number, CTD values and percentages of captured medfly adults (Males and/or females) inside Makkar & El-Abbassi traps throughout a period of four weeks in Valencia orange at the fourth period (March 30th – April 26th 2016).

Treatments	Means ± SD	CTD	% of captured medfly adults		Total of males and females
			♂	♀	
A-(AA)	46.00 ± 30.3 a	1.6	16.3	83.7	184
B- (AA) + (DAP) + (PT)	72.50 ± 5.0 ab	2.6	13.1	86.9	290
C- (AA) + (DAP) + (TMA)	152.25 ± 22.5 b	5.4	12.5	87.5	609
D-(AA) + (PT) + (TMA)	153.50 ± 58.4 b	5.5	7.8	92.2	614
Computed (F)	3.69				1697
Tabulated (F) at level 5% of 3.12			3.49		
L.S.D.			88.5		

Means followed by the same letters are not significantly different at 5% level.

Data revealed also that the highest percentages of captured females at this period was in treatment (D) (92.2%), while the highest percentage of captured males in treatment (A) was 16.3%. There were non significant differences between treatments (A) and (B), likewise, there were non significant differences between treatments (B, C and D), while there were significant difference in mean number of captured flies between treatments (C, D) and treatments (A, B), where the computed (F) value was 3.69 and L.S.D. = 88.5. Total

number of *C. capitata* females captured inside Makkar and El-Abbassi traps all over the period of experiment (16 weeks) are illustrated in (Fig. 1 and 2). Total number of captured medfly males and females were (1120 & 2153). During the first and second location, respectively. Also figures 1 and 2 clearly show that the highest total number of captured females at the two locations in treatment (D) (AA + PT + TMA) were 547 and 783 flies during the first and second location, respectively.

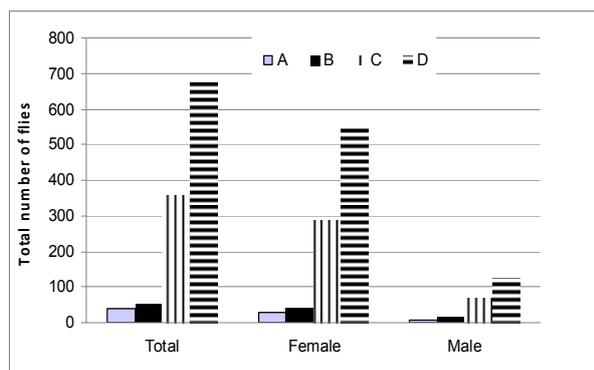


Fig. 1. Total cumulated number, males and females inside Makkar & El- Abbassi traps at first location.

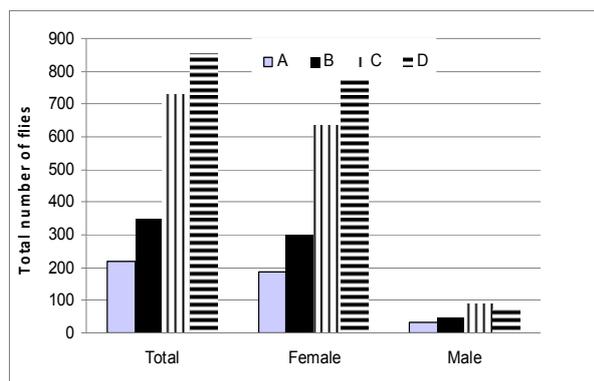


Fig. 2. Total cumulated number, males and females inside Makkar & El-Abbassi traps at second location.

