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Standardization of Medfly (**Ceratitis capitata** Wied.) trapping for use in sterile insect technique programmes : Two-year investigations on the efficiency of various Medfly trapping systems in Western part of Turkey*

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Summary

Several trap-lure combinations mainly based on single and combined lures i.e. food-related odors, sex-related odors and colours were tested under the Medfly trapping coordination programme of FAO/IAEA division. Among the compared treatments, International Pheromones McPhail Traps baited with Nu-lure, Borax and Trimedlure was the most attractive treatment to attract both males and females of Medfly in 1987 and 1988. International Pheromones McPhail Traps baited with Nulure and Borax and International McPhail Pheromones Traps baited with Nu-lure, Borax, DDVP and Trimedlure showed almost the equal efficiency. International Pheromones McPhail Traps baited with Nu-Lure, Borax and Ammonium phosphate and Jackson trap with white and yellow sticky inserts were the weakest treatments.

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Introduction

Trapping systems or trap-lure combinations which is one of the main topics of biotechnical pest control methods have always been important tools for fruit fly researchers. Up to date several trapping seystems have been developed for fruit flies for various purposes such as survey, to monitor and estimate the populations, control i.e. Especially in the sterile insect technique an efficient and accurate method is needed before and during releasing phases and to survey the area following eradication for possible re-introductions. In spite of rich arsenal of trapping systems, no comparative data are available so far on the performance of the same traps under different weather, host-tree and population density condition. In view of this fact, a coordinated research programme was initiated by the Joint FAO/IAEA division in 1987 with the objective developing standard trapping systems for use in sterile insect technique of Medfly in nine different countries Egypt, Libya and Morocco in Northern Africa, Turkey, Greece, Italy and Spain in Southern Europe, and Guatemala and Mexico in Central America. This paper deals with the results of the experiments carried out in Turkey within the years of 1987 and 1988.

Material and Method

The experiments were conducted in the experimental area of the Horticulture Department of the Faculty of Agriculture, University of Ege. Elevation of this area is 20 m. above the sea level. Species and varieties of stone and pome fruits, citrus and others are distributed in 50-hectare area.

1. Treatment and preparation

Five treatments in 1987 and six treatments in 1988 were tested.

Treatments compared were as follows :

a. Jackson trap with sticky insert and baited with Trimedlure plug (No 1).

b. International pheromones sticky trap baited with Trimedlure plug (No 2).

c. International pheromones McPhail trap baited with Nu-lure (9 %) and Borax (3 %) and water (88 %) (No 3).

d. International pheromones McPhail trap baited with Nu-lure (9 %), Borax (3 %), ammonium salt (5 %) and water (83 %) (no 4).

e. International pheromones McPhail trap baited with Nu-lure (9 %), Borax (3 %), water (88 %) and Trimedlure (plug hung 1/3 of distance from trap ceiling center to trap opening) (No 5).

In 1988, treatment (b) was substitued for the treatment (a) as above but with a yellow sticky insert. In additional treatment as above (e) including DDVP dispanser (hung on the ceiling center) was added to the experiment as the 6th treatment.

2. Plot selection and design

The field plot design was randomized complete block. Six blocks and five blocks of 5 and 6 traps each (total of 30 traps) were conducted simultaneously in 1987 and 1988 respectively. Each test was run for two weeks and trap data were collected twice a weak. The entire experiment was replicated three times. In order to reduce the random error, the tests were conducted in areas low to moderate medfly populations. All the trap site locations within a single block were tried to keep as uniform as be.

3. Trap placement and description of block

Traps were hung 1.5-2 meters above the ground in host trees. All traps were in the same relative shade and position at the southeast direction of the lower half of the canopy. The distance between the traps was 15-20 meters.

4. Data collection

All traps were checked on the same day, two times per week on a regular schedule for each 2-week test. Number of male and female medflies and the number of other fruit flies captured were recorded. Presence of fruits in the trees with traps of each block were recorded according to the abundance of fruits.

In 1988, infestation level was estimated by recording % fruits infested by live immature stages of the medfly on the first week of each replicate in every major host in the experimental area. For this purpose 10 fruits picked at random 10 trees of each host were examined. Once per replicate, presence of fruits, fruit maturity and suitability for medfly oviposition of major host trees in the test area were also recorded.

