Evaluation of Traps and Lures for Mass Trapping of Mediterranean Fruit Fly in Citrus Groves

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ABSTRACT Mass trapping has proven to be a powerful weapon in the control of *Ceratitis capitata* (Wiedemann), and its application in Mediterranean countries has currently increased notably as a control method. In this study, the efficacy of newly developed traps and dispensers of attractants were assessed with the aim of finding the best trap and set the lifetime of the dispensers, thus improving the total efficacy of mass trapping. Efficacy trials with six different types of traps and six different types of female dispensers were carried out. Moreover, the lifetime of three female dispensers, including a new attractant composition dispenser with *n*-methyl pyrrolidine, were studied. Results show significant differences among the trap types using female attractants, with an advantage of nearly 3 times more catches in best trap. Tested female dispensers showed no significant differences in efficacy between trimethylamine and putrescine attractants regard n-methyl pyrrolidine, however we observed differences in lifetime between dispensers. Thus, there are significant differences among different types of traps and dispensers in efficacy, and the appropriate selection of the trap and dispenser will improve the mass trapping results.

KEY WORDS *Ceratitis capitata*, lure, attractant, trap, fruit fly

Mass trapping is currently being used over large areas in Mediterranean regions to control Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), and olive fruit fly, *Bactrocera oleae* (Gmelin) (Broumas et al. 2002, Delrio 1989). This technique, and the lure-and-kill method, are now being used worldwide with good results (Cunningham et al. 1978, Agunloye 1987, McQuate et al. 2005). Moreover, the perimeter trapping strategy has obtained satisfactory results to avoid fruit fly intrusions in medium-to-large orchards, and this strategy depends on the efficacy of traps and lures (Cohen and Yuval 2000).

Traps designs, including different colors and shapes, are essential to obtain a high efficacy in fruit fly catches (Epsky et al. 1995, Vargas et al. 1997). In the last decade, the development of new powerful attractants, (Heath et al. 1997, Epsky et al. 1999) has increased the possibility of using mass trapping as a more economical Mediterranean fruit fly control method. Recent studies demonstrate that the International Pheromone McPhail Trap (IPMT) combined with Biolure (three-component lure) is highly efficacious in Mediterranean fruit fly catches (Gazit et al. 1998, Katsoyannos et al. 1999, Katsoyannos and Papadopoulos 2004) with respect to other traps and attractants. Currently, in Spain, the most frequently used lure is Biolure associated with Tephri-trap, a modified McPhail trap with four lateral holes, which shows a similar efficacy compared with the IPMT (Miranda et al. 2001). Similar results were obtained in Australia using IPMT and Tephri-trap with Biolure, that improve the traditional protein baits (Broughton and De Lima 2002).

Currently, >30,000 ha of citrus groves in Spain are being treated with mass trapping, and surface treatment increases year by year. Initial field trials showed a good efficacy with this technique using a density of 50 traps per ha during the 3 mo before harvest, but more studies for trap density optimization and preharvest placing time are being carried out. To improve the efficacy of this technique, longer lasting dispensers covering the entire growing season and more efficient traps are necessary. The efficacy of the dispensers also varies depending on weather conditions, mainly temperature and humidity; thus, field trials should be performed in all kinds of climatic conditions.

The efficacy of new longer lasting dispensers is also being studied. A mesoporous material such as zeolites (Munoz-Pallares et al. 2001) has been used to manufacture dispensers. This material adsorbs substances through a physicochemical interaction and releases substances at a controlled emission rate. They have been used to increase the lifetime of the dispensers and to optimize the release rate In this work, we compare the longevity of a new mesoporous dispenser (EPAlure) with the most used lure in Spain, Biolure.

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The main objectives of this study are to compare the efficacy of available traps and lures, to study and quantify the attractant composition of the dispensers, and to extend their lifetime.

Materials and Methods

Traps and Lures. Traps used were as follows: EPAtrap by Ecologia y Protección Agrícola SA (EPA) (Carlet, Valencia, Spain), Probodelt trap by Probodelt (Amposta, Tarragona, Spain), Multilure by Better World Manufacturing Inc. (Fresno, CA), IPMT by Econex (Santomera, Murcia, Spain), Tephri-trap by Utiplas SL (Madrid, Spain), Easytrap by J.P. Ros (INIA, Madrid), and Mosquitrap by Sansan (Valencia, Spain).

