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**International Plant Protection Convention**  
Protecting the world's plant resources from pests

INTERNATIONAL STANDARD FOR PHYTOSANITARY MEASURES 26

ISPM 26

ENG

# REVOKE ~~Establishment of pest free areas for fruit flies (Tephritidae)~~

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REVOKE

INTERNATIONAL STANDARDS FOR  
PHYTOSANITARY MEASURES

ISPM 26

Establishment of pest free areas for fruit flies  
(Tephritidae)

REVOKE~~D~~

Produced by the Secretariat of the  
International Plant Protection Convention  
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## Adoption

This standard was adopted by the First Session of the Commission on Phytosanitary Measures in April 2006. Revision of Appendix 1 on Fruit fly trapping was adopted by the Sixth Session of the Commission on Phytosanitary Measures in March 2011. Annex 2 was adopted by the Ninth Session of the Commission on Phytosanitary Measures in April 2014. Annex 3 was adopted by the Tenth Session of the Commission on Phytosanitary Measures in March 2015.

## INTRODUCTION

### Scope

This standard provides guidelines for the establishment of pest free areas for fruit flies (Tephritidae) of economic importance, and for the maintenance of their pest free status.

### References

The present standard refers to International Standards for Phytosanitary Measures (ISPMs). ISPMs are available on the International Phytosanitary Portal (IPP) at <https://www.ippc.int/core-activities/standards-setting/ispm>.

IPPC. 1997. *International Plant Protection Convention*. Rome, IPPC/FAO.

### Definitions

Definitions of phytosanitary terms used in the present standard can be found in ISPM 5 (*Glossary of phytosanitary terms*).

### Outline of Requirements

The general requirements for establishing a fruit fly-pest free area (FF-PFA) include:

- the preparation of a public awareness programme
- the management elements of the system (documentation and review systems, record-keeping)
- supervision activities

The major elements of the FF-PFA are:

- the characterization of the FF-PFA
- the establishment and maintenance of the FF-PFA.

These elements include the surveillance activities of trapping and fruit sampling, and official control on the movement of regulated articles. Guidance on surveillance and fruit sampling activities is provided in Appendices 1 and 2.

Additional elements include: corrective action planning, suspension, loss of pest free status and reinstatement (if possible) of the FF-PFA. Corrective action planning is described in Annex 1.

## BACKGROUND

Fruit flies are a very important group of pests for many countries due to their potential to cause damage in fruits and to their potential to restrict access to international markets for plant products that can host fruit flies. The high probability of introduction of fruit flies associated with a wide range of hosts results in restrictions imposed by many importing countries to accept fruits from areas in which these pests are established. For these reasons, there is a need for an ISPM that provides specific guidance for the establishment and maintenance of pest free areas for fruit flies.

A pest free area is “an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained” (ISPM 5). Areas initially free from fruit flies may remain naturally free from fruit flies due to the presence of barriers or climate conditions, and/or maintained free through movement restrictions and related measures (though fruit flies have the potential to establish there) or may be made free by an eradication programme (ISPM 9 (*Guidelines for pest eradication programmes*)). ISPM 4 (*Requirements for the establishment of pest free areas*) describes different types of pest free areas and provides general guidance on the establishment of pest free areas. However, a need for additional guidance on establishment and maintenance of pest free areas specifically for fruit flies (fruit fly-pest free areas, FF-PFA) was recognized. This standard describes additional requirements for establishment and maintenance of FF-PFAs. The target pests for which this standard was developed include insects of the order Diptera, family Tephritidae, of the genera *Anastrepha*, *Bactrocera*, *Ceratitis*, *Dacus*, *Rhagoletis* and *Toxotrypana*.

The establishment and maintenance of an FF-PFA implies that no other phytosanitary measures specific for the target species are required for host commodities within the PFA.

## REQUIREMENTS

### 1. General Requirements

The concepts and provisions of ISPM 4 apply to the establishment and maintenance of pest free areas for all pests including fruit flies and therefore ISPM 4 should be referred to in conjunction with this standard.

Phytosanitary measures and specific procedures as further described in this standard may be required for the establishment and maintenance of FF-PFA. The decision to establish a formal FF-PFA may be made based on the technical factors provided in this standard. They include components such as pest biology, size of the area, pest population levels and dispersal pathway, ecological conditions, geographical isolation and availability of methods for pest eradication.

FF-PFAs may be established in accordance with this ISPM under a variety of different situations. Some of them require the application of the full range of elements provided by this standard; others require only the application of some of these elements.

In areas where the fruit flies concerned are not capable of establishment because of climatic, geographical or other reasons, there should be no records of presence and it may be reasonable to conclude that the pest is absent (ISPM 8 (*Determination of pest status in an area*)). If, however, the fruit flies are detected and can cause economic damage during a season (Article VII.3 of the IPPC), corrective actions should be applied in order to allow the maintenance of a FF-PFA.

In areas where the fruit flies are capable of establishment and known to be absent, general surveillance in accordance with ISPM 8 is normally sufficient for the purpose of delimiting and establishing a pest free area. Where appropriate, import requirements and/or domestic movement restrictions against the introduction of the relevant fruit fly species into the area may be required to maintain the area free from the pest.

## 1.1 Public awareness

A public awareness programme is most important in areas where the risk of introduction is higher. An important factor in the establishment and maintenance of FF-PFAs is the support and participation of the public (especially the local community) close to the FF-PFA and individuals that travel to or through the area, including parties with direct and indirect interests. The public and stakeholders should be informed through different forms of media (written, radio, TV) of the importance of establishing and maintaining the pest free status of the area, and of avoiding the introduction or re-introduction of potentially infested host material. This may contribute to and improve compliance with the phytosanitary measures for the FF-PFA. The public awareness and phytosanitary education programme should be ongoing and may include information on:

- permanent or random checkpoints
- posting signs at entry points and transit corridors
- disposal bins for host material
- leaflets or brochures with information on the pest and the pest free area
- publications (e.g. print, electronic media)
- systems to regulate fruit movement
- non-commercial hosts
- security of the traps
- penalties for non-compliance, where applicable.

## 1.2 Documentation and record-keeping

The phytosanitary measures used for the establishment and maintenance of FF-PFA should be adequately documented as part of phytosanitary procedures. They should be reviewed and updated regularly, including corrective actions, if required (see also ISPM 4).

The records of surveys, detections, occurrences or outbreaks and results of other operational procedures should be retained for at least 24 months. Such records should be made available to the NPPO of the importing country on request.

## 1.3 Supervision activities

The FF-PFA programme, including regulatory control, surveillance procedures (for example trapping, fruit sampling) and corrective action planning should comply with officially approved procedures.

Such procedures should include official delegation of responsibility assigned to key personnel, for example:

- a person with defined authority and responsibility to ensure that the systems/procedures are implemented and maintained appropriately
- entomologist(s) with responsibility for the authoritative identification of fruit flies to species level.

The effectiveness of the programme should be monitored periodically by the NPPO of the exporting country, through review of documentation and procedures.

# 2. Specific Requirements

## 2.1 Characterization of the FF-PFA

The determining characteristics of the FF-PFA include:

- the target fruit fly species and its distribution within or adjacent to the area
- commercial and non-commercial host species

- delimitation of the area (detailed maps or global positioning system (GPS) coordinates showing the boundaries, natural barriers, entry points and host area locations, and, where necessary, buffer zones)
- climate, for example rainfall, relative humidity, temperature, prevailing wind speed and direction.

Further guidance on establishing and describing a PFA is provided in ISPM 4.

## 2.2 Establishment of the FF-PFA

The following should be developed and implemented:

- surveillance activities for establishment of the FF-PFA
- delimitation of the FF-PFA
- phytosanitary measures related to movement of host material or regulated articles
- pest suppression and eradication techniques as appropriate.

The establishment of buffer zones may also be necessary (as described in section 2.1) and it may be useful to collect additional technical information during the establishment of the FF-PFA.

### 2.2.1 Buffer zone

In areas where geographic isolation is not considered adequate to prevent introduction to or reinfestation of a PFA or where there are no other means of preventing fruit fly movement to the PFA, a buffer zone should be established. Factors that should be considered in the establishment and effectiveness of a buffer zone include:

- pest suppression techniques which may be used to reduce the fruit fly population, including:
  - use of selective insecticide-bait
  - spraying
  - sterile insect technique
  - male annihilation technique
  - biological control
  - mechanical control, etc.
- host availability, cropping systems, natural vegetation
- climatic conditions
- the geography of the area
- capacity for natural spread through identified pathways
- the ability to implement a system to monitor the effectiveness of buffer zone establishment (e.g. trapping network).

### 2.2.2 Surveillance activities prior to establishment

A regular survey programme should be established and implemented. Trapping is the preferred option to determine fruit fly absence or presence in an area for lure/bait responsive species. However, fruit sampling activities may sometimes be required to complement the trapping programme in cases where trapping is less effective, for example when species are less responsive to specific lures.

Prior to the establishment of a FF-PFA, surveillance should be undertaken for a period determined by the climatic characteristics of the area, and as technically appropriate for at least 12 consecutive months in the FF-PFA in all relevant areas of commercial and non-commercial host plants to demonstrate that the pest is not present in the area. There should be no populations detected during the surveillance activities prior to establishment. A single adult detection, depending on its status (in accordance with ISPM 8), may not disqualify an area from subsequent designation as an FF-PFA. For qualifying the area as a pest free area, there should be no detection of an immature specimen, two or

more fertile adults, or an inseminated female of the target species during the survey period. There are different trapping and fruit sampling regimes for different fruit fly species. Surveys should be conducted using the guidelines in Appendixes 1 and 2. These guidelines may be revised as trap, lure and fruit sampling efficiencies improve.

