DRAFT REVISION OF ISPM 26: Establishment and maintenance of pest free areas for tephritid fruit flies (2021-010)

Status box

This is not an official part of the standard and it will be modified by the IPPC Secretariat after adoption.	
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Adoption

[Text to this paragraph will be added following adoption.]

INTRODUCTION

Scope

This standard provides requirements and guidance for the establishment and maintenance of pest free areas for economically important tephritid fruit flies.

If an exporting country has declared a fruit fly to be absent in an area in accordance with ISPM 8 (*Determination of pest status in an area*), then establishing a fruit fly pest free area (FF-PFA) in that area should not be required by importing countries – and hence this standard will not apply – unless there is technical justification.

Bibliography

References

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

Further reading

Information to support the implementation of this standard may be available on the IPP at https://www.ippc.int/en/about/core-activities/capacity-development/guides-and-training-materials/.

IPPC Secretariat. 2019. *Guide for establishing and maintaining pest free areas – Understanding the principal requirements for pest free areas, pest free places of production, pest free production sites and areas of low pest prevalence*. IPPC Secretariat. Rome, FAO. xviii + 107 pp. https://www.ippc.int/en/publications/90620/

Definitions

Definitions of phytosanitary terms used in this standard can be found in ISPM 5 (*Glossary of phytosanitary terms*). In addition to the definitions in ISPM 5, in this standard the following definitions apply.

fruit fly pest free area	An **area** where a **national plant protection organization** (**NPPO**) has declared that the target fruit fly is absent (in accordance with ISPM 8, including when the target fruit fly has been **eradicated** in accordance with ISPM 9 (*Guidelines for pest eradication programmes*)) and where the **NPPO officially** maintains the area as a **pest free area** in accordance with this **standard**. A fruit fly pest free area is a **phytosanitary measure**.
target fruit fly	The **pest** specified for a fruit fly pest free area, regardless of whether the fruit fly is one species or more. "Target fruit fly" does not include sterile fruit flies released in a **sterile insect technique** programme.
breeding population	A group of fruit flies of the same species that interbreed and are capable of producing viable offspring within an **area**. A detection of an immature life stage (egg, larva or pupa), a female with viable eggs, or a specified number of adults is evidence of a breeding population.
fruit	Fruit in the botanical sense, including fruits that are sometimes called vegetables (e.g. tomato, melon).

host material	Any part of a **plant** that fruit flies can **infest**.

Outline of requirements

This standard provides requirements for FF-PFAs as a phytosanitary measure that may be used to protect plant resources and facilitate safe trade. National plant protection organizations should consider an FF-PFA to be a phytosanitary measure that, when used alone, is sufficient for managing the pest risk posed by a target fruit fly.

This standard includes general requirements for FF-PFA programmes relating to resources and infrastructure, communication and engagement, review activities for programme improvement, and documentation and record-keeping for transparency. It also has specific requirements for NPPOs to follow when initiating an FF-PFA, establishing an FF-PFA, maintaining an FF-PFA and suspending, reinstating or withdrawing an FF-PFA.

BACKGROUND

This standard, which focuses specifically on the establishment and maintenance of pest free areas for fruit flies, supplements the more general requirements for pest free areas in ISPM 4 (*Requirements for the establishment of pest free areas*). The measures and specific phytosanitary procedures in this standard target the fruit flies of the economically important species of the order Diptera, family Tephritidae, such as the genera *Anastrepha*, *Bactrocera*, *Carpomya* (synonym *Myiopardalis*), *Ceratitis*, *Dacus*, *Euleia*, *Rhagoletis*, *Strauzia* and *Zeugodacus*.

Areas naturally free from fruit flies may remain free from fruit flies as a result of the presence of physical barriers, unsuitable climatic conditions or the absence of hosts. Other areas naturally free from fruit flies may need to be maintained free through restrictions on the movement of regulated articles and related measures (if fruit flies have the potential to establish there). Areas where fruit flies are present may be made free by an eradication programme (ISPM 9).

IMPACTS ON BIODIVERSITY AND THE ENVIRONMENT

This standard may contribute to the protection of biodiversity and the environment by preventing the introduction and spread of fruit flies that are regulated pests. However, eradicating or excluding fruit flies may also have unintended effects, such as removing an important food source for endemic natural enemies that may be present in the FF-PFA. When establishing and maintaining FF-PFAs, countries are encouraged to consider the environmental impacts of the measures they are choosing and to apply phytosanitary measures and procedures that minimize impact on biodiversity and the environment.

GENERAL REQUIREMENTS

When designating and maintaining an area as an FF-PFA, the NPPO of the exporting country should follow the requirements outlined in ISPM 4 as well as the requirements in this standard.

The decision to establish an FF-PFA may be made based on factors such as:

- the biology and ecology of the target fruit fly;
- the population density of the target fruit fly in the area;
- the dispersal pathways of the target fruit fly;
- the size of the area;
- the geographical isolation of the area;
- the effectiveness of available survey methods; and
- the availability of methods for eradication of the target fruit fly.

1. Resources and infrastructure

When establishing and maintaining an FF-PFA, the NPPO of the exporting country should ensure that it has in place, or has ready access to, adequate infrastructure and operational capability and resources to establish and maintain the FF-PFA. Operational capability includes trained personnel to collect and identify specimens of the target fruit fly in a timely manner.

In circumstances where an entity is authorized to undertake certain activities on behalf of an NPPO, (such as diagnosis, application of phytosanitary treatments, eradication activities), this should be done in accordance with ISPM 45 (*Requirements for national plant protection organizations if authorizing entities to perform phytosanitary actions*). Authorized entities should be audited in accordance ISPM 47 (*Audit in the phytosanitary context*).

2. Communication and engagement

An important factor determining the success of an FF-PFA programme is the support and participation of the public close to the area, especially the local community. This includes the producers in the area, individuals who travel to or through the area, and parties with direct or indirect interests. Public support is particularly important in areas where the risk of introducing the target fruit fly is higher. The NPPO of the exporting country may implement an ongoing public- and stakeholder-awareness programme. It may be helpful to inform the public and stakeholders using different media (e.g. written, radio, television, social media, internet). This could be on topics such as the importance of establishing and maintaining the FF-PFA, and the importance of avoiding introducing or reintroducing the target fruit fly through potentially infested host material. Public and stakeholder support is likely to lead to more compliance with the various measures used to establish and maintain the FF-PFA.

3. Review activities

The FF-PFA programme should comply with all sections of this standard and its annexes, including the sections on regulatory control (section 7.1), surveillance procedures (e.g. trapping, fruit sampling – see Annex 1) and corrective action planning (section 7.3).

Once the FF-PFA is established, the NPPO of the exporting country should regularly review the FF-PFA maintenance programme to verify its effectiveness. The review should allow the NPPO to find and correct any deficiencies and to update procedures to take account of any new and relevant information on the target fruit fly or associated pathways.

4. Documentation and record-keeping

The phytosanitary measures used to establish and maintain an FF-PFA should be adequately documented. They should be reviewed and updated regularly, and they should include corrective actions if required.

The records of surveys, detections and incursions should be retained for at least 24 months, depending on the biology of the target fruit fly.

SPECIFIC REQUIREMENTS

5. Initiating the establishment of a fruit fly pest free area

When initiating the establishment of an FF-PFA, the NPPO of the exporting country should:

- ensure that a regulatory framework is in place to establish and maintain the FF-PFA;
- describe and delimit the area proposed as an FF-PFA (maps or coordinates showing the boundaries, natural barriers, locations where goods, people or vehicles enter the area, locations of hosts (commercial and non-commercial) in the area and, where necessary, the buffer zone);

- specify the target fruit fly species, describe its biology and ecology (seasonal abundance, distribution, host sequence) within, and adjacent to, the proposed area, and identify valid diagnostic methods;
- list the hosts of the target fruit fly in the proposed area in accordance with the criteria outlined in ISPM 37 (*Determination of host status of fruit to fruit flies (Tephritidae)*);
- describe potential pathways of entry for the target fruit fly into the proposed area (e.g. movement of hosts and other regulated articles, natural spread); and
- describe the annual climatic conditions in the proposed area (e.g. temperature, rainfall, relative humidity, prevailing wind speed and direction) and the potential effect of these on the establishment and spread of the target fruit fly.

Additional information that may be useful while establishing the FF-PFA includes:

- historical records of detections of, and surveys for, the target fruit fly in the area proposed as an FF-PFA;
- the results of phytosanitary actions taken following detections of the target fruit fly in the area;
- knowledge about hosts in the area, such as their growth patterns in different seasons or under different climatic conditions;
- a map of areas that are at high risk of infestation by the target fruit fly at particular times of the year according to stages of fruit ripening;
- a list of the other fruit fly species that may be present in the area, regardless of economic importance, to assist with identification; and
- comparison with other similar FF-PFAs.

