Efficiency of Mixing Methyl eugenol and Trimedlure to Attract Peach Fruit Fly, *Bactrocera zonata* and the Mediterranean Fruit Fly, *Ceratitis capitata* Males Under Field Conditions in Egypt

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Abstract

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Detection and control of the peach fruit fly, *Bactrocera zonata* (Saunders) and the Mediterranean fruit fly, *Ceratitis capitata* (Wiedmann) depends mainly on two male lures, methyl eugenol and trimedlure which are used individually in separate traps. This study was carried out under field conditions in three governorates in Egypt: Kafer –El sheikh, Sharqia and Ismailia to investigate the effect of mixing methyl eugenol and trimedlure in a single trap on the mean number of attracted male flies of *B. zonata* and *C. capitata* as compared to the same lures individually in separate traps. The study investigated also the effect of different concentrations (1, 2 and 3%) of ammonium acetate traps as well as the effect of different times of inspection and different locations of these two types of traps inside the orchards on the mean number of attracted flies. The results obtained showed that in the three governorates there was no significant difference in mean number of *B. zonata* male flies attracted to single methyl eugenol (9.86 male flies/trap/week) and those attracted to that mixed with trimedlure (10.16 male flies/trap/week). In case of *C. capitata*, in Kafer –El sheikh and Ismailia governorates, there was no significant differences in mean number of attracted male flies between the single trimedlure trap (9.09 and 6.11 male flies/trap/week) and the mixture of it with methyl eugenol (8.11 and 5.63 male flies/trap/week) for the two governorates, respectively. There were no significant differences found between the three concentrations 1, 2 and 3% of ammonium acetate traps in the mean number of attracted flies of the two insects among the three tested governorates. Time of inspection for each tested orchard had a high significant effect on the mean number of attracted *B. zonata* and *C. capitata* male flies with both single and mixed lures and also on the mean number of the two insect flies captured by Ammonium acetate traps. The study also showed that there were no significant differences between the three locations of the tested traps inside all orchards in the mean number of male flies of the two insects attracted by the single lures or the mixture of them or by Ammonium acetate traps. Based on the results obtained, it can be concluded that using the mixture of methyl eugenol and trimedlure as a single lure in a single trap as a practical alternative to each of them alone in two separate traps should be considered, and this will have positive economic impact on the control of these insects.

Keywords: *Bactrocera zonata, Ceratitis capitata*, trimedlure, methyl eugenol, ammonium acetate.

Introduction

Great number of fruits and vegetables in Egypt and in the world are attacked by two dangerous pests, the peach fruit fly, *Bactrocera zonata* (Saunders) and the Mediterranean fruit fly (med fly), *Ceratitis capitata* (Wiedmann), infesting economically important fruit crops such as guava, plums, orange, peach and mango (Hashem *et al*., 2001). In addition, the export of these crops can be affected because of strict quarantine constraint imposed by the importing countries.

Detection of the fruit flies, *B. zonata* and *C. capitata* relies on the use of two types of traps , male-lure traps, which specifically attract and capture only males (Jang & Light, 1996), and methyl eugenol, an essential oil that occurs naturally in a number of plant species, used in Egypt as specific lure in traps to attract males of the peach fruit fly, *B. zonata* either for monitoring, detection or control (Abd El-Kareim *et al*., 2009; Bajaj & Singh 2018; El-Metwally *et al*., 2017; Ghanim, 2013).The lure that is most commonly used in traps to attract *C. capitata* males is the synthetic compound, trimedlure (Beroza *et al*., 1961) in addition to food–based traps which capture both males and females, but primarily females (Epsky *et al*., 2014) and ammonium acetate baited traps used to attract males and females of fruit flies (Moore, 1969; Prokopy, 1968).

No data are available about mixing the two male lures, methyl eugenol of *B. zonata* and trimmedlure of *C. capitata* as single lure. The use of this mixture in a single trap could be economically important, accordingly, the aim of this study was to investigate this option under field conditions.

