DEVELOPMENT AND EVALUATION OF IMPROVED MEDITERRANEAN FRUIT FLY ATTRACTANTS IN ISRAEL

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Abstract

A survey on development and evaluation of synthetic food attractants for Mediterranean fruit fly trapping, had been carried out within various plantations in Israel, throughout the years, 2001-2004. All field tests followed a standard protocol developed by the participants of Coordinated Research Project (CRP), of the FAO and IAEA Joint Programme. The research work was aimed at developing an oPTimal mass trapping system for the Mediterranean fruit fly (*Ceratitis capitata,* Wied.) in support of area-wide IPM programmes. Trapping experiments included combinations of different lures, traps and various retention agents. Positive results were obtained in three consecutive years, showing a significant response of medflies to a three-component synthetic food lure (AA+ PT+TMA), in McPhail type traps (Multilure Traps (MLT) and an Israeli-MLT trap design)), using DDVP or water as the retention agents. Both sexes of *C. capitata* did not respond as well to MLT traps baited with NuLure and some combinations of the synthetic food lure throughout the four year project. Likewise, relatively low captures were documented in sticky Jackson traps with AA+ PT+TMA. Similar results regarding optimal trapping system for medflies had been obtained in other countries by participants of the CRP. These trapping systems may be tested for mass trapping for medfly suppression, which is required prior to the release of sterile insects, a technique in use in Israel and in some other countries.

Key Words: Mediterranean fruit fly, medfly, *Ceratitis capitata*, food based attractants

1. INTRODUCTION

The Mediterranean fruit fly (medfly) *Ceratitis capitata* (Wiedemann), is a tephritid fruit fly pest of great economic importance for its extremely wide host range [1]. As any key pest, medfly needs to be effectively controlled, however, the use of calendar spraying of broad spectrum insecticides is not sustainable in the long term because of its negative effect to the environment [2], and the high control costs [3]. Medfly can be effectively controlled through an area-wide integrated pest management approach. Among the methods used for medfly control, area-wide SIT integrated with other control methods and surveillance systems, has shown to be cost-effective [4, 5, 6]. In the last decade substantial financial resources have been invested in optimizing SIT technology. This Coordinated Research Project (CRP), of the FAO and IAEA Joint Programme has the aim of developing and evaluating female biased synthetic food attractants applied against fruit flies of economic importance for their integration into fruit fly SIT management programmes. CRP participants from countries in Africa, Asia, Latin America and Europe were separated in groups according with the dominant fruit fly species present in their countries. Israel, as other Mediterranean countries, is typically affected by *C. capitata* with considerable economic damage [7]. Since medfly management in Israel is still based on aerial bait sprays, efforts are aimed towards the development of an effective strategy for the suppression of medfly populations. Accordingly, trapping systems used for mass trapping of adult populations are considered to be a promising control alternative. Unsuccessful experience with mass trapping for suppression has been documented via the use of male annihilation technique with Methyl Eugenol, a male specific attractant used against several species of *Bactrocera* [8]. However, research focused on female-targeted trapping systems did yield encouraging results [9, 10]. Further studies in Israel, which included different trapping strategies resulted in successful medfly control [11, 12]. The current study includes a wide range of trapping systems including those that have been tested in the studies mentioned above.

2. MATERIALS AND METHODS

Studies during the years 2001 to 2003 were conducted in the northern east region of Israel. One of the sites was located in Hauula Valley, in Kibutz Dan, in a 15 year old organic persimmon orchard. Conditions of the site are: Altitude 100 meters over seal level, Avg. Temp. (Min-Max): 22°C (17°C-37°C). Avg. RH (Min-Max): 67% (37%-96%). Traps were hung on trees at 2 to 2.5m high. Since

1997, the management of medfly in the experimental persimmon orchard was based on mass trapping with MLT traps baited with the three component lure Ammonium Acetate (AA), Trimethylamine (TMA) and Putrescine (PT) (Biolure). For the experiment all traps were removed from the orchard, before placing the different treatments used in the experiment. The basic trap used in all studies was the McPhail type Multilure (MLT) trap. Attractants consisted of combinations of the synthetic food lures AA+ PT+TMA [13]. Retention materials used were: water, DDVP and sticky coating. The Israeli designed Shabtiely trap, was chosen as one of the optional treatments in all field tests. The experimental design used was a complete randomized block with 5 replicates. Traps were hung equidistant at a distance of 17m between treatments and 20 m between rows (blocks). Traps were checked and rotated twice a week. Dead and captured insects were counted and removed after each trap check. Other experimental sites were located around the same area described above with other various hosts as detailed bellow.

