INTERNATIONAL STANDARDS FOR PHYTOSANITARY MEASURES

DRAFT APPENDIX to ISPM 26:2006

FRUIT FLY TRAPPING

(201-)

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APPENDIX 1: Fruit fly trapping

This appendix provides detailed information for trapping fruit fly species (Tephritidae) of economic importance under different pest situations. Specific trapping systems should be used depending on the technical feasibility, the species of fruit fly and the phytosanitary status of the delimited areas, which can be either an infested area, an area of low pest prevalence (FF-ALPP), or a pest free area (FF-PFA). The information in this appendix can be used by National Plant Protection Organizations (NPPOs) to develop FF-PFA and FF-ALPP in line with guidance provided in other ISPMs related to fruit flies. It describes the most widely used trapping systems, including materials such as traps and attractants, trapping densities and delimiting surveys, as well as procedures including evaluation, data recording and analysis.

In cases where a fruit fly trapping programme is intended to be part of an export programme, the exporting country should check with the importing country to determine if the trapping programme meets the specific phytosanitary requirements of that country.

1. Pest Situations and Survey Types

There are five pest situations where surveys may be applied:

A. Pest present without control. The pest population is present but not subject to any control measures.

B. Pest present under suppression. The pest population is present and subject to control measures. Includes FF-ALPP.

C. Pest present under eradication. The pest population is present and subject to control measures.

D. Pest absent and FF-PFA being maintained. The pest is absent (e.g. eradicated, no pest records, no longer present) and measures to maintain pest absence are applied.

E. Pest transient. Pest actionable, under surveillance and actionable, under eradication.

The three types of trapping surveys and corresponding objectives are:

- **monitoring surveys**, to verify the characteristics of the pest population
- **delimiting surveys**, to establish the boundaries of an area considered to be infested by or free from the pest
- **detection surveys**, to determine if the pest is present in an area.

Monitoring surveys are necessary in the first three situations (A, B and C) to verify the characteristics of the pest population before the initiation or during the application of suppression and eradication measures to verify the population levels and to evaluate the efficacy of the control measures. Delimiting surveys are applied to determine the boundaries of an established FF-ALPP and as part of a corrective action plan when the pest exceeds the established low prevalence levels (situation B) (ISPM 30:2008) or in an FF-PFA as part of a corrective action plan when a detection occurs (situation E) (ISPM 26:2006). Detection surveys are necessary to demonstrate pest absence (situation D) and to detect a possible entry of the pest into the FF-PFA (pest transient actionable) (ISPM 8:1998).

Additional information on how or when specific types of surveys should be applied can be found in other relevant standards dealing with specific topics such as pest status, eradication, pest free areas or areas of low pest prevalence.

2. Trapping Scenarios

Based on the status of the pest, there are two scenarios that may gradually progress towards the subsequent scenario:

- Pest present. Starting from an established population with no control (situation A), phytosanitary measures may be applied, and potentially lead toward an FF-ALPP (situation B), and or an FF-PFA (situation C).
- Pest absent. Starting from an FF-PFA (situation D), the pest status is either maintained or a detection occurs (situation E), where measures would be applied aimed at restoring the FF-PFA.

In each of these scenarios, the types of trapping surveys necessary would change over time based on the pest situation.

3. Trapping Systems – Materials

The effective use of traps in undertaking fruit fly surveys relies on the combined ability of the trap, attractant and killing agent to attract and capture target fruit fly species and then to kill and preserve them for effective identification, counting data collection and analysis. Trapping systems for fruit fly surveys use the following materials:

- attractants (pheromones, parapheromones and food attractants)
- killing agents in wet and dry traps (with physical or chemical action)
- devices for trapping.

A number of fruit fly species of economic importance and the attractants commonly used to attract them are presented in Table 1. Presence or absence of a species from this table does not indicate that pest risk analysis has been performed and in no way is it indicative of the regulatory status of a fruit fly species.

Table 1. A number of fruit fly species of economic importance and commonly used attractants

Scientific name	Attractant
Anastrepha fraterculus (Wiedemann)	Protein attractant (PA)
Anastrepha grandis (Macquart)	PA
Anastrepha ludens (Loew)	PA, 2C-1[1]
Anastrepha obliqua (Macquart)	PA, 2C-1[1]
Anastrepha serpentina (Wiedemann)	PA
Anastrepha striata (Schiner)	PA
Anastrepha suspensa (Loew)	PA, 2C-1[1]
Bactrocera carambolae (Drew & Hancock)	Methyl eugenol (ME)
Bactrocera caryeae (Kapoor)	ME
Bactrocera correcta (Bezzi)	ME
Bactrocera dorsalis (Hendel)[4]	ME
Bactrocera invadens (Drew, Tsuruta, & White)	ME, 3C[2]
Bactrocera kandiensis (Drew & Hancock)	ME
Bactrocera occipitalis (Bezzi)	ME
Bactrocera papayae (Drew & Hancock)	ME
Bactrocera philippinensis (Drew & Hancock)	ME
Bactrocera umbrosa (Fabricius)	ME
Bactrocera zonata (Saunders)	ME, 3C[2], ammonium acetate (AA)

Scientific name	Attractant
Bactrocera cucurbitae (Coquillett)	Cuelure (CUE), 3C[2], AA
Bactrocera tryoni (Froggatt)	CUE
Bactrocera neohumeralis (Hardy)	CUE
Bactrocera tau (Walker)	CUE
Bactrocera citri (Chen) (*B. minax*, Enderlein)	PA
Bactrocera cucumis (French)	PA
Bactrocera jarvisi (Tryon)	PA
Bactrocera latifrons (Hendel)	PA
Bactrocera oleae (Gmelin)	PA, ammonium bicarbonate (AC), Spiroketal
Bactrocera tsuneonis (Miyake)	PA
Ceratitis capitata (Wiedemann)	Trimedlure (TML), Capilure, PA, 3C[2], 2C-2[3]
Ceratitis cosyra (Walker)	PA, 3C[2], 2C-2[3]
Ceratitis rosa (Karsch)	TML, PA, 3C[2], 2C-2[3]
Dacus ciliatus (Loew)	PA, 3C[2], AA
Myiopardalis pardalina (Bigot)	PA
Rhagoletis cerasi (Linnaeus)	Ammonium salts (AS), AA, AC
Rhagoletis cingulata (Loew)	AS, AA, AC
Rhagoletis pomonella (Walsh)	butyl hexanoate (BuH), AS
Toxotrypana curvicauda (Gerstaecker)	2-methyl-vinylpyrazine (MVP)

1 Two-component (2C-1) synthetic food attractant of ammonium acetate and putrescine, mainly for female captures.

2 Three-component (3C) synthetic food attractant, mainly for female captures (ammonium acetate, putrescine, trimethylamine).

3 Two-component (2C-2) synthetic food attractant of ammonium acetate and trimethylamine, mainly for female captures.

4 Taxonomic status of some listed members of the *Bactrocera dorsalis* complex is uncertain.

3.1 Attractants

3.1.1 Male specific

The most widely used attractants are pheromone or parapheromones that are male specific. The parapheromone trimedlure (TML) captures species of the genus *Ceratitis* (including *C. capitata* and *C. rosa*). The parapheromone methyl eugenol (ME) captures a large number of species of the genus *Bactrocera* (including *B. dorsalis, B. zonata, B. carambolae, B. invadens, B. philippinensis* and *B. musae*). The pheromone Spiroketal captures *B. oleae*. The parapheromone cuelure (CUE) captures a large number of other *Bactrocera* species, including *B. cucurbitae* and *B. tryoni*. Parapheromones are generally highly volatile, and can be used with a variety of traps. Examples are listed in Table 2a. Controlled-release formulations exist for TML, CUE and ME, providing a longer-lasting attractant for field use. It is important to be aware that some inherent environmental conditions may affect the longevity of pheromone and parapheromone attractants.

3.1.2 Female-biased

Female-specific pheromones/parapheromones are not usually commercially available (except, for example, 2-methyl-vinylpyrazine). Therefore, the female-biased attractants (natural, synthetic, liquid or dry) that are commonly used are based on food or host odours (Table 2b). Historically, liquid protein attractants have been used to capture a wide range of different fruit fly species. Liquid protein attractants capture both females and males. These liquid attractants are generally less sensitive than the parapheromones. In addition, liquid attractants capture high numbers of non-target insects.

Several food-based synthetic attractants have been developed using ammonia and its derivatives. This may reduce the number of non-target insects captured. For example, for capturing *C. capitata* a synthetic food attractant consisting of three components (ammonium acetate, putrescine and trimethylamine) is used. For capture of *Anastrepha* species the trimethylamine component may be removed. A synthetic attractant lasts approximately 4–10 weeks depending on climatic conditions, captures few non-target insects and captures significantly fewer male fruit flies, making this attractant suited for use in sterile fruit fly release programmes. New synthetic food attractant technologies are available for use, including the long-lasting three-component and two-component mixtures contained in the same patch, as well as the three components incorporated in a single cone-shaped plug (Tables 1 and 3).

In addition, because food-foraging female and male fruit flies respond to synthetic food attractants at the sexually immature adult stage, these attractant types are capable of detecting female fruit flies earlier and at lower population levels than liquid protein attractants.