Materials and Methods

The experiments of this work were carried out in three different governorates in Egypt , Kafer –El sheikh, Sharqia and Ismailia which represent different climatic conditions (Ismailia is the highest in annual average temperature followed by Sharqia, whereas Kafer–El Sheikhis the lowest). Consequently, effect of different populations of the two fruit flies, *B. zonata* and *C. capitata* in guava orchards (each orchard 5 acres) during the 2022 season were investigated.

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Effect of mixing methyl eugenol (ME) and trimedlure (TML):

The efficiency of mixing the two different male lures,methyl eugenol(ME) (4-allyl-1,2-dimethoxybenzen) 98% and trimedlure (TML) (tert-butyl 4(and 5)-chloro-trans2methylcyclohexane-1-carboxylate) together as a single lure in a single trap on the mean number of attracted males of *B. zonata* and *C. capitata* flies was investigated. Both ME and TML were manufactured by the chemical company Delta. This experiment was performed in guava orchards in the three abovementioned governorates. All experimental orchards were not treated with any chemical insecticide during the period of the experiment. Jackson traps (Harris *et al*., 1971) were hanged before the ripening of guava fruits by about one week, starting from 15-8-2022 until 1-10-2022. Three ml of each ME and TML were added individually toacylindrical shape cotton wick (1.5 cm long and 1.0 cm diameter), and another 3ml of each lure were added together to another cotton wick (its volume is twice that of the previous one). Each cotton wick was then fixed into Jackson's trap. A total of 9 traps and nine cotton wicks were used for each treatment in each orchard, distributed in three different locations; location1 (after 3 rows from the start of the orchard trees, location2(middle of the orchard), and location3 (3 rows before the end of the orchard).Three traps (3replicates) of each treatment were hanged and distributed in each location for each orchard, and the distance between each two different traps was about 50 meters. The distribution of the traps was ME, TML and Mixed lures (ME+ TML) in each location in all orchards. All traps were hanged on aerated and shadowed tree branches at a distance of about 1.5-2.0 meters from the ground (El-Gendy, 2012; El-Gendy *et al.,* 2020). Every week, all traps were inspected and the number of captured males on the sticky cards in the trap was counted and recorded. New sticky cards were placed in all traps weekly. The inspection of traps continued for about six successive weeks. The cotton wicks were not renewed for the duration of the experiment. The efficiency of the traps was determined by the number of captured male flies/week/governorate.

Effect of ammonium acetate concentrations

This experiment was carried out in the same guava orchards in the same governorates of the first experiment, to investigate the suitable concentration of A. acetate (obtained from El-Gomhouria Company) for *C. capitata* and *B. zonata* for all orchards in all locations. In each orchard, three locations were identified (L1, L2 and L3) as described in the first experiment. Three different concentrations of ammonium acetate (1, 2 and 3%) were used. 200 ml of each concentration were placed individually in a clear plastic bottle with four small pores (3mm in diameter each) in its upper part. These pores allow the entry of both fruit flies*, B. zonata* and *C. capitata*. A total of 27 traps (bottles) for each orchard were used, nine traps for each concentration (three traps/each location) in each orchard. The traps were hanged before fruit ripening by about one week (starting from 15/8/2022 until 1/10/2022) within the canopy of the trees at about 1.5-2.0 meters from the ground. The distance between each two adjacent traps was about 20-30 meters (Ragab & Youssef, 2021) to avoid the overlapping among traps with different treatments. The solution in the bottles was not renewed for the duration of the experiment. Weekly examination of all traps was made for six successive weeks, and numbers of captured fruit flies, *C. capitata* and *B. zonata* per each week for each location in each orchard in each governorate were counted and recorded.

Statistical analysis

Analysis of the results was achieved by using ProcGLM in SAS software (Anonymous, 2003) and significance between means was made by using Duncan's multiple range test at P= 0.05.

Results and Discussion

Effect of mixing methyl eugenol and trimedlure

Effect of mixing the two different male lures, methyl eugenol and trimedlure on the mean number of attracted males of *B. zonata* and *C. capitata* flies is presented in Table1.