2.1. Trapping Experiments in 2001

2.1.1. Site 1

Traps were hung in a 0.5 hectare 30 year old organic plum orchard in trees at 3 to 3.5m from the ground. No chemical control was used in this site against medfly as it was located in the backyard of a small motel. In an optional treatment the AA+ PT+TMA was replaced by Trimedlure (TML) plugs, a medfly males specific para-pheromone. The experiment was conducted from 13 of June to 13 of August 2001.

TABLE I. LIST OF TREATMENTS USED IN SITE 1 IN 2001.

	Trap	Attractant	Retention
A	MLT	AA+ PT+TMA	Water
B	MLT	AA+ PT+TMA	DDVP
C	MLT	AA+ PT+TMA	Sticky
D	Israreli	AA+ PT+TMA	Water
E (optional)	MLT	TML	Water

2.1.2. Site 2

Traps were hung in the persimmon orchard described in Section 2. This experiment was an excePTion with regards to the retention materials. Two new materials were included in treatments, propylene glycol (PG), and Deltamethrine (DM). The experiment was conducted from 9 of September to 11 of November 2001.

TABLE II. LIST OF TREATMENTS USED IN SITE 2 IN 2001.

	Trap	Attractant	Retention
A	MLT	AA+ PT+TMA	Water
B	MLT	AA+ PT+TMA	DDVP
C	MLT	AA+ PT+TMA	Sticky
D	Israeli	AA+ PT+TMA	PG
E	MLT	AA+ PT+TMA	DM

2.2. Trapping Experiments in 2002

Traps were hung in the persimmon orchard described in Section 2. The experiment was conducted from 7 of October to 30 of November 2002.

TABLE III. LIST OF TREATMENTS USED IN 2002.

	Trap	Attractant	Retention
A	MLT	NuLure	
B	MLT	AA+TMA	DDVP
C	MLT	AA+ PT+TMA	DDVP
D	MLT	AA+PT	DDVP
E	MLT	AA	DDVP
F	MLT	AA+ PT+TMA	Sticky
G (optional)	Israeli	AA+ PT+TMA	DDVP

2. 3. Trapping experiments in 2003

Traps were hung in the persimmon orchard described in Section 2. Two additional optional treatments were included in this experiment, apart from the standard ones. These were a Jackson trap (JT) baited with Biolure (AA+PT+TMA) and a JT baited with AA+TMA. The experiment was conducted from 16 of September to 14 of November 2003.

TABLE IV. LIST OF TREATMENTS USED IN SITES 1 AND 2 IN 2003.

Treatment	Trap	Attractant	Retention
A	MLT	NuLure	Water
B	MLT	AA + PT +TMA	Water
C	MLT	AA + TMA	Water
D	MLT	1/2AA+TMA	Water
E	MLT	1/2AA+PT+TMA	Water
F (optional)	Israeli	AA + PT+TMA	Water
G (optional)	JT	AA + PT + TMA	Sticky
H (optional)*	JT	AA + PT	Sticky

*tested only in site 1

Data were analyzed using a multifactor analysis of variance, followed by pairwise comparisons with the LSD test.

3. RESULTS AND DISCUSSION

Results of trapping tests in 2001 that were aimed mainly at measuring the effect of various retention materials, indicate that the most efficient material was DDVP, with a total of 35.4% relative female trap efficiency (Table V). Nevertheless, fly per trap per day (FTD) values did not show any significant statistical difference among treatments using different retention materials (Table VI). The optional treatment that presented a different attractant, TML, appeared as expected with the highest Captures of male medflies (P= 0.008), but with a significant low value of females (P=0.012).

TABLE V. RELATIVE TRAP EFFICIENCY IN SITE 1, 2001.

Treatment			Relative Trap Efficiency		
Trap	Attractant	Retention	%Females	%Males	%Total
MLT	AA + PT +TMA	Water	18.0	12.8	15.5
MLT	AA + PT +TMA	DDVP	35.4	16.5	26.1
MLT	AA + PT +TMA	Sticky	25.1	8,7	17.1
Israeli MLT	AA + PT +TMA	Water	14.6	3.9	9.4
MLT	TML	Water	5.8	58.0	31.9

TABLE VI. AVERAGE NUMBER OF FLIES PER TRAP PER DAY IN SITE 1, 2001.