Table 2a. Attractants and traps for male fruit fly surveys

Fruit fly species	Attractant and trap (see below for abbreviations)																										
	TML/CE											ME								CUE							
	CC	CH	ET	JT	LT	MM	ST	SE	TP	YP	VARs	CH	ET	JT	LT	MM	ST	TP	YP	CH	ET	JT	LT	MM	ST	TP	YP
Anastrepha fraterculus																											
Anastrepha ludens																											
Anastrepha obliqua																											
Anastrepha striata																											
Anastrepha suspensa																											
Bactrocera carambolae												**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**								
Bactrocera caryeae												x	x	x	x	x	x	x	x								
Bactrocera citri (B. minax)																											
Bactrocera correcta												x	x	x	x	x	x	x	x								
Bactrocera cucumis																											
Bactrocera cucurbitae																				x	x	x	x	x	x	x	x
Bactrocera dorsalis												**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**								
Bactrocera invadens												x	x	x	x	x	x	x	x								
Bactrocera kandiensis												**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**								
Bactrocera latifrons																											
Bactrocera occipitalis												**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**								
Bactrocera oleae																											
Bactrocera papayae												**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**								
Bactrocera philippinensis												x	x	x	x	x	x	x	x								
Bactrocera tau																				**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**
Bactrocera tryoni																				x	x	x	x	x	x	x	x
Bactrocera tsuneonis																											
Bactrocera umbrosa												x	x	x	x	x	x	x	x								
Bactrocera zonata												**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**								
Ceratitis capitata		x	x	x	x	x	x	x	x	x	x																
Ceratitis cosyra																											
Ceratitis rosa		x	x	x	x	x	x	x	x	x	x																
Dacus ciliatus																											
Myiopardalis pardalina																											
Rhagoletis cerasi																											

Table 2a *continued*

Fruit fly species	Attractant and trap (see below for abbreviations)																										
	TML/CE											ME								CUE							
	CC	CH	ET	JT	LT	MM	ST	SE	TP	YP	VARs	CH	ET	JT	LT	MM	ST	TP	YP	CH	ET	JT	LT	MM	ST	TP	YP
Rhagoletis cingulata																											
Rhagoletis pomonella																											
Toxotrypana curvicauda																											

Attractant abbreviations

TML Trimedlure
CE Capilure
ME Methyl eugenol
CUE Cuelure

Trap abbreviations

CC Cook and Cunningham (C&C) trap
CH ChamP trap
ET Easy trap
JT Jackson trap
LT Lynfield trap
MM Maghreb-Med or Morocco trap
ST Steiner trap
SE Sensus trap
TP Tephri trap
VARs Modified funnel trap
YP Yellow panel trap

Table 2b. Attractants and traps for female-biased fruit fly surveys

Fruit fly species	Attractant and trap (see below for abbreviations)																									
	3C							2C-1					2C-2	PA			SK+AC		AS (AA, AC)				BuH			MVP
	ET	SE	MLT	OBDT	LT	MM	TP	ET	MLT	LT	MM	TP	MLT	ET	McP	MLT	CH	YP	RB	RS	YP	PALz	RS	YP	PALz	GS
Anastrepha fraterculus															x	x										
Anastrepha grandis															x	x										
Anastrepha ludens													x		x	x										
Anastrepha obliqua													x		x	x										
Anastrepha striata															x	x										
Anastrepha suspensa													x		x	x										
Bactrocera carambolae															x	x										
Bactrocera caryeae															x	x										
Bactrocera citri (B. minax)															x	x										
Bactrocera correcta															x	x										
Bactrocera cucumis															x	x										
Bactrocera cucurbitae			x												x	x										
Bactrocera dorsalis															x	x										
Bactrocera invadens			x												x	x										
Bactrocera kandiensis															x	x										
Bactrocera latifrons															x	x										
Bactrocera occipitalis															x	x										
Bactrocera oleae														x	x	x	x	x			x	x				
Bactrocera papayae															x	x										
Bactrocera philippinensis															x	x										
Bactrocera tau															x	x										
Bactrocera tryoni															x	x										
Bactrocera tsuneonis															x	x										
Bactrocera umbrosa															x	x										
Bactrocera zonata			x												x	x										
Ceratitis capitata	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x										
Ceratitis cosyra			x						x						x	x										
Ceratitis rosa		x	x						x						x	x										

Table 2b *continued*

Fruit fly species	Attractant and trap (see below for abbreviations)																									
	3C							2C-1					2C-2	PA			SK+AC		AS (AA, AC)				BuH			MVP
	ET	SE	MLT	OBDT	LT	MM	TP	ET	MLT	LT	MM	TP	MLT	ET	McP	MLT	CH	YP	RB	RS	YP	PALz	RS	YP	PALz	GS
Dacus ciliatus			x												x	x										
Myiopardalis pardalina															**x**	**x**										
Rhagoletis cerasi																			x	x	x	x	x	x	x	
Rhagoletis cingulata																					**x**	**x**		**x**	**x**	
Rhagoletis pomonella																			x		x	x	x			
Toxotrypana curvicauda																										**x**

Attractant abbreviations

3C	(AA+Pt+TMA)	AS	ammonium salts
2C-1	(AA+TMA)	AA	ammonium acetate
2C-2	(AA+Pt)	BuH	butyl hexanoate
PA	protein attractant	MVP	papaya fruit fly pheromone (2-methyl vinylpyrazine)
SK	Spiroketal	Pt	putrescine
AC	ammonium (bi)carbonate	TMA	trimethylamine

Trap abbreviations

CH	ChamP trap	McP	McPhail trap	RS	Red sphere trap
ET	Easy trap	MLT	Multilure trap	SE	Sensus trap
GS	Green sphere	OBDT	Open bottom dry trap	TP	Tephri trap
LT	Lynfield trap	PALz	Fluorescent yellow sticky "cloak" trap	YP	Yellow panel trap
MM	Maghreb-Med or Morocco trap	RB	Rebell trap		

Table 3. List of attractants and field longevity

Common name	Attractant abbreviations	Formulation	Field longevity[1] (weeks)
Parapheromones			
Trimedlure	TML	Polymeric plug	4–10
		Laminate	3–6
		Liquid	1–4
		PE bag	4-5
Methyl eugenol	ME	Polymeric plug	4–10
		Liquid	4–8
Cuelure	CUE	Polymeric plug	4–10
		Liquid	4–8
Capilure (TML plus extenders)	CE	Liquid	12–36
Pheromones			
Papaya fruit fly (*T. curvicauda*) (2-methyl-6-vinylpyrazine)	MVP	Patches	4–6
Olive Fly (spiroketal)	SK	Polymer	4–6
Food-based attractants			
Torula yeast/borax	PA	Pellet	1–2
Protein derivatives	PA	Liquid	1–2
Ammonium acetate	AA	Patches	4–6
		Liquid	1
		Polymer	2–4
Ammonium (bi)carbonate	AC	Patches	4–6
		Liquid	1
		Polymer	1–4
Ammonium salts	AS	Salt	1
Putrescine	Pt	Patches	6–10
Trimethylamine	TMA	Patches	6–10
Butyl hexanoate	BuH	Vial	2
Ammonium acetate Putrescine Trimethylamine	3C	Cone/patches	6–10
Ammonium acetate Putrescine Trimethylamine	3C	Long-lasting patches	18–26
Ammonium acetate Trimethylamine	2C-1	Patches	6–10
Ammonium acetate Putrescine	2C-2	Patches	6–10
Ammonium acetate Ammonium carbonate	AA/AC	PE bag w. alufoil cover	3–4

1 Based on half-life. Attractant longevity is indicative only. Actual timing should be supported by field testing and validation.

3.2 Killing and preserving agents

Traps retain attracted fruit flies through the use of killing and preserving agents. In some dry traps, killing agents are a sticky material or a toxicant. Some organophosphates may act as a repellent at higher doses. The use of insecticides in traps is subject to the registration and approval of the product in the respective national legislation.

In other traps, liquid is the killing agent. When liquid protein attractants are used, mix borax 3% concentration to preserve the captured fruit flies. There are protein attractants that are formulated with borax, and thus no additional borax is required. When water is used in hot climates, 10% propylene glycol is added to prevent evaporation of the attractant and to preserve captured flies.

3.3 Commonly used fruit fly traps

This section describes widely used fruit fly traps. The list of traps is not comprehensive; other types of traps may achieve equivalent results and may be used for fruit fly trapping.

Based on the killing agent, there are three types of traps commonly used:

- **Dry traps**. The fly is caught on a sticky material board or killed by a chemical agent. Some of the most widely used dry traps are Cook and Cunningham (C&C), ChamP, Jackson/Delta, Lynfield, open bottom dry trap (OBDT) or Phase IV, red sphere, Steiner and yellow panel/Rebell traps.
- **Wet traps**. The fly is captured and drowns in the attractant solution or in water with surfactant. One of the most widely used wet traps is the McPhail trap. The Harris trap is also a wet trap with a more limited use.
- **Dry or wet traps**. These traps can be used either dry or wet. Some of the most widely used are Easy trap, Multilure trap and Tephri trap.