Table 1. Mean numbers of *B. zonata* (BZ) and *C. capitata* (CC) male flies captured by the traps with methyl eugenol as a bait compared to the bait mixture of methyl eugenol and trimedlure at Kafer-El sheikh, Sharqia and Ismailia governorates.

	Mean number of captured males/trap/week													
	Time (Week)													
	1		2		3		4		5		6		Mean	
Male-lure	**BZ**	**CC**	**BZ**	**CC**	**BZ**	**CC**	**BZ**	**CC**	**BZ**	**CC**	**BZ**	**CC**	**BZ**	**CC**
Kafer –El Sheikh														
Methyl eugenol	17.33 a	5.56 b	18.70 a	5.89 b	17.33 a	7. 67 ab	10.70 b	13.33 ab	0.89 c	11.00 ab	0.00 c	11.11 ab	10.82	9.09
Methyl eugenol + trimedlure	15.70 a	7.44 abc	16.00 a	8.78 abc	14.70 a	10.0 ab	11.00 b	12.33 a	4.80 c	6.00 abc	0.00 d	4.11c	10.35	8.11
Sharqia														
Methyl eugenol	14.00 a	15.33 a	13.00 ab	16.33 a	12.00 ab	16.00 a	11.00 b	15.67 a	7.00 c	9.33 b	0.00 d	1.11 c	9.50	12.29
Methyl eugenol + trimedlure	15.70 a	10.67 b	14.70 ab	12.33 ab	13.80 ab	14.00 a	12.33 b	13.33 a	9.33 c	5.00 c	1.22 d	0.22 d	11.20	9.26
Ismailia														
Methyl eugenol	14.33 a	1.111 c	11.70 ab	6.33 b	12.70 ab	10.33 a	9.33 bc	10.00 a	7.00 c	8.67 ab	0.60 d	0.22 c	9.26	6.11
Methyl eugenol + trimedlure	13.00 a	2.33 cd	10.70 ab	5.67 b	9.33 b	12.33 a	9.00 b	9.33 a	10.0 ab	4.11 bc	1.80 c	0.00 d	8.96	5.63

Values followed by the same letters in the same row are not significantly different at P= 0.05.

The results obtained showed that there were no significant differences between the mean numbers of male flies attracted to methyl eugenol and those attracted to methyl eugenol mixed with trimedlure in Kafer–El Sheikh (10.82 and 10.35 male flies/trap/week) and Ismailia governorates (9.26 and 8.96 male flies/trap/week), respectively. Statistical analysis of results from all governorates showed that there was no significant in mean number of *B. zonata* male flies attracted to single methyl eugenol (9.86 male flies/trap/week) and those attracted to the mixture of methyl eugenol + trimedlure (10.16 male flies/trap/week). Results obtained (Table 1) also showed that the time of inspection for each tested orchard had a highly significant effect on the mean number of trapped *B. zonata* male flies when either single or mixed lures were used. At Kafer–El Sheikh governorate, the highest mean number of 18.70 and 16.0 male flies/trap/week was recorded on the second week of inspection and the lowest value of 0.00 male flies/trap/week was recorded on the last week of inspection for single and mixed methyl eugenol + trimedlure traps, respectively, whereas at both Sharqia and Ismailia governorates, the highest value was recorded on the first week of inspection.

When the efficiency of the single lure, trimedlure and the mixture of the two lures, trimedlure and methyl eugenolon the captured number of male flies of *C. capitata* in the three governorates were compared, the results obtained (Table 1) showed that in Kafer–El Sheikh and Ismailia governorates, there was no significant differences in mean number of captured male flies between the single lure (9.09 and 6.11 male flies/trap/week)and the mixture of two lures (8.11 and 5.63 male flies/trap/week)in the two governorates, respectively. Data also showed that the inspection time in each orchard in each governorates had a highly significant effect on the mean number of attracted *C. capitata* male flies with both single and mixed lures, with the highest mean number of 13.33 and 12.33 male flies/trap/week for the single and two lures, respectively, were recorded on the fourth week at Kafer –El sheikh governorate, whereas at Sharqia governorate, the highest scores of 16.33 and 14.00male flies/trap/week were recorded on the second and third week for the single and two lures, respectively. However, at Ismailia governorate the highest scores were 10.33and12.33 male flies/trap/week were recorded on the third week.

