LIFE CYCLE, MORPHOLOGY, AGRICULTURAL DAMAGE AND MANAGEMENT OF THE BALUCHISTAN MELON FLY (MYIOPARDALIS PARDALINA BIGOT, 1891) IN CENTRAL ASIA

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https://doi.org/10.5281/zenodo.23086894

Abstract. The Baluchistan melon fly, Myiopardalis pardalina (Bigot, 1891) (Diptera: Tephritidae), is a major pest of melon and other cucurbits in Central Asia, the Middle East and Türkiye. This narrative review summarises its taxonomy, external morphology and identification features, distribution, hosts, life cycle, seasonal phenology, damage and management, drawing on international and regional literature. Adults are small (about 5–7 mm) yellow-brown flies with banded wings and a spotted mesonotum; larvae are apodous and feed inside the fruit. The species overwinters as puparia in the soil and completes two to three generations per year (up to four in some regions). Because larvae develop inside the fruit, contact insecticides are of limited value. Reported fruit losses range from 6.7% to about 90%, depending on region and cultivar. An integrated programme combining monitoring, field sanitation, soil-related cultural measures, targeted insecticide timing at the end of flowering and at second-generation emergence, fruit bagging and pheromone-based trapping is proposed.

Keywords: Baluchistan melon fly; Myiopardalis pardalina; morphology; identification; cucurbits; life cycle; integrated pest management; Central Asia.

1. Introduction

Melon (Cucumis melo L.) is one of the traditional and export-oriented crops of Central Asian agroecosystems and, together with watermelon, cucumber and pumpkin, forms the cucurbit production system of the region. Asia accounts for about 75% of the world melon area and 83% of output (Liu et al., 2025). Among the factors limiting yield and quality, fruit flies (Tephritidae) have a special place: the family comprises more than 5,000 species, of which about 200 are of economic importance (Papadopoulos et al., 2024).

In Central Asian literature the “melon fly” (qovun pashshasi) refers mainly to Myiopardalis pardalina (Bigot, 1891). The species was formerly placed in Carpomya (Carpomyia), now treated as a synonym of Myiopardalis (Norrbom, 1997). It was described from Baluchistan, an area stretching from south-eastern Iran to western Pakistan, hence the English name Baluchistan melon fly. It should not be confused with the tropical Zeugodacus cucurbitae (Coquillett), a member of a different tribe (Table 2). Because severe outbreaks were reported in Central Asia, the European and Mediterranean Plant Protection Organization (EPPO) added M. pardalina to its Alert List (EPPO, n.d.).

This article summarises current knowledge on the morphology, life cycle and damage of M. pardalina and systematises control measures suited to Central Asian conditions.

2. Materials and methods

This is a narrative review; no new field or laboratory experiments were carried out. The analysis relied on the EPPO Global Database, a recent international review in Insects (Liu et al., 2025) and the primary sources it cites, together with studies from Türkiye, Iran, Kazakhstan, Uzbekistan, Turkmenistan and Afghanistan. Classical Russian-language studies (Novozhilov and Zhukovskii, 1967; Prokudina and Shevchenko, 1983) were consulted through that review. Numerical values are given as ranges reported in the sources. Figures were prepared by the author as schematic illustrations based on published descriptions and data; they are not photographs or measured data.

3. Taxonomy, external morphology and identification

3.1. Taxonomic position

M. pardalina belongs to Animalia – Arthropoda – Insecta – Diptera – Tephritidae, tribe Carpomyini (Korneyev et al., 2017). Like all Diptera, adults have a single pair of functional wings (the hind wings are reduced to halteres), a head with large compound eyes, a thorax carrying the wings and three pairs of legs, and a segmented abdomen.

3.2. Adult body structure

Adults are small flies: males are 5.0–6.4 mm and females 6.3–7.3 mm long, so the sexes differ in size (Liu et al., 2025). The **head** is dark yellow, broader than long, without facial spots or silvery markings on the frons and parafrons; the face is flat or convex with distinct antennal grooves, the compound eyes are elongate, the antennae are shorter than the face and the proboscis is short and capitate. The **thorax** (mesonotum) ranges from light yellow to brown and bears black spots, with a central black spot at the posterior margin; the scutellum is light yellow with a small median black dot; the legs lack dark femoral spots. The **abdomen** is yellow to orange-brown, with tergites III–V lacking a dark median longitudinal stripe and tergite V lacking glandular spots. Males lack dark setae on tergite III; in females, tergite VI is exposed and as long as tergite V, and the flattened, non-serrated ovipositor (aculeus) is used to pierce fruit skin; females have three sclerotised spermathecae (Korneyev et al., 2017; Baris and Cobanoglu, 2014).