6. Establishment of the fruit fly pest free area

6.1 Surveillance for the establishment of the fruit fly pest free area

General surveillance may be sufficient in cases where the target fruit fly has never been introduced into the area proposed as an FF-PFA nor into the surrounding areas (because of, for example, natural barriers or environmental conditions), and there have been no records of the target fruit fly's presence in the area proposed as an FF-PFA.

Where this is not the case, the NPPO of the exporting country should conduct specific surveillance to confirm the status of the target fruit fly in the proposed FF-PFA. The surveillance should be conducted in accordance with Annex 1 and in accordance with the requirements for a detection survey programme in ISPM 6 (*Surveillance*). For species that respond strongly to attractants, trapping should be used to determine fruit fly presence or absence in the area with a specified level of confidence. Fruit sampling may be used to support the trapping programme, particularly if trapping is less effective (e.g. if the species responds weakly to attractants). In cases where other parts of the plant can be infested by the fruit fly (e.g. flowers), then these parts should be sampled. If the species does not respond to attractants, host-material sampling may be used instead of trapping. When specific surveillance is used during the establishment of the FF-PFA, it should be undertaken for a period determined by:

- the biology and the ecology of the target fruit fly;
- the climatic conditions in the area;
- the availability of host material (e.g. fruit, flowers); and
- the sensitivity of the survey method used (e.g. how effective a trapping network is at detecting the target fruit fly).

To conduct specific surveillance, the NPPO of the exporting country should have:

- personnel who are trained to collect samples (e.g. fruit, fruit flies) in a timely manner; and
- access to trained personnel and to laboratory facilities with the equipment needed to identify specimens of the target fruit fly in a timely manner.

6.2 Controls on the movement of regulated articles

Controls on the movement of regulated articles should be applied to prevent the target fruit fly entering and establishing in the area proposed as an FF-PFA. These controls depend on the assessed pest risk (after identification of pathways) and should include:

- regulation of the target fruit fly species;
- the establishment of domestic movement restrictions, phytosanitary import requirements, or other measures to control the movement of regulated articles into or through the area proposed as an FF-PFA;
- inspection of regulated articles and examination of the relevant documentation; and
- where necessary in cases of non-compliance, the implementation of an appropriate phytosanitary action (e.g. treatment, refusal, destruction).

6.3 Establishment of a buffer zone

If the geographical isolation of the area proposed as an FF-PFA is not adequate to prevent the natural spread of the target fruit fly into it, the NPPO of the exporting country should consider establishing a buffer zone. The population of the target fruit fly in the buffer zone should be maintained at or below the specified tolerance level, which should be verified by surveillance. The NPPO of the exporting country should describe, with supporting maps, the boundaries of the buffer zone. Factors that should be considered when determining the boundaries for the buffer zone include:

- the biology and ecology of the target fruit fly;
- the rate and range of dispersal of the target fruit fly;
- the population density of the target fruit fly in surrounding areas;
- the presence of natural enemies that could reduce the target fruit fly population;
- host availability, host phenology, cropping systems, natural vegetation;
- the climatic conditions;
- the geography;
- the likelihood of assisted spread through identified pathways and control options for these pathways;
- the implementation of a surveillance system; and
- pest-control strategies that may be used.

6.4 Criteria for the area to qualify as a fruit fly pest free area

For the area to qualify as an FF-PFA, there should be verifiable evidence, collected over a specified period, that the target fruit fly is not present in the area. The period should be specified based on scientific information, such as:

- trapping sensitivity;
- the number of offspring per female and number of generations in a year;
- environmental conditions, including temperature (e.g. using degree-day models); and
- the level of confidence required by the NPPO of the importing country.

Detections of sterile fruit flies do not affect the establishment of an FF-PFA, as they are not the “target fruit fly” (see Definitions).

6.5 Official designation of the fruit fly pest free area

The NPPO of the exporting country may designate the area as an FF-PFA when it has been established in accordance with this standard and a programme of maintenance is in place.

7. Maintenance of the fruit fly pest free area

The NPPO of the exporting country should develop and implement a programme to ensure maintenance of the FF-PFA. This programme should be risk-based and should incorporate at least the following elements:

- a regulatory framework to control the movement of regulated articles;
- surveillance and collection of relevant data to maintain the FF-PFA, including a framework for reporting detections of the target fruit fly; and
- a corrective action plan, with associated provisions for suspension and reinstatement of the FF-PFA in accordance with this standard.

7.1 Controls on the movement of regulated articles

Controls on the movement of regulated articles are the same as for the establishment of the FF-PFA (see section 6.2).

7.2 Surveillance for maintaining the fruit fly pest free area

After establishing the FF-PFA, the surveillance programme should be continued at a level assessed as providing sufficient confidence that the FF-PFA is being maintained. Surveillance records should be well maintained. Reports on surveillance activities should be made available to the NPPOs of relevant importing countries on request.

For more information on surveillance, see section 6.1 and Annex 1.

7.3 Corrective action plan

The NPPO of the exporting country should prepare a corrective action plan for incursions, interceptions and maintenance issues. The plan should be implemented if the target fruit fly is detected in the FF-PFA, if the target fruit fly is intercepted in host material from the FF-PFA (see Annex 2), or if procedures are found to be inadequate to maintain the FF-PFA. This plan should cover:

- when the FF-PFA – the whole area or a part of it – should be suspended;
- notifying affected parties and NPPOs that the entire FF-PFA or a part of the FF-PFA has been suspended (in accordance with ISPM 17 (*Pest reporting*));
- the appropriate response to an incursion, depending on the biology and ecology of the target fruit fly and the characteristics of the FF-PFA (in whole or part), including:
    - where possible, identifying and addressing the cause of the incursion,
    - determining the extent of the infested area with delimiting surveys (trapping and host-material sampling) and determining whether the target fruit fly has established a population,
    - eradicating the fruit fly (see Annex 3),
    - if a breeding population is found, increasing surveillance to determine the effectiveness of eradication measures in the infested area and any buffer zone and hence whether the FF-PFA may be reinstated,
    - imposing movement controls on host material,
    - communicating and engaging with affected stakeholders; and
- the appropriate responses to interceptions of the target fruit fly in consignments originating from the FF-PFA, including:
    - where possible, identifying the cause of the interception (traceback investigation) and addressing it.

The corrective action plan may include interim measures proportionate to the number of detections in a specified period, agreed between relevant NPPOs to enable the continuation of trade. In some cases, the NPPO of the exporting country may consider that the target fruit fly is unable to establish a permanent

breeding population within the FF-PFA, for example if the fruit fly would normally die off in winter and a breeding population is found shortly before winter. In such cases, the relevant NPPOs may agree that no action is needed, unless a scientific assessment shows that the presence of the target fruit fly poses an unacceptable risk to trade.

The corrective action plan should be initiated as soon as possible after the confirmed identification of the target fruit fly.

8. Suspension, reinstatement or withdrawal of the fruit fly pest free area

8.1 Suspension

The FF-PFA should be suspended, in whole or in part, when the presence of a breeding population of the target fruit fly is determined based on one of the following triggers:

- detection of an immature life stage;
- detection of a female with viable eggs;
- detection of a specified number of adults (not including sterile adults); or
- interception in consignments originating from the FF-PFA.

The number of captured adults required to indicate the presence of a breeding population may be determined in advance by the NPPO of the exporting country. This number will depend on the biology and ecology of the target fruit fly, the trapping sensitivity (determined by the trapping density and the response of the target fruit fly to attractants), the distance and time between detections, the climate, the season, and the geographical location. Other information obtained, such as from modelling, may also be used to help determine whether a breeding population is present.

The FF-PFA should also be suspended, in whole or in part, if procedures have been implemented incorrectly (e.g. inadequate measures, such as trapping, movement controls or treatments, required to manage the target fruit fly within the FF-PFA).

If there is a detection, the corrective action plan should be implemented as specified in this standard (see Annex 2). If the presence of a breeding population that poses a risk to trade is confirmed, the NPPOs of relevant importing countries should be notified in accordance with ISPM 17. If the FF-PFA has been suspended, the notification should include criteria for lifting the suspension.

8.2 Reinstatement

Reinstatement of the FF-PFA should be based on the same requirements as for establishment (section 6), with the following conditions:

- there has been no further detection of the target fruit fly (other than sterile fruit flies) in the suspended area for a specified period; and
- in the case of a fault in the procedures, the fault has been corrected, and the consequences have been mitigated.

The period should consider the biology and ecology of the species, the prevailing environmental conditions, and the effectiveness of the surveillance system (see Annex 1).

