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

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[3]

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

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

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

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

[8] Various phytosanitary procedures are used for fruit fly suppression, containment, eradication and exclusion. These procedures may be integrated to establish, verify and maintain fruit fly-pest free areas (FF-PFAs) (ISPM 26:2006) and areas of low pest prevalence for fruit flies (FF-ALPPs) (ISPM 30:2008), as well as to develop fruit fly systems approaches (ISPM 35:2012).

[9] The phytosanitary procedures include mechanical and cultural controls, insecticide bait application, bait stations, male annihilation technique (MAT), mass trapping, sterile insect technique (SIT), biological control, and controls on the movement of regulated articles. These procedures can be environment-friendly alternatives to insecticide application for managing fruit fly pests.

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

[11] The four strategies used to manage fruit fly populations are suppression, containment, eradication and exclusion. One or more of these strategies can be used. The corresponding phytosanitary procedures will be influenced by the phytosanitary import requirements, fruit fly status in the target area, host status and host susceptibility, pest biology, and economic and technical feasibility of the available phytosanitary procedures.

[12] The objectives for each strategy are:

[13] 1. For suppression: to reduce the fruit fly population in an infested area below an economic threshold

[14] 2. For containment: to prevent the spread of the fruit fly from an infested area to an adjacent FF-PFA

[15] 3. For eradication: to eliminate a fruit fly population from an area

[16] 4. For exclusion: to prevent the introduction of a fruit fly to an FF-PFA.

[17] **1.1 Suppression**

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

[19] 1. suppress a fruit fly population in order to reduce its level to below an economic threshold or to establish an FF-ALPP, or as a corrective action in an ALPP when the specified level of low pest prevalence has been exceeded (ISPM 22:2005; ISPM 30:2008)

[20] 2. suppress a fruit fly population in order to achieve a specified pest population level that can be used as part of a systems approach (ISPM 14:2002; ISPM 35:2012)

[21] 3. precede, as part of a process, fruit fly population eradication in order to establish an FF-PFA (ISPM 4:1995; ISPM 26:2006).

[22] **1.2 Containment**

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

[24] 1. protect an FF-PFA from an adjacent infested area

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

[26] 3. protect, as a temporary measure, individual areas where fruit flies have been eradicated within an ongoing eradication programme in a larger area.

[27] **1.3 Eradication**

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

[29] 1. eliminate a fruit fly population in order to establish an FF-PFA (ISPM 4:1995; ISPM 26:2006)

[30] 2. establish a fruit fly free place of production or production site (ISPM 4:1995 and ISPM 10:1999)

[31] 3. 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 (ISPM 26:2006).)

[32] **1.4 Exclusion**

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

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

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

[36] **2.1 Fruit fly identification capabilities**

[37] Accurate identification of the fruit fly species should be ensured so that the appropriate strategies and phytosanitary procedures can be selected and applied. NPPOs should have in place adequate infrastructure and trained personnel to identify adult stages of the target fruit fly species in an expeditious manner (ISPM 6:1997; ISPM 26:2006).

[38] **2.2 Fruit fly biology**

[39] Knowledge of the biology of the target fruit fly species should be ensured to determine the strategy required to address its management and the phytosanitary procedures that will be applied. Basic information on the target fruit fly species may include life cycle, host(s), host sequence and abundance, dispersal capacity, geographical distribution and population dynamics.

[40] **2.3 Stakeholder participation**

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

[42] **2.4 Public awareness**

[43] An ongoing public awareness programme should be put in place to inform interested and affected groups about the 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 programme it is important to have the support and participation of the public (especially the local community) within the programme area and of individuals who travel to or through the area (ISPM 26:2006).

[44] **2.5 Operational plans**

[45] An official operational plan that specifies the required phytosanitary procedures should be elaborated. An 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 4:1995; ISPM 22:2005).

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

[47] Fruit fly management strategies will in most cases involve the use of more than one phytosanitary procedure.

[48] Phytosanitary procedures may be applied in an area, at a production site or at a place of production; 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 (ISPM 10:1999; ISPM 26:2006).

[49] **3.1 Mechanical and cultural controls**

[50] Mechanical and cultural control procedures reduce the accumulation of fruit fly populations by preventing the development of fruit flies in fruits and soil. These controls include phytosanitary procedures such as orchard sanitation, fruit stripping, ploughing, ground swamping, pruning, host tree removal, fruit bagging, host-free periods, use of resistant varieties, and trap cropping.