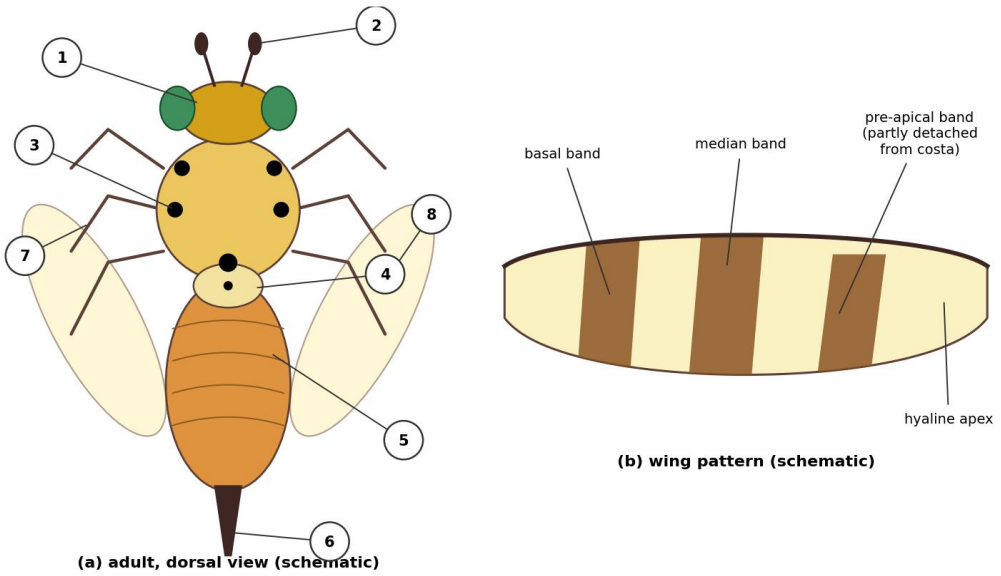


Figure 1. External morphology of the adult. (a) Dorsal view: 1, head (dark yellow, broader than long, no facial spots); 2, short antennae; 3, mesonotum with black spots; 4, scutellum with a small median black dot; 5, abdomen (yellow to orange-brown, no dark median stripe on tergites III–V); 6, female ovipositor; 7, legs (no dark femoral spots); 8, wing. (b) Wing with basal, median and pre-apical crossbands; the pre-apical band is partly detached from the costa. Schematic drawing by the author based on published descriptions (Baris and Cobanoglu, 2014; Korneyev et al., 2017; Liu et al., 2025); not to scale, spot arrangement simplified.

The **wings** are light yellow with banding akin to Rhagoletis: basal, median and pre-apical crossbands extend towards the posterior margin; the pre-apical band is partly or fully detached from vein C, leaving a hyaline area distally in cell R2+3. Vein R2+3 is straight and ends in a distinct, anteriorly inclined spur; the r-m crossvein meets the discal medial cell near its middle; the basal medial cell is narrow and triangular, 2.5–3 times longer than wide; the anal streak is absent or incomplete (Liu et al., 2025).

3.3. Immature stages

Table 1. Characteristics of the developmental stages of M. pardalina (Baris and Cobanoglu, 2013, 2014; Liu et al., 2025)

Stage	Description	Duration, days	Location / remarks
Egg	Elliptical, glossy white, ~1.2 × 2.0 mm	2–3 (field); 1.5–3.7 (lab.)	Laid under the skin of young fruit; in severe outbreaks also in flower buds
Larva	Cream-white, apodous; ~10 mm when mature; (as in tephritids generally) three instars	8–18 (field); 5–13 (lab.)	Feeds in fruit pulp; mature larva leaves the fruit to pupate
Puparium	Brown, coarctate, mean ~7.2 mm	13–20 (field); 12–19.2 (lab.)	Soil, 1–16 cm deep; overwintering stage
Adult	Males 5.0–6.4 mm, females 6.3–7.3 mm; banded wings	Lives 10–20; pre-oviposition 2–6; oviposition 11–18	Shaded foliage and plant bases in the heat; feeds on sugary secretions