The NPPO of the exporting country should notify the NPPOs of relevant importing countries when the FF-PFA has been reinstated, in accordance with ISPM 17.

8.3 Withdrawal

If the target fruit fly becomes established in the whole or a part of the FF-PFA, and if eradication is no longer pursued, the NPPO of the exporting country should either withdraw the whole FF-PFA or change its boundaries to remove the affected part of it.

In this event, the NPPO of the exporting country should notify the NPPOs of relevant importing countries, in accordance with ISPM 17, as well as domestic stakeholders.

This annex is a prescriptive part of the standard.

ANNEX 1: Specific surveillance for fruit flies (trapping and host-material sampling)

This annex contains general information on specific surveillance for fruit flies.

Trapping using attractants (such as lures) is generally the most effective surveillance method. However, some target fruit flies are not lure-responsive or only weakly lure-responsive.

Trapping should only be used as the sole method for fruit fly surveys if it can provide confidence that an FF-PFA is free from breeding populations, if it can rapidly detect any new breeding populations, and if it can support incursion response and the reinstatement of the FF-PFA when needed. If trapping does not provide sufficient confidence, it may be combined with host-material sampling. Host-material sampling may be used on its own if trapping is not an option.

1. Trapping procedures

Trapping procedures should contain enough information to give confidence that when the procedures are followed, the trapping network will work as designed. Factors to consider when developing procedures include:

- the biology and ecology of the target fruit fly;
- the conditions in the survey area (e.g. climate, environment, geography);
- the trap types and attractants;
- the trap density (number of traps per unit area), distribution and rotation between hosts;
- the presence of hosts of the target fruit fly;
- trap servicing (maintaining the traps);
- trap examination and specimen collection;
- record-keeping (including records of trap locations, examinations, and specimen collections);
- the diagnostic capacity and capability of the NPPO to identify target fruit fly species; and
- quality assurance for all procedures.

1.2 Traps and attractants

The type of trap selected should be appropriate for the target fruit fly, the environmental conditions, and the nature of the attractant.

When trapping multiple species of fruit fly, more than one attractant may be used. However, the potential for interference and cross-contamination between attractants, and the consequential reduction in trap effectiveness, should be considered.

1.3 Trap density

Trap density (number of traps per unit area) is a critical factor for effective fruit fly surveys. Trap density should be based on:

- the effectiveness of the trap (including attractant) at detecting the target fruit fly;
- host-cultivation practices;
- the availability of resources;
- the geography of the area;
- the climate;
- the time of year;
- existing pest-management practices; and
- any other factors that may affect the effectiveness of the survey.

Trap density may change depending on the phase of the FF-PFA programme, with the density required during the establishment phase being different to that required during the maintenance phase.

1.4 Trap deployment

Traps should be placed where they are most likely to detect a breeding population. Trap locations should be focused on places that are favourable to fruit fly breeding and potential incursions. The exact placement of traps within a network should be guided by:

- the climate, environment, geography and accessibility of the area;
- host presence and distribution;
- commercial crop-management practices; and
- the biology and ecology of the target fruit fly.

Trap locations, including rotation between hosts, should align with the sequence of fruit maturity in those hosts. In commercial-production areas, producers should take into account the location of traps when undertaking pest management, such as when applying pesticides (or other chemicals). The NPPO should also consider commercial pest-management practices when interpreting the results of the trapping programme and consider whether these practices are causing false-negative results.

Where feasible, the geographical coordinates of deployed traps should be recorded to help manage the trapping network.

1.5 Trap servicing

The frequency of trap servicing (maintaining traps and refreshing the lures or baits) should be determined according to:

- the longevity of the attractants (attractant persistency) and killing agents;
- the number of fruit flies the trap can hold;
- the rate of catch of target and non-target species;
- the placement of the traps;
- the biology and ecology of the target fruit fly;
- economic considerations; and
- environmental conditions.

The traps should be replaced when damaged.

When servicing traps, measures should be taken to avoid cross-contamination between different attractant types (e.g. cue-lure and methyl eugenol). Cross-contamination may reduce trap effectiveness and may delay corrective actions. Some attractants are highly volatile and care should be taken when storing, packaging, handling and disposing of attractants to avoid compromising the attractant effectiveness and operator safety. The used traps should be collected, checked and then disposed of securely.

1.6 Examining traps for fruit flies

The frequency with which traps are examined for the presence of fruit flies should be determined and adjusted according to:

- the prevailing environmental conditions;
- the likely catch rate; and
- the biology and ecology of the target fruit fly.

2. Host-material sampling procedures

To maximize the ability to detect breeding populations, procedures for sampling hosts as part of a target fruit fly survey should take into consideration:

- host status determination (in accordance with ISPM 37);
- factors related to the preferred hosts of the target fruit fly:
  - rate of infestation,
  - the effect of fruit maturity on infestation,
  - the signs or symptoms of infestation of host material;
- areas likely to be at risk of infestation:
  - backyards and gardens,
  - abandoned places of production,
  - host-waste collection sites,
  - fruit markets,
  - host packing, storage, processing and treatment facilities,
  - sites with a high concentration of cultivated or wild hosts,
  - where appropriate, locations where goods, people or vehicles enter the FF-PFA; and
- the sample size and selection, including consideration of:
  - the required level of statistical confidence,
  - the availability of hosts in the survey area,
  - the sampling of hosts with symptoms of fruit fly damage (e.g. fruit rejected at packing facilities), where appropriate.

3. Handling host samples and identification of fruit fly species

Samples of host material and the contents of traps should be labelled, transported and held in a secure manner to avoid mixing up host material or specimens and to protect the physical integrity of the contents. Samples of host material should be handled, transported and held in suitable conditions to maintain the viability of all immature stages of fruit flies in infested host material for identification.

Samples of host material collected in the field and specimens from traps should be taken to a secure facility for fruit flies to be recovered and the species identified. Host samples may be dissected, mashed up or sieved immediately or they may be maintained until identifiable fruit fly life stages develop.

Information about the sample taken should be recorded, such as:

- the date and location the sample was taken;
- the type of sample taken (host material or trap sample);
- the type of trap and type of attractant, if applicable;
- the number, sex and developmental stage of fruit fly individuals;
- host information (species and number of host plants);
- the condition of the sample (fresh or decayed);
- the name and contact details of the person who collected the sample; and
- any other relevant observations (e.g. trap density, quantity of samples, frequency of result).

Specimens can be identified using molecular techniques at any life stage, depending on the species, or they can be reared to adults and then identified using morphological techniques. Immature stages should be reared until they reach a life stage that allows for identification with the technology available to the NPPO (molecular or morphological).

Diagnostic protocols adopted as annexes to ISPM 27 (*Diagnostic protocols for regulated pests*) are available for pest diagnosis.

Once the results have been recorded, samples and specimens should be disposed of securely.

4. Quality assurance of trapping and host-material sampling

The NPPO of the exporting country may establish a quality-assurance strategy for the survey to confirm and document that all trapping and host-material sampling protocols have been met. The key elements of the quality-assurance strategy may include verification of ingredients in attractants and their effectiveness, placement and recovery of sterile fruit flies to assess trap effectiveness, regular reviews of survey documentation, audits of trap placement and servicing and of host-material sampling, and confirmation of diagnostic competency.

This annex is a prescriptive part of the standard.

ANNEX 2: Corrective action plans

1. General considerations

If the target fruit fly is detected either in an FF-PFA or in host material from that area, the NPPO of the exporting country should implement a corrective action plan. However, no action is required if the detection is solely of sterile fruit flies.

If the target fruit fly that has been detected is not able to establish a permanent population (pest status "present: transient" according to ISPM 8), then it may not be necessary to take any action. However, if the presence of the target fruit fly poses an unacceptable risk to trade, a delimiting survey should be conducted immediately after the detection.

Once it is determined that the detection represents a breeding population, the objective of the corrective action plan should be to eradicate the target fruit fly to enable reinstatement of the FF-PFA.

The corrective action plan should consider:

- the biology and ecology of the target fruit fly;
- the prevailing environmental conditions in the FF-PFA (e.g. climate, geography);
- the distribution of the target fruit fly within the FF-PFA; and
- the distribution of hosts within the FF-PFA.

For more information, see ISPM 9.

Before implementing the corrective action plan, the NPPO of the exporting country should ensure that the following elements are in place:

- a regulatory framework under which the corrective action plan can be implemented;
- technical criteria for the determination of a breeding population;
- technical criteria for:
  - the selection of survey (trapping or host-material sampling) parameters,
  - the application of corrective actions for eradication,
  - the establishment of regulatory measures;
- the availability of sufficient operational resources and expertise;
- pest diagnostic capacity and capability to identify the target fruit fly; and
- effective communication within the NPPO of the exporting country and with the NPPOs of importing countries.