[51] The effectiveness of orchard sanitation increases when the collection of fruit and the disposal of fallen fruit are focused on the primary hosts of the pests 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 trees after harvest, fruit rejected because of poor quality during harvest and packing, and fruit on hosts present in the surrounding area should be collected and disposed of.

[52] Eliminating vegetation in the orchard is important to facilitate collection of fallen fruit. Fallen fruit with larvae may be more exposed to direct sunlight and natural enemies, which contribute to fruit fly mortality.

[53] Non-commercial and wild hosts are major reservoirs of fruit flies from where the flies can disperse to commercial orchards. Replacing or removing these host plants is a useful procedure to reduce fruit fly populations.

[54] Bagging of fruit can prevent fruit fly infestation of the fruit. Where used, bagging should be carried out before the fruit become susceptible to fruit fly infestation.

[55] 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) and ploughing (causing pupae desiccation).

[56] **3.2 Insecticide bait application technique**

[57] The insecticide bait application technique uses an appropriate insecticide mixed together with a food bait. Commonly used food baits include attractants such as hydrolyzed protein, high-fructose syrup and molasses, 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.

[58] Insecticide bait applications should start in time to prevent the infestation of fruit. 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 orchard. The number of and interval(s) between applications will depend on the characteristics of the target fruit fly pest species (biology, abundance, behaviour, distribution, life cycle etc.), host phenology and weather conditions.

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

[60] **3.2.1 Ground application**

[61] Ground application of insecticide bait may be used for relatively small production areas, such as individual orchards, or in urban areas, where aerial application would not be practical.

[62] For ground application, manual or motorized backpack sprayers may be used. The insecticide bait should be applied on or inside the canopy of host and shelter plants. 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. The application should generally be done on the inner, middle-to-top part of the canopy of the host plant, but specific application will depend on 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.

[63] **3.2.2 Aerial application**

[64] Aerial application of insecticide bait is commonly used on large production areas and in areas where hosts are scattered in patches over large areas of land. Aerial spraying is more cost-effective than ground spraying for large-scale programmes, and a more uniform coverage of bait in the target area can be achieved.

[65] Aeroplanes are usually used for aerial application on flat terrain in continuous host areas, whereas helicopters are usually used in areas difficult to access or where hosts are scattered. Once the treatment area is selected, it should be defined using global positioning systems (GPS) and recorded in digitized maps using geographical information systems (GIS) software: this will ensure the efficient application of bait sprays, reducing the environmental impact.

[66] To treat the target area, insecticide bait applications may be conducted in alternate swaths or as full coverage. The altitude and speed of aerial application depends on several factors, including wind velocity, temperature, cloud cover, and topography of the terrain. Commonly used altitudes range from 100 to 130 m above the plant canopy for aeroplanes and 60 to 95 m for helicopters, and speeds range from 120 to 190 km/h.

[67] **3.3 Bait stations**

[68] Lure and kill devices known as “bait stations” can be an environment-friendly control procedure for fruit fly suppression. 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.

[69] Bait stations are suitable for use in, for example, commercial fruit production, area-wide fruit fly control programmes, public areas and organic groves. Bait stations can be used in fruit fly free areas for population suppression of localized and well-isolated outbreaks. A common application is in infested areas known to be fruit fly reservoirs and sources of infestation for FF-ALPPs and FF-PFAs. Bait stations are deployed in these areas at high densities.

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

[71] **3.4 Male annihilation technique**

[72] 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). The technique 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 fruit flies to such a low level that mating is unlikely to occur (FAO, 2007).

[73] Methyl eugenol is more effective than cuelure for male annihilation of species attracted to these lures.

[74] **3.5 Mass trapping**

[75] Mass trapping uses trapping systems at high density to suppress fruit fly populations in commercial fruit orchards. Although recent development of less expensive trap devices, longer lasting lures, and better killing agent formulations has significantly reduced the costs of mass trapping, it continues to be expensive and is essentially limited to protecting high-value crops. In general, mass trapping procedures are the same as for traps used for survey purposes (ISPM 26:2006, Appendix 1). Traps should be deployed in the orchards early in the season when the first adult flies move into the orchards and populations are still at low levels.

[76] Trap density should be based on such factors as pest density, physiological stage of the pest, 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 fruit fly pest and host ecological data.

[77] **3.6 Sterile insect technique**

[78] This species-specific technique is environmentally friendly and can provide effective control of fruit fly populations (FAO, 2007).