Cook and Cunningham (C&C) trap

General description

The C&C trap consists of three removable creamy white panels, spaced approximately 2.5 cm apart. The two outer panels are made of rectangular paperboard measuring 22.8 cm × 14.0 cm. One or both panels are coated with sticky material (Figure 1). The adhesive panel has one or more holes which allow air to circulate through. The trap is used with a polymeric panel containing an olfactory attractant (usually trimedlure), which is placed between the two outer panels. The polymeric panels come in two sizes – standard and half panel. The standard panel (15.2 cm × 15.2 cm) contains 20 g of TML, while the half size (7.6 cm × 15.2 cm) contains 10 g. The entire unit is held together with clips, and suspended in the tree canopy with a wire hanger.

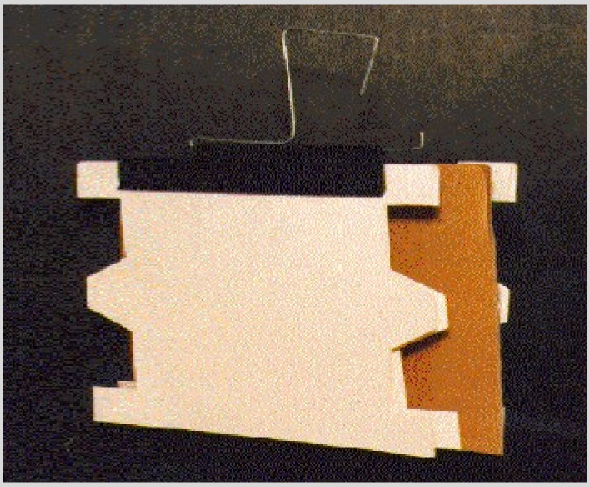


Figure 1. Cook and Cunningham (C&C) trap.

Use

As a result of the need for economic highly sensitive delimiting trapping of *C. capitata*, polymeric panels were developed for the controlled release of greater amounts of TML. This keeps the release rate constant for a longer period of time reducing hand labour and increasing sensitivity. The C&C trap with its multipanel construction has significant adhesive surface area for fly capture.

- For the species for which the trap is used, see Table 2a.
- For attractants used and rebaiting (field longevity), see Tables 2 and 3.
- For use under different scenarios and recommended densities, see Table 4d.

ChamP trap (CH)

General description

The ChamP trap is a hollow, yellow panel-type trap with two perforated sticky side panels. When the two panels are folded, the trap is rectangular in shape (18 cm × 15 cm), and a central chamber is created to place the attractant (Figure 2). A wire hanger placed at the top of the trap is used to place it on branches.

Figure 2. ChamP trap.

Use

The ChamP trap can accommodate patches, polymeric panels, and plugs. It is equivalent to a Yellow panel/Rebell trap in sensitivity.

- For the species for which the trap is used, see Tables 2a and 2b).
- For attractants used and rebaiting (field longevity), see Tables 2 and 3.
- For use under different scenarios and recommended densities, see Table 4b and 4c.

Easy trap (ET)

General description

The Easy trap is a two-part rectangular plastic container with an inbuilt hanger. It is 14.5 cm high, 9.5 cm wide, 5 cm deep and can hold 400 ml of liquid (Figure 3). The front part is transparent and the rear part is yellow. The transparent front of the trap contrasts with the yellow rear enhancing the trap's ability to catch fruit flies. It combines visual effects with parapheromone and food-based attractants.

Figure 3. Easy trap.

Use

The trap is multipurpose. It can be used dry baited with parapheromones (e.g. TML, CUE, ME) or synthetic food attractants (e.g. 3C and both combinations of 2C attractants) and a retention system such as dichlorvos. It can also be used wet baited with liquid protein attractants holding up to 400 ml of mixture. When synthetic food attractants are used, one of the dispensers (the one containing putrescine) is attached inside to the yellow part of the trap and the other dispensers are left free.

The Easy trap is one of the most economic traps commercially available. It is easy to carry, handle and service, providing the opportunity to service a greater number of traps per man-hour than some other traps.

- For the species for which the trap is used, see Tables 2a and 2b.
- For attractants used and rebaiting (field longevity), see Tables 2 and 3.
- For use under different scenarios and recommended densities, see Table 4d.

Fluorescent yellow sticky "cloak" trap (PALz)

General description

The PALz trap is prepared from fluorescent yellow plastic sheets (36 cm × 23 cm). One side is covered with sticky material. When setting up, the sticky sheet is placed around a vertical branch or a pole in a “cloaklike” manner (Figure 4), with the sticky side facing outward, and the back corners are fastened together with clips.

Figure 4. Fluorescent yellow sticky cloak trap.

Use

The trap uses the optimal combination of visual (fluorescent yellow) and chemical (cherry fruit fly synthetic bait) attractant cues. The trap is kept in place by a piece of wire, attached to the branch or pole. The bait dispenser is fastened to the front top edge of the trap, with the bait hanging in front of the sticky surface. The sticky surface of the trap has a capture capacity of about 500 to 600 fruit flies. Insects attracted by the combined action of these two stimuli are caught on the sticky surface.

- For the species for which the trap is used, see Table 2b.
- For attractants used and rebaiting (field longevity), see Tables 2 and 3.
- For use under different scenarios and recommended densities, see Table 4e.

Jackson trap (JT) or Delta trap

General description

The Jackson trap is hollow, delta shaped and made of a white waxed cardboard. It is 8 cm high, 12.5 cm long and 9 cm wide (Figure 5). Additional parts include a white or yellow rectangular insert of waxed cardboard which is covered with a thin layer of adhesive known as “sticky material” used to trap fruit flies once they land inside the trap body; a polymeric plug or cotton wick in a plastic basket or wire holder; and a wire hanger placed at the top of the trap body.

Use

This trap is mainly used with parapheromone attractants to capture male fruit flies. The attractants used with JT/Delta traps are TML, ME and CUE. When ME and CUE are used a toxicant must be added.

Figure 5. Jackson trap or Delta trap.

For many years this trap has been used in exclusion, suppression and/or eradication programmes for multiple purposes, including population ecology studies (seasonal abundance, distribution, host sequence, etc.); detection and delimiting trapping; and surveying sterile fruit fly populations in areas subjected to sterile fly mass releases. JT/Delta traps may not be suitable for some environmental conditions (e.g. rain or dust).

The JT/Delta traps are some of the most economic traps commercially available. They are easy to carry, handle and service, providing the opportunity of servicing a greater number of traps per man-hour than some other traps.

- For the species for which the trap is used, see Table 2a.
- For attractants used and rebaiting (field longevity), see Tables 2a and 3.
- For use under different scenarios and recommended densities, see Table 4b and 4d.

Lynfield trap (LT)

General description

The conventional Lynfield trap consists of a disposable, clear plastic, cylindrical container measuring 11.5 cm high with a 10 cm diameter base and 9 cm diameter screw-top lid. There are four entry holes evenly spaced around the wall of the trap (Figure 6). Another version of the Lynfield trap is the Maghreb-Med trap also known as Morocco trap (Figure 7).

Figure 6. Lynfield trap.

Figure 7. Maghreb-Med trap or Morocco trap.

Use

The trap uses an attractant and insecticide system to attract and kill target fruit flies. The screw-top lid is usually colour-coded to the type of attractant being used (red, CAP/TML; white, ME; yellow, CUE). To hold the attractant a 2.5 cm screw-tip cup hook (opening squeezed closed) screwed through the lid from above is used. The trap uses the male-specific parapheromone attractants CUE, Capilure (CE), TML and ME.

CUE and ME attractants, which are ingested by the male fruit fly, are mixed with malathion. However, because CE and TML are not ingested by either *C. capitata* or *C. rosa*, a dichlorvos-impregnated matrix is placed inside the trap to kill fruit flies that enter.

- For the species for which the trap is used, see Table 2a.
- For attractants used and rebaiting (field longevity), see Tables 2 and 3.
- For use under different scenarios and recommended densities, see Tables 4b and 4d.

McPhail (McP) trap type

General description

The conventional McPhail (McP) trap is a transparent glass or plastic, pear-shaped invaginated container. The trap is 17.2 cm high and 16.5 cm wide at the base and holds up to 500 ml of solution (Figure 8). The trap parts include a rubber cork or plastic lid that seals the upper part of the trap and a wire hook to hang traps on tree branches. A plastic version of the McPhail trap is 18 cm high and 16 cm wide at the base and holds up to 500 ml of solution (Figure 9). The top part is transparent and the base is yellow.

Figure 8. McPhail trap.

Use

For this trap to function properly it is essential that the body stays clean. Some designs have two parts in which the upper part and base of the trap can be separated allowing for easy service (rebaiting) and inspection of fruit fly captures.

This trap uses a liquid food attractant, based on hydrolysed protein or torula yeast/borax tablets. Torula tablets are more effective than hydrolysed proteins over time because the pH is stable at 9.2. The level of pH in the mixture plays an important role in attracting fruit flies. Fewer fruit flies are attracted to the mixture as the pH becomes more acidic.

Figure 9. Plastic McPhail trap.

To bait with yeast tablets, mix three to five torula tablets in 500 ml of water. Stir to dissolve tablets. To bait with protein hydrolysate, mix protein hydrolysate and borax (if not already added to the protein) in water to reach 5–9% hydrolysed protein concentration and 3% of borax.