Results obtained also showed a variation in the mean number of attracted males of *B. zonata* and *C. capitata* in the different governorates at varied inspection times, which may be due to availability of other hosts and difference in fruits ripening time as a result of differences in weather factors such as, temperature among the three studied governorates, which is in agreement with what has been reported earlier (El-Metwally *et al*., 2017; Tiboni *et al*., 2008).

Generally in all experimental orchards among the three governorates results of Statistical analysis showed that different inspection time had a highly significant influence on mean number of attracted male flies of *B. zonata* and *C.capitata*, with the highest mean number of attracted males of *B. zonata* recorded on the first week, followed by the second week of inspection, whereas that of *C. capitata* was obtained on the fourth week followed by the third week of inspection, and the lowest mean number of attracted males of both insects was recorded on the sixth week of inspection (Figure1). The statistical analysis of data (Table 2) showed that there were no significant differences between the three locations for all orchards in the mean number of male flies of the two insects attracted by the single lure or the mixture of two lures.

It can be concluded from the results summarized in Tables (1 and 2) that, by using methyl eugenol and trimedlure as a mixture in a single cotton wick and in a single trap did not negatively effect on the attraction efficiency of two lures and there were no significant differences in the mean number of attracted male flies of both *B. zonata* and *C. capitata* compared to each of them alone in a separated trap ,which has economic impact. In addition, different locations of the male-lure traps in the same orchard have no influences on the attraction efficiency of the traps. It can be concluded in this study that if farmers use the mixture of the methyl eugenol and trimedlure they can reduce the cost of trapping the flies by 40-50 %.

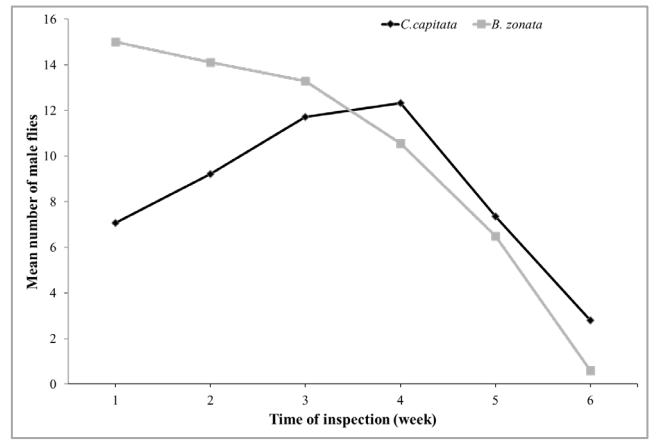

Figure1. Effect of different inspection times on mean number of male flies of *B. zonata* and *C.capitata* in all three governorates.

Table 2. Effect of different locations of traps with methyl eugenol, trimmedlure and the mixture of both lures inside the orchard on the mean number of captured male flies of *B. zonata* and *C. capitata.*

	Mean number of attracted male flies/location/week		
Male lure	**Location 1**	**Location 2**	**Location 3**
B. zonata			
Methyl eugenol	10.13 a	9.68 a	9.76 a
Methyl eugenol + trimedlure	10.46 a	9.96 a	10.05 a
C. capitata			
Trimedlure	9.44 a	9.00 a	9.05 a
Methyl eugenol + trimedlure	7.94 a	7.39 a	7.67 a

Values followed by the same letters in the same row are not significantly different at P=0.05 according to Duncan's multiple range test.

