National regulatory control systems
Systèmes de lutte nationaux réglementaires

Bactrocera zonata: procedure for official control

Specific scope

This standard describes procedures for official control aiming to monitor, contain and eradicate *Bactrocera zonata*.

Specific approval and amendment

First approved in 2010–09.

1. Introduction

Bactrocera zonata (peach fruit fly) is an A1 pest for EPPO and is regulated by many EPPO member countries (often as *Dacus zonatus*). Details of its biology, distribution and economic importance can be found in EPPO/CABI (1997).

Bactrocera zonata originates from South and South-East Asia (India, Indonesia, Laos, Sri Lanka, Thailand, Vietnam) and has been introduced into Bangladesh, Myanmar, Nepal, Pakistan, Saudi Arabia, Oman, Mauritius and Reunion Island. It is now present throughout Egypt, up to the borders of the Palestinian Territories (Gaza Strip) and Israel. Its presence has also been recorded recently in southern Iran and Lebanon. Experience in Egypt shows that *B. zonata* has already adapted to climatic conditions different to those in its area of origin. This major economic pest presents a threat to countries in West Asia, but also in North Africa and in Southern Europe.

The main hosts of *B. zonata* are guava, mango and peach. Secondary hosts include apricot, fig and citrus. This fly has been recorded on over 50 cultivated and wild plant species, mainly those with fleshy fruits. A list of susceptible species is given in Appendix 1. Eggs are laid inside the fruit and larvae feed on the fruit. Transport of infested fruit, either through trade or by travellers, is the main means of movement, and the pest will also spread via fruit packaging material. Its natural means of spread is adult flight.

EPPO member countries with areas at risk are advised to prepare a contingency plan for surveillance, eradication and containment of *B. zonata*.

This standard presents the basis of a national regulatory control system for the eradication and containment of *B. zonata* and includes guidance on its surveillance.

Countries where *B. zonata* is not capable of establishment due to climatic, geographical or other reasons, and where absence is recognized according to the first paragraph of section 3.1.2 of International Standard for Phytosanitary Measures (ISPM) No. 8 (Determination of pest status in an area), may decide that they have no reasons to apply the standard.

The EPPO countries bordering areas of known infestation are at highest risk and are advised to prepare a contingency plan for surveillance and eradication. Attention should be paid to providing sufficient traps, and registering suitable plant protection products for emergency treatments. Facilities should be identified which are suitable for disposal of contaminated wastes, destruction of woody plants and treatment of harvested fruits to ensure freedom from pests. Field inspection staff, including non-permanent workers, should be trained. Laboratories should have specimens of adults, larvae and pupae available and staff suitably trained in determining *B. zonata*.

This standard has been prepared on the basis of the Peach Fruit Fly Action Plan (FAO/IAEA, 2000), the NAPPO Regional Standards for Phytosanitary Measures No. 10 (NAPPO, 1998) and ISPM No. 26 Establishment of pest free areas for fruit flies (Tephritidae) (IPPC, 2006c).

2. Monitoring of *Bactrocera zonata*

Monitoring of *B. zonata* should be conducted in areas in which the risk of spread of this pest has been identified and/or where outbreaks have occurred in the past. Monitoring procedures including in particular trapping scenarios, relevant attractants and trap types for *B. zonata* are described in Appendix 1 to ISPM No. 26 *Establishment of pest free areas for fruit flies (Tephritidae)* (in preparation).

3. Eradication programme

The eradication programme for *B. zonata* is based on the delimitation of an area or areas within the country in which measures

are applied to eradicate it. Measures should also be taken to prevent further spread of the pest. These measures are described in Appendix 2.

References

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Appendix 1 – *Bactrocera zonata* host plants from FAO/IAEA (2000)

The following host list (Table 1) was developed from literature citations and communication with plant protection officials and research scientists familiar with the peach fruit fly. Fruits that have been found infested with *B. zonata* larvae are marked with an asterisk. These hosts should be included on any list of regulated hosts for quarantine purposes.