The nature of its attractant means this trap is more effective at catching females. Food attractants are generic by nature, and so McP traps tend to also catch a wide range of other non-target tephritid and non-tephritid fruit flies in addition to the target species.

McP-type traps are used in fruit fly management programmes in combination with other traps. In areas subjected to suppression and eradication actions, these traps are used mainly to monitor female populations. Female catches are crucial in assessing the amount of sterility induced to a wild population in a sterile insect technique (SIT) programme. In programmes releasing only sterile males or in a male annihilation technique (MAT) programme, McP traps are used as a population detection tool by targeting feral females, whereas other traps (e.g. Jackson traps), used with male-specific attractants, catch the released sterile males, and their use should be limited to programmes with an SIT component. Furthermore, in fruit fly-free areas, McP traps are an important part of the non-indigenous fruit fly trapping network because of their capacity to capture fruit fly species of quarantine importance for which no specific attractants exist.

McP traps with liquid protein attractant are labour intensive. Servicing and rebaiting take time, and the number of traps that can be serviced in a normal working day is half that of some other traps described in this annex.

- For the species for which the trap is used, see Table 2b.
- For attractants used and rebaiting (field longevity), see Tables 2 and 3.
- For use under different scenarios and recommended densities, see Tables 4a, 4b, 4d and 4e.

Modified funnel trap (VARs+)

General description

The modified funnel trap consists of a plastic funnel and a lower catch container (Figure 10). The top roof has a large (5 cm diameter) hole, over which an upper catch container (transparent plastic) is placed.

Use

Since it is a non-sticky trap design, it has a virtually unlimited catch capacity and very long field life. The bait is attached to the roof, so that the bait dispenser is positioned into the middle of the large hole on the roof. A small piece of matrix impregnated with a killing agent is placed inside both the upper and lower catch containers to kill fruit flies that enter.

Figure 10. Modified funnel trap.

- For the species for which the trap is used, see Table 2a.
- For attractants used and rebaiting (field longevity), see Tables 2 and 3.
- For use under different scenarios and recommended densities, see Table 4d.

Figure 11. Multilure trap.

Multilure trap (MLT)

General description

The Multilure trap (MLT) is a version of the McPhail trap described previously. The trap is 18 cm high and 15 cm wide at the base and can hold up to 750 ml of liquid (Figure 11). It consists of a two-piece plastic invaginated cylinder-shaped container. The top part is transparent and the base is yellow. The upper part and base of the trap separate, allowing the trap to be serviced and rebaited. The transparent upper part of the trap contrasts with the yellow base enhancing the trap's ability to catch fruit flies. A wire hanger, placed on top of the trap body, is used to hang the trap from tree branches.

Use

This trap follows the same principles as those of the McP trap. However, an MLT used with dry synthetic attractant is more efficient and selective than an MLT or McP trap used with liquid protein attractant. Another important difference is that an MLT with a dry synthetic attractant allows for a cleaner servicing and is much less labour intensive than a McP trap. When synthetic food attractants are used, dispensers are attached to the inside walls of the upper cylindrical part of the trap or hung from a clip at the top. For this trap to function properly it is essential that the upper part stays transparent.

When the MLT is used as a wet trap a surfactant should be added to the water. In hot climates 10% propylene glycol can be used to decrease water evaporation and decomposition of captured fruit flies.

When the MLT is used as a dry trap, a suitable (non-repellent at the concentration used) insecticide such as dichlorvos or a deltamethrin (DM) strip is placed inside the trap to kill the fruit flies. DM is applied to a polyethylene strip placed on the upper plastic platform inside the trap. Alternatively, DM may be used in a circle of impregnated mosquito net and will retain its killing effect for at least six months under field conditions. The net must be fixed on the ceiling inside the trap using adhesive material.

- For the species for which the trap is used, see Table 2b.
- For attractants used and rebaiting (field longevity), see Tables 2b and 3.
- For use under different scenarios and recommended densities, see Tables 4a, 4b, 4c and 4d.

Figure 12. Open bottom dry trap (Phase IV).

Open bottom dry trap (OBDT) or (Phase IV) trap

General description

This trap is an open-bottom cylindrical dry trap that can be made from opaque green plastic or wax-coated green cardboard. The cylinder is 15.2 cm high and 9 cm in diameter at the top and 10 cm in diameter at the bottom (Figure 12). It has a transparent top, three holes (each of 2.5 cm diameter) equally spaced around the wall of the cylinder midway between the ends, and an open bottom, and is used with a sticky insert. A wire hanger, placed on top of the trap body, is used to hang the trap from tree branches.

Use

A food-based synthetic chemical female biased attractant can be used to capture *C. capitata*. However, it also serves to capture males. Synthetic attractants for are attached to the inside walls of the cylinder. Servicing is easy because the sticky insert permits easy removal and replacement, similar to the inserts used in the JT. This trap is less expensive than the plastic or glass McP-type traps.

- For the species for which the trap is used, see Table 2b.
- For attractants used and rebaiting (field longevity), see Tables 2b and 3.
- For use under different scenarios and recommended densities, see Table 4d.

Red sphere trap (RS)

General description

The trap is a red sphere 8 cm in diameter (Figure 13). The trap mimics the size and shape of a ripe apple. A green version of this trap is also used. The trap is covered with a sticky material and baited with the synthetic fruit odour butyl hexanoate, which has a fragrance like a ripe fruit. Attached to the top of the sphere is a wire hanger used to hang it from tree branches.

Figure 13. Red sphere trap.

Use

The red or green traps can be used unbaited, but they are much more efficient in capturing fruit flies when baited. Fruit flies that are sexually mature and ready to lay eggs are attracted to this trap.

Many types of insects will be caught by these traps. It will be necessary to positively identify the target fruit fly from the non-target insects likely to be present on the traps.

- For the species for which the trap is used, see Table 2b.
- For attractants used and rebaiting (field longevity), see Tables 2b and 3.
- For use under different scenarios and recommended densities, see Table 4e.

Sensus trap (SE)

General description

The Sensus trap consists of a vertical plastic bucket 12.5 cm in high and 11.5 cm in diameter (Figure 14). It has a transparent body and a blue overhanging lid, which has a hole just underneath it. A wire hanger placed on top of the trap body is used to hang the trap from tree branches.

Figure 14. Sensus trap.

Use

The trap is dry and uses male-specific parapheromones or, for female-biased captures, dry synthetic food attractants. A dichlorvos block is placed in the comb on the lid to kill the flies.

- For the species for which the trap is used, see Tables 2a and 2b.
- For attractants used and rebaiting (field longevity), see Tables 2 and 3.
- For use under different scenarios and recommended densities, see Table 4d.

Steiner trap (ST)

General description

The Steiner trap is a horizontal, clear plastic cylinder with openings at each end. The conventional Steiner trap is 14.5 cm long and 11 cm in diameter (Figure 15). Other versions of the Steiner traps are 12 cm long and 10 cm in diameter (Figure 16) and 14 cm long and 8.5 cm in diameter (Figure 17). A wire hanger, placed on top of the trap body, is used to hang the trap from tree branches.

Figure 15. Conventional Steiner trap.

Figure 16. Steiner trap version.

Figure 17. Steiner trap version.

Use

This trap uses the male-specific parapheromone attractants TML, ME and CUE. The attractant is suspended from the centre of the inside of the trap. The attractant may be a cotton wick soaked in 2–3 ml of a mixture of parapheromone or a dispenser with the attractant and an insecticide (usually malathion, dibrom or deltamethrin) as a killing agent.

- For the species for which the trap is used, see Table 2a.
- For attractants used and rebaiting (field longevity), see Tables 2a and 3.
- For use under different scenarios and recommended densities, see Tables 4b and 4d.

Tephri trap (TP)

General description

The Tephri trap is similar to a McP trap. It is a vertical cylinder 15 cm high and 12 cm in diameter at the base and can hold up to 450 ml of liquid (Figure 18). It has a yellow base and a clear top, which can be separated to facilitate servicing. There are entrance holes around the top of the periphery of the yellow base, and an invaginated opening in the bottom. Inside the top is a platform to hold attractants. A wire hanger, placed on top of the trap body, is used to hang the trap from tree branches.

Use

The trap is baited with hydrolysed protein at 9% concentration; however, it can also be used with other liquid protein attractants as described for the conventional glass McP trap or with the female dry synthetic food attractant and with TML in a plug or liquid as described for the JT/Delta and Yellow panel traps. If the trap is used with liquid protein attractants or with dry synthetic attractants combined with a liquid retention system and without the side holes, the insecticide will not be necessary. However, when used as a dry trap and with side holes, an insecticide solution (e.g. malathion) soaked into a cotton wick or other killing agent is needed to avoid escape of captured insects. Other suitable insecticides are dichlorvos or deltamethrin (DM) strips placed inside the trap to kill the fruit flies. DM is applied in a polyethylene strip, placed on the plastic platform inside the top of

Figure 18. Tephri trap.

the trap. Alternatively, DM may be used in a circle of impregnated mosquito net and will retain its killing effect for at least six months under field conditions. The net must be fixed on the ceiling of the inside of the trap using adhesive material.