Attractants used were as follows: female attractants: Biolure by Suterra (Bend, OR) with three sachets containing ammonium acetate, trimethylamine, and putrescine; Biolure Medfly 100 by Suterra, with the larger sachets containing ammonium acetate, trimethylamine, and putrescine; TMA female attractant by Susbin (Mendoza, Argentina), with only one sachet containing a mixture of ammonium and trimethylamine; SEDQ (Barcelona, Spain) Ferag female attractant, with three sachets containing ammonium acetate, trimethylamine, and cadaverine; and Trypack by Econex (Santomera, Murcia, Spain), with only one sachet containing ammonium acetate, trimethylamine and putrescine. Another female attractant with ammonium acetate and *n*-methyl pyrrolidine (NMP) was EPAlure by EPA (Valencia, Spain). A male attractant of trimedlure (TML) (Beroza et al. 1961) plug by Agrisense (Pontypridd, United Kingdom).

Trap Evaluation. Field trials were performed in 2004 and 2005, during summer and autumn seasons, when the *C. capitata* population is high enough to obtain representative numbers of catches, and citrus fruit begins to ripen. Traps were tested in four different citrus groves (*Citrus reticulata* Blanco variety Marisol) in Sagunto, Alzira, Denia, and Tavernes, near the western coast of the Mediterranean Sea, in Valencia, Spain. Each field was located at least 30 km apart. Field trials are described in Table 1.

Each field trial included four plots, with each plot using all types of tested traps. Traps were separated 20–25 m to avoid direct interaction between traps, with no distance >25 m, so as to reduce Mediterranean fruit fly population variation to a minimum inside the same field. The plots within each field were separated by almost 100 m to obtain four independent replications. Within each plot *C. capitata* catches were counted every week, distinguishing males and females in traps with Biolure, and traps were rotated clockwise.

Traps tested in 2004 were IPMT, Probodelt, Easytrap, Multilure, and Tephri-trap, with two types of attractants, female attractants (Biolure) and male attractants (TML plug). During 2004, the traps were hung in all fields in mid-June and they were left for 6 wk for the trap trial with Biolure and for six more weeks for the second trial from 2 August with TML dispensers. In 2005, based on 2004 results, the best trap for 2004 was tested, the same standard trap (Tephri-trap), plus two new traps, Mosquitrap and EPAtrap, to confirm 2004 results. In 2005, the trap trial was carried out from June to August, lasting 6 wk.

Table 1. Plots and field trials description

Trial yr	Location	Trap type[a]	Attractant[b]	n[c]	Wk	Variety
2004	Sagunto	TT, ML, IPMT,	F, M	4	12	Marisol
	Alzira	P, ET	F, M	4	12	Marisol
	Tavernes		F, M	4	12	Clementina
	Denia		F, M	4	12	Clemenules and Okitsu
2005	Sagunto	TT, EPA, MT,	F	4	6	Marisol
	Alzira	P	F	4	6	Marisol
	Tavernes	TT, EPA, MT,	F	4	6	Clementina
	Denia	P	F	4	6	Clemenules and Okitsu

[a] TT, Tephri-trap; ML, Multilure; IPMT, International Pheromone McPhail Trap; P, Probodelt; ET, Easytrap; MT, Mosquitrap; and EPA, EPAtrap.
[b] F, female attractant (Biolure); M, male attractant (Trimedlure).
[c] Plots per field.

Lure Evaluation. Attractants were tested in the same field trials as the trap evaluations. Tests were carried out in 2005 for 13 wk from August to November (traps where placed 1 wk after the trap type trial finished in August). Six different dispensers with different female attractants were tested: Biolure, EPAlure, Biolure M100, TMA Susbin, SEDQ, and Trypack. There are two types of lures in this list: several formulations of the mixture ammonium acetate, trimethylamine, and a diaminoalkane (putrescine or cadaverine), and a formulation of the mixture ammonium acetate, *n*-methyl pyrrolidine (NMP).Putrescine and cadaverine are considered to be equal efficiency in *C. capitata* attraction (Clemente-Angulo, 2002), so this trial compares trimethylamine + diaminoalkane and *n*-methyl pyrrolidine as a component of female attractants.