2. Actions to implement the corrective action plan

2.1 Determination of the pest status upon detection

If the detection of the target fruit fly could constitute a breeding population that is not transient (i.e. one of the other "present" categories described in ISPM 8), a delimiting survey should be conducted immediately after detection. The delimiting survey may include placement of additional traps and an increased frequency of trap examination and host-material sampling activities.

The outcome of the delimiting survey will determine necessary corrective actions. In cases where an established population is present, the delimiting survey is also used to determine the size of the infested area for eradication of the target fruit fly.

2.2 Suspension or withdrawal of the fruit fly pest free area

If a breeding population has established (i.e. if any of the triggers specified in sections 8.1 or 8.3 of the core text of this standard have been reached), the affected area should be either suspended or withdrawn from the FF-PFA. The affected area – including the infested area and, where necessary, a buffer zone – may be the whole FF-PFA or part of it. In most cases, the affected area may be delimited by applying a suspension radius that depends on the biology and ecology of the target fruit fly. The same radius may apply for all FF-PFAs for a given target fruit fly unless scientific evidence supports a deviation.

2.3 Application of control measures in the affected area

Specific corrective actions to eradicate the target fruit fly from the affected area should be applied immediately and adequately communicated to stakeholders. These actions may include one or more of the following:

- harvest and destruction, treatment or removal of host fruit;
- removal of fallen host fruit;
- destruction of other host material (e.g. flowers);
- soil treatment (chemical or physical);
- insecticide application, including selective insecticide bait treatments;
- biological controls;
- male annihilation technique;
- sterile fly release; or
- mass trapping.

Phytosanitary measures should be immediately enforced to control the movement of regulated articles that can host the target fruit fly. These measures may include, as appropriate, host disinfestation and the operation of roadblocks to prevent the movement of infested host material from the affected area to the rest of the FF-PFA. Other measures may be applied, such as increased surveys, supplementary trapping or phytosanitary treatment of host consignments from the affected area. Interim measures (e.g. phytosanitary treatments, systems approaches) may be agreed with importing countries before a breeding population occurs within the FF-PFA to minimize disruption to trade.

Details about control measures for a breeding population within an FF-PFA are given in Annex 3.

2.4 Criteria for reinstatement of the fruit fly pest free area and actions to be taken

The criteria for determining that eradication from the affected area has been successful are specified in section 8.2 of the core text of this standard and should be included in the corrective action plan for the target fruit fly. The length of time before eradication may officially be declared successful depends on the biology and ecology of the species, the prevailing environmental conditions, and the effectiveness of the surveillance used to detect the target fruit fly. Once the criteria have been fulfilled, the NPPO of the exporting country should reinstate the FF-PFA and surveillance levels for the maintenance of the FF-PFA.

2.5 Reporting of changes in the fruit fly pest free area

The NPPO of the exporting country should continue to inform all affected parties of changes to the FF-PFA, as appropriate. This includes the NPPOs of relevant importing countries, entities authorized to undertake relevant activities on behalf of the NPPO of the exporting country (see ISPM 45), and domestic stakeholders. Pest reporting obligations should be observed (see ISPM 17).

This annex is a prescriptive part of the standard.

ANNEX 3: Control measures when a breeding population is detected within a fruit fly pest free area

The objective of the control measures should be to eradicate the population of the target fruit fly and reinstate the FF-PFA, protect the FF-PFA surrounding the affected area, and meet the phytosanitary import requirements of importing countries. The area in which the control measures will be applied is known as the "eradication area". Control measures are needed because movements of regulated articles out of and through an eradication area pose a risk of spreading the target fruit fly.

If eradication is not possible, then either the whole FF-PFA should be withdrawn or its boundaries should be changed to remove the affected part of it.

1. Initiation of an eradication area

The eradiation area should be larger than the infested area.

The size of the eradication area (see Figure 1) should be based on a technical evaluation and that part of the FF-PFA should be suspended until successful eradication has been demonstrated.

A boundary delimiting the minimum size of the eradication area should be drawn, centred on the actual detected population of the target fruit fly and with a radius large enough to cover the area suspected to be infested and some distance beyond, as determined by the NPPO of the exporting country. In the case of several population detections, several (possibly overlapping) boundaries may 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 adjust the eradication area to correspond to administrative boundaries or topography.

A map with geographical coordinates should 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 raise public awareness.

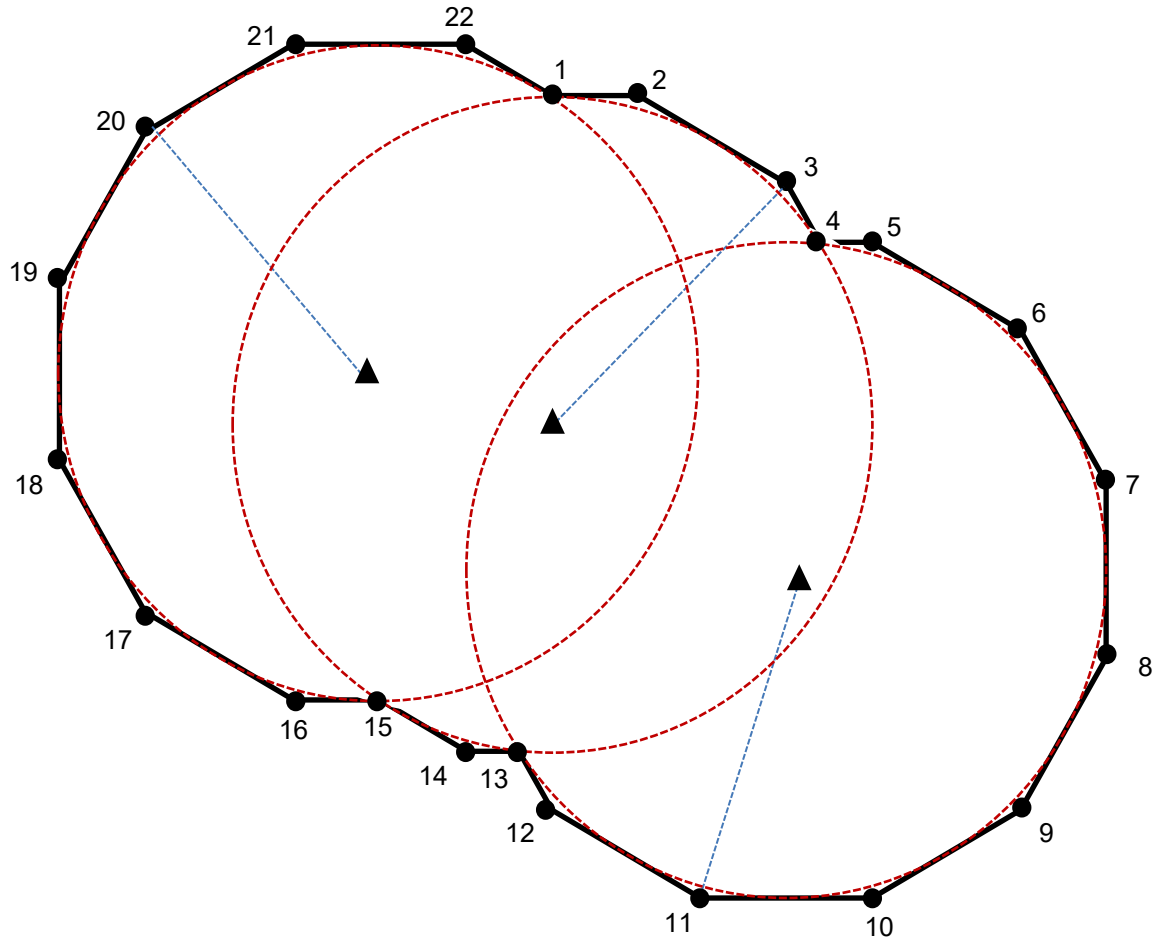

Figure 1. Example of circles delimiting the eradication area around three detected pest populations.

Notes: The centres of three detected fruit fly populations are marked by triangles (▲), with a delimiting circle (red dotted lines) around each one. The solid circles (●) and associated numbers indicate places with geo-referenced coordinates, and the black line is the boundary of the entire eradication area.

2. Control measures

Each stage of the production chain (e.g. growing, sorting, packing, transporting, distribution) may lead to the target fruit fly entering the FF-PFA from the eradication area. Appropriate control measures should be applied to manage the pest risk to the surrounding FF-PFA and any importing countries.