The following specific meteorological data for each replicate were provided from the local weather station of the Meteorology Department which is only 100-500 meters away from the experimental area.

- Daily maximum and minimum temperatures.
- Daily maximum and minimum humidity.
- Daily rainfall.
- Daily estimate of wind direction and speed.

5. Assessement

Assessement was based on the number of adults captured. Differences among the treatments were determined by analysis of variance and the means were ranked by using Duncan's multiple range test.

Results and Discussion

1987 Experiments

Tables 1, 2 and 3 gives the entire results of the three independent tests respectively. In all three replicates of the entire experiment the combinations from the attractiveness standpoint fell to the same category in a sequence of (3), (4), (2), (5) and (1). IPMT (no.3)

baited with Trimedlure, Borax and Nu-lure captured 2-20 times more flies then other combinations during the first test. In the second and third tests the same combination captured 2-10 and 3-7 times more flies than the others. The percentage of males captured in this combination and in the Nu-lure+Borax combination were always higher than females as indicated follows :

IPMT (no. 3) : 67 %, 57 % 57 %

IPMT (no. 4) : 59%, 57% 52% males in three tests. However the percentage of males and females captured in the Ammonium solution, IPMT (no. 5), during three tests, were 44% male, 56% female, 42% male, 58% female and 54% male and 47% female respectively. Jackson Traps (1) and International Pheromone Sticky Traps (2) which were baited with Trimedlure captured only males since this lure only attracts the males. Although 1 and 2 females were captured by these traps during the first test, these females probably were carried away by the males for copulation.

Table 1. Comparative attractiveness of various trap and lure combinations against the Medfly adults

Host : Apricot — Trap hang date : 3.7.1987

Treatments	Sex	Medflies captured at indicated dates (a) 7/7	10/7	14/7	17/7	Total	Total adults	M/F %
(1) JT (TML)	M	65	170	532	275	1042	1043	99.90
	F	0	1	0	0	1		
(2) IPST (TML)	M	83	548	1647	1011	3289	3291	99.93
	F	0	2	0	0	2		
(3) IPMT (TML, NU, B)	M	243	1184	7204	6232	14863	21968	68.00
	F	57	461	2021	4296	6835		
(4) IPMT (NU, B)	M	16	72	2628	4120	6836	11678 (b)	59.00
	F	41	130	1106	3565	4842		
(5) IPMT (AS)	M	7	49	518	393	967	2211 (c)	44.00
	F	6	24	920	294	1244		

(a) : Total of six blocks
(b) : Total 13 D oleae
(c) : Total 50 D. oleae

Table 2 . Comparative attractiveness of various trap and lure combinations against the Medfly adults

Host : Peach — Trap hang date : 11.8.1987

Treatments	Sex	Medflies captured at indicated dates (a) 14/8	17/8	21/8	25/8	Total	Total adults	M/F %
(1) JT (TML)	M	607	269	137	124	1137	1137	100
	F	-	-	-	-	-		
(2) IPST (TML)	M	782	641	706	920	3043	3043	100
	F	-	-	-	-	-		
(3) IPMT (TML, NU, B)	M	1413	1881	1135	2415	6844	11982	57
	F	712	975	1186	2265	5138		
(4) IPMT (NU, B)	M	658	882	914	995	3440	6077 (b)	5 7
	F	404	493	922	809	2628		
(5) IPMT (AS)	M	53	53	170	407	683	1620 (c)	4 2
	F	35	33	150	312	937		

(a) : Total of six blocks
(b) : Total 24 D. oleae
(c) : Total 93 D. oleae

Table 3 . Comparative attractiveness of various trap and lure combinations against the Medfly adults

Host : Peach — Trap hang date : 1.9.1987

Treatments	Sex	Medflies captured at indicated dates (a) 4/9	8/9	11/9	15/9	Total	Total adults	M/F %
(1) JT (TML)	M	683	195	118	103	1099	1099	100
	F	-	-	-	-	-		
(2) IPST (TML)	M	1446	404	434	256	2540	2540	100
	F	-	-	-	-	-		
(3) IPMT (TML, NU, B)	M	2216	721	728	388	4053	7077	57
	F	1583	574	562	305	3024		
(4) IPMT (NU, B)	M	945	190	192	183	1515	2903 (b)	52
	F	921	148	152	165	1388		
(5) IPMT (AS)	M	568	104	140	77	889	1651 (c)	54
	F	518	84	96	64	762		

(a) : Total of six blocks
(b) : Total 39 D. oleae
(c) : Total 161 D. oleae

Therefore this very small number of females may be neglected.