In recent years, this insect has expanded its global distribution and host range. The adventive nature of this fly demands that National Plant Protection Organizations give greater attention to its presence in order to take prudent measures for its early detection, containment and elimination. As this pest spreads to new areas, it will be exposed to new hosts suitable for its reproduction, and may attack closely related species within the same genus. For this reason, some closely related species are included below without a star. Since it is not fully known which plants will be suitable hosts for *B. zonata* should it become established in other parts of the world, any host listed below should be carefully inspected for possible infestation. In fact, it is not known which hosts may be preferred by adult *B. zonata* and no assumptions have been made in this regard.

This pest is similar to the Oriental fruit fly, *Bactrocera dorsalis* in terms of its broad host preferences. *Bactrocera zonata*

Table 1 *Bactrocera zonata* host plants and plants closely related to host plants

Scientific name	Common name
*Abelmoschus esculentus**	Okra
*Aegle marmelos**	Indian bael
Annona cherimola	Cherimoya
Annona muricata	Soursop
*Annona reticulata**	Custard apple, Annona
*Annona squamosa**	Custard apple
*Careya arborea**	Patana oak; Kumbhi
*Carica papaya**	Papaya, common
Citrofortunella japonica	Calamondin orange
*Citrullus lanatus**	Watermelon
*Citrus aurantilifolia**	Sour lime
*Citrus aurantium**	Sour orange
*Citrus limon**	Lemon; Baramasi
*Citrus medica**	Citron
Citrus maxima	Pummelo
*Citrus nobilis**	King orange; Tangor
*Citrus paradisi**	Grapefruit
*Citrus reticulata**	Mandarin (tangerine)
*Citrus sinensis**	Orange, sweet
*Coccinia grandis**	Gourd, Ivy
*Cucumis melo**	Cantaloupe
Cucumis sativus	Cucumber
*Cucumis utilissimus**	Melon, long
*Cydonia oblonga**	Quince
Elaeocarpus angustifolius	Blue marbletree; New Guinea quandong
Elaeocarpus grandiflorus	
*Elaeocarpus madopetalus**	Ma-kok-nam
*Eriobotrya japonica**	Loquat; Lokat
Eugenia brasiliensis	Brazil cherry
Eugenia uniflora	Surinam cherry
Felijoa sellowiana	Pineapple guava
Ficus benghalensis	Banyan fig
*Ficus carica**	Fig, common
Ficus macrophylla	Moreton Bay fig
Ficus retusa	Glossy leaf fig
Ficus rubiginosa	Port Jackson fig
Ficus spp	Fig
*Fortunella japonica**	Chinese orange; Kumquat; Narange
*Grewia asiatica**	Phalsa
*Lagenaria siceraria(=L. vulgaris)**	White flower; bottle gourd, calabash gourd
*Luffa acutangula**	Ribbed or ridged gourd; Kali torai, Jhinga, Luffa
*Luffa aegyptiaca**	Smooth loofah; sponge gourd; Ghia torai
*Lycopersicon esculentum**	Tomato; Tamatar
*Madhuca indica**	*(=Bassia latifolia)* Mahua; Mohua; Mowra-buttertree
Malus spp.*	Apple
*Malus(=domestica) sylvestris**	Apple, common
Malus pumila	Paradise apple
Mangifera foetida	Bachang mango
*Mangifera indica**	Mango
Mangifera odorata	Kuine
Manilkara emarginata	Sapodilla

Table 1 (Continued)