### 2.2.2.1 Trapping procedures

This section contains general information on trapping procedures for target fruit fly species. Trapping conditions may vary depending on, for example, the target fruit fly and environmental conditions. More information is provided in Appendix 1. When planning for trapping, the following should be considered.

#### Trap type and lures

Several types of traps and lures have been developed over decades to survey fruit fly populations. Fly catches differ depending on the types of lure used. The type of trap chosen for a survey depends on the target fruit fly species and the nature of the attractant. The most widely used traps include Jackson, McPhail, Steiner, open bottom dry trap (OBDT), yellow panel traps, which may use specific attractants (para-pheromone or pheromone lures that are male specific) or food or host odours (liquid protein or dry synthetic). Liquid protein is used to catch a wide range of different fruit fly species and capture both females and males, with a slightly higher percentage of females captured. However identification of the fruit flies can be difficult due to decomposition within the liquid bait. In traps such as McPhail, ethylene glycol may be added to delay decomposition. Dry synthetic protein baits are female biased, capture less non-target organisms and, when used in dry traps, may prevent premature decomposition of captured specimens.

#### Trap density

Trap density (number of traps per unit area) is a critical factor for effective fruit fly surveys and it should be designed based on target fruit fly species, trap efficiency, cultivation practices, and other biotic and abiotic factors. Density may change depending on the programme phase, with different densities required during the establishment of a PFA and the maintenance phase. Trap density also depends on the risk associated with potential pathways for entry into the designated PFA.

#### Trap deployment (determination of the specific location of the traps)

In a FF-PFA programme an extensive trapping network should be deployed over the entire area. The trapping network layout will depend on the characteristics of the area, host distribution and the biology of the fruit fly of concern. One of the most important features of trap placement is the selection of a proper location and trap site within the host plant. The application of GPS and geographic information systems (GIS) are useful tools for management of a trapping network.

Trap location should take into consideration the presence of the preferred hosts (primary, secondary and occasional hosts) of the target species. Because the pest is associated with maturing fruit, the location including rotation of traps should follow the sequence of fruit maturity in host plants. Consideration should be given to commercial management practices in the area where host trees are selected. For example, the regular application of insecticides (and/or other chemicals) to selected host trees may have a false-negative effect on the trapping programme.

#### Trap servicing

The frequency of trap servicing (maintaining and refreshing the traps) during the period of trapping should depend on the:

- longevity of baits (attractant persistency)
- retention capacity
- rate of catch
- season of fruit fly activity
- placement of the traps

- biology of the species
- environmental conditions.

### Trap inspection (checking the traps for fruit flies)

The frequency of regular inspection during the period of trapping should depend on:

- expected fruit fly activity (biology of the species)
- response of the target fruit fly in relation to host status at different times of the year
- relative number of target and non-target fruit flies expected to be caught in a trap
- type of trap used
- physical condition of the flies in the trap (and whether they can be identified).

In certain traps, specimens may degrade quickly making identification difficult or impossible unless the traps are checked frequently.

### Identification capability

NPPOs should have in place, or have ready access to, adequate infrastructure and trained personnel to identify detected specimens of the target species in an expeditious manner, preferably within 48 hours. Continuous access to expertise may be necessary during the establishment phase or when implementing corrective actions.

#### 2.2.2.2 Fruit sampling procedures

Fruit sampling may be used as a surveillance method in combination with trapping where trapping is less effective. It should be noted that fruit sampling is particularly effective in small-scale delimiting surveys in an outbreak area. However, it is labour intensive, time consuming and expensive due to the destruction of fruit. It is important that fruit samples should be held in suitable condition to maintain the viability of all immature stages of fruit fly in infested fruit for identification purpose.

#### Host preference

Fruit sampling should take into consideration the presence of primary, secondary and occasional hosts of the target species. Fruit sampling should also take into account the maturity of fruit, apparent signs of infestation in fruit, and commercial practices (e.g. application of insecticides) in the area.

#### Focusing on high-risk areas

Fruit sampling should target on areas likely to have presence of infested fruits such as:

- urban areas
- abandoned orchards
- rejected fruit at packing facilities
- fruit markets
- sites with a high concentration of primary hosts
- entrance points into the FF-PFA, where appropriate.

The sequence of hosts that are likely to be infested by the target fruit fly species in the area should be used as fruit sampling areas.

#### Sample size and selection

Factors to be considered include:

- the required level of confidence
- the availability of primary host material in the field
- fruits with symptoms on trees, fallen or rejected fruit (for example at packing facilities), where appropriate.

## Procedures for processing sampled fruit for inspection

Fruit samples collected in the field should be brought to a facility for holding, fruit dissection, pest recovery and identification. Fruit should be labelled, transported and held in a secure manner to avoid mixing fruits from different samples.

### Identification capability

NPPOs should have in place, or have ready access to, adequate infrastructure and trained personnel to identify fruit fly immature stages and emerged adults of the target species in an expeditious manner.

### 2.2.3 Controls on the movement of regulated articles

Movement controls of regulated articles should be implemented to prevent the entry of target pests into the FF-PFA. These controls depend on the assessed risks (after identification of likely pathways and regulated articles) and may include:

- listing of the target fruit fly species on a quarantine pest list
- regulation of the pathways and articles that require control to maintain the FF-PFA
- domestic restrictions to control the movement of regulated articles into the FF-PFA
- inspection of regulated articles, examination of relevant documentation as appropriate and, where necessary for cases of non-compliance, the application of appropriate phytosanitary measures (e.g. treatment, refusal or destruction).

### 2.2.4 Additional technical information for establishment of a FF-PFA

Additional information may be useful during the establishment phase of FF-PFAs. This includes:

- historical records of detection, biology and population dynamics of the target pest(s), and survey activities for the designated target pest(s) in the FF-PFA
- the results of phytosanitary measures taken as part of actions following detections of fruit flies in the FF-PFA
- records of the commercial production of fruit crops in the area, an estimate of non-commercial production and the presence of wild host material
- lists of the other fruit fly species of economic importance that may be present in the FF-PFA.

### 2.2.5 Domestic declaration of pest freedom

The NPPO should verify the fruit fly free status of the area (in accordance with ISPM 8) specifically by confirming compliance with the procedures set up in accordance with this standard (surveillance and controls). The NPPO should declare and notify the establishment of the FF-PFA, as appropriate.

In order to be able to verify the fruit fly free status in the area and for purposes of internal management, the continuing FF-PFA status should be checked after the PFA has been established and any phytosanitary measures for the maintenance of the FF-PFA have been put in place.

## 2.3 Maintenance of the FF-PFA

In order to maintain the FF-PFA status, the NPPO should continue to monitor the operation of the surveillance and control activities, continuously verifying the pest free status.

### 2.3.1 Surveillance for maintenance of the FF-PFA

After verifying and declaring the FF-PFA, the official surveillance programme should be continued at a level assessed as being necessary for maintenance of the FF-PFA. Regular technical reports of the survey activities should be generated (for example monthly). Requirements for this are essentially the same as for establishment of the FF-PFA (see section 2.2) but with differences in density and trap locations dependent upon the assessed level of risk of introduction of the target species.

### **2.3.2 Controls on the movement of regulated articles**

These are the same as for establishment of the FF-PFA (provided in section 2.2.3).

### **2.3.3 Corrective actions (including response to an outbreak)**

The NPPO should have prepared plans for corrective actions that may be implemented if the target pest(s) is detected in the FF-PFA or in host material from that area (detailed guidelines are provided in Annex 1), or if faulty procedures are found. This plan should include components or systems to cover:

- outbreak declaration according to criteria in ISPM 8 and notification
- delimiting surveillance (trapping and fruit sampling) to determine the infested area under corrective actions
- implementation of control measures
- further surveillance
- criteria for the reinstatement of freedom of the area affected by the outbreak
- responses to interceptions.

A corrective action plan should be initiated as soon as possible and in any case within 72 hours of the detection (of an adult or immature stage of the target pest).

## **2.4 Suspension, reinstatement or loss of a FF-PFA status**

### **2.4.1 Suspension**

The status of the FF-PFA or the affected part within the FF-PFA should be suspended when an outbreak of the target fruit fly occurs or based on one of the following triggers: detection of an immature specimen of the target fruit fly, two or more fertile adults as demonstrated by scientific evidence, or an inseminated female within a defined period and distance. Suspension may also be applied if procedures are found to be faulty (for example inadequate trapping, host movement controls or treatments).

If the criteria for an outbreak are met, this should result in the implementation of the corrective action plan as specified in this standard and immediate notification to interested importing countries' NPPOs (see ISPM 17 (*Pest reporting*)). The whole or part of the FF-PFA may be suspended or revoked. In most cases a suspension radius will delimit the affected part of the FF-PFA. The radius will depend on the biology and ecology of the target fruit fly. The same radius will generally apply for all FF-PFAs for a given target species unless scientific evidence supports any proposed deviation. Where a suspension is not in place, the criteria for lifting the suspension should be made clear. Interested importing countries' NPPOs should be informed of any change in FF-PFA status.