3.4. Recognition in the field and distinguishing similar species

In the field, infestation is first suggested by oviposition punctures on young fruit, often with a small exudate of plant tissue, followed by softening and decay of the pulp, foul odour and premature fruit drop; cutting open the fruit reveals cream-white, legless larvae, and mature fruits show round exit holes (Liu et al., 2025). Adults are best recognised by their size, yellow-brown colouring, spotted mesonotum and banded wings; species-level confirmation requires keys for Carpomyini (Korneyev et al., 2017) or molecular tests (Section 7.1). M. pardalina is not lured by Cue-lure or methyl eugenol, unlike many other fruit flies, which means such traps cannot be used to survey it.

Table 2. Distinguishing M. pardalina from Z. cucurbitae (Liu et al., 2025; White and Elson-Harris, 1992)

Feature	Myiopardalis pardalina	Zeugodacus cucurbitae
Distribution	Central Asia, Middle East, Türkiye, Caucasus; seasonal climate with cold winters	Mainly tropical and subtropical Asia, Africa and Pacific islands
Taxonomic group	Tephritidae, tribe Carpomyini; banded wings akin to Rhagoletis	Tephritidae, subfamily Dacinae (different wing pattern and body markings)
Hosts	Oligophagous; mainly cucurbits	Wider range of hosts including non-cucurbits
Lures	Not attracted to Cue-lure or methyl eugenol; melon fruit attracts	Males strongly attracted to Cue-lure (widely used in monitoring)
Overwintering	Puparia in soil; survive snow cover and light frost	Adapted to tropical climates; poor cold tolerance

4. Distribution and host plants

The species has been recorded in more than 20 countries across Africa, Asia and Europe, including Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Afghanistan, Iran, Pakistan, Türkiye, Azerbaijan and Armenia (Liu et al., 2025). In China it has only been intercepted. It is regulated as a quarantine pest by the European Union, the USA, Kazakhstan, Japan and others (EFSA, 2020; Liu et al., 2025). The main pathway of spread is trade in fruit infested with larvae or puparia, and climate models indicate suitable conditions across much of Europe and China (Qin et al., 2021).

M. pardalina is oligophagous on Cucurbitaceae. Melon is the principal host; watermelon (Citrullus lanatus), cucumber (Cucumis sativus), snake melon (C. melo var. flexuosus) and pumpkin (Cucurbita maxima) are also attacked, and wild hosts include Cucumis trigonus and Ecballium elaterium (Liu et al., 2025).

5. Life cycle and seasonal development

Development is holometabolous: egg, larva, puparium and adult (Figure 2). The puparium is the overwintering stage, located in the soil at depths from 1–2 cm down to 15–16 cm, where it survives under snow cover and at temperatures just below freezing. Adults emerge in spring in step with melon flowering, in mid-May to early June in the eastern Mediterranean; in Central Asia the exact timing shifts with local climate, soil temperature and sowing date (Liu et al., 2025).

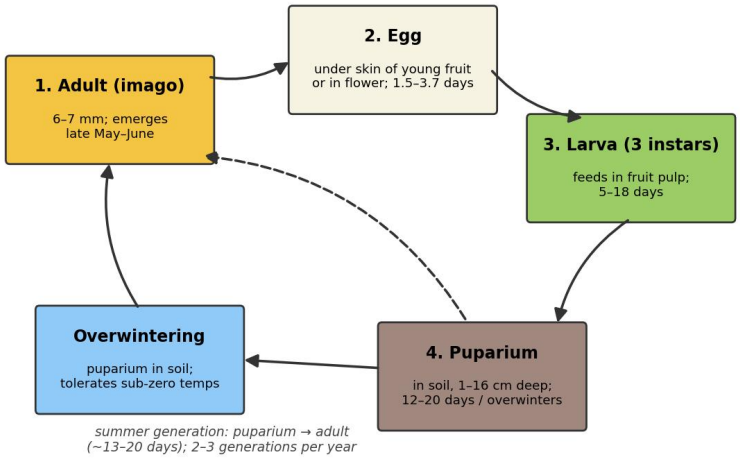


Figure 2. Life cycle of M. pardalina (schematic based on the literature).