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 the application of control measures to avoid infestation, such as mechanical and cultural controls (e.g. removal and destruction of host fruit, soil swamping and ploughing), chemical treatment of soil, fruit bagging, insecticide baits, bait stations, male annihilation technique, mass trapping, sterile insect technique, biological control.

2.2 Movement of regulated articles

To prevent the spread of the target fruit fly, regulated articles (e.g. host fruit, soil, contaminated equipment and waste) being moved from, through or within the eradication area should be transported in a way that prevents infestation and contamination. For example, packhouses could be required to bag fruit; transporters could be required to use insect proofing, cover the load or use fully enclosed transport. This also pertains to moving regulated articles for phytosanitary certification.

2.3 Packing, storage, processing and treatment facilities

Facilities for packing, storing, processing or treating fruit fly host material may be located within the eradication area or in the FF-PFA. Control measures to prevent the target fruit fly entering the FF-PFA from the eradication area should be considered for each type of facility. The NPPO of the exporting country should have a clear overview of all facilities located within the FF-PFA and eradication area. The NPPO should require that all facilities within the FF-PFA and eradication area are registered and audited. The NPPO should also require the facilities to have appropriate control measures in place to do the following:

- maintain traceability of host material;
- prevent the target fruit fly from entering or escaping the facility;
- monitor regularly for the presence or absence of the target fruit fly in and around the facility;
- eliminate fruit flies if detected in and around the facility;
- prevent mixing of host material originating from areas of different pest status (e.g. by consignment segregation, insect proofing to prevent contamination);
- securely dispose of rejected host material; and
- ensure that any packaging, containers and conveyances are insect-proof and clean.

2.4 Sale inside the eradication area

Host material sold within the eradication area may be at 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 to avoid spread of the target fruit fly while on display and being stored. If at risk of infestation and not physically protected, the host material should not be moved outside the eradication area after being exposed.

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) and these records should be retained for at least 24 months. Such documents should be made available to the NPPOs of relevant importing countries on request.

4. Termination of control measures in the eradication area

To be considered successful, eradication of the target fruit fly in the eradication area should meet the requirements for reinstatement of the FF-PFA after a breeding population is detected, in accordance with this standard (see section 8.2 of the core text of this standard).

Any control measures that could interfere significantly with the effectiveness of the surveillance network should be removed for a specified period before eradication is declared. The other control measures should remain in force until eradication is declared. If eradication is successful, the control measures in the eradication area may be terminated and the FF-PFA may be reinstated. If eradication is unsuccessful, then either the whole FF-PFA should be withdrawn or its boundaries should be changed to remove the affected part of it. The NPPOs of relevant importing countries should be notified, as well as other affected parties.

ATTACHMENTS

Guidance material for further reading

It is intended that Annex 3, Appendix 1 and Appendix 2 of ISPM 26 as adopted in 2015 are moved to guidance material so that they can be updated more easily. To ensure that this information is not lost in the interim period, it is provided as attachments to this standard. Once the information has been updated and made available as guidance material, these attachments will be removed from this standard.

This attachment is for reference purposes only and is not a prescriptive part of this standard.

ATTACHMENT 1: Phytosanitary procedures for fruit fly management (formerly Annex 3 of ISPM 26, adopted in 2015)

This annex provides guidance 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 FF-PFAs (this standard), and to develop a systems approach for fruit flies, which may include the establishment and maintenance of fruit fly areas of low pest prevalence (FF-ALPPs) (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 35)
- implement a corrective action in an FF-ALPP when the specified level of low pest prevalence has been exceeded (ISPM 22; ISPM 35)
- 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 fruit fly species that is a quarantine pest 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. 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 risk 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, pest free places of production and pest free 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 larvae 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 anoxia) or ploughing (causing physical damage, desiccation to the pupae and exposing them to natural enemies).

3.2 Insecticide bait application technique

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.

3.2.1 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 GIS software in order to ensure the efficient application of bait sprays and reduce the environmental impact.

To treat the target area, insecticide bait may not need to be applied as full coverage but only in some swathes, such as every second or third swathe. 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 FF-PFAs 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, 2017).

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 a high density to suppress fruit fly populations. In general, mass trapping procedures are the same as for trapping used for survey purposes (Appendix 1 of this standard). 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

The SIT is a species-specific environmentally friendly technique that can provide effective control of target fruit fly populations (FAO, 2017).

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 and 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, 2017).

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 low 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, 2017).

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 release 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 (see details in Annex 1 of this standard).

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 24 months.

6. References

FAO/IAEA (International Atomic Energy Agency)**. 2017.** *Guideline for packing, shipping, holding and release of sterile flies in area-wide fruit fly control programmes*, Second edition, by Zavala-López J.L. and Enkerlin W.R. (eds.). Rome, Italy. 140 pp.

FAO/IAEA (International Atomic Energy Agency)/**USDA** (United States Department of Agriculture)**.** 2014. *Product quality control for sterile mass-reared and released tephritid fruit flies*. Version 6.0. Vienna, IAEA. 164 pp.

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

ATTACHMENT 2: Fruit fly trapping (formerly Appendix 1 of ISPM 26, adopted in 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 area, which can be an infested area, an FF-ALPP, or an FF-PFA. It describes the most widely used traps, including materials such as trapping devices and attractants, and trap densities, as well as procedures including evaluation, data recording and analysis.

Additional information about fruit fly trapping is available in the following publication of the Food and Agriculture Organization of the United Nations (FAO) and the International Atomic Energy Agency (IAEA) (in English only):

FAO/IAEA (International Atomic Energy Agency). 2018. *Trapping guidelines for area-wide fruit fly programmes*, 2nd edn, eds W.R. Enkerlin & J. Reyes-Flores. Rome, FAO. 65 pp. Available at https://www.iaea.org/about/insect-pest-control-section (last accessed 1 October 2018).

Diagnostic protocols adopted as annexes to ISPM 27 (*Diagnostic protocols for regulated pests*) may be useful tools to diagnose the adult fruit fly specimens.

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 being applied.

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

The three types of surveys and corresponding objectives are:

- **monitoring surveys**, conducted to verify the characteristics of the pest population
- **delimiting surveys**, conducted to establish the boundaries of an area considered to be infested by or free from the pest
- **detection surveys**, conducted 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 surveys are necessary for situations A, B and C. Delimiting surveys are conducted 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) (Annex 1 of ISPM 35) and as part of a corrective action plan when the pest exceeds the established low pest prevalence level or in an FF-PFA (situation E) as part of a corrective action plan when a detection occurs. Detection surveys are conducted 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 (*Determination of pest status in an area*)).

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 to an FF-ALPP (situation B and C) or an FF-PFA (situation D).
- Pest absent. Starting from an FF-PFA (situation D), either the pest status is maintained or a detection occurs (situation E), where measures aimed at restoring the FF-PFA would be applied.

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 and data analysis. Traps for fruit fly surveys use the following materials, as appropriate:

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

3.1 Attractants

Some fruit fly species of economic importance and the attractants commonly used to capture them are presented in Table 1. The presence or absence of a species from this table does not indicate that pest risk analysis has been performed and in no way is presence or absence 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

Species	Attractant
Anastrepha fraterculus (Wiedemann)[4]	Protein attractant (PA)
Anastrepha grandis (Macquart)	PA
Anastrepha ludens (Loew)	PA, 2C-1[1]
Anastrepha obliqua (Macquart)	PA, 2C-1[1]
Anastrepha serpentina (Wiedemann)	PA
Anastrepha striata (Schiner)	PA
Anastrepha suspensa (Loew)	PA, 2C-1[1]
Bactrocera carambolae (Drew & Hancock)	Methyl eugenol (ME)
Bactrocera caryeae (Kapoor)	ME
Bactrocera correcta (Bezzi)	ME
Bactrocera dorsalis (Hendel)[4]	ME, 3C[2]
Bactrocera kandiensis (Drew & Hancock)	ME
Bactrocera musae (Tryon)	ME
Bactrocera occipitalis (Bezzi)	ME
Bactrocera umbrosa (Fabricius)	ME
Bactrocera zonata (Saunders)	ME, 3C[2], ammonium acetate (AA)
Bactrocera cucurbitae (Coquillett)	Cuelure (CUE), 3C[2], AA
Bactrocera neohumeralis (Hardy)	CUE
Bactrocera tau (Walker)	CUE
Bactrocera tryoni (Froggatt)	CUE
Bactrocera minax (Enderlein)	PA
Bactrocera cucumis (French)	PA