DISCUSSION

The present investigation showed that in all treatments both sexes of medfly were attracted, however females were more attracted than males. Similar results were obtained by (Alemany *et al.*, 2004 and Braga Sobrinho *et al.*, 2004). In this study, it was found that, all four treatments showed marked selectivity for females. This results coincides with the findings of (Manrakhan *et al.*, 2017), who found that significantly more *C. capitata* females were trapped in three-component Biolure-baited Chempac Bucket trap (AA + TMA + PT) than in other lures (a combination of AA + TMA, a combination of AA + PT, torula yeast and Questlure in McPhail-type traps. In the same trend Ben Jemâa *et al.*, (2010) found that the percentage of captured *C. capitata* females was significantly higher than that of males in mandarin and washengton navel orange orchards. Also this data in almost in agreement with the findings of Alemany *et al.*, (2004) who found that mean percentage of *C. capitata* females captured in 125 traps placed in alternative trees using synthetic food attractants for females (ammonium acetate, putrescine and trimethylamine) was 79.3%. However, in this study, data revealed that the highest percentages of captures females of the fourth period was in treatment (D) (AA + PT + TMA) (92.2%). The present investigation showed that in all four periods there was non significant difference between treatment (D) (AA + Pt + TMA) and treatment (C) (AA + DAP + TMA). Similarly, Heath *et al.*, (2004) and Leblanc *et al.*, (2010) found non significant difference in number of captured *C. capitata* with

ammonium acetate and trimethylamine alone or in combination with putrescine unless population levels were very low (<1.0 and 0.3 females per trap per day, respectively)

CONCLUSION

Results obtained revealed that the three components lure (AA +PT + TMA) in Makkar and El-Abassi plastic trap with retention system (Deltamthrine 0.2 mg.) was the most efficient in capturing flies in the two tested locations and could be used in mass trapping technique for controlling this insect pest. Results showed that Makkar and El-Abassi trap with three components lure (AA +PT + TMA), treatment (D) captured flies more than other treatments at the two tested locations. All four lures showed marked selectivity for females. Treatment (C) (AA + DAP + TMA) was more efficient in capturing flies when compared with treatments A (AA). Synthetic food lures are more species specific than liquid portion baits whilst still maintaining dual sex attraction. Moreover, the lack of water in tested lures reduces the catch rates of beneficial insects and trash flies (Epsky *et al.*, 1999).

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تقييم حقلي لمركبات كيميائية مختلفة في جذب ذبابة فاكهة البحر المتوسط باستخدام مصيدة مقار والعباسي البلاستيكية عبد المسيح وهيه مقار ، طلال صلاح الدين العباسي و مصطفى مهرا ن المتولي معهد بحوث وقاية النباتات – مركز البحوث الزراعية -الدقي – الجيزة – مصر

أجريت تجارب حقلية لتقييم كفاءة مصيدة مقار والعباسي باستخدام أربع معاملات (أكياس جانبية) ضد ذبابة فاكهة البحر المتوسط. تم تنفيذ التجارب في منطقتين مختلفتين. في محافظة الغربية خلال الفترة من 24 نوفمبر 2015 وحتى 17 يناير 2016، وفي محافظة الدقهلية خلال الفترة من 29 فبراير وحتى 26 إبريل 2016 والمنطقتين مزروعتان بأشجار الموالح. أوضحت النتائج أن مصيدة مقار والعباسي مع الجاذب المكون من ثلاث مركبات (أمونيوم أسيتات + بنترولين + تراي ميثيل أمين) معاملة (د) كانت أكثر جذباً للذبابة من باقي المعاملات خلال فترة التجريبه (16 اسبوع) بينما كانت المعاملة (أ) المحتويه على أمونيوم أسيتات فقط هي أقل المعاملات جذباً للذبابة. وسجلت المعاملة (ج) والمكونه من (أمونيوم أسيتات + داي امونيوم فوسفات + تراي ميثيل أمين) أعلى قراءات بالمقارنه بالمعاملتين (أ) ، (ب). أيضاً أوضحت النتائج أن أعلى نسبة لجذب الإناث خلال الأربع قترات هي المعاملة (د) 92.2%. لقد أوضح التحليل الإحصائي عدم وجود فروق معنويه بين المعاملة (د) والمعامله (ج) خلال فترة التجريبه. توضح النتائج المتحصل عليها أن ذبابة فاكهة البحر المتوسط تقاوم بواسطة استخدام المصايد المكثفه وان المعامله (د) افضل اختيار لنظام المصايد المكثفه.