After emergence and a maturation period, both sexes mate repeatedly. In the laboratory, females mated on average 5.83 times and males 6.26 times in eight days, mostly in the early afternoon, each mating lasting about five to seven hours (Movahedi Fazel and Mohammadipour, 2014). A female lays at least 100 eggs under the epidermis of developing fruit; hatching larvae tunnel straight into the pulp, and mature larvae leave the fruit and pupate in the soil (Liu et al., 2025).

Development time depends on temperature (Figure 3). Under summer field conditions the egg hatches in 2–3 days, the larva develops in 8–18 days and the puparium in 13–20 days, so a full cycle takes about 30 days; at 25 ± 1 °C in the laboratory the stages last 1.5–3.7, 5–13 and 12–19.2 days. Near Ankara, development from egg to adult took 36–39 days and two to three generations occurred per year (Baris and Cobanoglu, 2013). Adults live 10–20 days, so generations overlap; most regions report two to three generations, and up to four are known in Iran and Israel (Liu et al., 2025). In Kazakhstan, the mass emergence of the second generation was treated as a separate control window (Toyzhigitova et al., 2017).

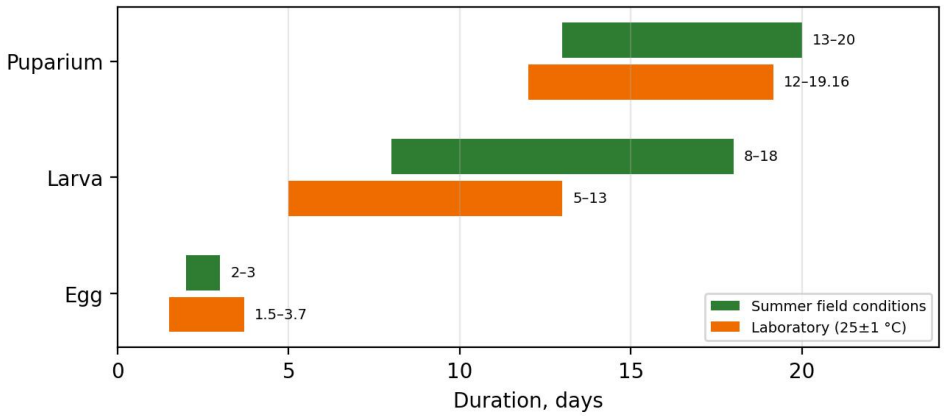


Figure 3. Duration of developmental stages (ranges from sources cited in Liu et al., 2025).

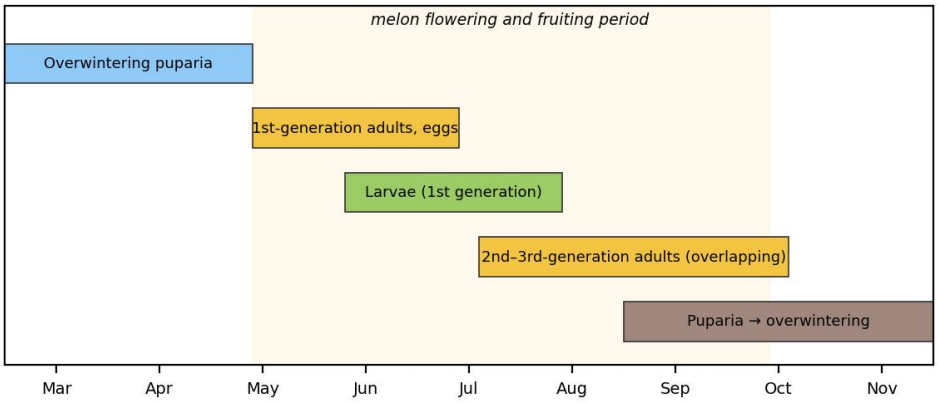


Figure 4. Generalised seasonal development (exact dates vary with region and year; schematic is the author's interpretation).

Detailed multi-year field observations of generation number and phenology are still lacking for Uzbekistan and neighbouring republics. A regional warning system therefore needs each province to record, with pheromone or yellow sticky traps, the first emergence of adults and the peak of the second generation.