Species	Attractant
Bactrocera jarvisi (Tryon)	PA, zingerone
Bactrocera latifrons (Hendel)	PA
Bactrocera oleae (Gmelin)	PA, ammonium bicarbonate (AC), spiroketal (SK)
Bactrocera tsuneonis (Miyake)	PA
Ceratitis capitata (Wiedemann)	Trimedlure (TML), Capilure (CE), PA, 3C[2], 2C-2[3]
Ceratitis cosyra (Walker)	PA, 3C[2], 2C-2[3]
Ceratitis rosa (Karsch)	TML, PA, 3C[2], 2C-2[3]
Dacus ciliatus (Loew)	PA, 3C[2], AA
Myiopardalis pardalina (Bigot)	PA
Rhagoletis cerasi (Linnaeus)	Ammonium salts (AS), AA, AC
Rhagoletis cingulata (Loew)	AS, AA, AC
Rhagoletis indifferens (Curran)	AA, AC
Rhagoletis pomonella (Walsh)	Butyl hexanoate, AS
Toxotrypana curvicauda (Gerstaecker)	2-Methyl-vinylpyrazine

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

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

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

[4] 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 pheromones or male lures that are male-specific. The male lure trimedlure (TML) captures species of the genus *Ceratitis* (including *C. capitata* and *C. rosa*). The male lure methyl eugenol (ME) captures a large number of species of the genus *Bactrocera* (including *B. carambolae, B. dorsalis, B. musae,* and *B. zonata*). The pheromone spiroketal captures *B. oleae*. The male lure cuelure (CUE) captures a large number of other *Bactrocera* species, including *B. cucurbitae* and *B. tryoni*. Male lures 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 male lures.

3.1.2 Female-biased attractants

Female-specific pheromones 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 (PAs) have been used to capture a wide range of fruit fly species. Liquid PAs capture both females and males. These liquid PAs are generally less sensitive than the male lures. In addition, liquid PAs 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. These 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 *Anastrepha* species the trimethylamine component may be removed. A synthetic attractant lasts approximately four to ten weeks, depending on climatic conditions. It captures few non-target insects and significantly fewer male than female fruit flies, making this attractant suited for use in sterile fruit fly release programmes. New synthetic food attractant technologies are available,

including the long-lasting three-component and two-component mixtures contained in the same patch, as well as the three component mixture incorporated in a single cone-shaped plug.

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 PAs.

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

Fruit fly species	Attractant and trap																									
	TML/CE											ME								CUE							
	CC	CH	ET	JT	LT	MM	ST	SE	TP	YP	VARs+	CH	ET	JT	LT	MM	ST	TP	YP	CH	ET	JT	LT	MM	ST	TP	YP
Anastrepha fraterculus																											
Anastrepha ludens																											
Anastrepha obliqua																											
Anastrepha striata																											
Anastrepha suspensa																											
Bactrocera carambolae												x	x	x	x	x	x	x	x								
Bactrocera caryeae												x	x	x	x	x	x	x	x								
Bactrocera minax																											
Bactrocera correcta												x	x	x	x	x	x	x	x								
Bactrocera cucumis																											
Bactrocera cucurbitae																				x	x	x	x	x	x	x	x
Bactrocera dorsalis												x	x	x	x	x	x	x	x								
Bactrocera kandiensis												x	x	x	x	x	x	x	x								
Bactrocera latifrons																											
Bactrocera occipitalis												x	x	x	x	x	x	x	x								
Bactrocera oleae																											
Bactrocera tau																				x	x	x	x	x	x	x	x
Bactrocera tryoni																				x	x	x	x	x	x	x	x
Bactrocera tsuneonis																											
Bactrocera umbrosa												x	x	x	x	x	x	x	x								
Bactrocera zonata												x	x	x	x	x	x	x	x								
Ceratitis capitata		x	x	x	x	x	x	x	x	x	x																
Ceratitis cosyra																											
Ceratitis rosa		x	x	x	x	x	x	x	x	x	x																
Dacus ciliatus																											
Myiopardalis pardalina																											
Rhagoletis cerasi																											
Rhagoletis cingulata																											
Rhagoletis indifferens																											
Rhagoletis pomonella																											

Fruit fly species	Attractant and trap																								
	TML/CE											ME								CUE							
	CC	CH	ET	JT	LT	MM	ST	SE	TP	YP	VARs+	CH	ET	JT	LT	MM	ST	TP	YP	CH	ET	JT	LT	MM	ST	TP	YP
Toxotrypana curvicauda																											

Attractant abbreviations

CE	Capilure
CUE	Cuelure
ME	Methyl eugenol
TML	Trimedlure

Trap abbreviations

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

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

Fruit fly species	Attractant and trap (see below for abbreviations)																									
	3C							2C-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	CH	YP	RB	RS	YP	PALz	RS	YP	PALz	GS
Anastrepha fraterculus															x	x										
Anastrepha grandis															x	x										
Anastrepha ludens													x		x	x										
Anastrepha obliqua													x		x	x										
Anastrepha striata															x	x										
Anastrepha suspensa													x		x	x										
Bactrocera carambolae															x	x										
Bactrocera caryeae															x	x										
Bactrocera minax															x	x										
Bactrocera correcta															x	x										
Bactrocera cucumis															x	x										
Bactrocera cucurbitae			x												x	x										
Bactrocera dorsalis															x	x										
Bactrocera kandiensis															x	x										
Bactrocera latifrons															x	x										
Bactrocera occipitalis															x	x										
Bactrocera oleae														x	x	x	x	x			x	x				
Bactrocera tau															x	x										
Bactrocera tryoni															x	x										
Bactrocera tsuneonis															x	x										
Bactrocera umbrosa															x	x										
Bactrocera zonata			x												x	x										
Ceratitis capitata	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x										
Ceratitis cosyra			x						x						x	x										
Ceratitis rosa		x	x						x						x	x										
Dacus ciliatus			x												x	x										

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	CH	YP	RB	RS	YP	PALz	RS	YP	PALz	GS
Myiopardalis pardalina															x	x										
Rhagoletis cerasi																			x	x	x	x	x	x	x	
Rhagoletis cingulata																					x	x		x	x	
Rhagoletis indifferens																				x	x					
Rhagoletis pomonella																			x		x	x	x			
Toxotrypana curvicauda																										x

Attractant abbreviations

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

Trap abbreviations

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

Table 3. List of attractants and field longevity

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

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

3.2 Killing and preserving agents

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

In other traps, liquid is the killing agent. When liquid PAs are used, borax to 3% concentration is mixed in to preserve the captured fruit flies. Some PAs 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) trap, ChamP (CH) trap, Jackson trap (JT) or Delta trap, Lynfield trap (LT), open bottom dry trap (OBDT) or Phase IV trap, red sphere (RS) trap, Steiner trap (ST), and yellow panel (YP) trap and Rebell (RB) trap.
- **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 (McP) 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 (ET), Multilure trap (MLT) and Tephri (TP) trap.

3.3.1 Cook and Cunningham trap

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 that allow air to circulate. The trap is used with a polymeric panel containing an olfactory attractant (usually TML), which is placed between the two outer panels. The polymeric panels come in two sizes – standard and half. The standard panel (15.2 cm × 15.2 cm) contains 20 g TML, while the half size panel (7.6 cm × 15.2 cm) contains 10 g. The entire unit is held together with clips and is suspended in the tree canopy with a wire hanger.

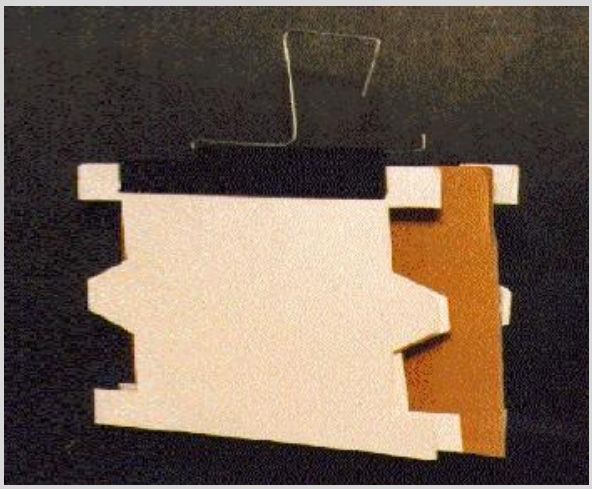

Figure 1. Cook and Cunningham (C&C) trap.

Use

As a result of the need for economical highly sensitive delimiting trapping of *C. capitata*, polymeric panels were developed for the controlled release of greater amounts of TML. These keep 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.

3.3.2 ChamP trap

Description

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

Figure 2. ChamP trap.

Use

The CH trap can accommodate patches, polymeric panels, and plugs. It is equivalent to a YP trap and 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 Table 4 (b and c).

3.3.3 Easy trap

Description

The ET is a two-part rectangular plastic container with an inbuilt hanger. It is 14.5 cm high, 9.5 cm wide and 5 cm deep and can hold 400 ml of solution (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 male lure and food-based attractants.