Dispensers were extracted and analyzed at 0 d and after 90 d of use in the field to obtain a lifetime for each dispenser. Trimethylamine, putrescine, cadaverine, and *n*-methyl pyrrolidine were quantified by gas chromatography, and ammonium acetate was quantified by acid-base evaluation. All dispensers were placed in Tephri-trap traps with a DDVP strip and hung at 1.5 m from southern tree faces. Each field plot contained six traps, each one with one type of dispensers. Each trial field contained four plots and the trial was replicated four times in four different fields separated by almost 30 km. As in the trap evaluation trials, traps with different dispensers were rotated clockwise each week after counting *C. capitata* catches.

Lure Longevity. To obtain an estimation of attractant duration, three female lures were tested: Biolure, Trypack, and EPAlure. This trial was carried out in 2005 in same orchard of Sagunto, but 900 m away of trap evaluation trials field. All attractants were placed in Tephri-traps and hung from orange trees facing south at 1.5 m. The three lures, each in one Tephri-trap, were hung 30 m apart in the same plot to avoid interference. The plots within each field were separated by almost 100 m to obtain four independent replications. This trial was replicated in four plots in

Table 2. Overall weekly captures of male and female Mediterranean fruit fly (mean ± SE) by trap type during 2004 assay with Trimedlure and Biolure

Trap	Males[a] (mean ± SE)[c]	Females[a] (mean ± SE)[c]	Total[a] (mean ± SE)[c]	% females[a] (mean ± SE)[d]	Total[b] (mean ± SE)[c]
Tephri-trap	24.32 ± 2.60b	30.61 ± 3.45a	54.93 ± 5.88bc	53.71 ± 1.56a	10.37 ± 1.53b
Easy-trap	19.27 ± 1.78b	33.98 ± 2.73b	53.25 ± 4.36bc	63.04 ± 1.20b	10.57 ± 1.56b
Multilure	16.57 ± 1.95a	25.26 ± 2.59a	41.83 ± 4.41a	64.67 ± 1.57b	5.46 ± 0.81a
IPMT	22.88 ± 2.30b	38.70 ± 3.31b	61.60 ± 5.41c	64.85 ± 1.16b	16.20 ± 2.33c
Probodelt	34.12 ± 4.03c	60.5 ± 6.17c	94.62 ± 10.02d	64.16 ± 1.11b	15.57 ± 1.64c

[a] Captures with Biolure attractant during first 6 wk.
[b] Captures with Agrisense Trimedlure plug during 6 wk after Biolure assay.
[c] Means followed by the same letter are not significantly different at the 5% level by Fisher protected LSD conducted in the logarithm scale.
[d] Total females captured divided by total flies. Means followed by the same letter are not significantly different at the 5% level by Fisher protected LSD.

the same orchard. Traps were hung at the end of June, and they remained in the field until the end of October. At the beginning of the second month of aging (last week of July) and the fourth month of aging (last week of September), two new traps were added to the trial. These traps contained a new Biolure and Trypack lures in each trap to compare Mediterranean fruit fly catches of an aged lure versus a new lure. These new traps were added to every one of the four trial fields.

Flies were counted and traps rotated clockwise every week. *C. capitata* catches were accumulated monthly to obtain monthly efficacies and monthly estimations of lost efficacy through aging.

Statistical Analysis. Statistical analysis was performed using one-way analysis of variance (ANOVA) of the weekly catches in each trap for each plot. Data were transformed $X = (\log(x + 1))$ to normalize distribution in trap evaluation and $X = \mathrm{SQRT}(x)$ in lure evaluation. Index of trap efficacy versus Tephri-trap was transformed to log x+0.5 before ANOVA analysis.

All means were separated using Fisher least significant difference (LSD) test at $P = 0.05$. Data are presented as untransformed means and standard errors. Statgraphics Plus 5.1 (Statpoint Inc. 2000) was used for all statistical analysis.

Results

Trap Evaluation. Results of catches depending on type of trap are shown on Table 2 and Table 3 for 2004 and 2005 respectively. In 2004, using Biolure as a *C. capitata* lure, Probodelt catch significantly more flies than the other traps ($F = 14.97$; df = 4,644; $P < 0.0001$). This difference is also significant for female and males catches ($F = 17.67$; df = 4,644; $P < 0.0001$ and $F = 10.61$; df = 4,644; $P < 0.0001$, respectively). In 2005, only EPAtrap results as efficient as Probodelt ($F = 7.19$; df = 3,455; $P < 0.001$). When we observe the 2-yr results, we can summarize that IPMT and Mosquitrap obtained significantly fewer catches than Probodelt but significantly more than Easy-trap, Multilure, or Tephri-trap for females ($F = 7.04$; df = 5,185; $P < 0.001$) and for total catches ($F = 7.85$; df = 5,185; $P < 0.001$). Probodelt and EPAtrap trapped >3 times more females than the Tephri-trap or Multilure when we used Biolure as a lure.