- For the species for which the trap is used, see Tables 2a and 2b.
- For attractants used and rebaiting (field longevity), see Tables 2a and 3.
- For use under different scenarios and recommended densities, see Tables 4b and 4d.

Yellow panel trap (YP)/Rebell trap (RB)

General description

The Yellow panel (YP) trap consists of a yellow rectangular cardboard plate (23 cm × 14 cm) coated with plastic (Figure 19). The rectangle is covered on both sides with a thin layer of sticky material. The Rebell trap is a three-dimensional YP-type trap with two crossed yellow rectangular plates (15 cm × 20 cm) made of plastic (polypropylene) making them extremely durable (Figure 20). The trap is also coated with a thin layer of sticky material on both sides of both plates. A wire hanger, placed on top of the trap body, is used to hang it from tree branches.

Figure 19. Yellow panel trap.

Figure 20. Rebell trap.

Use

These traps can be used as visual traps alone and baited with TML, spiroketal or ammonium salts(ammonium acetate). The attractants may be contained in controlled-release dispensers such as a polymeric plug. The attractants are attached to the face of the trap. The attractants can also be mixed into the cardboard's coating. The two-dimensional design and greater contact surface make these traps more efficient, in terms of fly captures, than the JT and McPhail-type traps. It is important to consider that these traps require special procedures for transportation, submission and fruit fly screening methods because they are so sticky that specimens can be destroyed in handling. Although these traps can be used in most types of control programme applications, their use is recommended for the post-eradication phase and for fly-free areas, where highly sensitive traps are required. These traps should not be used in areas subjected to mass release of sterile fruit flies because of the large number of released fruit flies that would be caught. It is important to note that their yellow colour and open design allow them to catch other non-target insects including natural enemies of fruit flies and pollinators.

- For the species for which the trap is used, see Tables 2a and 2b.
- For attractants used and rebaiting (field longevity), see Tables 2 and 3.
- For use under different scenarios and recommended densities, see Tables 4b, 4c, 4d and 4e.

4. Trapping Procedures

4.1 Spatial distribution of traps

Trap layout will be guided by the purpose of the survey, the intrinsic characteristics of the area, the biological characteristics of the fruit fly and its interactions with its hosts, as well as the efficacy of the attractant and trap. In areas where continuous compact blocks of commercial orchards are present and in urban and suburban areas where hosts exist, traps are usually deployed in a grid system, which may have a uniform distribution.

In areas with scattered commercial orchards, rural areas with hosts and in marginal areas where hosts exist, trap networks are normally distributed along roads that provide access to host material.

In suppression and eradication programmes, an extensive trapping network should be deployed over the entire area that is subject to surveillance and control actions.

Trapping networks are also placed as part of early detection programmes for target fruit fly species. In this case traps are placed in high-risk areas such as points of entry, fruit markets, urban areas garbage dumps, as appropriate. This can be further supplemented by traps placed along roadsides to form transects and at production areas close to or adjacent to land borders, port of entries and national roads.

4.2 Trap deployment (placement)

Trap deployment involves the actual placement of the traps in the field. One of the most important factors of trap deployment is selecting an appropriate trap site. It is important to have a list of the primary, secondary and occasional fruit fly hosts, their phenology, distribution and abundance. With this basic information, it is possible to properly place and distribute the traps in the field, and it also allows for effective planning of a programme of trap relocation. Traps should be relocated according to the phenology of hosts.

When possible, pheromone traps should be placed in mating areas. Fruit flies normally mate in the crown of host plants or close by, selecting semi-shaded spots and usually on the upwind side of the crown. Other suitable trap sites are the eastern side of the tree which gets the sunlight in the early hours of the day, resting and feeding areas in plants that provide shelter and protect fruit flies from strong winds and predators. In specific situations trap hangers may need to be coated with an appropriate insecticide to prevent ants from eating captured fruit flies.

Protein traps should be deployed in shaded areas in host plants. In this case traps should be deployed in primary host plants during their fruit maturation period. In the absence of primary host plants, secondary host plants should be used. In areas with no host plants identified, traps should be deployed in plants that can provide shelter, protection and food to adult fruit flies.

Traps should be deployed in the middle to the top part of the host plant canopy, depending on the height of the host plant, and oriented towards the upwind side. Traps should not be exposed to direct sunlight, strong winds or dust. It is of vital importance to have the trap entrance clear from twigs, leaves and other obstructions such as spider webs to allow proper airflow and easy access for the fruit flies.

Placement of traps in the same tree baited with different attractants should be avoided because it may cause interference among attractants and a reduction of trap efficiency. For example, placing a *C. capitata* male-specific TML trap and a protein attractant trap in the same tree will cause a reduction of female capture in the protein traps because TML acts as a female repellent.

Traps should be relocated following the maturation phenology of the fruit hosts present in the area and biology of the fruit fly species. By relocating the traps it is possible to follow the fruit fly population throughout the year and increase the number of sites being checked for fruit flies.

4.3 Trap mapping

Once traps are placed in carefully selected sites at the correct density and distributed in an adequate array, the location of the traps must be recorded. It is recommended that the location of traps should be geo-referenced with the use of global positioning system (GPS) equipment. A map or sketch of the trap location and the area around the traps should be prepared.

The application of GPS and geographic information systems (GIS) in the management of trapping network has proved to be a very powerful tool. GPS allows each trap to be geo-referenced through geographical coordinates, which are then used as input information in a GIS.

In addition to GPS location data or in the event that GPS data is not available for trap locations, reference for the trap location should include visible landmarks. In the case of traps placed in host plants located in suburban and urban areas, references should include the full address of the property where the trap was placed. Trap reference should be clear enough to allow those servicing the traps, control teams and supervisors to find the trap easily.

A database or trapping book of all traps with their corresponding coordinates is kept, together with the records of trap services, rebaiting, trap captures etc. GIS provides high-resolution maps showing the exact location of each trap and other valuable information such as exact location of fruit fly detections, historical profiles of the geographical distribution patterns of the fruit flies, relative size of the populations in given areas and spread of the fruit fly population in case of an outbreak. This information is extremely useful in planning control activities, ensuring that bait sprays and sterile fruit fly releases are accurately placed and cost-effective in their application.

4.4 Trap servicing and inspection

Trap servicing intervals are specific to each trapping system and are based on the half-life of the attractant (see Table 3). Capturing fruit flies will depend, in part, on how well the trap is serviced. Trap servicing includes rebaiting and maintaining the trap in a clean and appropriate operating condition. Traps should be in a condition to consistently kill and retain in good condition any target flies that have been captured.

Attractants have to be used in the appropriate volumes and concentrations and replaced at the recommended intervals, as indicated by the manufacturer. The release rate of attractants varies considerably with environmental conditions. The release rate is generally high in hot and dry areas, and low in cool and humid areas. Thus, in cool climates traps may have to be rebaited less often than in hot conditions.

Inspection intervals (i.e. checking for fruit fly captures) should be adjusted according to the prevailing environmental conditions, pest situations and biology of fruit flies. The interval can range from one day up to 30 days. However, the most common inspection interval is seven days in areas where fruit fly populations are present and 14 days in fruit fly free areas. In the case of delimiting surveys inspection intervals may be more frequent, being in this case two to three days the most common interval.

Avoid handling more than one lure type at a time if more than one lure type is being used at a single locality. Cross-contamination between traps of different attractant types (e.g. Cue and ME) reduces trap efficacy and makes laboratory identification unduly difficult. When changing attractants it is important to avoid spillage or contamination of the external surface of the trap body or the ground. Attractant spillage or trap contamination would reduce the chances of fruit flies entering the trap. For traps that use a sticky insert to capture fruit flies, it is important to avoid contaminating areas in the trap that are not meant for capturing fruit flies with the sticky material. This also applies to leaves and twigs that are in the trap surroundings. Attractants, by their nature, are highly volatile and care should be taken when storing, packaging, handling and disposing of lures to avoid compromising the lure and operator safety.

The number of traps serviced per day per person will vary depending on type of trap, survey, environmental and topographic conditions and experience of the operators.

4.5 Trapping records

The following information should be included in order to keep proper trapping records as they provide confidence in the survey results: trap location, plant where the trap is placed, trap and attractant type, servicing and inspection dates, and target fruit fly capture. Any other information considered necessary can be added to the trapping records. Retaining results over a number of seasons can provide useful information on spatial changes in fruit fly population.

4.6 Flies per trap per day

Flies per trap per day (FTD) is a population index that indicates the average number of flies of the target species captured per trap per day during a specified period in which the trap was exposed in the field.

The function of this population index is to have a comparative measure of the size of the adult pest population in a given space and time.

It is used as baseline information to compare the size of the population before, during and after the application of a fruit fly control programme. The FTD should be used in all reports of trapping surveys.

The FTD is comparable within a programme; however, for meaningful comparisons between programmes, it should be based on the same fruit fly species, trapping system and trap density.

In areas where sterile fruit fly release programmes are in operation FTD is used to measure the relative abundance of the sterile and wild fruit flies.

FTD is obtained by dividing the total number of captured fruit flies by the product obtained from multiplying the total number of inspected traps by the average number of days the traps were exposed. The formula is as follows:

$$FTD = \frac{F}{T \times D}$$

where

F = total number of fruit flies

T = number of inspected traps

D = average number of days traps were exposed in the field.

