[1] **Phytosanitary Procedures for Fruit Fly (Tephritidae) Management (2005-010)**

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[3] This annex was adopted by the XXth Session of the Commission on Phytosanitary Measures in [month] [year].

[4] This annex is a prescriptive part of the standard.

[5] **ANNEX Y: Phytosanitary procedures for fruit fly (Tephritidae) management (Year)**

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

[7] Various phytosanitary procedures are used for fruit fly suppression, containment, eradication and exclusion. These procedures may be applied to establish and maintain fruit fly-pest free areas (FF-PFAs)

(this standard) and areas of low pest prevalence for fruit flies (FF-ALPPs) (ISPM 30 (*Establishment of areas of low pest prevalence for fruit flies (Tephritidae)*)), as well as to develop systems approaches for fruit flies (ISPM 35 (*Systems approach for pest risk management of fruit flies (Tephritidae)*)).

[8] 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.

[9] **1. Objectives of Fruit Fly Management Strategies**

[10] 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.

[11] **1.1 Suppression**

[12] Suppression strategies may be applied for purposes such as to:

[13] 1. reduce a target fruit fly population to below an acceptable level

[14] 2. establish an FF-ALPP (ISPM 22 (*Requirements for the establishment of areas of low pest prevalence*); ISPM 30)

[15] 3. implement a corrective action in an FF-ALPP when the specified level of low pest prevalence has been exceeded (ISPM 22; ISPM 30)

[16] 4. 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)

[17] 5. precede, as part of a process, target fruit fly population eradication in order to establish an FF-PFA (ISPM 4 (*Requirements for the establishment of pest free areas*)).

[18] **1.2 Containment**

[19] Containment strategies may be applied for purposes such as to:

[20] 1. prevent the spread of a target fruit fly from an infested area to an adjacent FF-PFA

[21] 2. contain an incursion of a target fruit fly into non-infested areas

[22] 3. 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.

[23] **1.3 Eradication**

[24] Eradication strategies may be applied for purposes such as to:

[25] 1. eliminate a fruit fly population in order to establish an FF-PFA (ISPM 4)

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

[27] **1.4 Exclusion**

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

[29] **2. Requirements for the Application of the Phytosanitary Procedures**

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

[31] **2.1 Fruit fly identification capabilities**

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

[33] **2.2 Knowledge of fruit fly biology**

[34] 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.

[35] **2.3 Area delimitation**

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

[37] **2.4 Stakeholder participation**

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

[39] **2.5 Public awareness**

[40] 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.

[41] **2.6 Operational plans**

[42] 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).

[43] **3. Phytosanitary Procedures Used in Fruit Fly Management Strategies**

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

[45] Phytosanitary procedures may be applied in an area, at a place of production or at a production site; during the pre- or post-harvest period; at the packing house; or during shipment or distribution of the commodity. Pest free areas, places of production and production sites may require the establishment and maintenance of an appropriate buffer zone. Appropriate phytosanitary procedures may be applied in the buffer zone if necessary (this standard and ISPM 10 (*Requirements for the establishment of pest free places of production and pest free production sites*)).

[46] **3.1 Mechanical and cultural controls**

[47] 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.

[48] 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.

[49] 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).

[50] 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.

[51] 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.

[52] 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).

[53] **3.2 Insecticide bait application technique**

[54] 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.

[55] 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.

[56] Insecticide baits can be applied from the ground or from the air.

[57] **3.2.1 Ground application**

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

[59] 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.

[60] **3.2.2 Aerial application**

[61] 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.

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

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

[64] **3.3 Bait stations**

[65] 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.

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

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

[68] **3.4 Male annihilation technique**

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

[70] 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.

[71] **3.5 Mass trapping**

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

[73] 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.

[74] **3.6 Sterile insect technique**

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

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

[77] 1. suppression, where SIT may be a stand-alone phytosanitary procedure or combined with other phytosanitary procedures to achieve and maintain low population levels

[78] 2. 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

[79] 3. eradication, where SIT may be applied when population levels are low to eradicate the remaining population

[80] 4. exclusion, where SIT may be applied in endangered areas that are subject to high pest pressure from neighbouring areas.

[81] **3.6.1 Sterile fruit fly release**

[82] 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.

[83] 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, 2007).

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

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

paper bag systems (FAO, 2007).

[86] 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.

[87] **3.6.2 Sterile fruit fly quality control**

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

[89] **3.7 Biological control**

[90] 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.

[91] **3.8 Controls on the movement of regulated articles**

[92] 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.

[93] **4. Materials Used in the Phytosanitary Procedures**

[94] 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.

[95] **5. Verification and Documentation**

[96] 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.

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

[98] **6. References**

[99] **FAO.** 2007. *Guidance for packing, shipping, holding and release of sterile flies in area-wide fruit fly control programmes*, ed. W. Enkerlin. Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture. FAO Plant Production and Protection Paper 190. Rome. 145 + vii pp.

[100] **FAO/IAEA/USDA.** 2014. *Product quality control for sterile mass-reared and released tephritid fruit flies*. Version 6.0. Vienna, International Atomic Energy Agency. 164 pp.

[101] The present standard also refers to other International Standards for Phytosanitary Measures (ISPMs). ISPMs are available on the IPP at https://www.ippc.int/core-activities/standards-setting/ispms.