Scientific name	Common name
Manilkara hexandra	Balata sapodilla
*Manilkara zapota**	Sapodilla
Momordica balsamina	Balsam apple hawthorn
*Momordica charantia**	Balsam pear, bitter melon; bitter gourd
Momordica cochinchinensis	Balsam apple
Ochrosia elliptica	Bourbon orange
*Persea americana**	Avocado
*Phoenix dactylifera**	Date palm
Prunus americana	American plum
*Prunus armeniaca**	Apricot
Prunus avium	Sweet cherry
Prunus cerasifera	Cherry plum
Prunus domestica	Garden plum (common European prune)
Prunus dulcis	Almond
Prunus ilicifolia(ornamental)	Cherry, hollyleaf
Prunus lusitanica	Portuguese laurel cherry
Prunus lyonii	Cherry, Catalina
*Prunus persica**	Peach
*Prunus persica var. nectarina**	Nectarine
Prunus salicina x Prunus cerasifera	Methley plum
Prunus salicina	Japanese plum
*Psidium cattleianum**	Strawberry guava; Chinese guava
Psidium cattleianum littorale	Red strawberry guava
Psidium cattleianum lucidum	Yellow strawberry guava
*Psidium guajava**	Guava
*Punica granatum**	Pomegranate
*Putranjiva roxburghii**	Olive, wild; Indian amulet plant
*Pyrus communis**	Pear
*Pyrus pashia**	Kaenth
Pyrus pyrifolia	Pear, sand
Solanum aculeatissimum	Nightshade,
*Solanum auriculatum**	Wild tobacco; Tabac marron
*Solanum melongena**	Eggplant
Solanum muricatum	Pepino
Solanum pseudocapsicum	Jerusalem cherry
Solanum seaforthianum	Brazilian nightshade
Solanum verbascifolium	Mullein nightshade
*Syzygium aquea**	Water apple; Watery roseapple; Lal; Jumrool
*Syzygium cumini**	Java plum; Jambolana
*Syzygium jambos**	Rose-apple; Jamrosat; Jambos; Malabar-plum
Syzygium malaccense	Malayapple
*Syzygium samarangense**	Java apple; Water apple
Terminalia bellirica	Myrobalan
*Terminalia catappa**	Tropical or Indian almond
Terminalia chebula	
*Ziziphus mauritiana**	Chinese date (India jujube); Ber
Ziziphus jujuba	Jujube

Plants listed without an asterisk are closely related to host plants for *B. zonata*.
*Host plants for *B. zonata*

may be similar to *B. dorsalis* in other respects. Some scientists believe that *B. zonata* may be a hybrid or intermediate form resulting from the cross of *B. dorsalis* with the guava fly, *B. correcta* (Iwahashi & Routhier, 2001). Hosts are listed first by scientific name followed by common name(s). An attempt has been made to select the most widely recognized common name, although common names vary from location to location. All hosts with asterisks by their names in Table 1 should be regulated for *B. zonata*.

Appendix 2 – Eradication programme for *Bactrocera zonata*

In order to conduct an eradication programme in an area where *B. zonata* has been trapped, surveillance should be carried out to determine the extent of the infestation. A quarantine area should be designated in which eradication measures should be implemented. In addition, measures may be put into place to prevent further spread to non-infested areas.

Different areas are defined for eradication and surveillance.

Surveillance

Delimiting survey

When one or more *B. zonata* are collected in an area, a delimiting survey should be implemented immediately to determine the extent of the infestation.

Trapping procedures

Using the site of detection as the epicentre, Jackson traps will be set out in a 10-3-3-3-3 per square kilometre (km^2) trap array sequence. This area will constitute the trapping area. Such design may be adapted to local conditions (no trapping is necessary when uncultivated areas such as desert surround the epicentre). In areas with scattered commercial orchards, rural low-population villages with backyard fruit host, and in marginal areas where commercial and wild hosts exist, trap network arrays are normally linear with a distribution pattern that follows roads that provide access to host material. Traps should be controlled every week.

A core area is delimited as the 2.56 km^2 area immediately surrounding the epicentre. McPhail traps (See Appendix 1 of ISPM No. 26 for trap information) are to be placed in the core area as well as in the first array around the core area at the same rate as Jackson traps.

The area with a radius 7–40 km from the core should be trapped at a minimum of 1 Jackson trap km^{-2} (See Appendix 1 of ISPM No. 26 for trap information).

An illustration of trapping setting is given in Fig. 1.