### **2.4.2 Reinstatement**

Reinstatement should be based on requirements for establishment with the following conditions:

- no further detection of the target pest species for a period determined by the biology of the species and the prevailing environmental conditions<sup>1</sup>, as confirmed by surveillance, or
- in the case of a fault in the procedures, only when the fault has been corrected.

### **2.4.3 Loss of FF-PFA status**

If the control measures are not effective and the pest becomes established in the whole area (the area recognized as pest free), the status of the FF-PFA should be lost. In order to achieve again the FF-PFA, the procedures of establishment and maintenance outlined in this standard should be followed.

<sup>1</sup> The period starts from the last detection. For some species, no further detection should occur for at least three life cycles; however the required period should be based on scientific information including that provided by the surveillance systems in place.

This annex is a prescriptive part of the standard.

## ANNEX 1: Guidelines on corrective action plans

The detection of a single fruit fly (adult or immature) of the target species in the FF-PFA should trigger enforcement of a corrective action plan.

In case of an outbreak, the objective of the corrective action plan is to ensure eradication of the pest to enable reinstatement of pest status in the affected area into the FF-PFA.

The corrective action plan should be prepared taking into account the biology of the target fruit fly species, the geography of the FF-PFA area, climatic conditions and host distribution within the area.

The elements required for implementation of a corrective action plan include:

- legal framework under which the corrective action plan can be applied
- criteria for the declaration of an outbreak
- time scales for the initial response
- technical criteria for delimiting trapping, fruit sampling, application of the eradication actions and establishment of regulatory measures
- availability of sufficient operational resources
- identification capability
- effective communication within the NPPO and with the NPPO(s) of the importing country(ies), including provision of contact details of all parties involved.

### **Actions to apply the corrective action plan**

#### *(1) Determination of the pest status of the detection (actionable or non-actionable)*

- (1.1) If the detection is a transient non-actionable occurrence (ISPM 8), no further action is required.
- (1.2) If the detection of a target pest may be actionable, a delimiting survey, which includes additional traps, and usually fruit sampling as well as an increased trap inspection rate, should be implemented immediately after the detection to assess whether the detection represents an outbreak, which will determine necessary responsive actions. If a population is present, this action is also used to determine the size of the affected area.

#### *(2) Suspension of FF-PFA status*

If after detection it is determined that an outbreak has occurred or any of the triggers specified in section 2.4.1 is reached, the FF-PFA status in the affected area should be suspended. The affected area may be limited to part of the FF-PFA or may be the whole FF-PFA.

#### *(3) Implementation of control measures in the affected area*

As per ISPM 9, specific corrective or eradication actions should be implemented immediately in the affected area(s) and adequately communicated to the community. Eradication actions may include:

- selective insecticide-bait treatments
- sterile fly release
- total harvest of fruit in the trees
- male annihilation technique
- destruction of infested fruit
- soil treatment (chemical or physical)
- insecticide application.

Phytosanitary measures should be immediately enforced for control of movement of regulated articles that can host fruit flies. These measures may include cancellation of shipments of fruit commodities from the affected area and as appropriate, fruit disinfection and the operation of road blocks to

prevent the movement of infested fruit from the affected area to the rest of the pest free area. Other measures could be adopted if agreed by the importing country, for example treatment, increased surveys, supplementary trapping.

(4) *Criteria for reinstatement of a FF-PFA after an outbreak and actions to be taken*

The criteria for determining that eradication has been successful are specified in section 2.4.2 and should be included in the corrective action plan for the target fruit fly. The time period will depend on the biology of the species and the prevailing environmental conditions. Once the criteria have been fulfilled the following actions should be taken:

- notification of NPPOs of importing countries
- reinstatement of normal surveillance levels
- reinstatement of the FF-PFA.

(5) *Notification of relevant agencies*

Relevant NPPOs and other agencies should be kept informed of any change in FF-PFA status as appropriate, and IPPC pest reporting obligations observed (ISPM 17).

**REVOKED**

This annex was adopted by the Ninth Session of the Commission on Phytosanitary Measures in April 2014.  
This annex is a prescriptive part of the standard.

## ANNEX 2: Control measures for an outbreak within a fruit fly-pest free area (2014)

### BACKGROUND

A fruit fly (Tephritidae) outbreak detected in a fruit fly-pest free area (FF-PFA) may pose a risk for those importing countries where the fruit fly species is considered a quarantine pest. This annex describes control measures to be taken in a fruit fly eradication area established within an FF-PFA in the event of an outbreak.

Corrective actions and other phytosanitary measures that may be used in an eradication area within an FF-PFA are covered by this standard.

The eradication area and the related control measures are established with the intent to eradicate the target fruit fly species and restore FF-PFA status, to protect the surrounding FF-PFA, and to meet the phytosanitary import requirements of the importing country, where applicable. In particular, control measures are needed because movements of regulated articles from and through an eradication area pose a potential risk of spreading the target fruit fly species.

#### 1. Establishment of an Eradication Area

The national plant protection organization (NPPO) of the exporting country should declare an outbreak in accordance with this and other relevant international standards for phytosanitary measures. When a target fruit fly species outbreak is detected within an FF-PFA, an eradication area should be established based on a technical evaluation. The freedom status of the eradication area should be suspended. If control measures cannot be applied to establish an eradication area, then the status of the FF-PFA should be revoked in accordance with this standard.

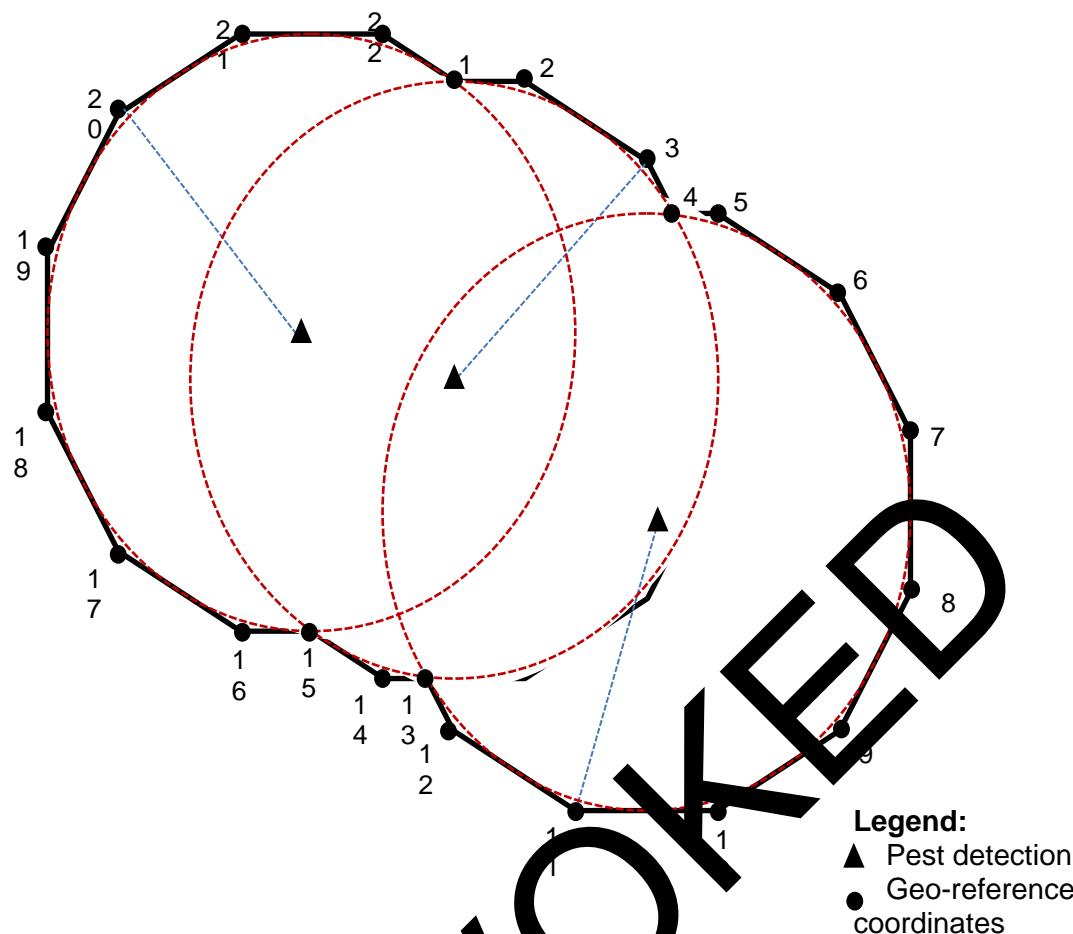
The eradication area should cover the infested area. In addition, a buffer zone should be established in accordance with this standard, and as determined by delimiting surveys, taking into account the natural dispersal capability of the target fruit fly species, its relevant biological characteristics, and other geographic and environmental factors.

A circle delimiting the minimum size of the eradication area should be drawn, centred on the actual target fruit fly species detection point with a radius large enough to comply with the above considerations, as determined by the NPPO of the exporting country. In the case of several pest detections, several (possibly overlapping) circles should be drawn accordingly, as illustrated in Figure 1.

If necessary for the practical implementation of the eradication area, the NPPO of the exporting country may decide to adjust the eradication area to correspond to administrative boundaries or topography, or to approximate the circle with a polygon.