5. Trap Densities

Establishing a trapping density appropriate to the purpose of the survey is critical and underpins confidence in the survey results. The trap densities need to be adjusted based on many factors including type of survey, trap efficiency, location (type and presence of host, climate and topography), pest situation and lure type. In terms of type and presence of hosts, as well as the risk involved, the following types of location may be of concern:

- production areas
- marginal areas
- urban areas
- points of entry (and other high-risk areas such as fruit markets).

Trap densities may also vary as a gradient from production areas to marginal areas, urban areas and points of entry. For example, in a pest free area, a higher density of traps is required at high-risk points of entry and a lower density in commercial orchards. Or, in an area where suppression is applied, such as in an area of low pest prevalence or an area under a systems approach where the target species is present, the reverse occurs, and trapping densities for that pest should be higher in the production field and decrease toward points of entry. Other situations such as high-risk urban areas should be taken into consideration when assessing trapping densities.

Tables 4a–4f show trap densities for various fruit fly species based on common practice. These densities have been determined taking into consideration research results, feasibility and cost effectiveness. Trap densities are also dependent on associated survey activities, such as the type and intensity of fruit sampling to detect immature stages of fruit flies. In those cases where trapping survey programmes are complemented with equivalent fruit sampling activities, trap densities can be lower than the suggested densities shown in Tables 4a–4f.

The suggested densities presented in Tables 4a–4f have been made also taking into account the following technical factors:

- various survey objectives and pest situations
- target fruit fly species (Table 1)
- pest risk associated with working areas (production and other areas).

Within the delimited area, the suggested trap density should be applied in areas with a significant likelihood of capturing fruit flies such as areas with primary hosts and possible pathways (e.g. production areas versus industrial areas).

Table 4a. Trap densities for *Anastrepha* spp.

Trapping	**Trap type**[1]	**Attractant**	**Trap density/km² (2)**			
			Production area	**Marginal**	**Urban**	**Points of entry**[3]
Monitoring survey, no control	MLT/McP	2C/PA	0.25–1	0.25–0.5	0.25–0.5	0.25–0.5
Monitoring survey for suppression	MLT/McP	2C/PA	2–4	1–2	0.25–0.5	0.25–0.5
Delimiting survey in an FF-ALPP after an unexpected increase in population	MLT/McP	2C/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	MLT/McP	2C/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	MLT/McP	2C/PA	1–2	2–3	3–5	5–12
Delimitation survey in an FF-PFA after a detection in addition to detection survey	MLT/McP	2C/PA	20–50[4]	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.
(2) Refers to the total number of traps.
3 Also other high-risk sites.
4 This range includes high-density trapping in the immediate area of the detection (core area) and decreasing towards the surrounding trapping zones.

Trap type		**Attractant**	
McP	McPhail trap	2C	(AA+Pt)
MLT	Multilure trap	PA	protein attractant

Table 4b. Trap densities for *Bactrocera* spp. responding to methyl eugenol (ME), cuelure (CUE) and food attractants[1] (PA = protein attractants)

Trapping	Trap type[2]	Attractant	Trap density/km² (3)			
			Production area	Marginal	Urban	Points of entry[4]
Monitoring survey, no control	JT/ST/TP/LT/MM/ MLT/McP/TP	ME/CUE/PA	0.5–1.0	0.2–0.5	0.2–0.5	0.2–0.5
Monitoring survey for suppression	JT/ST/TP/LT/MM/ MLT/McP/TP	ME/CUE/PA	2–4	1–2	0.25–0.5	0.25–0.5
Delimiting survey in an FF-ALPP after an unexpected increase in population	JT/ST/TP/MLT/LT/ MM/McP/YP	ME/CUE/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	JT/ST/TP/MLT/LT/ MM/McP/TP	ME/CUE/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	CH/ST/LT/MM/ML T/McP/TP/ YP	ME/CUE/PA	1	1	1–5	3–12
Delimitation survey in a PFA after a detection in addition to detection survey	JT/ST/TP/MLT/LT/ MM/McP/YP	ME/CUE/PA	20–50[5]	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.
(2) Refers to the total number of traps.
3 Also other high-risk sites.
4 This range includes high-density trapping in the immediate area of the detection (core area) and decreasing towards the surrounding trapping zones.

Trap type

CH	ChamP trap	McP	McPhail trap	ST	Steiner trap
JT	Jackson trap	MLT	Multilure trap	TP	Tephri trap
LT	Lynfield trap	MM	Maghreb-Med or Morocco	YP	Yellow panel trap

Table 4c. Trap densities for *Bactrocera oleae*

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	MLT/CH/YP	AC+SK/PA	0.5–1.0	0.25–0.5	0.25–0.5	0.25–0.5
Monitoring survey for suppression	MLT/CH/YP	AC+SK/PA	2–4	1–2	0.25–0.5	0.25–0.5
Delimiting survey in an FF-ALPP after an unexpected increase in population	MLT/CH/YP	AC+SK/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	MLT/CH/YP	AC+SK/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	MLT/CH/YP	AC+SK/PA	1	1	2–5	3–12
Delimitation survey in a PFA after a detection in addition to detection survey	MLT/CH/YP	AC+SK/PA	20–50[4]	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.
(2) Refers to the total number of traps.
3 Also other high-risk sites.
4 This range includes high-density trapping in the immediate area of the detection (core area) and decreasing towards the surrounding trapping zones.

Trap type		**Attractant**	
CH	ChamP trap	AC	ammonium bicarbonate
MLT	Multilure trap	PA	protein attractant
YP	Yellow panel trap	SK	Spiroketal

Table 4d. Trap densities for *Ceratitis* spp.

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control[4]	JT/MLT/McP/ OBDT/ST/SE/ET/ LT/TP/VARs+	TML/CE/3C/ 2C/PA	0.5–1.0	0.25–0.5	0.25–0.5	0.25–0.5
Monitoring survey for suppression	JT/MLT/McP/ OBDT/ST/SE/ET/ LT/MMTP/VARs+	TML/CE/3C/ 2C/PA	2–4	1–2	0.25–0.5	0.25–0.5
Delimiting survey in an FF-ALPP after an unexpected increase in population	JT/YP/MLT/McP/ OBDT/ST/ET/LT/ MM/TP/VARs+	TML/CE/3C/ PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication[5]	JT/MLT/McP/ OBDT/ST/ET/LT/ MM/TP/VARs+	TML/CE/3C/ 2C/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion[5]	JT/MLT/McP/ST/ ET/LT/MM/CC/ VARs+	TML/CE/3C/ PA	1	1–2	1–5	3–12
Delimitation survey in a PFA after a detection in addition to detection survey[6]	JT/YP/MLT/McP/ OBDT/ST//ET/LT/ MM/TP/VARs+	TML/CE/3C/ PA	20–50[6]	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.
(2) Refers to the total number of traps.
3 Also other high-risk sites.
4 1:1 ratio (1 female trap per male trap).
5 3:1 ratio (3 female traps per male trap).
6 This range includes high-density trapping in the immediate area of the detection (core area) and decreasing towards the surrounding trapping zones (ratio 5:1, 5 female traps per male trap).

Trap type	
CC	Cook and Cunningham (C&C) Trap (with TML for male capture)
ET	Easy trap (with 2C and 3C attractants for female-biased captures)
JT	Jackson trap (with TML for male capture)
LT	Lynfield trap (with TML for male capture)
McP	McPhail trap
MLT	Multilure trap (with 2C and 3C attractants for female-biased captures)
MM	Maghreb-Med or Morocco
OBDT	Open Bottom Dry Trap (with 2C and 3C attractants for female-biased captures)
SE	Sensus trap (with CE for male captures and with 3C for female-biased captures)
ST	Steiner trap (with TML for male capture)
TP	Tephri trap (with 2C and 3C attractants for female-biased captures)
VARs+	Modified funnel trap
YP	Yellow panel trap

Attractant	
2C	(AA+TMA)
3C	(AA+Pt+TMA)
CE	Capilure
AA	Ammonium acetate
PA	Protein attractant
Pt	Putrescine
TMA	Trimethylamine
TML	Trimedlure

Table 4e. Trap densities for *Rhagoletis* spp.

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	RB/RS/PALz/YP /McP	BuH/AS	0.5–1.0	0.25–0.5	0.25–0.5	0.25–0.5
Monitoring survey for suppression	RB/RS/PALz/YP /McP	BuH/AS	2–4	1–2	0.25–0.5	0.25–0.5
Delimiting survey in an FF-ALPP after an unexpected increase in population	RB/RS/PALz/YP /McP	BuH/AS	3–5	3–5	3–5	3–5
Monitoring survey for eradication	RB/RS/PALz/YP /McP	BuH/AS	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	RB/RS/PALz/YP /McP	BuH/AS	1	0.4–3	3–5	4–12
Delimitation survey in a PFA after a detection in addition to detection survey	RB/RS/PALz/YP /McP	BuH/AS	20–50[4]	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.
(2) Refers to the total number of traps.
3 Also other high-risk sites.
4 This range includes high-density trapping in the immediate area of the detection (core area) and decreasing towards the surrounding trapping zones.