Very similar results were obtained when TML was used as the *C. capitata* lure: Probodelt and IPMT obtained significantly more male catches than Tephri-trap and Easy-trap, whereas Multilure obtained significant fewer catches than the other traps ($F = 14.57$; df = 4,594; $P < 0.001$).

The proportion of females captured per trap type in 2004 shows that Tephri-trap captured significantly fewer females than Probodelt, Mosquitrap, EPAtrap, Easytrap, and Multilure ($F = 12.57$; df = 4,644; $P < 0.001$).The same occurs in 2005 when Tephri-trap captured a female proportion significant fewer than EPAtrap, Probodelt or Mosquisan ($F = 9.57$; df = 3,455; $P < 0.001$).

Lure Evaluation. Table 4 shows the results of *C. capitata* catches with each type of lure tested. Biolure Medfly 100 captured significant more flies than Econex TP or SEDEQ, although this difference was not significant compared with Biolure, TMA-Susbin,

Table 3. Overall weekly captures of male and female Mediterranean fruit fly by trap type baited with Biolure attractant during 2005 assay

Trap	Males (mean ± SE)[a]	Females (mean ± SE)[a]	Total (mean ± SE)[a]	% females (mean ± SE)[b]
Tephri-trap	19.07 ± 3.06a	24.61 ± 4.76a	43.83 ± 7.08a	58.55 ± 2.47a
EPAtrap	25.17 ± 2.92ab	49.90 ± 5.27bc	74.98 ± 7.83bc	71.70 ± 1.57b
Probodelt	34.64 ± 4.42b	56.43 ± 6.06c	91.05 ± 9.96c	68.81 ± 1.76b
Mosquitrap	22.47 ± 3.40a	39.47 ± 5.02b	61.92 ± 7.98ab	70.70 ± 1.86b

[a] Mean flies per trap. Means followed by the same letter are not significantly different at the 5% level by Fisher protected LSD conducted in the logarithm scale.
[b] Total females captured divided by total flies. Means followed by the same letter are not significantly different at the 5% level by Fisher protected LSD.

Table 4. Overall weekly captures of male and female Mediterranean fruit fly by type of attractant with Tephri-trap in 2005

Attractant	Males (mean ± SE)[a]	Females (mean ± SE)[a]	Total (mean ± SE)[a]	% females (mean ± SE)[b]
Biolure	9.24 ± 0.69bc	18.06 ± 1.42ab	27.30 ± 1.91abc	62.84 ± 1.79bc
TMA-Susbin	10.43 ± 1.06bc	21.03 ± 2.66ab	31.46 ± 3.61bc	60.01 ± 1.93b
EPAlure	12.53 ± 1.57c	16.17 ± 3.46a	28.71 ± 4.87abc	48.46 ± 2.03a
SEDQ	8.38 ± 0.69ab	15.83 ± 1.53a	24.21 ± 2.08ab	61.74 ± 1.72bc
Biolure M100	11.53 ± 1.47bc	26.64 ± 3.57b	38.18 ± 4.90c	66.70 ± 1.63c
Trypack	6.65 ± 0.95a	13.72 ± 1.99a	20.37 ± 2.88a	62.97 ± 1.92bc

[a] Mean flies per trap. Means followed by the same letter are not significantly different at the 5% level by Fisher protected LSD conducted in the square root scale.
[b] Total females captured divided by total flies. Means followed by the same letter are not significantly different at the 5% level by Fisher protected LSD.

and EPAlure ($F = 2.6$; df = 5,210; $P = 0.02$). However, only Biolure, Biolure M100, and TMA Susbin caught significantly more *C. capitata* females than the other attractants ($F = 2.46$; df = 5,210; $P = 0.03$). In addition, Biolure M100, Biolure, SEDQ, TMA-Susbin, and Econex TP showed a significant higher percentage of female catches than EPAlure. This significant difference in female proportions was attributed to the attractants composition of the lures. Whereas NMP attracts the same number of *C. capitata* as trimethylamine + diaminoalkane, the proportion of females caught with NMP is always closer to 40–50%. However, female proportions in trimethylamine + diaminoalkane dispensers vary over the year from 40 to 80%, averaging between 61 and 66%.