A georeferencing device (e.g. global positioning system (GPS)) or map with geographical coordinates may be used for delimiting and enabling recognition of the eradication area. Signposts may be placed along boundaries and on roads to alert the public, and notices may be published to facilitate public awareness.

The NPPO of the exporting country should inform the NPPO of the importing country when a fruit fly outbreak is confirmed and an eradication area is established within an FF-PFA.



**Figure 1:** Example of delimiting circles and approximating polygons to determine the eradication area around three pest detections.

## 2. Control Measures

Each stage of the production chain (e.g. growing, sorting, packing, transporting, dispatching) may lead to spread of the target fruit fly species from the eradication area into the FF-PFA. This statement does not apply to any facilities located in the FF-PFA and handling only host fruit from the FF-PFA. Appropriate control measures should be applied to manage the pest risk for the surrounding FF-PFA and the importing country.

Control measures in use in other fruit fly-infested areas may be implemented in the eradication area.

Control measures may be audited by the NPPO of the importing country, in accordance with the NPPO of the exporting country's requirements.

Control measures applied at each stage of the production chain are described in the following sections.

### 2.1 Production

During the production period, within the eradication area, the NPPO of the exporting country may require control measures to avoid infestation, such as fruit bagging, fruit stripping (i.e. removal of unwanted fruits from trees), protein bait sprays, sterile insect technique, parasitoid releases, field sanitation, male annihilation technique, bait stations or netting.

## 2.2 Movement of regulated articles

Movement of regulated articles (e.g. soil, host plants, host fruit) into, from, through or within the eradication area should comply with control measures to prevent the spread of the target fruit fly species and should be accompanied by the necessary documentation to indicate the articles' origin and destination. This also pertains to moving regulated articles for phytosanitary certification.

## 2.3 Packing and packing facilities

Fruit packing facilities may be located within or outside the eradication area and may pack host fruit grown in or outside the eradication area. Control measures preventing spread of the target fruit fly species should be taken into account in each case.

The NPPO of the exporting country should:

- register the facility
- require control measures to prevent the target fruit fly species from entering or escaping the facility, as appropriate
- require and approve methods of physical separation of different host fruit lots (e.g. by using insect-proof packaging) to avoid cross-contamination
- require appropriate measures to maintain segregation of host fruits originating from areas of different pest status (e.g. separate locations for reception, processing, storage and dispatch)
- require appropriate measures regarding the handling and movement of host fruit through the facility to prevent mixing of fruit from areas of different pest status (e.g. flowcharts, signs and staff training)
- require and approve methods of disposal of rejected host fruit from the eradication area
- monitor the target fruit fly species at the facility and, if relevant, in the adjacent FF-PFA
- verify the packing material is insect proof and clean
- require appropriate control measures to eradicate target fruit fly species from the facility when they are detected
- audit the facility.

## 2.4 Storage and storage facilities

Fruit storage facilities may be located within or outside the eradication area. Such facilities should be registered with the NPPO of the exporting country and comply with the control measures to prevent the spread of the target fruit fly species; for example, they should:

- maintain distinct and separate between host fruit originating from the eradication area and from the FF-PFA
- use an approved method of disposal of host fruit from the eradication area that has been rejected as a result of inspection or quality control activities
- monitor for the target fruit fly species at the facility and if relevant, in the adjacent FF-PFA
- take appropriate control measures to eradicate the target fruit fly species from the facility when detected.

## 2.5 Processing and processing facilities

If the processing facility is located within the eradication area, host fruit destined for processing (such as juicing, canning and puréeing) does not pose additional fruit fly risk to the area.

If the facility is located outside the eradication area, the NPPO of the exporting country should require measures within the facility to prevent the escape of the target fruit fly species, through insect-proof reception, storage and processing areas.

Monitoring for the target fruit fly species may be conducted at the facility and, if relevant, in the adjacent FF-PFA. Appropriate control measures should be taken to eradicate target fruit fly species from the facility when they are detected.

Approved disposal of rejected host fruit and plant waste from the eradication area should be required by the NPPO of the exporting country. Rejected host fruit should be disposed of in such a way that the target fruit fly species are rendered non-viable.

## 2.6 Treatment and treatment facilities

Treatment facilities should be registered by the NPPO of the exporting country.

Post-harvest treatment (e.g. cold treatment, heat treatment, fumigation, irradiation), or in some cases pre-harvest treatment (e.g. bait spray, fruit bagging), may be required for host fruit moving into an FF-PFA or being exported to countries where the target fruit fly species is regulated as quarantine pest.

Control measures preventing the escape of the target fruit fly species may be required for treatment facilities located within the FF-PFA, if treating regulated articles from the eradication area. The NPPO of the exporting country may require physical isolation within the facility.

The NPPO of the exporting country should approve the method of disposal of rejected host fruit from the eradication area to reduce the risk of spread of the target fruit fly species. Disposal methods may include double bagging followed by deep burial or incineration.

## 2.7 Sale inside the eradication area

Host fruit sold within the eradication area may be a risk of infestation if exposed before being sold (e.g. placed on display in an open air market) and may therefore need to be physically protected, when feasible, to avoid spread of the target fruit fly species while on display and being stored.

## 3. Documentation and Record-Keeping

The control measures, including corrective actions used in the eradication area should be adequately documented, reviewed and updated (see also ISPM 4). Such documents should be made available to the NPPO of the importing country on request.

## 4. Termination of Control Measures in the Eradication Area

Eradication of the target fruit fly species in the eradication area should meet the requirements for reinstatement of an FF-PFA status after an outbreak, according to this standard. The declaration of eradication should be based on no further detections of the target fruit fly species for a period determined by biology and prevailing environmental conditions, as confirmed by surveillance referred to in this standard.<sup>2</sup>

The control measures should remain in force until eradication is declared. If eradication is successful, the particular control measures in the eradication area may be terminated and the FF-PFA status should be reinstated. If eradication is unsuccessful, the FF-PFA delimitation should be modified accordingly. The NPPO of the importing country should be notified as appropriate.

<sup>2</sup> The period starts from the last detection. For some species, no further detection should occur for at least three life cycles; however, the required period should be based on scientific information, including that provided by the surveillance systems in place.

This annex was adopted by the Tenth Session of the Commission on Phytosanitary Measures in March 2015.  
This annex is a prescriptive part of the standard.

## ANNEX 3: Phytosanitary procedures for fruit fly (Tephritidae) management (2015)

This annex provides guidelines for the application of phytosanitary procedures for fruit fly management.

Various phytosanitary procedures are used for fruit fly suppression, containment, eradication and exclusion. These procedures may be applied to establish and maintain fruit fly-pest free areas (FF-PFAs) (this standard) and areas of low pest prevalence for fruit flies (FF-ALPPs) (ISPM 30 (*Establishment of areas of low pest prevalence for fruit flies (Tephritidae)*)), as well as to develop systems approaches for fruit flies (ISPM 35 (*Systems approach for pest risk management of fruit flies (Tephritidae)*))).

The phytosanitary procedures include mechanical and cultural controls, insecticide bait application technique (BAT), bait stations, male annihilation technique (MAT), mass trapping, sterile insect technique (SIT), biological control, and controls on the movement of regulated articles. Many of these procedures can be environmentally friendly alternatives to insecticide application for managing fruit flies.

### 1. Objectives of Fruit Fly Management Strategies

The four strategies used to manage target fruit fly populations are suppression, containment, eradication and exclusion. One or more of these strategies can be used depending on the circumstances and objectives. The corresponding phytosanitary procedures used for fruit fly management should take into account the phytosanitary import requirements of the importing country, fruit fly status in the target area, hosts, host phenology and host susceptibility, pest biology, and economic and technical feasibility of the available phytosanitary procedures, as relevant.

#### 1.1 Suppression

Suppression strategies may be applied for purposes such as to:

- reduce a target fruit fly population to below an acceptable level
- establish an FF-ALPP (ISPM 22 (*Requirements for the establishment of areas of low pest prevalence*); ISPM 30)
- implement a corrective action in an FF-ALPP when the specified level of low pest prevalence has been exceeded (ISPM 22; ISPM 30)
- reduce a target fruit fly population in order to achieve a specified pest population level that can be used as part of a systems approach (ISPM 14 (*The use of integrated measures in a systems approach for pest risk management*); ISPM 35)
- precede, as part of a process, target fruit fly population eradication in order to establish an FF-PFA (ISPM 4).

#### 1.2 Containment

Containment strategies may be applied for purposes such as to:

- prevent the spread of a target fruit fly from an infested area to an adjacent FF-PFA
- contain an incursion of a target fruit fly into non-infested areas
- protect, as a temporary measure, individual areas where target fruit flies have been eradicated as part of an ongoing eradication programme in a larger area.

#### 1.3 Eradication

Eradication strategies may be applied for purposes such as to:

- eliminate a fruit fly population in order to establish an FF-PFA (ISPM 4)

- eliminate an incursion of a quarantine fruit fly before establishment can occur (this may be part of a corrective action plan in an FF-PFA if the target fruit fly species is detected).

## 1.4 Exclusion

Exclusion strategies may be applied to prevent the introduction of a fruit fly into an FF-PFA.

## 2. Requirements for the Application of the Phytosanitary Procedures

The following requirements should be considered when applying phytosanitary procedures for fruit fly management:

### 2.1 Fruit fly identification capabilities

Accurate identification of the target fruit fly species should be ensured so that the appropriate strategies and phytosanitary procedures can be selected and applied. National plant protection organizations (NPPOs) should have access to trained personnel to identify detected specimens of adult and, where possible, immature stages of the target fruit fly species in an expeditious manner (ISPM 6 (*Guidelines for surveillance*)).