Effect of different concentrations of Ammonium acetate

Results obtained in this study showed that there were no significant differences between the three concentrations 1, 2 and 3% of ammonium acetate used on the mean number of attracted flies of the two insects in the three governorates (Table 3), which is in disagreement with the results obtained by Pinero *et al.* (2011) who reported a significant positive relationship between amounts of ammonium acetate used in the bait and the responding number of attracted Medfly. However, the results obtained were in agreement with what has been reported by Ragab & Youssef (2021) who showed that, when ammonium acetate was used alone, highest attraction of females and males of *C. capitata* was recorded at concentration1% of ammonium acetate. Thus, using the lowest concentration 1% of A. acetate for the attraction of *B. zonata* and *C. capitata* flies is more economical than using higher concentrations.

Table 3. Effect of different concentrations of ammonium acetateon mean number of attracted fruit flies *B. zonata* and *C. capitata.*

	Mean number of attracted fruit flies			
	Concentration (ml/100ml)			
Governorate	1	2	3	Mean
B. zonata				
Kafer–El Sheikh	6.98 a	8.19 a	8.43 a	7.87
Sharqia	7.06 a	7.69 a	5.57 a	6.77
Ismailia	10.35 a	11.67 a	10.35 a	10.79
C. capitata				
Kafer–El Sheikh	6.24 a	7.52 a	7.85 a	7.20
Sharqia	7.85 a	6.74 a	5.82 a	6.80
Ismailia	4.91 a	4.59 a	4.32 a	4.61

Values followed by the same letters in the same row are not significantly different at P=0.05 according to Duncan's multiple range test.

Effect of different inspection time in the three governorates on mean number of attracted flies of *B. zonata* and *C. capitata*

Results obtained (Table 4) showed that there were a highly significant difference between different inspection times on the mean number of attracted flies of the two insects. The highest trapped number of *B. zonata* was 11.27 male flies/trap/week was recorded on the fourth week, whereas the highest trapped number of *C. capitata* was 7.629 male flies/trap/week was recorded on the last inspection time (sixth week). Such variability may be due to difference in the optimum temperature for the two pests. Mostafa & Ghanim (2008) and Ghanim *et al*. (2014) reported earlier that the highest attracted number with ammonium acetate traps was recorded in the second week of inspection.

Table 4. Effect of inspection time on mean number of attracted fruit flies *B. zonata* and *C. capitata.*

	Mean number of attracted flies/trap/week						
	Time (Week)						
Insect	1	2	3	4	5	6	Mean
B. zonata	5.00 d	6.95 cd	9.30 ab	11.27 a	10.31 a	8.09 bc	8.49
C. capitata	4.47 d	5.42 cd	5.85 bc	6.96 a	6.89 ab	7.63 a	6.20

Values followed by the same letters in the same row are not significantly different at P=0.05 according to Duncan's multiple range test.

Effect of different locations of ammonium acetate traps on the mean number of attracted insects

Results obtained (Table 5) showed that there were no significant differences between the three different locations in the mean number of attracted flies of the two insects in the three governorates. Accordingly, the different locations of ammonium acetate traps inside the orchard do not have any influence on the mean number of attracted flies.

Table 5. Effect of different locations of ammonium acetate traps inside each orchard on the mean number of attracted fruit flies *B. zonata* and *C. capitata* at Kafer –El Sheikh, Sharqia and Ismailia governorates.

	Mean number of attracted fruit flies/location/week		
Governorate	Location 1	Location 2	Location 3
B. zonata			
Kafer –El Sheikh	8.06 a	7.76 a	7.78 a
Sharqia	7.06 a	7.69 a	5.58 a
Ismailia	10.35 a	11.67 a	10.463 a
C. capitata			
Kafer –El sheikh	7.39 a	7.09 a	7.13 a
Sharqia	6.98 a	6.74 a	6.69 a
Ismailia	4.78 a	4.50 a	4.54 a

Values followed by the same letters in the same row are not significantly different at P=0.05 according to Duncan's multiple range test.