Table 5 shows the quantification of female attractants when they were placed in the traps (aging 0) and 3 mo later (aging 90 d). All cited attractants contain trimethylamine and ammonium acetate combined with a diaminoalkane, except EPAlure, which consists of ammonium acetate and *n*-methyl pyrrolidine. It was shown that attractant concentration varied among the commercial products used. The initial ammonium acetate content was different for each dispenser, and the values varied between 8.12 and 3.7 g for SEDQ and Trypack, respectively. The initial trimethylamine values varied from 3.23 to 0.46 for Biolure M100 and SEDQ, respectively. In this study, it was important to know which dispensers released more ammonium acetate and trimethylamine, because such differences in emission might help explain the different levels of insect catches for each dispenser.

On Table 5, Biolure M100, Biolure, SEDQ, and EPAlure can be seen to release from 2.46 to 3.07 g of ammonium acetate over the same interval (90 d). However, Trypack only released 0.65 g. The largest trimethylamine emission was for Biolure M100 (0.52 g), with the smallest for SEDQ (0.18 g). The best dispenser for insect catches, therefore, proves to be Biolure M100, as the dispenser emitting the most ammonium acetate and trimethylamine. Trypack and SEDQ, however, show minor emissions of ammonium acetate and trimethylamine, respectively, and only provided minor catches. In summary, different ammonium acetate and trimethyamine emissions can explain the levels of insect catches for each dispenser.

Lure Longevity. Trial results are shown on Table 6. Initial results show that Econex TP attracts significantly fewer flies than Biolure or EPAlure during the first 2 mo ($F = 3.52$; df = 2, 56; $P < 0.036$). If Econex TP and Biolure are compared directly, Biolure can be seen to be significantly better over the first 2 mo ($F = 3.11$; df = 4, 3; $P < 0.05$), but by the third month Econex TP is just as efficient as Biolure, and no differences can be found between a Econex TP dispenser aged for 3 mo and a new one. Thus, although Biolure is better than Econex TP for the first 2 mo, it has a shorter duration in the field. Nevertheless, Econex TP is as active at the start of the trial as it is in the third month, so it is as attractive as a Biolure in the third month of the test.

In the fourth month, significant differences between aged and new Econex TP can be detected ($F = 3.16$; df = 7,103; $P = 0.007$). It was therefore concluded that Econex TP has a lifespan between 3 and 4 mo, whereas Biolure is shorter, 2–3 mo. EPAlure was the only lure to remain just as efficient in the fourth aging month as a new Biolure or Trypack dispenser, so EPAlure can be seen to have a lifespan of >4 mo.

Table 5. Composition of female dispensers

Attractant type	Component quantity ± SE							
	0 d				90 d			
	AA (g)	TMA (g)	PUT (mg)	MP (g)	AA (g)	TMA (g)	PUT (mg)	MP (g)
EPAlure	4.26 ± 0.21			0.42 ± 0.01	1.19 ± 0.02			0.21 ± 0.02
Biolure	5.03 ± 0.02	2.24 ± 0.02	39.60 ± 0.16		2.57 ± 0.19	1.80 ± 0.03	34.31 ± 0.44	
Biolure M100	7.23 ± 0.06	3.23 ± 0.03	39.60 ± 0.16		4.41 ± 0.26	2.71 ± 0.10	31.59 ± 4.36	
Trypack	3.70 ± 0.10	0.80 ± 0.10	33.89 ± 3.85		3.05 ± 0.22	0.50 ± 0.03	17.24 ± 1.34	
SEDQ	8.12 ± 0.12	0.46 ± 0.09			5.32 ± 0.25	0.28 ± 0.01		

AA, ammonium acetate; TMA, HCl-trimethyl amine; PUT, putrescine; and MP, methyl pyrrolidine.