### 2.2 Knowledge of fruit fly biology

The biology of the target fruit fly species should be known in order to determine the appropriate strategy to address its management and select the phytosanitary procedures that will be applied. Basic information on the target fruit fly species may include life cycle, hosts, host sequence, host distribution and abundance, dispersal capacity, geographical distribution and population dynamics. The climatic conditions may also affect the strategy adopted.

### 2.3 Area delimitation

The area in which the phytosanitary procedures will be applied should be delimited. Geographical characteristics and host distribution within this area should be known.

### 2.4 Stakeholder participation

Successful implementation of fruit fly phytosanitary procedures requires active and coordinated participation of interested and affected groups, including government, local communities and industry.

### 2.5 Public awareness

An ongoing public awareness programme should be put in place to inform interested and affected groups about the pest and phytosanitary procedures that will be implemented as part of the fruit fly management strategy. Such a programme is most important in areas where the risk of introduction of the target fruit fly species is high. For the success of the management programme it is important to have the support and participation of the public (especially the local community) within the management programme area and of individuals who travel to or through the area.

### 2.6 Operational plans

An official operational plan that specifies the required phytosanitary procedures should be developed. This operational plan may include specific requirements for the application of phytosanitary procedures and describe the roles and responsibilities of the interested and affected groups (ISPM 4; ISPM 22).

## 3. Phytosanitary Procedures Used in Fruit Fly Management Strategies

Fruit fly management strategies may involve the use of more than one phytosanitary procedure.

Phytosanitary procedures may be applied in an area, at a place of production or at a production site; during the pre- or post-harvest period; at the packing house; or during shipment or distribution of the commodity. Pest free areas, places of production and production sites may require the establishment

and maintenance of an appropriate buffer zone. Appropriate phytosanitary procedures may be applied in the buffer zone if necessary (this standard and ISPM 10 (*Requirements for the establishment of pest free places of production and pest free production sites*)).

### **3.1 Mechanical and cultural controls**

Mechanical and cultural control procedures may be applied in order to reduce the level of fruit fly populations. These controls include phytosanitary procedures such as orchard and field sanitation, fruit stripping, pruning, host plant removal or netting, fruit bagging, host-free periods, use of resistant varieties, trap cropping, ploughing and ground swamping.

The effectiveness of field sanitation increases when the collection and disposal of fallen fruit are focused on the preferred hosts and are done continuously on an area-wide basis. For good results, collection and disposal should be done before, during and after harvest.

Fruit that remains on the host plants after harvest, fruit rejected because of poor quality during harvest and packing, and fruit on host plants present in the surrounding area should be collected and safely disposed of (e.g. by deep burial).

Elimination or maintaining a low level of vegetation at the place of production will facilitate collection of fallen fruit. In addition, when vegetation is kept low fallen fruit with larvae may be more exposed to direct sunlight and natural enemies, which will contribute to fruit fly larva mortality.

Bagging of fruit and use of exclusion netting can prevent fruit fly infestation of the fruit. Where used, bagging or exclusion netting should be carried out before the fruit becomes susceptible to fruit fly infestation.

The pupae of many fruit flies can be targeted by disturbing the soil medium in which they pupate. This can be done by ground swamping (causing pupae anaemia) or ploughing (causing physical damage, desiccation to the pupae and exposing them to natural enemies).

### **3.2 Insecticide bait application techniques**

BAT uses an appropriate insecticide mixed together with a food bait. Commonly used food baits include attractants such as hydrolysed protein, high-fructose syrup and molasses, used alone or in combination. This technique is an effective control of adult fruit fly populations and reduces the negative impacts on non-target insects and the environment.

Insecticide bait applications should start in time to target maturing adults and to prevent the infestation of fruit. For fruit protection this may be up to three months before the beginning of the harvesting season for fruit intended for export or on detection of the first adult flies or larvae in the field or urban area. Maturing adults should be targeted as this is when protein demands are at their highest. The number of and intervals between applications will depend on the characteristics of the target fruit fly species (biology, abundance, behaviour, distribution, life cycle, etc.), host phenology and weather conditions.

Insecticide baits can be applied from the ground or from the air.

#### **□.2.1 Ground application**

Ground application of insecticide bait is usually used for relatively small production areas, such as individual orchards, or in urban areas.

The insecticide bait should generally be applied on or inside the middle-to-top part of the canopy of host and shelter plants, but specific application should relate to the height of the host plant. For low-growing host plants (e.g. cucurbits, tomatoes, peppers), the insecticide bait should be applied on taller plants surrounding the cultivated area that serve as shelter and a source of food. In FF-PFAs, as part of an emergency action plan to eliminate an outbreak, the insecticide bait can also be applied to non-host plants or other appropriate surfaces around the detection site.

### 3.2.2 Aerial application

Aerial application of insecticide bait may be used on large production areas and in areas where hosts are scattered in patches over large areas of land. Aerial spraying may be more cost-effective than ground spraying for large-scale programmes, and a more uniform coverage of bait in the target area may be achieved. In some countries, however, aerial spraying may be subject to restrictions due to environmental considerations.

Once the treatment area is selected, it may be defined using a georeferencing device and recorded in digitized maps using geographical information systems (GIS) software in order to ensure the efficient application of bait sprays and reduce the environmental impact.

To treat the target area, insecticide bait applications may not need to be applied as full coverage but only in some swathes, such as every second or third swath. The altitude and speed of aerial application should be adjusted to conditions such as bait viscosity and nozzle specifications, wind velocity, temperature, cloud cover and topography of the terrain.

### 3.3 Bait stations

Lure and kill devices known as “bait stations” may be a more environmentally-friendly control procedure for fruit fly suppression than BAT. Bait stations consist of an attractant and a killing agent that may be contained in a device or directly applied to an appropriate surface. Unlike traps, bait stations do not retain the attracted fruit flies.

Bait stations are suitable for use in, for example, commercial fruit production operations, area-wide fruit fly management programmes, public areas and, in many cases, organic groves. Bait stations may be used in fruit fly pest free areas for population suppression of localized and well-isolated outbreaks. In infested areas known to be fruit fly reservoirs and sources of incursions into FF-ALPPs and FF-PFAs, bait stations should be deployed at high densities.

It is recommended that the attractant used in the bait station be female-biased, thereby directly reducing the overall fruit infestation.

### 3.4 Male annihilation technique

MAT involves the use of a high density of bait stations consisting of a male lure combined with an insecticide to reduce the male population of target fruit flies to such a low level that mating is unlikely to occur (FAO, 2007).

MAT may be used for the control of those fruit fly species of the genera *Bactrocera* and *Dacus* that are attracted to male lures (cuelure or methyl eugenol). Methyl eugenol is more effective than cuelure for male annihilation of species attracted to these lures.

### 3.5 Mass trapping

Mass trapping uses trapping systems at high density to suppress fruit fly populations. In general, mass trapping procedures are the same as for traps used for survey purposes (Appendix 1). Traps should be deployed at the place of production early in the season when the first adult flies move into the field and populations are still at low levels and should be serviced appropriately.

Trap density should be based on such factors as fruit fly density, physiological stage of the fruit fly, efficacy of the attractant and killing agent, phenology of the host and host density. The timing, layout and deployment of traps should be based on the target fruit fly species and host ecological data.

### 3.6 Sterile insect technique

Sterile insect technique (SIT) is a species-specific environmentally-friendly technique that can provide effective control of target fruit fly populations (FAO, 2007).

SIT is effective only at low population levels of the target species and may be used for:

- suppression, where SIT may be a stand-alone phytosanitary procedure or combined with other phytosanitary procedures to achieve and maintain low population levels
- containment, where SIT may be particularly effective in areas that are largely pest free (such as buffer zones) but that are subjected to regular pest entries from adjacent infested areas
- eradication, where SIT may be applied when population levels are low to eradicate the remaining population
- exclusion, where SIT may be applied in endangered areas that are subject to high pest pressure from neighbouring areas.

### **3.6.1 Sterile fruit fly release**

Sterile fruit flies may be released from the ground or from the air. Release intervals should be adjusted according to the longevity of the insect. Sterile fruit flies are generally released once or twice per week but the frequency of release may be influenced by circumstances such as pupae supply, staggered adult fly emergence and unfavourable weather. To establish sterile fruit fly release density, the quality of the sterile fruit flies, the level of the wild population and the desired sterile : wild fruit fly ratio should be considered.

After release of the sterile fruit flies, trapping and identification of the sterile : wild flies should be performed in order to evaluate the effectiveness of the release procedure and also to prevent unnecessary corrective actions. Released sterile flies should be recaptured in the same traps that are used for detection of the wild population as this provides feedback on whether the desired sterile fruit fly density and sterile : wild fly ratio were attained (FAO, 2007).

Ground release may be used when aerial release is neither cost-effective nor efficient (i.e. discontinuous distribution or relatively small area), or where additional releases are required to provide a higher density of fruit flies for a particular reason (e.g. in areas where a specified level of pest prevalence is exceeded).

Aerial release is more cost-effective than ground release for large-scale programmes and it provides a more uniform sterile fruit fly distribution than ground release, which may clump sterile fruit flies in localized sites or along release routes. Once the release area is selected, it may be defined using a georeferencing device and recorded in digitized maps using GIS software: this will help ensure the efficient distribution of sterile flies. The most common methods for aerial release are chilled adult and paper bag systems (FAO, 2007).