Trap type		Attractant	
McP	McPhail trap	AS	Ammonium salt
RB	Rebell trap	BuH	Butyl hexanoate
RS	Red sphere trap	CE	Capilure
PALz	Fluorescent yellow sticky trap	AA	Ammonium acetate
YP	Yellow panel trap		

Table 4f. Trap densities for *Toxotrypana curvicauda*

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	GS	MVP	0.25–0.5	0.25–0.5	0.25–0.5	0.25–0.5
Monitoring survey for suppression	GS	MVP	2–4	1	0.25–0.5	0.25–0.5
Delimiting survey in an FF-ALPP after an unexpected increase in population	GS	MVP	3–5	3–5	3–5	3–5
Monitoring survey for eradication	GS	MVP	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	GS	MVP	2	2–3	3–6	5–12
Delimitation survey in a PFA after a detection in addition to detection survey	GS	MVP	20–50[4]	20–50	20–50	20–50

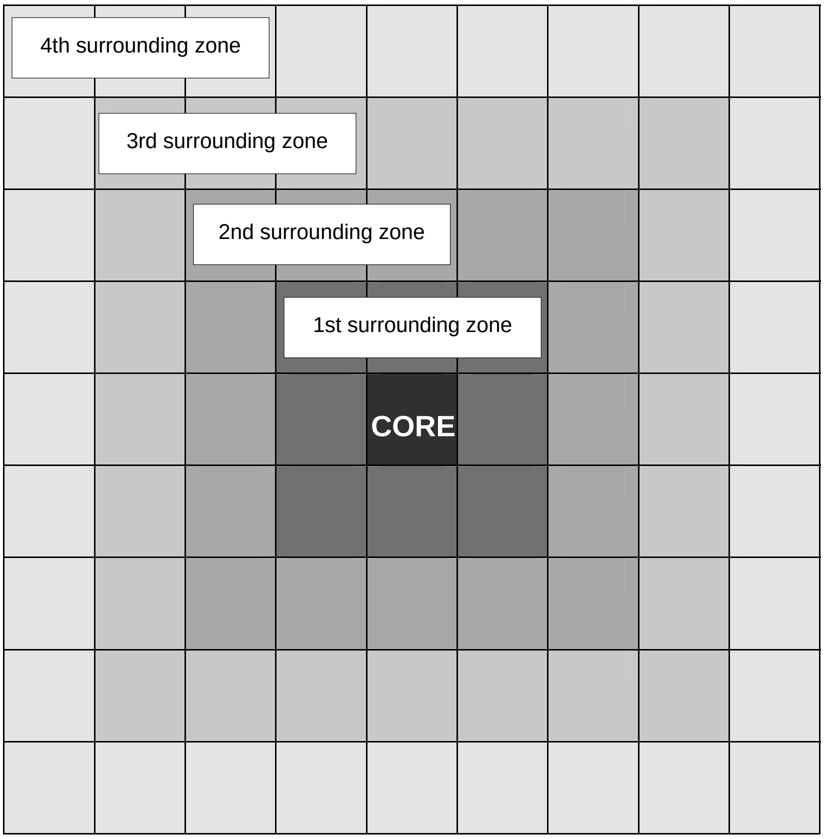
1 Different traps can be combined to reach the total number.
(2) Refers to the total number of traps.
3 Also other high-risk sites.
4 This range includes high-density trapping in the immediate area of the detection (core area) and decreasing towards the surrounding trapping zones.

Trap type		Attractant	
GS	Green sphere	MVP	Papaya fruit fly pheromone (2-methyl-vinylpyrazine)

6. Trapping for Delimiting Surveys in Fruit Fly Free Areas

When a delimiting survey is designed to determine the boundaries of a fruit fly pest detection into an FF free area, trap density may vary by situation (climatic conditions, biology of species, etc), but there are some commonalities. The area immediately surrounding each detection is termed a core area. The core area is defined by a set radius surrounding each detection. The size of the core area may vary depending on the species of fruit fly, types of traps and other considerations. The area defined by the radius is often squared off to produce a grid. The trapping density in the core area is higher than that used for detection surveys. Around the core area may be one or more surrounding zones where the trap density is higher than for detection surveys but usually lower than that of the core area, as appropriate. Trap densities in the surrounding zones may be proportionally tiered in a decreasing density the further away they are from the core area. An example of a delimiting survey for a single core area is presented in Figure 21. In cases where target fruit flies are detected in several traps distant from each other, the respective zones are identified individually and the area for delimiting survey is finally determined taking into account the overlap of the core zones.

A delimiting survey should be implemented as soon as possible after the initial detection of a target fruit fly species. The duration of a delimiting survey is dependent on the biology of the species. In general, delimiting survey trapping continues for three life cycles beyond the last trap capture for multivoltine species. However, one or two life cycles may be used for particular situations or fruit fly species based on scientific information, as well as that provided by the surveillance system in place.



Surrounding zones	km^2	*Anastrepha* spp. McP	*Bactrocera* spp. CUE + McP	*B. dorsalis, B. carambolae* ME + McP	*Ceratitis capitata* TML + MLT (MLT core only)
Core	1	32	20 + 10	10 + 10	40 + 10
1st	8	16	10	2	20
2nd	16	8	6	2	10
3rd	24	4	4	2	8
4th	32	2	2	2	4

Figure 21. Example of delimiting survey using single km^2 core and surrounding zones for various fruit flies and attractants/trap types (number of traps per km^2)

7. Supervision Activities

Supervision of trapping activities includes assessing the quality of the materials used and reviewing the effectiveness of the use of these materials and trapping procedures.

The materials used should perform effectively and reliably at an acceptable level for a prescribed period of time. The traps themselves should maintain their integrity for the entire duration that they are anticipated to remain in the field. The attractants should be certified or bioassayed for an acceptable level of performance based on their anticipated use.

The effectiveness of trapping should be technically reviewed periodically by individuals not directly involved in implementing the programme. The timing of review will vary by programme, but it is recommended to occur at least twice a year in programmes that run for six months or longer. The review should address all aspects related to the ability of trapping to detect targeted fruit flies within the timeframe required to meet programme outcomes e.g. Early detection of a fruit fly entry. Aspects of a review include quality of trapping materials, record-keeping, layout of the trapping network, trap mapping, trap placement, trap condition, trap servicing, trap inspection frequency and capability for fruit fly identification.

The trap deployment should be evaluated to ensure that the prescribed types and densities of traps are in place. Field confirmation is achieved through inspection of individual routes.

Trap placement should be evaluated for appropriate host selection, trap relocation schedule, height, light/shade balance, fruit fly access to trap, and proximity to other traps. Host selection, trap relocation and proximity to other traps can be evaluated from the records for each trap route. Host selection, placement and proximity can be further evaluated by field examination.

Proper record-keeping is crucial to the appropriate functioning of trapping. The records for each trap route should be inspected to ensure that they are complete and up to date. Field confirmation can then be used to validate the accuracy of the records.

Traps should be evaluated for their overall condition, correct attractant, appropriate trap servicing and inspection intervals, correct identifying markings (such as trap identification and date placed), evidence of contamination and proper warning labels. This is performed in the field at each site where a trap is placed.

Evaluation of identification capability can occur via target fruit flies that have been marked in some manner in order to distinguish them from wild trapped fruit flies. These marked fruit flies are placed in traps in order to evaluate the operator’s diligence in servicing the traps, competence in recognizing the targeted fruit fly species, and knowledge of the proper reporting procedures once a fruit fly is found. Commonly used marking systems are fluorescent dyes and/or wing clipping.

In some programmes that survey for eradication or to maintain FF-PFAs, the fruit flies may also be marked by using sterile irradiated fruit flies in order to further reduce the chances of the marked fruit fly being falsely identified as a wild fruit fly and resulting in unnecessary actions by the programme. A slightly different method is necessary under a sterile fruit fly release programme in order to evaluate personnel on their ability to accurately distinguish target wild fruit flies from the released sterile fruit flies. The marked fruit flies used are sterile and lack the fluorescent dye, but are marked physically by wing clipping or some other method. These fruit flies are placed into the trap samples after they have been collected in the field but before they are inspected by the operators.

The review should be summarized in a report detailing how many inspected traps on each route were found to be in compliance with the accepted standards in categories such as trap mapping, placement, condition, and servicing and inspection interval. Aspects that were found to be deficient should be identified, and specific recommendations should be made to correct these deficiencies.

8. Selected References

The technical justification contained in this standard is based on the following references that are accessible scientific publications. These references may provide further guidance on the methods and procedures contained in this document.

Baker, R., Herbert, R., Howse, P.E. & Jones, O.T. 1980. Identification and synthesis of the major sex pheromone of the olive fly (*Dacus oleae*). *J. Chem. Soc., Chem. Commun*., 1: 52–53.

Calkins, C.O., Schroeder, W.J. & Champers, D.L. 1984. The probability of detecting the Caribbean fruit fly, *Anastrepha suspensa* (Loew) (Diptera: Tephritidae) with various densities of McPhail traps. *J. Econ. Entomol*., 77: 198–201.