Treatment			FTD	
Trap	Attractant	Retention	Females	Males
MLT	AA + PT +TMA	Water	0.9±0.2 a	0.7±0.2 b
MLT	AA + PT +TMA	DDVP	1.8±0.5 a	0.9±0.2 b
MLT	AA + PT +TMA	Sticky	1.2±0.3 a	0.5±0.2 b
Israeli MLT	AA + PT +TMA	Water	0.7±0.2 a	0.2±0.0 b
MLT	TML	Water	0.3±0.1 b	3.1±1.2 a

Results in the other tests conducted in site 2, follow the same trend, showing no influence of retention materials on trapping efficacy. Although PG in Israeli trap appeared with the highest trapping efficiency (Table VII), no significant differences in FTD values were found among treatments, for both females and males (P=0.924, and P= 0.07, respectively), (Table VIII).

TABLE VII. RELATIVE TRAP EFFICIENCY IN SITE 2, 2001

Treatment			Relative Trap Efficiency		
Trap	Attractant	Retention	%Females	%Males	%Total
MLT	AA + PT +TMA	Water	17.6	12.4	15.0
MLT	AA + PT +TMA	DDVP	20.6	14.4	17.5
MLT	AA + PT +TMA	Sticky	21.2	9.3	15.3
Israeli	AA + PT +TMA	PG	27.0	39.2	33.2
MLT	AA + PT +TMA	DM	13.6	24.7	19.2

TABLE VIII. AVERAGE NUMBER OF FLIES PER TRAP PER DAY IN SITE 2, 2001

Treatment			Fly/Trap/Day	
Trap	Attractant	Retention	Females	Males
MLT	AA+ PT+TMA	Water	0.8±0.4 a	0.1±0.0
MLT	AA+ PT+TMA	DDVP	0.8±0.3 a	0.0±0.0
MLT	AA+ PT+TMA	Sticky	0.9±0.5 a	0.0±0.0
MLT	AA+ PT+TMA	PG	1.2±0.6 a	0.2±0.0
MLT	AA+ PT+TMA	DM	0.8±0.2 a	0.1±0.5

The second phase of the research project emphasized the effect of attractants on trapping efficiency, clearly showing a difference among treatments. NuLure showed the lowest total trapping efficiency value, only 1.5% (Table XIV). With regards to the FTD, NuLure was again the lowest with a significant difference compared to other treatments in female (P= 0.005) as well as in male captures (P=0.001), as shown in Table X. The highest values among all treatments was obtained by Israeli trap for both sexes, though with no significant difference, when compared to all other combinations of synthetic food lures including the AA + PT + TMA (Biolure) in a MLT trap

TABLE XIV. RELATIVE TRAP EFFICIENCY IN 2002

Treatment			Relative Trap Efficiency		
Trap	Attractant	Retention	%Females	%Males	%Total
MLT	NuLure	Water	2.3	0.8	1.5
MLT	AA+TMA	DDVP	13.3	12.8	13.1
MLT	AA+TMA+PT	DDVP	15.8	17.4	16.6
MLT	AA+PT	DDVP	15.2	13.5	14.3
MLT	AA	DDVP	15.0	13.0	14.0
MLT	AA+TMA+PT	Sticky	14.4	16.4	15.4
Israeli MLT	AA+TMA+PT	DDVP	24.0	26.2	25.1

TABLE X. AVERAGE NUMBER OF FLIES PER TRAP PER DAY IN 2002.

Treatment			Fly/Trap/Day	
Trap	Lure	Retention	Females	Males
MLT	NuLure	water	1.7±0.1 b	0.1±0.0 b
MLT	AA+TMA	DDVP	9.4±2.3 a	2.3±0.5 a
MLT	AA+TMA+PT	DDVP	11.2±3.1 a	3.1±0.6 a
MLT	AA+PT	DDVP	9.5±2.4 a	2.4±0.3 a
MLT	AA	DDVP	10.7±2.3 a	2.3±0.4 a
MLT	AA+TMA+PT	Sticky	10.7±2.9 a	2.9±0.5 a
Israeli MLT	AA+TMA+PT	DDVP	17.7±4.6 a	4.6±1.6 a

Trapping experiments in 2003, included some treatments that had been tested in previous years, in order to validate the results. Results of this experiment were consistent with what was obtained in 2002, with NuLure being the worst treatment and AA+TMA+PT the best both using the MLT trap or the Israeli trap. As shown in Table XI trap efficiency using NuLure reached only 2.3%, whereas the two other mentioned treatments showed to be the most efficient trapping systems. Results of Jackson trap did not appear with any advantages in trapping efficiency as well as the combination between MLT trap with a sticky insert (Table XII). In this case no significant differences was found between treatments in rate of Captures, despite the relatively big gaps between the most efficient systems that had an average female FTD of 6.1 and 5.9 whereas the Jackson trap baited with AA+PT+TMA and the MLT trap baited with NuLure, had an average female FTD of only 0.5 and 0.7, respectively (Table XII).