Figure 3. Easy trap.

Use

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

The ET is one of the most economical traps commercially available. It is easy to carry, handle and service, providing the opportunity to service a greater number of traps per person-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.

3.3.4 Fluorescent yellow sticky "cloak" trap

Description

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

Figure 4. Fluorescent yellow sticky cloak trap.

Use

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

- For the species for which the trap 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.

3.3.5 Jackson trap or Delta trap

Description

The JT 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 male lures to capture male fruit flies. The attractants used with JT or Delta traps are TML, ME and CUE. When ME and CUE are used a toxicant must be added.

Figure 5. Jackson trap or Delta trap.

For many years this trap has been used in exclusion, suppression 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 or Delta traps may not be suitable for some environmental conditions (e.g. rain or dust).

The JT or Delta traps are some of the most economical traps commercially available. They are easy to carry, handle and service, providing the opportunity of servicing a greater number of traps

per
person-hour than some other traps.

- 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 4 (b and d).

3.3.6 Lynfield trap

Description

The conventional LT 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 LT is the Maghreb-Med trap, also known as the Morocco trap (Figure 7).

Figure 6. Lynfield trap.

Figure 7. Maghreb-Med trap or Morocco trap.

Use

The trap uses an attractant and insecticide system to attract and kill target fruit flies. The screw-top lid is usually colour-coded to the type of attractant being used (red, Capilure (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 lures CUE, 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 Table 4 (b and d).

3.3.7 McPhail trap

Description

The conventional 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 the trap on tree branches. A plastic version of the McP trap is 18 cm high and 16 cm wide at the base and holds up to 500 ml of solution (Figure 9). The top part is transparent and the base is yellow.

Figure 8. McPhail trap.

Use

For this trap to function properly it is essential that the body stays clean. Some designs have two parts in which the upper part and base of the trap can be separated, allowing for easy 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 protein over time because the pH is stable at 9.2. The level of pH in the mixture plays an important role in attracting fruit flies. Fewer fruit flies are attracted to the mixture as the pH becomes more acidic.

Figure 9. Plastic McPhail trap.

To bait with yeast tablets, mix three to five torula tablets in 500 ml of water or follow the manufacturer's recommendation. Stir to dissolve the 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% 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 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 programme, McP traps are used as a population detection tool by targeting feral females, whereas other traps (e.g. JT), 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 PA 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 of the 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 Table 4 (a, b, d and e).

3.3.8 Modified funnel trap

Description

The modified funnel trap (VARs+) 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

As 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 in 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 the 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.

Figure 10. Modified funnel trap.

3.3.9 Multilure trap

Description

The 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 solution (Figure 11). It consists of a two-piece plastic invaginated cylindrical 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 PA. Another important difference is that an MLT with a dry synthetic attractant allows for cleaner servicing and is much less labour-intensive than a McP trap. When synthetic food attractants are used, dispensers are attached to the inside walls of the upper cylindrical part of the trap or hung from a clip at the top. For this trap to function properly it is essential that the upper part stays transparent.

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

When the MLT is used as a dry trap, a suitable (non-repellent at the concentration used) insecticide such as dichlorvos or a deltamethrin (DM) strip is placed inside the trap to kill the fruit flies. DM is applied to a polyethylene strip placed on the upper plastic platform inside the trap. Alternatively, DM may be used in a circle of impregnated mosquito net and will retain its killing

Figure 11. Multilure trap.

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 Table 4 (a-d).

3.3.10 Open bottom dry trap or Phase IV trap

Description

The OBDT or Phase IV 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.

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

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 JT. This trap is less expensive than the plastic or glass McP 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.

3.3.11 Red sphere trap

Description

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

Figure 13. Red sphere trap.

Use

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

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

- For the species for which the trap 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.

3.3.12 Sensus trap

Description

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

Figure 14. Sensus trap.

Use

The trap is dry and uses male lures 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.

3.3.13 Steiner trap

Description

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

Figure 15. Conventional Steiner trap.

Figure 16. Steiner trap version.

Figure 17. Steiner trap version.

Use

This trap uses the male lures 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 male lure or a dispenser with the attractant and an insecticide (usually malathion, dibrom or DM) 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 4 (b and d).

3.3.14 Tephri trap

Description

The TP is similar to the 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 solution (Figure 18). It has a yellow base and a clear top, which can be separated to facilitate servicing. There are entrance holes around the top of the periphery of

the yellow base, and an invaginated opening in the bottom. Inside the top is a platform to hold attractants. A wire hanger, placed on top of the trap body, is used to hang the trap from tree branches.

Use

The trap is baited with hydrolysed protein at 9% concentration; however, it can also be used with other liquid PAs 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 or Delta trap and YP trap. If the trap is used with liquid PAs 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 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.

Figure 18. Tephri trap.

- 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 4 (b and d).

3.3.15 Yellow panel trap and Rebell trap

Description

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

Figure 19. Yellow panel trap.

Use

Figure 20. Rebell trap.

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 McP trap. 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 fruit 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 Table 4 (b-e).

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, in 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 and garbage dumps, as appropriate. Traps in these locations can be supplemented by traps placed along roadsides to form transects and in production areas close to or adjacent to land borders, ports of entry and national roads.

4.2 Trap deployment

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, and their phenology, distribution and abundance. With this basic information, it is possible to properly place and distribute the traps in the field, and this information 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 usually on the upwind side of the crown. Other suitable trap sites are the eastern side of the tree, which gets the sunlight in the early hours of the day,

and 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.

PA 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 PA trap in the same tree will cause a reduction of female capture in the PA trap 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 GPS equipment, where available. A map or sketch of the trap location and the area around the traps should be prepared.

GPS and GIS have proven to be very powerful tools in the management of trapping networks. 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 are not available for trap location, 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 traps were 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 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 at the appropriate 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 situation and biology of fruit flies, on a case-by-case basis. The interval can range from one day up to 30 days, for example, 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.

It is recommended to 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 chance of fruit flies entering the trap. For traps that use a sticky insert to capture fruit flies, it is important to avoid contaminating areas in the trap that are not meant for capturing fruit flies with the sticky material. This also applies to leaves and twigs that 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 efficacy and operator safety.

The number of traps serviced per day per person will vary depending on the 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” that systematically ensure all traps within the network are inspected and serviced and none is missed.

4.5 Trapping records

The following information should be included in proper trapping records that 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 populations.

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 (see also Annex 2 of ISPM 35).

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. FTD should be used in all reports of trapping.

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:

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

5. Trap Densities

Establishing a trapping density appropriate to the purpose of the survey is critical and underpins confidence in the survey results. Trap density needs 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 host, 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 density 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 ALPP or an area under a systems approach where the target species is present, the reverse occurs, and trap density for that pest should be higher in the place of production and decrease towards points of entry. Other situations such as high-risk urban areas should be taken into consideration when assessing trapping density.

Table 4 (a–f) shows 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 dependent on associated surveillance activities, such as the type and intensity of fruit sampling to detect immature stages of fruit flies. In cases where trapping surveillance programmes are complemented with fruit sampling activities, trap densities could be lower than the suggested densities shown in Table 4 (a–f).

The suggested trap densities presented in Table 4 (a–f) take 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[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	McP/MLT	2C-1/PA	0.25–1.00	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	McP/MLT	2C-1/PA	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	McP/MLT	2C-1/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	McP/MLT	2C-1/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	McP/MLT	2C-1/PA	1–2	2–3	3–5	5–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	McP/MLT	2C-1/PA	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

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

Trap type		Attractant	
McP	McPhail trap	2C-1	AA+Pt
MLT	Multilure trap	AA	Ammonium acetate
		PA	Protein attractant
		Pt	Putrescine

Table 4b. Trap densities suggested for *Bactrocera* spp. responding to cuelure, methyl eugenol and food attractants

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	ET/JT/LT/McP/MLT/ MM/ST/TP	CUE/ME/PA	0.25–1.00	0.2–0.5	0.2–0.5	0.2–0.5
Monitoring survey for suppression	ET/JT/LT/McP/MLT/ MM/ST/TP	CUE/ME/PA	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	ET/JT/LT/McP/MLT/ MM/ST/TP/YP	CUE/ME/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	ET/JT/LT/McP/MLT/ MM/ST/TP	CUE/ME/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	CH/ET/JT/LT/McP/ MLT/MM/ST/TP/YP	CUE/ME/PA	1	1	1–5	3–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	ET/JT/LT/McP/MLT/ MM/ST/TP/YP	CUE/ME/PA	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