Campaña Nacional Contra Moscas de la Fruta, DGSV/CONASAG/SAGAR 1999. Apéndice Técnico para el Control de Calidad del Trampeo para Moscas de la Fruta del Género *Anastrepha* spp. México D.F. febrero de 1999. 15 pp.

Conway, H.E. & Forrester, O.T. 2007. Comparison of Mexican fruit fly (Diptera: Tephritidae) capture between McPhail traps with Torula Yeast and Multilure Traps with Biolure in South Texas. *Florida Entomologist*, 90(3).

Cowley, J.M., Page, F.D., Nimmo, P.R. & Cowley, D.R. 1990. Comparison of the effectiveness of two traps for *Bactrocera tryoni* (Froggat) (Diptera: Tephritidae) and implications for quarantine surveillance systems. *J. Entomol. Soc*., 29: 171–176.

Drew, R.A.I. 1982. Taxonomy. *In* R.A.I. Drew, G.H.S. Hooper & M.A. Bateman, eds. *Economic fruit flies of the South Pacific region*, 2nd edn, pp. 1–97. Brisbane, Queensland Department of Primary Industries.

Drew, R.A.I. & Hooper, G.H.S. 1981. The response of fruit fly species (Diptera; Tephritidae) in Australia to male attractants. *J. Austral. Entomol. Soc*., 20: 201–205.

Epsky, N.D., Hendrichs, J., Katsoyannos, B.I., Vasquez, L.A., Ros, J.P., Zümreoglu, A., Pereira, R., Bakri, A., Seewooruthun, S.I. & Heath, R.R. 1999. Field evaluation of female-targeted trapping systems for *Ceratitis capitata* (Diptera: Tephritidae) in seven countries. *J. Econ. Entomol*., 92: 156–164.

Heath, R.R., Epsky, N.D., Guzman, A., Dueben, B.D., Manukian, A. & Meyer, W.L. 1995. Development of a dry plastic insect trap with food-based synthetic attractant for the Mediterranean and the Mexican fruit fly (Diptera: Tephritidae). *J. Econ. Entomol*., 88: 1307–1315.

Heath, R.H., Epsky, N., Midgarden, D. & Katsoyanos, B.I. 2004. Efficacy of 1,4-diaminobutane (putrescine) in a food-based synthetic attractant for capture of Mediterranean and Mexican fruit flies (Diptera: Tephritidae). *J. Econ. Entomol.*, 97(3): 1126–1131.

Hill, A.R. 1987. Comparison between trimedlure and capilure® – attractants for male *Ceratitis capitata* (Wiedemann) (Diptera Tephritidae). *J. Austral. Entomol. Soc*., 26: 35–36.

Holler, T., Sivinski, J., Jenkins, C. & Fraser, S. 2006. A comparison of yeast hydrolysate and synthetic food attractants for capture of *Anastrepha suspensa* (Diptera: Tephritidae). *Florida Entomologist*, 89(3): 419–420.

IAEA (International Atomic Energy Agency). 1996. *Standardization of medfly trapping for use in sterile insect technique programmes*. Final report of Coordinated Research Programme 1986–1992. IAEA-TECDOC-883.

—— 1998. *Development of female medfly attractant systems for trapping and sterility assessment*. Final report of a Coordinated Research Programme 1995–1998. IAEA-TECDOC-1099. 228 pp.

—— 2003. *Trapping guidelines for area-wide fruit fly programmes*. Joint FAO/IAEA Division, Vienna, Austria. 47 pp.

—— 2007. *Development of improved attractants and their integration into fruit fly SIT management programmes*. Final report of a Coordinated Research Programme 2000–2005. IAEA-TECDOC-1574. 230 pp.

Jang, E.B., Holler, T.C., Moses, A.L., Salvato, M.H. & Fraser, S. 2007. Evaluation of a single-matrix food attractant Tephritid fruit fly bait dispenser for use in feral trap detection programs. *Proc. Hawaiian Entomol. Soc.*, 39: 1–8.

Katsoyannos, B.I. 1983. Captures of *Ceratitis capitata* and *Dacus oleae* flies (Diptera, Tephritidae) by McPhail and Rebell color traps suspended on citrus, fig and olive trees on Chios, Greece. *In* R. Cavalloro, ed. *Fruit flies of economic importance*. Proc. CEC/IOBC Intern. Symp. Athens, Nov. 1982, pp. 451–456.

—— 1989. Response to shape, size and color. *In* A.S. Robinson & G. Hooper, eds. *World Crop Pests*, Volume 3A, *Fruit flies, their biology, natural enemies and control*, pp. 307–324. Elsevier Science Publishers B.V., Amsterdam.

Lance, D.R. & Gates, D.B. 1994. Sensitivity of detection trapping systems for Mediterranean fruit flies (Diptera: Tephritidae) in southern California. *J. Econ. Entomol*., 87: 1377.

Leonhardt, B.A., Cunningham, R.T., Chambers, D.L., Avery, J.W. & Harte, E.M. 1994. Controlled-release panel traps for the Mediterranean fruit fly (Diptera: Tephritidae). *J. Econ. Entomol*., 87: 1217–1223.

Martinez, A.J., Salinas, E. J. & Rendon, P. 2007. Capture of *Anastrepha* species (Diptera: Tephritidae) with Multilure traps and Biolure attractants in Guatemala. *Florida Entomologist*, 90(1): 258–263.

Prokopy, R.J. 1972. Response of apple maggot flies to rectangles of different colors and shades. *Environ. Entomol*., 1: 720–726.

Robacker D.C. & Czokajlo, D. 2006. Effect of propylene glycol antifreeze on captures of Mexican fruit flies (Diptera: Tephritidae) in traps baited with BioLures and AFF lures. *Florida Entomologist*, 89(2): 286–287.

Robacker, D.C. & Warfield, W.C. 1993. Attraction of both sexes of Mexican fruit fly, *Anastrepha ludens*, to a mixture of ammonia, methylamine, and putrescine. *J. Chem. Ecol*., 19: 2999–3016.

Tan, K.H. 1982. Effect of permethrin and cypermethrin against *Dacus dorsalis* in relation to temperature. *Malaysian Applied Biology*, 11:41–45.

Thomas, D.B. 2003. Nontarget insects captured in fruit fly (Diptera: Tephritridae) surveillance traps. *J. Econ. Entomol.*, 96(6): 1732–1737.

Tóth, M., Szarukán, I., Voigt, E. & Kozár, F. 2004. Hatékony cseresznyelégy- (Rhagoletis cerasi L., Diptera, Tephritidae) csapda kifejlesztése vizuális és kémiai ingerek figyelembevételével. [Importance of visual and chemical stimuli in the development of an efficient trap for the European cherry fruit fly (*Rhagoletis cerasi* L.) (Diptera, Tephritidae).] *Növényvédelem*, 40: 229–236.

Tóth, M., Tabilio, R. & Nobili, P. 2004. Különféle csapdatípusok hatékonyságának összehasonlitása a földközi-tengeri gyümölcslégy (Ceratitis capitata Wiedemann) hímek fogására. [Comparison of efficiency of different trap types for capturing males of the Mediterranean fruit fly *Ceratitis capitata* Wiedemann (Diptera: Tephritidae).] *Növényvédelem*, 40 :179–183.

—— 2006. Le trappole per la cattura dei maschi della Mosca mediterranea della frutta. *Frutticoltura*, 68(1): 70–73.

Tóth, M., Tabilio, R., Nobili, P., Mandatori, R., Quaranta, M., Carbone, G. & Ujváry, I. 2007. A földközi-tengeri gyümölcslégy (Ceratitis capitata Wiedemann) kémiai kommunikációja: alkalmazási lehetŒségek észlelési és rajzáskövetési célokra. [Chemical communication of the Mediterranean fruit fly (*Ceratitis capitata* Wiedemann): application opportunities for detection and monitoring.] *Integr. Term. Kert. Szántóf. Kult.*, 28: 78–88.

Tóth, M., Tabilio, R., Mandatori, R., Quaranta, M. & Carbone, G. 2007. Comparative performance of traps for the Mediterranean fruit fly *Ceratitis capitata* Wiedemann (Diptera: Tephritidae) baited with female-targeted or male-targeted lures. *Int. J. Hortic. Sci.*, 13: 11–14.

Tóth, M. & Voigt, E. 2009. Relative importance of visual and chemical cues in trapping *Rhagoletis cingulata* and *R. cerasi* in Hungary. *J. Pest. Sci.* (submitted).

Voigt, E. & Tóth, M. 2008. Az amerikai keleti cseresznyelegyet és az európai cseresznyelegyet egyaránt fogó csapdatípusok. [Trap types catcing both *Rhagoletis cingulata* and *R. cerasi* equally well.] *Agrofórum*, 19: 70–71.

Wall, C. 1989. Monitoring and spray timing. *In* A.R. Jutsum & R.F.S. Gordon, eds. *Insect pheromones in plant protection*, pp. 39–66. New York, Wiley. 369 pp.

White, I.M. & Elson-Harris, M.M. 1994. *Fruit flies of economic significance: their identification and bionomics*. ACIAR, 17–21.

Wijesuriya, S.R. & De Lima, C.P.F. De Lima. 1995. Comparison of two types of traps and lure dispensers for *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). *J. Austral. Ent. Soc.*, 34: 273–275.