To determine the release altitude, several factors should be considered, including wind velocity, temperature, cloud cover, topography of the terrain, vegetation cover, and whether the target area is urban or rural. Release altitudes range from 200 to 600 m above ground level. However, lower release altitudes should be preferred, especially in areas subjected to strong winds (to prevent excessive sterile fruit fly or bag drift) and in areas where predation by birds is high and frequent. Release in the early morning, when winds and temperature are moderate, is preferable.

### **3.6.2 Sterile fruit fly quality control**

Routine and periodic quality control tests should be carried out to determine the effect of mass rearing, irradiation, handling, shipment duration, holding and releasing on the performance of the sterile fruit flies, according to desired quality parameters (FAO/IAEA/USDA, 2014).

## **3.7 Biological control**

Classic biological control may be used to reduce fruit fly populations. For further suppression, inundative release may be used. During inundative release, large numbers of natural enemies, typically parasitoids, are mass reared and released during critical periods to reduce pest populations. The use of biological control by inundation is limited to those biological control agents for which mass-rearing technology is available. The mass-reared natural enemies should be of high quality so that suppression

of the target fruit fly population can be effectively achieved. The release of the biological control agents should be directed towards marginal and difficult to access areas that have high host density and that are known to be fruit fly reservoirs and sources of infestation for commercial fruit production or urban areas.

### **3.8 Controls on the movement of regulated articles**

For FF-PFAs, and under certain circumstances for FF-ALPPs, controls on the movement of regulated articles should be implemented to prevent the entry or spread of target fruit fly species.

## **4. Materials Used in the Phytosanitary Procedures**

The materials used in the phytosanitary procedures should perform effectively and reliably at an acceptable level for an appropriate period of time. The devices and equipment should maintain their integrity for the intended duration that they are deployed in the field. The attractants and chemicals should be certified or bio-assayed for an acceptable level of performance.

## **5. Verification and Documentation**

The NPPO should verify the effectiveness of the chosen strategies (suppression, containment, eradication and exclusion) and relevant phytosanitary procedures. The main phytosanitary procedure used for verification is adult and larval surveillance, as described in ISPM 6.

NPPOs should ensure that records of information supporting all stages of the suppression, containment, eradication and exclusion strategies are kept for at least 10 years.

## **6. References**

- FAO.** 2007. *Guidance for packing, shipping, holding and release of sterile flies in area-wide fruit fly control programmes*, ed. W. Enkerlin. Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture. FAO Plant Production and Protection Paper 190. Rome. 145 + vii pp.
- FAO/IAEA/USDA.** 2014. *Product quality control for sterile mass-reared and released tephritid fruit flies*. Version 6.0. Vienna, International Atomic Energy Agency. 164 pp.

This appendix was adopted by the Sixth Session of the Commission on Phytosanitary Measures in March 2011.  
This appendix is for reference purposes only and is not a prescriptive part of the standard.

## APPENDIX 1: Fruit fly trapping (2011)

This appendix provides detailed information for trapping procedures for fruit fly species (Tephritidae) of economic importance under different pest statuses. Specific traps, in combination with attractants, and killing and preserving agents, should be used depending on the technical feasibility, the species of fruit fly and the pest status of the areas, which can be either an infested area, an area of low pest prevalence (FF-ALPP), or a pest free area (FF-PFA). It describes the most widely used traps, including materials such as trapping devices and attractants, and trapping densities, as well as procedures including evaluation, data recording and analysis.

### 1. Pest status and survey types

There are five pest statuses where surveys may be applied:

- A. Pest present without control. The pest is present but not subject to any control measures.
- B. Pest present under suppression. The pest is present and subject to control measures. Includes FF-ALPP.
- C. Pest present under eradication. The pest is present and subject to control measures. Includes FF-ALPP.
- 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 under surveillance and actionable under eradication.

The three types of surveys and corresponding objectives are:

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

Monitoring surveys are necessary 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. These are necessary for situations A, B and C. Delimiting surveys are applied to determine the boundaries of an area considered to be infested by or free from the pest such as boundaries of an established FF-ALPP (situation B) (ISPM 30) and as part of a corrective action plan when the pest exceeds the established low prevalence levels or in an FF-PFA (situation E) as part of a corrective action plan when a detection occurs. Detection surveys are to determine if the pest is present in an area, that is to demonstrate pest absence (situation D) and to detect a possible entry of the pest into the FF-PFA (pest transient actionable) (ISPM 8).

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

### 2. Trapping scenarios

As the pest status may change over time, the type of survey needed may also change:

- 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 C) or an FF-PFA (situation D).
- 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.

### 3. Trapping materials

The effective use of traps relies on the proper combination of trap, attractant and killing agent to attract, capture, kill and preserve the target fruit fly species for effective identification, counting data collection and analysis. Traps for fruit fly surveys use the following materials as appropriate:

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

#### 3.1 Attractants

Some fruit fly species of economic importance and the attractants commonly used to capture 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
<i>Anastrepha fraterculus</i> (Wiedemann) <sup>4</sup>	Protein attractant (PA)
<i>Anastrepha grandis</i> (Macquart)	PA
<i>Anastrepha ludens</i> (Loew)	PA, 2C-
<i>Anastrepha obliqua</i> (Macquart)	PA, 2C-
<i>Anastrepha serpentina</i> (Wiedemann)	PA
<i>Anastrepha striata</i> (Schiner)	PA
<i>Anastrepha suspensa</i> (Loew)	PA, 2C-1 <sup>1</sup>
<i>Bactrocera carambolae</i> (Drew & Hancock)	Methyl eugenol (ME)
<i>Bactrocera caryae</i> (Kapoor)	ME
<i>Bactrocera correcta</i> (Bezzi)	ME
<i>Bactrocera dorsalis</i> (Hendel) <sup>4</sup>	ME
<i>Bactrocera invadens</i> (Drew, Tsuruta, & White)	ME, 3C <sup>2</sup>
<i>Bactrocera kandiensis</i> (Drew & Hancock)	ME
<i>Bactrocera musae</i> (Tryon)	ME
<i>Bactrocera occipitalis</i> (Bezzi)	ME
<i>Bactrocera papayae</i> (Drew & Hancock)	ME
<i>Bactrocera philippinensis</i> (Drew & Hancock)	ME
<i>Bactrocera umbrosa</i> (Fabricius)	ME
<i>Bactrocera zonata</i> (Saunders)	ME, 3C <sup>2</sup> , ammonium acetate (AA)
<i>Bactrocera cucurbitae</i> (Coquillett)	Cuelure (CUE), 3C <sup>2</sup> , AA
<i>Bactrocera neohumeralis</i> (Hardy)	CUE
<i>Bactrocera tau</i> (Walker)	CUE
<i>Bactrocera tryoni</i> (Froggatt)	CUE
<i>Bactrocera citri</i> (Chen) ( <i>B. minax</i> , Enderlein)	PA
<i>Bactrocera cucumis</i> (French)	PA
<i>Bactrocera jarvisi</i> (Tryon)	PA
<i>Bactrocera latifrons</i> (Hendel)	PA
<i>Bactrocera oleae</i> (Gmelin)	PA, ammonium bicarbonate (AC), spiroketal (SK)
<i>Bactrocera tsuneonis</i> (Miyake)	PA

Scientific name	Attractant
<i>Ceratitis capitata</i> (Wiedemann)	Trimedlure (TML), Capilure (CE), PA, 3C <sup>2</sup> , 2C-2 <sup>3</sup>
<i>Ceratitis cosyra</i> (Walker)	PA, 3C <sup>2</sup> , 2C-2 <sup>3</sup>
<i>Ceratitis rosa</i> (Karsch)	TML, PA, 3C <sup>2</sup> , 2C-2 <sup>3</sup>
<i>Dacus ciliatus</i> (Loew)	PA, 3C <sup>2</sup> , AA
<i>Myiopardalis pardalina</i> (Bigot)	PA
<i>Rhagoletis cerasi</i> (Linnaeus)	Ammonium salts (AS), AA, AC
<i>Rhagoletis cingulata</i> (Loew)	AS, AA, AC
<i>Rhagoletis indifferens</i> (Curran)	AA, AC
<i>Rhagoletis pomonella</i> (Walsh)	butyl hexanoate (BuH), AS
<i>Toxotrypana curvicauda</i> (Gerstaecker)	2-methyl-vinylpyrazine (MVP)

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

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

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

<sup>4</sup> Taxonomic status of some listed members of the *Bactrocera dorsalis* complex and of *Anastrepha fraterculus* is uncertain.

### 3.1.1 Male-specific attractants

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. carambolae*, *B. dorsalis*, *B. invadens*, *B. musae*, *B. philippinensis* and *B. zonata*). 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 attractants

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 (PA) 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 and require more frequent servicing.

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 capturing of *Anastrepha* species the trimethylamine component may be removed. A synthetic attractant lasts approximately 4–10 weeks depending on climatic conditions. It captures few non-target insects and 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.