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

Trap type		Attractant	
CH	ChamP trap	CUE	Cuelure
ET	Easy trap	ME	Methyl eugenol
JT	Jackson trap	PA	Protein attractant
LT	Lynfield trap		
McP	McPhail trap		
MLT	Multilure trap		
MM	Maghreb-Med or Morocco trap		
ST	Steiner trap		
TP	Tephri trap		
YP	Yellow panel trap		

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

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	CH/ET/McP/MLT/YP	AC+SK/PA	0.5–1.0	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	CH/ET/McP/MLT/YP	AC+SK/PA	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	CH/ET/McP/MLT/YP	AC+SK/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	CH/ET/McP/MLT/YP	AC+SK/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	CH/ET/McP/MLT/YP	AC+SK/PA	1	1	2–5	3–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	CH/ET/McP/MLT/YP	AC+SK/PA	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

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

Trap type		Attractant	
CH	ChamP trap	AC	Ammonium bicarbonate
ET	Easy trap	PA	Protein attractant
McP	McPhail trap	SK	Spiroketal
MLT	Multilure trap		
YP	Yellow panel trap		

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

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control[4]	CH/ET/JT/LT/McP/ MLT/OBDT/SE/ ST/TP/VARs+	2C-2/3C/ CE/PA/TML	0.5–1.0	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	CH/ET/JT/LT/McP/ MLT/MM/OBDT/ SE/ST/TP/VARs+	2C-2/3C/ CE/PA/TML	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	CH/ET/JT/LT/McP/ MLT/MM/OBDT/ ST/TP/VARs+/YP	3C/CE/PA/ TML	3–5	3–5	3–5	3–5
Monitoring survey for eradication[5]	CH/ET/JT/LT/McP/ MLT/MM/OBDT/ ST/TP/VARs+	2C-2/3C/ CE/PA/TML	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion[5]	CC/CH/ET/JT/LT/ McP/MLT/MM/ ST/VARs+	3C/CE/PA/ TML	1	1–2	1–5	3–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[6]	CH/ET/JT/LT/McP/ MLT/MM/OBDT/ ST/TP/VARs+/YP	3C/CE/PA/ TML	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

4 1:1 ratio (one female trap per male trap).

[5] 3:1 ratio (three female traps per male trap).

[6] 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; five female traps per male trap).

Trap type		Attractant	
CC	Cook and Cunningham trap (with TML for male capture)	2C-2	(AA+TMA)
CH	ChamP trap	3C	(AA+Pt+TMA)
ET	Easy trap (with 2C and 3C attractants for female-biased captures)	AA	Ammonium acetate
JT	Jackson trap (with TML for male capture)	CE	Capilure
LT	Lynfield trap (with TML for male capture)	PA	Protein attractant
McP	McPhail trap	Pt	Putrescine
MLT	Multilure trap (with 2C and 3C attractants for female-biased captures)	TMA	Trimethylamine
MM	Maghreb-Med or Morocco trap	TML	Trimedlure
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		

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

Trapping	Trap type[1]	Attractant	Trap density/km^2 (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	PALz/RB/RS/YP	AS/BuH	0.5–1.0	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	PALz/RB/RS/YP	AS/BuH	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	PALz/RB/RS/YP	AS/BuH	3–5	3–5	3–5	3–5
Monitoring survey for eradication	PALz/RB/RS/YP	AS/BuH	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	PALz/RB/RS/YP	AS/BuH	1	0.4–3.0	3–5	4–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	PALz/RB/RS/YP	AS/BuH	20–50	20–50	20–50	20–50

[1] Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

[3] Also other high-risk sites.

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

Trap type		Attractant	
RB	Rebell trap	AS	Ammonium salt
RS	Red sphere trap	BuH	Butyl hexanoate
PALz	Fluorescent yellow sticky “cloak” trap		
YP	Yellow panel trap		

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

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	GS	MVP	0.25–0.50	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	GS	MVP	2–4	1	0.25–0.50	0.25–0.50
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
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	GS	MVP	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

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

Trap type		Attractant	
GS	Green sphere trap	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 bio-assayed 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 time frame required to meet programme outcomes, for example, 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 trap proximity to other traps can be evaluated from the records for each trap route. Host selection, trap relocation and trap proximity to other traps 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. Evaluation 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 chance of the marked fruit flies being falsely identified as wild fruit flies resulting in unnecessary actions being taken 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 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 intervals. Specific recommendations should be made to correct aspects found to be deficient.

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. Bibliography

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*). *Journal of the Chemical Society, Chemical Communications*, 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. *Journal of Economic Entomology*, 77: 198–201.

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

Conway, H.E. & Forrester, O.T. 2007. Comparison of Mexican fruit fly (Diptera: Tephritidae) capture between McPhail traps with Torula and Multilure traps with Biolures in South Texas. *Florida Entomologist*, 90(3): 579–580.

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. *Australian Journal of Entomology*, 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, Australia, Queensland Department of Primary Industries. 150 pp.

Drew, R.A.I. & Hooper, G.H.S. 1981. The response of fruit fly species (Diptera; Tephritidae) in Australia to male attractants. *Australian Journal of Entomology*, 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. *Journal of Economic Entomology*, 92(1): 156–164.

FAO/IAEA (International Atomic Energy Agency). 2018. *Trapping guidelines for area-wide fruit fly programmes*, 2nd edn, eds W.R. Enkerlin & J. Reyes-Flores. Rome, FAO. 65 pp. Available at https://www.iaea.org/about/insect-pest-control-section (last accessed 1 October 2018).

Fay, H.A.C. 2012. A highly effective and selective male lure for *Bactrocera jarvisi* (Tryon) (Diptera: Tephritidae). *Australian Journal of Entomology,* 51: 189–187.

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). *Journal of Economic Entomology*, 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). *Journal of Economic Entomology*, 97(3): 1126–1131.

Hill, A.R. 1987. Comparison between trimedlure and Capilure® – Attractants for male *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). *Australian Journal of Entomology*, 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. Vienna, IAEA.

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

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

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

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

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

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

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

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

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

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

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

Schutze, M.K., Aketarawong, N., Amornsak, W., Armstrong, K.F., Augustinos, A.A., Barr, N., Bo, W., Bourtzis, K., Boykin, L.M., Cáceres, C., Cameron, S.L., Chapman, T.A.,

Chinvinijkul, S., Chomič, A., De Meyer, M., Drosopoulou, E., Englezou, A., Ekesi, S., Gariou-Papalexiou, A., Geib, S.M., Hailstones, D., Hasanuzzaman, M., Haymer, D., Hee, A.K.W., Hendrichs, J., Jessup, A., Ji, Q., Khamis, F.M., Krosch, M.N., Leblanc, L., Mahmood, K., Malacrida, A.R., Mavragani-Tsipidou, P., Mwatawala, M., Nishida, R., Ono, H., Reyes, J., Rubinoff, D., San Jose, M., Shelly, T.E., Srikachar, S., Tan, K.H., Thanaphum, S., Ul-Haq, I., Vijaysegaran, S., Wee, S.L., Yesmin, F., Zacharopoulou, A. & Clarke, A.R. 2014. Synonymization of key pest species within the *Bactrocera dorsalis* species complex (Diptera: Tephritidae): Taxonomic changes based on 20 years of integrative morphological, molecular, cytogenetic, behavioral, and chemoecological data. *Systematic Entomology,* 40: 456–471.

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

Tan, K.H., Nishida, R., Jang, E.B. & Shelly, T.E. 2014. Pheromones, male lures, and trapping of tephritid fruit flies. *In* T. Shelly, N. Epsky, E. Jang, J. Reyes-Flores & R. Vargas, eds. *Trapping and the detection, control, and regulation of tephritid fruit flies: Lures, area-wide programs, and trade implications,* pp. 15–74. Dordrecht, Springer. 638 pp.

Thomas, D.B. 2003. Nontarget insects captured in fruit fly (Diptera: Tephritridae) surveillance traps. *Journal of Economic Entomology*, 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., 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. *International Journal of Horticultural Science*, 13: 11–14.

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

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

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

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

White, I.M. & Elson-Harris, M.M. 1994. *Fruit flies of economic significance: Their identification and bionomics*. CABI & Australian Centre for International Agricultural Research (ACIAR), 601 pp.

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

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

ATTACHMENT 3: Fruit sampling (formerly Appendix 2 of ISPM 26, adopted in 2006)

Information about fruit sampling is available in *Fruit sampling guidelines for area-wide fruit fly programmes*, published in 2017 by FAO and the International Atomic Energy Agency (IAEA) (in English only) and available at: https://www.iaea.org/about/insect-pest-control-section.

IPPC Diagnostic protocols adopted as annexes to ISPM 27 (*Diagnostic protocols for regulated pests*) may be useful tools to diagnose the larvae of fruit fly specimens.