The conclusion on the attractiveness of the combinatons may be outlined as follows :

1. IPMT baited with Trimedlure, Nu-lure and Borax was the most effective combinaton atracts both males and females of Medflies. This was achieved in three replicates of the experiment.

2. IPMT baited with Nu-lure and Borax seemed at the second place to attract the males and females of Medflies. The lack of Trimedlure in this combination decreased the catches as compared with IPMT no.3. However this combination captured males more than females in each independent tests. Although some olive fly (Dacus oleae Gmel.) adults were captured, plenty of common flies and wasp were also found in these traps. Some our previous experiments showed that Nu-lure strongly attracts these kind of insect species.

3. IPMT, baited with Ammonium phosphate solution was the two of the weakest combinations followed by Jackson traps baited with Trimedlure. This combination captured more D.oleae adults than the combination no. 4.

4. Sticky traps (no. 1 and 2) baited with trimedlure were the fifth and third place from the attractiveness standpoint respectively. However since Trimedlure only attract the males, the values of captures are relatively lower than the other combinations except no.3. If we multiple the number of captures by (2) to correct for both sexes since only males caught, the attractiveness degree of the sticky traps with be higher or equal as compared with the combinations no.4 and no.5. Thiy may be an important factor for population studies with special reference to studies related to sterile insect technique (SIT) programmes.

IPST traps in all three replicates capture 2.5-3 times more males than Jackson traps. We consider this mainly is due to the difference between the spaces of the sticky inserts of the traps. In addition to, yellow color of the IPST traps might be a factor of increasing attractivity.

1988 Experiments

Table 4 gives the outlined results of the first replicate which was carried out on apricot and fig. According to the table, IPMT, baited with Nu-lure, Borax and Trimedlure (no.5) captured approximately 2-8 times more Medfly adults (total : 845) than other combinations. IPMT, baited with Nu-lure, Borax, Trimedlure and DDVP (no.6) captured total 411 Medfly adults whereas the captures in the Jackson traps batied with Trimedlure (no.1 and 2) were 216 and 229 respectively. IPMT baited with Nu-lure+Borax (no.3) and IPMT baited with Nu-lure+Borax+Ammonium phosphate seemed as the weakest combinations by catching total 121 and 22 adults. Statistical analysis which was based on orthogonal comparasion also showed the difference of the no.5 than the others. In all combinations except no.1 and no.2, the percentage of females were higher than males. Jackson traps baited with Trimedlure captured only males as might be excepted. Since the experimental orchard is next to an olive

plantation, considerable numbers of D. oleae were captured in four treatments. These captures were inversely proportional as compared with Medfly captures in the same treatments. Fruit infestation levels were estimated to be 5% and 0% on apricots and figs respectively.

Table 5 shows the results of the second replicate. No (5), this time again was the most attractive treatment by capturing total 9047 Medfly adults. No (3) was the second most attractive treatment with the total 5237 adults. These two treatments represented the same statistical category when the means were ranked by Duncans's multiple range test. Treatments nos. (1), (2), (4) and (6) captured 774, 654, 927 and 2253 Medfly adults respectively. However. the differences among them were not statistically significant. No. (3), (4) and (6) captured slightly higher females than males. The ratio of males to females was 54/46 in treatment no. (5). Fruit infestation level was found as 12 %. Few D. oleae adults were captured in the treatments of (3) and (4).

The details of the third replicate of the entire experiment which was conducted on citrus are given in table 6. Treatments No. (5), No. (6) and No. (3) were the first three most attractive treatments with the captures of 309, 244 and 204 adults respectively. When the data were analyzed statistically these three treatments fell into the same cetogory as shown in the table. The numbers of Medfly adults captured in the treatment nos. (1), (2) and (4) were 26, 99 and 57 as total. These treatments were not statistically different from each other. No. (3) almost captured the same percentage of males and females. The percentage in the treatment no. (4) was 61 % females and 39 males. No. (5) and (6) captured more males than females with the ratio of 68/32 and 60/40. During the test period 91, 177 and 84 D. oleae adults were found in the traps belong to the treatments no. (3), (4) and (5).