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**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
<i>Anastrepha fraterculus</i>																			
<i>Anastrepha ludens</i>																			
<i>Anastrepha obliqua</i>																			
<i>Anastrepha striata</i>																			
<i>Anastrepha suspensa</i>																			
<i>Bactrocera carambolae</i>												x	x	x	x	x	x	x	
<i>Bactrocera caryae</i>												x	x	x	x	x	x	x	
<i>Bactrocera citri</i> ( <i>B. minax</i> )																			
<i>Bactrocera correcta</i>												x	x	x	x	x	x	x	
<i>Bactrocera cucumis</i>																			
<i>Bactrocera cucurbitae</i>																	x	x	x
<i>Bactrocera dorsalis</i>												x	x	x	x	x	x	x	x
<i>Bactrocera invadens</i>												x	x	x	x	x	x	x	
<i>Bactrocera kandiensis</i>												x	x	x	x	x	x	x	
<i>Bactrocera latifrons</i>																			
<i>Bactrocera occipitalis</i>												x	x	x	x	x	x	x	
<i>Bactrocera oleae</i>																			
<i>Bactrocera papayae</i>												x	x	x	x	x	x	x	
<i>Bactrocera philippinensis</i>												x	x	x	x	x	x	x	
<i>Bactrocera tau</i>																	x	x	x
<i>Bactrocera tryoni</i>																	x	x	x
<i>Bactrocera tsuneonis</i>																			
<i>Bactrocera umbrosa</i>												x	x	x	x	x	x	x	
<i>Bactrocera zonata</i>												x	x	x	x	x	x	x	
<i>Ceratitis capitata</i>	x	x	x	x	x	x	x	x	x	x									
<i>Ceratitis cosyra</i>																			
<i>Ceratitis rosa</i>	x	x	x	x	x	x	x	x	x	x									
<i>Dacus ciliatus</i>																			
<i>Myioopardalis pardalina</i>																			
<i>Rhagoletis cerasi</i>																			

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
<i>Rhagoletis cingulata</i>																		
<i>Rhagoletis indifferens</i>																		
<i>Rhagoletis pomonella</i>																		
<i>Toxotrypana curvicauda</i>																		

**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 Maubre-Mor or Morocco trap  
 ST Steiner trap  
 SE Sensus trap

TP Tephri trap  
 VARs+ Modified funnel trap  
 YP Yellow panel trap

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

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

Fruit fly species	Attractant and trap (see below for abbreviations)																		BuH						
	3C						2C-2				2C-1		PA			SK+AC		AS (AA, AC)							
	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
<i>Ceratitis cosyra</i>		x						x					x	x											
<i>Ceratitis rosa</i>	x	x						x					x	x											
<i>Dacus ciliatus</i>	x												x												
<i>Myiopardalis pardalina</i>													x	x											
<i>Rhagoletis cerasi</i>																	x	x	x	x	x	x	x		
<i>Rhagoletis cingulata</i>																	x	x			x	x			
<i>Rhagoletis indifferens</i>																	x	x							
<i>Rhagoletis pomonella</i>																	x	x	x	x	x				
<i>Toxotrypana curvicauda</i>																								x	

**Attractant abbreviations**

3C	(AA+Pt+TMA)	AS	ammonium salts
2C-2	(AA+TMA)	AA	ammonium acetate
2C-1	(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	Chauvet trap
ET	East trap
GS	Green sphere
LT	Lynfield trap
MM	Maghreb-Med or Morocco trap

McP	McPhail trap
MLT	Multilure trap
OBDT	Open bottom dry trap
PALz	Fluorescent yellow sticky "cloak" trap
RB	Rebell trap

RS Red sphere trap  
 SE Sensus trap  
 TP Tephri trap  
 YP Yellow panel trap

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**Table 3.** List of attractants and field longevity

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

<sup>1</sup> 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 commonly 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 II, 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 trimedite lure), 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.

##### *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 and attractant is used, see Table 2a.

- For rebaiting (field longevity), see Table 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.

#### *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 and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Tables 4b and 4c.



**Figure 2.** ChamP trap.

### **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.

#### *Use*

The trap is multipurpose. It can be used dry baited with parapheromones (e.g. TM1, 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.



**Figure 3.** Easy trap.

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 and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 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.

### 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 and attractant is used, see Table 2b.
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4e.



**Figure 4.** Fluorescent yellow sticky cloak trap.

## 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 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 pheromone 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.

For many years this trap has been used in exclusion, suppression 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.



**Figure 5.** Jackson trap or Delta trap.

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

#### 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, CE/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 and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 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.

#### Use

For this trap to function properly it is essential that the body stays clean. Some designs have two parts



**Figure 6.** Lynfield trap.

**Figure 7.** Maghreb-Med trap or Morocco trap.



**Figure 8.** McPhail trap.

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.

To bait with yeast tablets, mix three to five torula tablets in 500 ml of water or follow the manufacturer's recommendation. 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 appendix.

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



Figure 9. Plastic McPhail trap.

## 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.

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

## Multilure trap (MLT)

### General description

The Multilure trap (MLT) is a version of the McP 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 integrated 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



**Figure 10.** Modified funnel trap.



**Figure 11.** Multilure trap.

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

### **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 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 yellow sticky traps. This trap is less expensive than the plastic orange or Melon-type traps.

- For the species for which the trap and attractant is used, see Table 2b.
- For attractants used and rebaiting (field longevity), see Table 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.

#### *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 and attractant is used, see Table 2b.
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4e.



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



**Figure 13.** Red sphere trap.

## Sensus trap (SE)

### *General description*

The Sensus trap consists of a vertical plastic bucket 12.5 cm in height 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.

### *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 and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 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). There are a number of versions of Steiner traps. These include the Steiner trap of 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.

### *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 in a dispenser with the attractant and an insecticide (usually malathion, dibrom or deltamethrin) as a killing agent.

- For the species for which the trap and attractant is used, see Table 2a.
- For rebaiting (field longevity), see Table 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



Figure 14. Sensus trap.



Figure 15. Conventional Steiner trap.



Figure 16. Steiner trap version.



Figure 17. Steiner trap version.

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 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 and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Tables 4b and 4d.

#### **REBELL** **Yellow panel trap (YP)/Rebell trap (RB)**

##### *General description*

The Yellow panel trap (YP) 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 18.** Tephri trap.



**Figure 19.** Yellow panel 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 and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 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**

The spatial distribution of traps 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.

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



**Figure 20.** Rebell trap.

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 deployed at carefully selected sites at the correct density and distributed in an appropriate pattern, 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 where available. A map or sketch of the trap locations 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 control teams and supervisors who service the traps to find the trap easily.

A database or trapping book of all traps with their corresponding coordinates should be kept, together with the records of trap services, date of collection, collector, rebaiting, trap captures, and if possible notes on the collection site such as ecological characteristics. 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 noting that actual timings should be supported by field testing and validation (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, on a case-by-case basis. The interval can range from one day up to 30 days, e.g. 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, with two to three days being 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 sticky material. This also applies to leaves and twigs that surround the trap. Attractants, by their nature, are highly volatile and care should be taken when storing, packaging, handling and disposing of lures to avoid compromising the attractant and operator safety.

The number of traps serviced per day per person will vary depending on type of trap, trap density, environmental and topographic conditions and experience of the operators. Where a large trap network is in place, it may need to be serviced over a number of days. In this case, the network may be serviced through a number of "routes" or "runs" which systematically ensure all traps within the network are inspected and serviced, and none are missed.

#### 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.

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 the result of dividing the total number of fruit flies captured (F) by the product obtained from multiplying the total number of inspected traps (T) by the average number of days between trap inspections (D). The formula is as follows:

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

## 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 suggested 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 surveillance activities, such as the type and intensity of fruit sampling to detect immature stages of fruit flies. In those cases where trapping surveillance programmes are complemented with fruit sampling activities, trap densities could 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 status
- 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 suggested for *Anastrepha* spp.

Trapping	Trap type <sup>1</sup>	Attractant	Trap density/km <sup>2</sup> <sup>(2)</sup>			
			Production area	Marginal	Urban	Points of entry <sup>3</sup>
Monitoring survey, no control	MLT/McP	2C-1/PA	0.25–1	0.25–0.5	0.25–0.5	0.25–0.5
Monitoring survey for suppression	MLT/McP	2C-1/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-1/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	MLT/McP	2C-1/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-1/PA	1–2	2–3	3–5	5–12
Delimitation survey in an FF-PFA after a detection in addition to detection survey <sup>4</sup>	MLT/McP	2C-1/PA	20–50	20–50	20–50	20–50

<sup>1</sup> Different traps can be combined to reach the total number.<sup>(2)</sup> Refers to the total number of traps.<sup>3</sup> Also other high-risk sites.<sup>4</sup> This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type	Attractant
McP	2C-1
	AA
	Pt
	PA
MLT	AA+Pt Ammonium acetate Putrescine Protein attractant
MLT	ChamP trap Easy trap Jackson trap Lynfield trap McPhail trap Multilure trap Maghreb-Med or Morocco Steiner trap Tephri trap
CH	ME
ET	CUE
JT	PA
LT	ME
McP	Methyleugenol
MLT	Cuelure
MM	Protein attractant
ST	
TP	

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

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

<sup>1</sup> Different traps can be combined to reach the total number.<sup>(2)</sup> Refers to the total number of traps.<sup>3</sup> Also other high-risk sites.<sup>4</sup> This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type	Attractant
CH	ME
ET	CUE
JT	PA
LT	ME
McP	Methyleugenol
MLT	Cuelure
MM	Protein attractant
ST	
TP	

YP Yellow panel trap

**Table 4c.** Trap densities suggested for *Bactrocera oleae*

Trapping	Trap type <sup>1</sup>	Attractant	Trap density/km <sup>2</sup> <sup>(2)</sup>			
			Production area	Marginal	Urban	Points of entry <sup>3</sup>
Monitoring survey, no control	MLT/CH/YP/ET/McP	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/ET/McP	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/ET/McP	AC+SK/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	MLT/CH/YP/ET/McP	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/ET/McP	AC+SK/PA	1	1	2–5	3–12
Delimitation survey in a PFA after a detection in addition to detection survey <sup>4</sup>	MLT/CH/YP/ET/McP	AC+SK/PA	20–50	20–50	20–50	20–50

<sup>1</sup> Different traps can be combined to reach the total number.