Fruit sampling procedures

Fruit sampling may be used as a surveillance method in combination with trapping where trapping is less effective. It should be noted that fruit sampling is particularly effective in small-scale delimiting surveys in an outbreak area. However, it is labour-intensive, time consuming and expensive due to the destruction of fruit. It is important that fruit samples are held in suitable con-

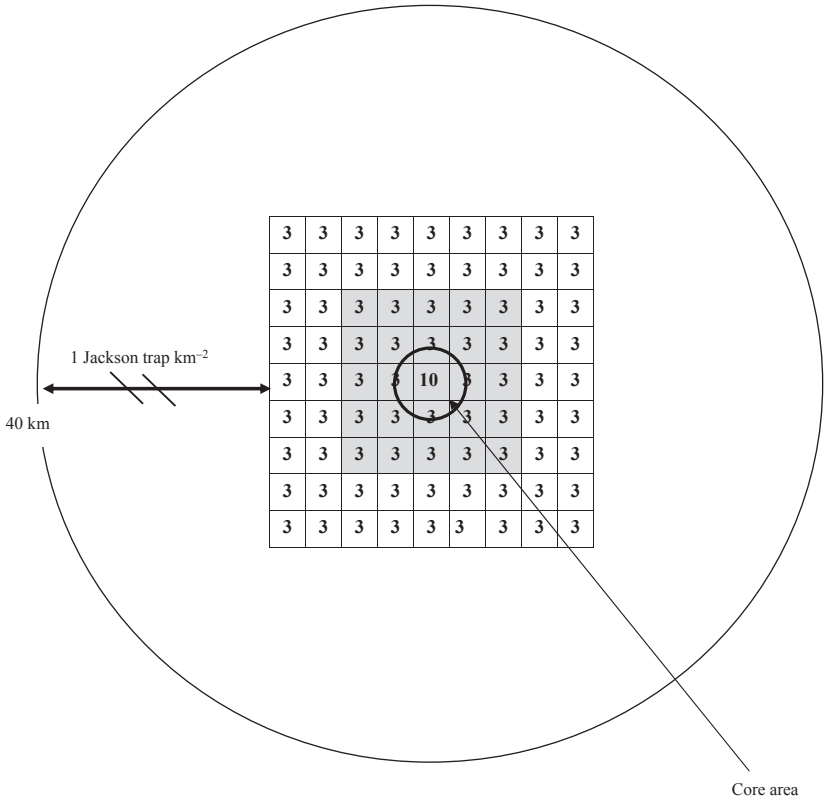

Fig. 1 Trapping procedures for an eradication programme.

ditions to maintain the viability of all immature stages of fruit fly in infested fruit for identification purposes.

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

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

- Urban areas
- Abandoned orchards
- Rejected fruit at packing facilities
- Fruit markets
- Sites with a high concentration of primary hosts
- Symptomatic fruits on trees, fallen fruit, where appropriate.

Fruits should be sampled during the period when the different hosts are likely to be infested by *B. zonata*.

Sample size and selection

Factors to be considered include:

- The required level of confidence
- The availability of primary host material in the field.

Valuable information on the size of samples in relation to the required level of confidence is given in ISPM 31 *Methodologies for Sampling of Consignments* (IPPC, 2008).

Fruit of preferred host in the trapping area may be cut and examined for larvae. If fruit fly larvae are found, the infested samples are taken in a sealed container for identification.

Initiation of eradication

When two adult flies or one mated female or a larva of *B. zonata* are detected within one estimated life cycle, within an area of 9 km radius, an infestation of *B. zonata* is considered to be detected. An eradication programme should then be initiated. It is also necessary to adjust the delimitation of the trapping area accordingly. In addition to eradication measures, other measures are applied to prevent further spread. This requires establishing two types of quarantine area (see Table 2).

Quarantine area where eradication measures are implemented

The eradication measures are applied in an area of 9 km radius from the epicentre.

Table 2 Determination of measures in relation to trapping results

Bactrocera zonata trapping results	Measures implemented
2 adult flies or 1 mated female or 1 larva within one estimated life cycle, within an area of 9 km radius.	Eradication measures in an area of 9 km radius from the epicentre are initiated.
>5 adult male flies or an unmated female and a male or one mated female, or a larva or a pupa or a single adult fly is found when eradication programme in place. within one estimated life cycle within an area less than 3 km^2	Eradication measures in an area of 9 km radius from the epicentre AND Containment measures are initiated in an area of 7.5 km radius from the epicentre maintained until eradication has been declared.