Conclusions drawn as the result of 1988 experiments may be summarized as follows:

1. IPMT baited with Nu-lure, Borax and Trimedlure (no.5) was the most attractive treatment to attract the males and females of Medfly. This was confirmed in three replicates of the experiment statistically. This treatment captured total 5489 males and 4712 females during the entire experiment. The percentage of the males and females were 53.80% and 46.20 % respectively.

2. Among the other treatments, IPMT baited with Nu-lure and Borax (no.3) and IPMT baited with Nu-lure, Borax and DDVP (no. 6) seemed more promising than the treatments no. (1), (2) and (4). However, the performance of these two treatments showed some fluctuations time after time. For instance, in the first replicate of the experiment, no. (6) was statistically different than the others (1, 2, 3, 4) following no(5). In the second replicate no. (3) and no (5) fell into the same statistical category showing difference than the others, However, in the third replicate, no. (3) and no. (6) associated in the same

Table 4 . Comparative attractiveness of various trap and lure combinations against the Medfly adults

Host : Apricot, fig — Trap hang date : 8.7.1988

Treatments	Sex	Medflies captured at indicated dates (a) 12/7	15/7	19/7	22/7	Total	Total adults	M/F %
(1) JT + TML (W)	M	155	17	24	20	216	216	100
	F	0	0	0	0	0		0
(2) JT + TML (Y)	M	70	69	54	36	229	229	100
	F	0	0	0	0	0		0
(3) IPMT + NU + B	M	12	16	8	14	50	121 (b)	41
	F	13	17	25	16	71		59
(4) IPMT+NU+B+A. phosphate	M	3	0	4	0	7	22 (c)	32
	F	5	3	5	2	15		68
(5) IPMT+NU+B+TML	M	119	145	103	37	404	845 (d)	48
	F	144	153	108	36	441		52
(6) IPMT+NU+B+TML+DDVP	M	90	43	25	29	187	411 (e)	45
	F	106	54	29	35	224		55

(a) : Total of five blocks
(b) : Total 449 D. oleae
(c) : Total 626 D. oleae
(d) : Total 159 D. oleae
(e) : Total 122 D. oleae

Meteorological data

Temperature (°C) : 18.6-41.4
R. Humidity (%) : 21-66
Rain (mm) : -
Wind speed and direction (m/sec) : 0.7-4.8; NE, SW, W, NNE, SSW

Fruit infestation (%)

Apricot : 5
Fig : 0

Table 5 . Comparative attractiveness of various trap and lure combinations against the Medfly adults

Host : Peach — Trap hang date : 20.9.1988

Treatments	Sex	Medflies captured at indicated dates (a) 23/9	27/9	30/9	4/10	Total	Total adults	M/F %
(1) JT + TML (W)	M	393	133	186	62	774	774	100
	F	0	0	0	0	0		0
(2) JT + TML (Y)	M	280	108	212	54	654	654	100
	F	0	0	0	0	0		0
(3) IPMT + NU + B	M	838	1089	276	306	2509	5237 (b)	48
	F	950	1136	304	338	2728		52
(4) IPMT+NU+B+A. phosphate	M	126	128	76	86	416	927 (c)	45
	F	157	152	97	105	511		55
(5) IPMT+NU+B+TML	M	1531	1550	890	904	4875	9047	54
	F	1175	1347	807	843	4172		46
(6) IPMT+NU+B+TML+DDVP	M	647	316	74	59	1096	2253	49
	F	645	361	86	65	1157		51

(a) : Total of five blocks
(b) : Total 2 D. oleae
(c) : Total 7 D. oleae

Meteorological data

Temperature (°C) : 16.0 - 32.6
R. Humidity (%) : 27-89
Rain (mm) : -
Wind speed and direction (m/sec) : 0.2-5.7; SW, WSW, NE, E, SSW

Fruit infestation (%)

Peaches : 12

Table 6 . Comparative attractiveness of various trap and lure combinations against the Medfly adults