الملخص

مرسي، غادة محمد عبد المنعم وسنية رشاد محمد فرج. 2025. كفاءة خلط الميثيل أوجينول والترايميدلور لجذب ذكور ذبابة الخوخ وذبابة فاكهة البحر المتوسط تحت الظروف الحقلية في مصر. مجلة وقاية النبات العربية، 43(4):488–493. https://doi.org/10.22268/AJPP-001349

يعتمد التنبؤ ورصد ومكافحة كلٍّ من ذبابة الخوخ (*Bactrocera zonata*) وذبابة فاكهة البحر المتوسط (*Ceratitis capitata*) على نوعين من الطعوم الجاذبة للذكور، وهما الميثيل أوجينول والترايميدلور، واللذان يتم استخدام كلٍّ منهما على حدة في مصيدة منفردة. أجريت هذه الدراسة تحت الظروف الحقلية في ثلاث محافظات مصرية، وهي كفر الشيخ، الشرقية والاسماعيلية، وذلك لدراسة تأثير خلط الميثيل أوجينول مع الترايميدلور في مصيدة واحدة على متوسط عدد جذب ذكور كلّ من ذباب *B. zonata* و *C. capitata* وذلك مقارنة بالعدد المنجذب لكل من الطعمين منفرداً، كما شملت الدراسة أيضاً تأثير استخدام تراكيز مختلفة (1، 2 و 3%) من خلات الأمونيوم في المصائد، وتأثير الأوقات المختلفة للفحص والمواقع المختلفة للمصائد داخل المزارع على متوسط أعداد الحشرات المنجذبة. أثبتت النتائج أنه عموماً وفي المحافظات الثلاثة لا يوجد فرق معنوي بين متوسط عدد ذكور ذبابة *B. zonata* المنجذبة للميثيل أوجينول مفرداً (9.86 ذبابة ذكر/مصيدة/أسبوع) وتلك المنجذبة لمخلوط المركبين (10.16 ذبابة ذكر/مصيدة/ أسبوع). أما فى حالة *C. capitata*، فقد وجد أنه في محافظتي كفر الشيخ والاسماعيلية لم يوجد فرق معنوي بين متوسط

عدد الذكور المنجذبة للترايميدلور مفرداً (6.11 و 9.09 ذبابة ذكر/مصيدة/أسبوع) والمخلوط مع الميثيل اوجينول (5.63 و 8.11 ذبابة ذكر/مصيدة/أسبوع) وذلك لكلا المحافظتين، على التوالي. كما أثبتت النتائج أنه لا يوجد فرق معنوي بين التراكيز الثلاث لمصائد خلات الأمونيوم في متوسط العدد المنجذب لنوعي الذباب كليهما وذلك في المحافظات الثلاثة محل الدراسة. وعلاوةً على ذلك، تبيّن وجود تأثير عالي المعنوية وقت الفحص في كل مزرعة على متوسط عدد جذب ذكور *B. zonata* و *C. capitata* وذلك لكلٍ من الطعوم المفردة والمخلوطة، وله تأثير عالي المعنوية أيضاً على متوسط العدد المنجذب لنوعي الذباب كليهما في مصائد خلات الأمونيوم. كما أثبتت الدراسة أيضاً أنه لا يوجد فرق معنوي بين المواقع الثلاث المختلفة للمصائد داخل المزارع في متوسط عدد ذكور الذباب المنجذب لنوعي الذباب كليهما، سواء بالطعم المفرد أو المخلوط، وكذلك على متوسط العدد المنجذب لنوعي الذباب كليهما بواسطة مصائد خلات الأمونيوم. تقترح النتائج المتحصل عليها أنه لابد من التركيز على استخدام مخلوط من الميثيل اوجينول والترايميدلور وذلك كطعمٍ واحد في مصيدة واحدة كبديلٍ لاستخدام كلٍ منهما منفرداً في مصيدتين منفصلتين، لما له من أهمية اقتصادية في مكافحة هذين النوعين الحشريين.

كلمات مفتاحية: ميثيل أوجينول، ترايميدلور، خلات الأمونيوم، *Bactrocera zonata*، *Ceratitis capitata*.

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