Quarantine area where measures to prevent further spread are implemented

In addition to eradication measures, measures to prevent the spread of the pest are applied to commodities leaving an infested area if any of the following are detected, within an area < 3 km^2, during one estimated *B. zonata* life cycle:

- More than 5 adult male flies or an unmated female and a male or 1 mated female,
- A larva, or a pupa
- A single adult fly which is determined to be associated with a current eradication project.

Measures to prevent further spread of the pest will be applied in an area of 7.5 km radius from the epicentre and will be maintained until eradication has been declared.

Eradication programme

The treatments described below are those applied in countries with fruit fly eradication programmes. Some of these treatments may not be allowed in EPPO countries and attention should be paid to the registering of suitable plant protection products for emergency treatments.

The minimum programme consists of ground-applied male annihilation treatments.

In an urban area, the control programme will be composed of ground-applied male annihilation treatments, soil treatments and fruit stripping. The commercial area may be treated as above with the addition of bait sprays. Eradication treatments recommended in the IAEA Peach fruit fly action plan are presented in Appendix 3.

The male annihilation technique (MAT) is the most suitable method available to date for the eradication/control of *B. zonata.* The MAT relies on the combined use of sexual attractants (methyl eugenol in the case of *B. zonata*) and insecticide to eliminate male flies, thus stopping mating. The insecticides used are generally organophosphorus compounds, such as malathion or naled. The lure/insecticide combination is applied as spot treatments. Two treatment options are possible: neutral gel as carrier of a mixture of methyl-eugenol and insecticide (also called Min-U-Gel applications) or lure-and-kill stations (i.e. wooden blocks, caneite blocks or cotton cord impregnated with the mixture methyl-eugenol and insecticide). The first option may result in foliage burn so the second is often preferred. It should be noted that the use of lure-and-kill blocks could interfere with trapping. This technique may be combined with the protein bait application technique (BAT), a widely used technique for controlling fruit flies, in which an insecticide and a protein source are associated. If treatments selected or proposed are not in conformity with current registration of plant protection products, an emergency exemption may be provided.

In areas where eradication is envisaged, *B. zonata* should be continually monitored using methyl eugenol insecticide baited traps. Eradication treatments should continue for at least two *B. zonata* life cycles.

Measures to prevent further spread

When measures to prevent further spread are necessary (see section Quarantine area where measures to prevent further spread are implemented), the following containment measures should be implemented in an area with a 7.5 km radius from the epicentre:

- Fresh fruits, nuts, vegetables and berries of susceptible hosts from the area concerned may not be moved unless treated appropriately. Treatments of fruits against *Bactrocera dorsalis* that are effective against *B. zonata* include cold treatment (e.g. 11, 12 or 14 days at 0.5, 1.0 or 1.5°C, respectively), or for certain fruits vapour heat treatment (e.g. treating at 43°C for 4–6 h), hot water treatment (46°C for 60–90 min according to the size and shape of fruits), or forced hot-air treatment. An approved fumigant may be applied alone or in conjunction with cold treatment procedures. Ethylene dibromide was once widely used as a fumigant but is now generally withdrawn because of its carcinogenicity; methyl bromide is less satisfactory, damaging many fruits and reducing their shelf life. Irradiation of fruits (150 Gy) is considered as a viable treatment alternative against all fruit fly species but this is not permitted in most European countries
- Plants for planting moved from the area concerned should be free from fruits
- Movement of plants for planting with soil attached from the area concerned should follow EPPO Standard PM 3/54 *Growing plants in growing medium prior to export*
- Movement of soil from the area concerned should be prohibited

- Plant/fruit waste should be disposed of safely *in situ* or measures should be taken to treat waste to remove the risk of spread prior to movement from the area concerned.

Verification of pest eradication

Eradication can be declared when measures have been applied for a minimum of two *B. zonata* life cycles, and trapping has been negative for at least one additional *B. zonata* cycle after eradication measures have stopped.

Appendix 3 – Eradication treatments mentioned in the IAEA Peach fruit fly action plan

The following is provided only to give some guidance on the type of measures which may be considered. Many of the plant protection products are unavailable in many EPPO member countries and the application techniques are not directly available.