Host : Citrus — Trap hang date : 6.10.1988

Treatments	Sex	Medflies captured at indicated dates (a) 10/10	13/10	17/10	20/10	Total	Total adults	M/F %
(1) JT + TML (W)	M	6	9	8	3	26	26	100
	F	0	0	0	0	0		0
(2) JT + TML (Y)	M	6	62	27	4	99	99	100
	F	0	0	0	0	0		0
(3) IPMT + NU + B	M	10	20	51	22	103	204 (b)	50.49
	F	5	21	51	24	101		49.51
(4) IPMT+NU+B+A. phosphate	M	4	5	10	3	22	57 (c)	39
	F	6	13	11	5	35		61
(5) IPMT+NU+B+TML	M	45	70	66	29	210	309 (d)	68
	F	25	51	17	6	99		32
(6) IPMT+NU+B+TML+DDVP	M	15	77	46	8	146	244 (e)	60
	F	7	66	21	4	98		40

(a) : Total of five blocks
(b) : Total 91 D. oleae
(c) : Total 177 D. oleae
(d) : Total 84 D. oleae

Meteorological data

Temperature (^{o}C) : 8.6-31.7
R. Humidity (%) : 32-96
Rain (mm) : 0.8
Wind speed and direction (m/sec) : 0.7-5;NW, NE, NNE

Fruit infestation (%)

Satsuma mandarine : 2
Clementine : 1
Native orange : 0

statistical category with no (5). IPMT baited with Nu-lure and Borax (no.3) captured 2662 males and 2900 females during the entire experiment. The percentage of males and females were 48% and 52 % respectively. Total Medflies captured by the treatment no. (6) was 2908 with the percentage of 49% males and 51% females.

3. IPMT baited with Nu-lure, Borax and Ammonium phosphate (no.4) captured Total 1006 Medfly adults during the three replicates. The percentage of males and females were 44% and 56 %.

4. Jackson traps baited with Trimedlure (no.1, white insert) captured total 1016 males whereas the number of males captured by the same combination (no.2, yellow insert) was 982. There was no significant difference between the colours of the sticky inserts was not a considerable factor.

5. According to the explanations given above, the treatments, from the attractiveness standpoint, may be classified as follows.

   Category I. No. (5).

   Category II No. (3), No. (6)

   Category III No. (1), No. (2), No. (4).

This classifacation almost confirms the results of 1987 experiments in which IPMT baited with Nu-lure, Borax and Trimedlure was the most effective treatment followed by IPMT baited with Nu-lure and Borax. The new treatment, IPMT baited with Nu-lure, Borax, Trimedlure and DDVP showed lower attractiveness as compared with IPMT baited with Nu-lure, Borax and Trimedlure. The presence of DDVP might have lessened the attractiveness of the combination probably due to its repellent effect. Nakagawa et al. (1971) stated that even the high concentrations of Trimedlure has repellent effect to Medfly adults.

Population density of 1988 was considerable lower compared to the density of 1987. Bait-sprayings applied in June 1988 on apricots remarkable decreased the population. Therefore the first and second replicates were conducted by the time the population density was low to moderate in the course of population increse. Since no application was made on fig parsel (fifth block of the first replicate) the number of adults were relatively higher at this block. Suitability of the figs as adult food source is another reason of more capturing (Katsoyannos, 1983).

The three replicates of the entire 1988 experiment were carried out between early July and the middle of October. Although there were some differences among the climatic conditions, generally, they were not unsuitable or limiting for the activity and breeding of the Medfly populations. There are some factors that may affect the attractancy of the treatments. Different population densities, season and climatic factors may have cansiderable differences on the treatments (Delrio and Zümreoğlu, 1983; Delrio, 1986; Economopoulos, 1986). These factors affecting the degree of attractiveness should be judged by comparing the results of other country's experiments which carried out under relatively different climatic conditions.

Özet

Akdeniz meyve sineği (Ceratitis capitata Wied.) tuzak sistemlerinin kısır böcek salma tekniğinde kullanılmak üzere standardize edilmesi : Ege bölgesinde çeşitli tuzak sistemlerinin etkinliği üzerinde iki yıllık araştırmalar

Bu çalışmada besi, seks, renk ve benzeri çeşitli tuzak-cezbedici kombinasyonları C. capitata tuzak sistemlerinin standart bir hale getirilmesi amacıyla FAO ve Uluslararası Atom Enerjisi Ajansınca koordine edilen bir proğram çerçevesinde denenmişlerdir. Denenen kombinasyonlar arasında %9 Nu-lure + %3 Borax + Trimedlure kapsülü içeren geliştirilmiş McPhail tuzakları gerek 1987 ve gerekse 1988 yılı denemelerinde denenen toplam yedi kombinasyon içinde en etkin kombinasyon olarak bulunmuştur.

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