Table 6. Weekly captures of Mediterranean fruit fly every aging month during the lifetime of dispensers

Attractant	Aging time			
	Weekly catches first month (mean ± SE)	Weekly catches second month (mean ± SE)	Weekly catches third month (mean ± SE)	Weekly catches fourth month (mean ± SE)
Biolure	19 ± 7.15ab	35.9 ± 6.70b	19.45 ± 8.12ab	3.81 ± 0.93a
Econex TP	9.85 ± 3.34a	18.05 ± 5.06a	7.3 ± 2.42a	6.37 ± 2.15ab
EPAlure	19.2 ± 5.25b	45.95 ± 7.79b	16.25 ± 5.89ab	12.12 ± 3.68cd
Biolure[a]		46.1 ± 11.43b	27.15 ± 7.41b	8 ± 1.68abc
Econex TP[a]		35.25 ± 7.80ab	12.3 ± 3.61ab	15.87 ± 3.95cd
Biolure[b]				19.37 ± 4.73d
Econex TP[b]				13.68 ± 3.46d

Mean flies per trap. Means followed by the same letter are not significantly different at the 5% level by Fisher protected LSD conducted in the logarithm scale.
[a] Attractants placed the 22 July.
[b] Attractants placed the 6 October.

Discussion

Field trials show that different trap designs give highly varying efficacies in Mediterranean fruit fly catches. Importantly, the best traps caught 3 times more flies than traps giving worse results. Such high efficacy differences are very important in systems using traps to control *C. capitata.* Fruit fly control methods include the mass trapping technique in extensive areas, but this technique has not been widely applied due to the high cost of attractants and the labor to install the traps. This study suggests that the number of traps per hectare can be reduced and also that reductions can be made in the number of attractants, insecticide, and the labor required to install the traps. As a general guideline, this study suggest to use Probodelt and EPAtrap traps because they can improve mass trapping efficacy greatly, because they catch more Mediterranean fruit flies by using the same dispenser under the same conditions.

Currently, in Spain the cost of mass trapping including labor, traps, and attractants amounts to ≈250 Euro/ha. To reduce this cost, it is essential to have a dispenser lifespan of >3 mo, because this allows for placing only one trap and dispenser per year. *C. capitata* population can therefore be reduced 1–2 mo before the beginning of fruit damage until the end of harvest, and this would make unnecessary the attractant replacement, halving the cost of mass trapping. Moreover, using 3 times more efficient traps we can reduce almost 50% of traps; therefore, this technique will cost ≈125 Euro/ha. Insecticide applications (almost five applications in mandarin orchards) cost ≈20 Euro/ha per application with malathion or 30 Euros/ha per application with Spinosad. This means that the cost of an optimized mass trapping and the spraying treatments is very similar, but mass trapping avoids insecticide residues in fruit and reduces affectation of nontarget organisms.

Monitoring programs should include a detailed description of the trap type being used, because the significant differences observed in this study may lead to overestimation, or, even worse, underestimation of high populations. In Spain, treatments against *C. capitata* depend on catches level in monitoring traps and ripening status of fruit hosts. In this case, using a low-efficacy trap would lead us to underestimate the fruit fly population and therefore decide not to treat with a population level that would require a treatment. When male attractants were used, nearly three times more males were captured in Probodelt or IPMT traps than in Multilure traps. This result is very important for monitoring programs or fruit import protocols in which maximum population levels are described for aerial treatments (USDA–APHIS 2003). It is clear that normalizing the type of trap and lure is necessary to obtain consistent results.

In addition, the mass trapping technique should obtain the highest female captures. The proportion of female catches is obviously influenced by attractant type, and it has been shown that trimethylamine was the best attractant when used with ammonium acetate with or without putrescine (Heath et al. 2004). But trap type also modifies this proportion (Gazit et al. 1998), so it is better to use a trap that achieves higher captures and better female proportions. In this work, we conclude that currently we should avoid using Tephri-trap for female mass trapping although it was recommended in previous research (Miranda et al. 2001), because it captured significant fewer females than the other traps, and in this technique females are the main objective.

Moreover, currently in Spain several field trials try to validate the use of mass trapping as a method of reducing female populations during sterilized male release in SIT programs. In this case, it is essential to use the trap that catches the higher female proportion. However, in other methods such as chemosterilization (Navarro-Llopis et al. 2004), the main objective is to attract the largest number of flies, both males and females, over the whole season. When this technique is used, the selected attractant should maximize both the number of total flies attracted and the lifetime of dispensers (Navarro-Llopis et al. 2007).

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