Recommended plant protection products

(1) Malathion
(2) Spinosad
(3) Diazinon
(4) Naled (Dibrom)

Eradication treatments

Male annihilation option

Spot treatment: Apply the lure/insecticide using a Panama pump gun (available from Forestry Supplies, Mississippi, US) or a hydraulic oil squirt can to localized spots on utility poles, trees, fences, etc. The bait will burn foliage and therefore leaves should not be treated unless no other sites exit. Alternatively, fibre blocks saturated with the attractant and insecticide or cordallitos (short segments of cotton rope or cigarette filters) also can be used effectively as lure-and-kill stations. Fibre blocks can easily be nailed or stapled to a surface temporarily and removed or collected after 90 days.

Apply the mixture at the rate of 3–5 mL per station at a height of about 2 m above the ground out of the reach of children. Apply at least 240 evenly distributed stations per km^2 or 60–80 to a city block. This equals about one bait station every 45–50 m. Apply treatment every 2 weeks. The area of coverage will be 25 km^2 around each fly find.

Aerial proteinaceous bait spray option

Treatment or retreatment should not be considered if weather reports indicate a 50% or greater chance of precipitation within 48 h.

The objectives are to eradicate the pest and minimize environmental contamination. Any treatment or retreatment recommendations must consider these objectives.

Application of full-coverage protein bait spray will be scheduled and applied 7–10 days apart. The area of full coverage bait spray will extend a minimum of 2.5 km beyond any known infestation. It may be expanded to 4.0 km from any find if the infestation is heavy. Weather conditions may dictate changes in spray schedule. After an estimated two *B. zonata* generations of negative trapping, spray operations may be discontinued.

Supplemental eradication methods

Soil treatment

Properties with confirmed larval infestations and the environs within 200 m will have approved soil treatments applied within a minimum of 1 m outside the dripline of all host plants, and a minimum of a 1 m radius around any spot to which host fruit may have dropped or rolled. Take particular care to soak cracks or crevices in or next to barriers to horizontal movement of larvae (i.e. sidewalks, stones, etc.). Apply prescribed treatments at intervals stated in the specific exemption, as appropriate. Normally, the interval is 14–16 days.

Diazinon: (Diazinon AG-500) 108 mL a.s. of 48% diazinon in enough water to soak 5 cm of soil over 900 m^2 (5.6 kg of a.s. per ha) to kill larvae, pupae, and emerging adults. Adjust water pH to 6.5 or less prior to adding insecticide.

Diazinon: (Diazinon 14 G). Work Diazinon 14 G 3–5 cm into the soil at the rate of 39 kg ha^{-1} (5.6 kg of a.s. per ha) or 41 g per 3.6 m diameter drip circle (9.6 m^2). The area should be treated with water that has been buffered (pH 6.0–6.5) to enhance percolation of the material into the soil.

Ground-applied proteinaceous bait spray

All hosts (available shelter, oviposition, or food sites in any stage of development) on the infested property, adjacent properties, and within approximately 200 m of the known find will be sprayed at the prescribed intervals. Ground spraying may be discontinued after an estimated two *B. zonata* generations of negative trapping or after the initiation of male annihilation or of aerial treatment.

The bait may be applied as a limited coverage application to hosts and plants providing shelter or resting areas by means of a backpack sprayer or equivalent unit. Applications are to be sprayed out of reach of children or pets. If full coverage application is desired, a mistblower or similar unit can be utilized. Treatments are to be applied 7–10 days apart. Subsequent applications, if in orchards or groves, may be decreased by treating every other tree.

Historically, ground applications of protein bait spray formulations in urban areas have not significantly reduced infestations, unless carried out on an area-wide basis in a centrally-coordinated fashion. This can overcome the failure to gain access to all sites requiring treatment, equipment constraints and timeliness of applications. If properly organized and carried out, such treatments can eradicate small outbreaks in urban areas.

Fruit stripping

All ripe preferred host fruit within 200 m of a confirmed larval site should be promptly stripped and placed in plastic bags and properly disposed of in an approved landfill.