<sup>(2)</sup> Refers to the total number of traps.

<sup>3</sup> Also other high-risk sites.

<sup>4</sup> This range includes high-density trapping in the immediate area of the detected area (core area). However, it may decrease towards the surrounding trapping zones.

**Trap type**

CH	Champ trap
ET	Easy trap
McP	McPhail trap
MLT	Multilure trap
YP	Yellow panel trap

**Attractant**

AC	Ammonium bicarbonate
PA	Protein attractant
SK	Spiroketa

**Table 4d.** Trap densities suggested for *Ceratitis capitata*

Trapping	Trap type <sup>1</sup>	Attractant	Trap density/km <sup>2</sup> <sup>(2)</sup>			
			Production area	Marginal	Urban	Points of entry <sup>3</sup>
Monitoring survey, no control <sup>4</sup>	MLT/McP/OBDT/ST/SE/ET/LT/TP/VARs+/CH	TML/CE/3C/2C-2/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+/CH	TML/CE/3C/2C-2/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+/CH	TML/CE/3C/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication <sup>5</sup>	JT/MLT/McP/OBDT/ST/ET/LT/MM/TP/VARs+/CH	TML/CE/3C/2C-2/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion <sup>5</sup>	JT/MLT/McP/ST/ET/LT/MM/CC/VARs+/CH	TML/CE/3C/PA	1	1–2	1–5	3–12
Delimitation survey in a PFA after a detection in addition to detection survey <sup>6</sup>	JT/YP/MLT/McP/OBDT/ST//ET/LT/MM/TP/VARs+/CH	TML/CE/3C/PA	20–50	20–50	20–50	20–50

<sup>1</sup> Different traps can be combined to reach the total number.

<sup>(2)</sup> Refers to the total number of traps.

- <sup>3</sup> Also other high-risk sites.  
<sup>4</sup> 1:1 ratio (1 female trap per male trap).  
<sup>5</sup> 3:1 ratio (3 female traps per male trap).  
<sup>6</sup> This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones (ratio 5:1, 5 female traps per male trap).

Trap type	Attractant
CC	Cook and Cunningham (C&C) Trap (with TML for male capture)
CH	ChamP trap
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
	2C-2 (AA+TMA)
	3C (AA+Pt+TMA)
	CE Capilure
	AA Ammonium acetate
	PA Protein attractant
	Pt Putrescine
	TMA Trimethylamine
	TML Trimedlure

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

Trapping	Trap type <sup>1</sup>	Attractant	Trap density/km <sup>2</sup> <sup>(2)</sup>				Points of entry <sup>3</sup>
			Production area	Marginal	Urban		
Monitoring survey, no control	RB/RS/PALz/YP	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	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	BuH/AS	3–5	3–5	3–5	3–5	
Monitoring survey for eradication	RB/RS/PALz/YP	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	BuH/AS	1	0.4–3	3–5	4–12	
Delimitation survey in a PFA after detection in addition to detection survey <sup>4</sup>	RB/RS/PALz/YP	BuH/AS	20–50	20–50	20–50	20–50	

<sup>1</sup> Different traps can be combined to reach the total number.

<sup>(2)</sup> Refers to the total number of traps.

<sup>3</sup> Also other high-risk sites.

<sup>4</sup> This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type	Attractant
RB	AS Ammonium salt
RS	BuH Butyl hexanoate
PALz	
YP	

**Table 4f.** Trap densities suggested for *Toxotrypana curvicauda*

Trapping	Trap type <sup>1</sup>	Attractant	Trap density/km <sup>2</sup> <sup>(2)</sup>				Points of entry <sup>3</sup>
			Production area	Marginal	Urban		
Monitoring survey, no control	GS	MVP	0.25–0.5	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 <sup>4</sup>	GS	MVP	20–50	20–50	20–50	20–50

<sup>1</sup> Different traps can be combined to reach the total number.

<sup>(2)</sup> Refers to the total number of traps.

<sup>3</sup> Also other high-risk sites.

<sup>4</sup> This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones.

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

## 6. 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 by the manufacturer for an acceptable level of performance based on their anticipated use.

The effectiveness of trapping should be officially reviewed periodically by individuals not directly involved in conducting trapping activities. 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 penetration, 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.

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 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.

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. Maintenance of voucher specimens of collected species of regulated fruit fly species is recommended.

## 7. References

This listing is for reference purposes only and it is not comprehensive.

- 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. & Chambers, 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** DCON/CONASAG/SAGAR 1999. Apéndice Técnico para el Control de Calidad del Trámite para Moscas de la Fruta del Género *Anastrepha* spp. México D.F. febrero 1999. 15 p.
- Conway, H.E. & Forrester, O.T.** 2000. Comparison of Mexican fruit fly (Diptera: Tephritidae) capture between McPhail traps with Torula Yeast and Multilure Traps with Biolure in South Texas. *Florida Entomologist*, 83(3).
- Cowley, J.M., Page, F.D., Nimmo, P.R. & Cowley, D.R.** 1990. Comparison of the effectiveness of two traps for *Bactrocera tryoni* (Froggatt) (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. & Katsoyannos, 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 Tephritis fruit fly bait dispenser for use in fall 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 in Chios, Greece. In R. Cavalloro, ed. *Fruit flies of economic importance*. Proc. CFC/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, J.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. & Bondon, P.** 2007. Capture of *Anastrepha* species (Diptera: Tephritidae) with MixLure 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: 720–724.
- Robacker D.C. & Czajailo, 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: Tephritidae) 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 összehasonlítása 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 lehetőségek észlelései és rajzás követési 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 cseresznyeleget és az európai cseresznyeleget egyaránt fogó csapdatípusok. [Trap types catching both *Rhagoletis cingulata* and *R. cerasi* equally well.] *Agrofórum*, 19: 70–71.
- Wall, C.** 1989. Monitoring and spray timing. In A.R. Jutsum & R.I.C. Gordon, eds. *Insect pheromones in plant protection*, pp. 39–66. New York, Wiley. 39 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.** 1995. Comparison of two types of traps and lure dispensers for *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). *J. Austral. Ent. Soc.*, 34: 273–275.

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This appendix is for reference purposes only and is not a prescriptive part of the standard.

## APPENDIX 2: Guidelines for fruit sampling

Information about sampling is available in the references listed below. The list is not exhaustive.

- Enkerlin, W.R., Lopez, L. & Celedonio, H.** 1996. Increased accuracy in discrimination between captured wild unmarked and released dyed-marked adults in fruit fly (Diptera: Tephritidae) sterile release programs. *Journal of Economic Entomology*, 89(4): 946–949.
- Enkerlin W. & Reyes, J.** 1984. *Evaluacion de un sistema de muestreo de frutos para la detección de Ceratitis capitata (Wiedemann)*. 11 Congreso Nacional de Manejo Integrado de Plagas. Asociación Guatemalteca de Manejo Integrado de Plagas (AGMIP). Ciudad Guatemala, Guatemala, Centro America.
- Programa Moscamed.** 1990. *Manual de Operaciones de Campo*. Talleres Graficos de la Nacion. Gobierno de Mexico. SAGAR//DGSV.
- Programa regional Moscamed.** 2003. *Manual del sistema de detección para el muestreo de la mosca del mediterráneo*. 26 pp.
- Shukla, R.P. & Prasad, U.G.** 1985. Population fluctuations of the Oriental fruit fly, *Dacus dorsalis* (Hendel) in relation to hosts and abiotic factors. *Tropical Pest Management*, 31(4): 273–275.
- Tan, K.H. & Serit, M.** 1994. Adult population dynamics of *Actrocera dorsalis* (Diptera: Tephritidae) in relation to host phenology and weather in two villages of Penang Island, Malaysia. *Environmental Entomology*, 23(2): 267–275.
- Wong, T.Y., Nishimoto, J.I. & Mochizuki, N.** 1982. Inestation patterns of Mediterranean fruit fly and the Oriental fruit fly (Diptera: Tephritidae) in the Kula area of Maui, Hawaii. *Environmental Entomology*, 12(4): 1031–1036. IV. Chemical control.

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## **IPPC**

The International Plant Protection Convention (IPPC) is an international plant health agreement that aims to protect cultivated and wild plants by preventing the introduction and spread of pests. International travel and trade are greater than ever before. As people and commodities move around the world, organisms that present risks to plants travel with them.

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- ◆ There are over 180 contracting parties to the IPPC.
- ◆ Each contracting party has a national plant protection organization (NPPO) and an Official IPPC contact point.
- ◆ Nine regional plant protection organizations (RPPOs) work to facilitate the implementation of the IPPC in countries.
- ◆ IPPC liaises with relevant international organizations to help build regional and national capacities.
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