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

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

[81] 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

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

[83] 4. exclusion, where SIT may be applied in endangered areas that are subject to high pest pressure from outside the area.

[84] **3.6.1 Sterile fly release**

[85] Sterile fruit flies can be released from the ground or from the air. Release intervals should be adjusted according to the longevity of the insect, but sterile flies are generally released once or twice per week. The frequency of release may be affected by circumstances such as pupae supply, staggered emergence and unfavourable weather. To establish sterile fly release density, it is important to consider the quality of the sterile fruit flies and the level of the wild population.

[86] After release of the sterile fruit flies, trapping and identification of the sterile and wild flies is important to evaluate the effectiveness of the release procedure. Moreover, released sterile flies are recaptured in the same traps that are used for detection of the wild population: this provides feedback on whether the desired sterile fruit fly density and sterile : wild fly ratio was attained (FAO, 2007).

[87] **3.6.1.1 Ground sterile fly release**

[88] Ground release may be used when aerial release is neither cost-effective nor efficient (i.e. discontinuous distribution and 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).

[89] Adults for ground release are generally transported in containers or paper bags from the fruit fly emergence and release facilities to the release sites in cool conditions (less than 20 °C). Sterile flies may be released from predetermined release points under or in a tree canopy, preferably more than 100 m from any monitoring site, or they may be released from a moving vehicle.

[90] **3.6.1.2 Aerial sterile fly release**

[91] 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 should be defined using GPS 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. The chilled adult release system is designed to handle large volumes of sterile fruit flies. The advantage of this system is that large numbers of fruit flies can be transported on each flight and uniformly dispensed into the environment. The paper bag release system is a relatively simple process whereby emerged flies within sealed bags are released when the bags are ripped open by hooks or knives located at the end of a chute exiting the aircraft. Operational programmes use different methodologies to calculate release rates (FAO, 2007).

[92] To determine the release altitude, several factors need to be considered, including wind velocity, temperature, cloud cover, topography of the terrain, vegetation cover, and whether the area is an urban or a rural one. Release altitudes range from 200 to 600 m above ground level. However, lower release altitudes are preferred, especially in areas subjected to strong dominant wind currents (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.

[93] **3.6.2 Sterile fly quality control**

[94] Routine and periodic quality control tests are required to determine the effect of mass rearing, irradiation, handling, shipment duration, holding and releasing on the performance of the sterile flies, according to desired quality parameters (FAO/IAEA/USDA, 2003).

[95] **3.7 Biological control**

[96] Classic biological control has been used to reduce fruit fly populations. For further suppression, inundative release may be used. During inundative release, large numbers of natural enemies are reared and released during critical periods for the rapid suppression of 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 parasitoids should be of high quality so that population suppression can be effectively achieved. The release of the biological control agents should be done on an area-wide basis and directed towards marginal areas that have high host density and that are known to be fruit fly reservoirs and sources of infestation for commercial fruit orchards.

[97] **3.8 Controls on the movement of regulated articles**

[98] For fruit fly exclusion zones and FF-PFAs, and under certain circumstances for FF-ALPPs, controls on the movement of regulated articles should be implemented to prevent the entry of target fruit fly species. The controls depend on the assessed pest risks (ISPM 26:2006).

[99] **4. Quality Control of Materials Used in the Phytosanitary Procedures**

[100] The materials used in the phytosanitary procedures should perform effectively and reliably at an acceptable level for a prescribed period of time. The devices and equipment should maintain their integrity for the entire duration that they are anticipated to remain in the field. The attractants and chemicals should be certified or bio-assayed for an acceptable level of performance.

[101] **5. Verification of Strategies and Phytosanitary Procedures for Fruit Fly Management**

[102] The effectiveness of the chosen strategies (suppression, containment, eradication and exclusion) and relevant phytosanitary procedures should be verified. The main phytosanitary procedure used for verification is adult and larval surveillance, as described in ISPM 6:1997 and ISPM 26:2006 (Appendix 1).

[103] **6. Documentation and Record-Keeping**

[104] NPPOs should ensure that records of information supporting all stages of the suppression, containment, eradication and exclusion strategies are kept. It is essential that NPPOs maintain such documentation for three years (or longer, if justified) in order to support claims of low pest prevalence or pest freedom (ISPM 9:1998; ISPM 26:2006).

[105] **7. References**

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