TABLE XI. RELATIVE TRAP EFFICIENCY IN SITE 1, 2003

Treatment			Relative Trap Efficiency		
Trap	Attractant	Retention	%Females	%Males	%Total
MLT	NuLure		2.4	2.2	2.3
MLT	AA + PT +TMA	Water	22.0	20.1	20.4
MLT	AA + TMA	Water	16.2	17.7	17.4
MLT	1/2AA+TMA	Water	15.1	13.7	14.0
MLT	1/2AA+PT+TMA	Water	13.2	14.1	13.9
Israeli MLT	AA + PT+TMA	Water	20.2	19.5	19.6
JT	AA + PT + TMA	Water	1.3	1.5	1.5
MLT	AA + PT	Sticky	9.6	11.2	10.9

TABLE XII. AVERAGE NUMBER OF FLIES PER TRAP PER DAY IN SITE 1, 2003.

Treatment			Fly/Trap/Day	
Trap	Lure	Retention	Females	Males
MLT	NuLure		0.7± 0.4 a	0.9±0.4
MLT	AA + PT +TMA	Water	6.1±2.5 a	1.3±0.6
MLT	AA + TMA	Water	5.4 ±2.5 a	0.2±0.1
MLT	1/2AA+TMA	Water	3.9 ±1.7 a	0.9±0.4
MLT	1/2AA+PT+TMA	Water	4.3±1.6 a	0.8±0.3
Israeli MLT	AA + PT+TMA	Water	5.9±2.7 a	1.2±0.5
JT	AA + PT + TMA	Sticky	0.5±0.2 a	0.09±0.0
MLT+JT	AA + PT		3.4 ±1.4 a	0.6±0.2

Studies in the second site generally maintained the results obtained in the first site, with certain differences. One obvious result shown in Tables XIII and XIV, is the significant difference between the efficiency of the Israeli trap and rate of female caPTure compared with all other trapping systems. FTD values presented in Table XIV show a definite statistical difference between treatments as mentioned above with a P=0.038 for females and a P=0.001 for males.

TABLE XIII. RELATIVE TRAP EFFICIENCY IN SITE 2, 2003

Treatment			Relative Trap Efficiency		
Trap	Attractant	Retention	%Males	%Females	%Total
MLT	NuLure		2.37	1.90	1.82
MLT	AA + PT +TMA	Water	17.14	14.99	15.36
MLT	AA + TMA	Water	18.29	16.00	16.40
MLT	1/2AA+TMA	Water	12.93	12.47	12.33
MLT	1/2AA+PT+TMA	Water	13.45	15.95	15.53
Israeli-MLT	AA + PT+TMA	Water	35.96	37.18	36.99
JT	AA + PT + TMA	Sticky	0.73	1.70	1.54

TABLE XIV. AVERAGE NUMBER OF FLIES PER TRAP PER DAY IN SITE 2, 2003.

Treatment			Fly/Trap/Day	
Trap	Attractant	Retention	Females	Males
MLT	NuLure		0.5±0.1 c	0.1±0.1 b
MLT	AA + PT +TMA	Water	3.7±2.1 b	1.1±0.8 b
MLT	AA + TMA	Water	4.5±1.6 b	1.1±0.3 b
MLT	1/2AA+TMA	Water	3.2±1.0 b	0.7±0.2 b
MLT	1/2AA+PT+TMA	Water	3.2±1.2 b	0.5±0.1 b
Israeli MLT	AA + PT+TMA	Water	7.4±2.4 a	1.6±0.4 a
JT	AA + PT + TMA	Sticky	0.4±1.0 c	0.0±0.0 b

4. CONCLUSIONS

Results obtained suggest that the three component lure AA + PT+TMA (Biolure) in a MLT trap and the Israeli trap, were the ones that obtained the highest caPTure rates in most field tests and could be tested for use in mass trapping.

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