6. Damage to agriculture

Damage is caused by the larvae, which tunnel through the pulp, causing rapid tissue decay, foul odour and premature spoilage; mature larvae exit through holes and the produce becomes unmarketable (Liu et al., 2025). In severe outbreaks females even lay eggs in unopened flowers, so larvae enter stems and leaf stalks before fruit forms, and surface-applied contact insecticides then fail.

Losses vary widely among regions, cultivars and protection levels (Figure 5). Reported figures include 85–90% in melon and 60% in watermelon in Israel; 56.7% in melon (2.8% in watermelon, 1.1% in pumpkin, 0.1% in cucumber) in Turkmenistan; 30–40% in unprotected melon in Afghanistan; 6.7–34.5% in Armenia; and 10–25% in Kazakhstan's Kyzylorda region, where about half of farms were affected and complete crop failure occurred in severe cases (Liu et al., 2025; Stonehouse et al., 2006; Toyzhigitova et al., 2019). In Iran, infestation of some melon cultivars was reported at 30–80% (Movahedi Fazel and Mohammadipour, 2014). Because these data come from different methods and years, they indicate the scale of risk rather than permit direct comparison.

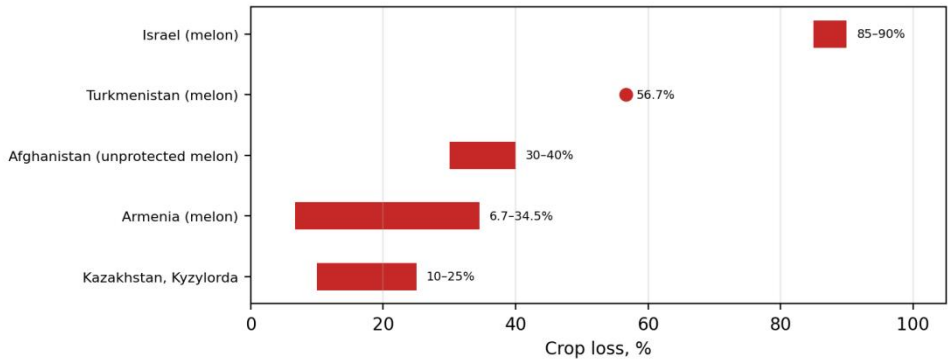


Figure 5. Reported melon crop losses caused by M. pardalina (Liu et al., 2025; Stonehouse et al., 2006; Toyzhigitova et al., 2019). Dot = single value; bar = range.

7. Management

7.1. Monitoring and quarantine

Quarantine inspection requires reliable detection and identification. A colour-change LAMP assay and an RPA-CRISPR/Cas12a on-site detection kit have been developed for M. pardalina, and its mitochondrial genome has been sequenced (Guo et al., 2024; Liu et al., 2025). In Kazakhstan, ionising radiation (a 65 Gy sterilising dose) was tested for quarantine purposes (Toyzhigitova et al., 2017). For field monitoring, pheromone traps, yellow sticky traps and feeding traps with melon-juice and sugar syrup have been used (Toyzhigitova et al., 2019); in Uzbekistan species-specific allelochemicals attractive to males were isolated and pheromone traps based on them were tested (Kholbekov et al., 2023; Yuldashev et al., 2024).

7.2. Cultural and sanitary measures

Because puparia overwinter in the soil, autumn–winter soil measures reduce populations: removal of crop residues after harvest, deep ploughing and winter irrigation (these follow from the pest's soil-dwelling overwintering biology; shallow ploughing was noted to give poor results — Liu et al., 2025). Infested and fallen fruits should not be left in the field but buried with lime in a pit, traditionally 1 m deep and at least 50 cm. Further measures include crop rotation and early planting, weed-free fields with good light and air movement, turning fruits towards the sun and pruning excess foliage. Bagging young fruits blocks oviposition; in Pakistan this markedly raised melon yield (Liu et al., 2025). Drawbacks are high labour demand and reduced effect under heavy pressure.

7.3. Chemical control

Because larvae live inside the fruit, treatments must be timed to adult emergence and oviposition. In Kazakhstan, a sequence applied at the end of flowering, at fruit formation and at mass emergence of the second generation reduced fruit infestation by 89.0–91.3% (Table 3). In Pakistan, bait sprays mixed with protein hydrolysate on a 5 m strip at the field edge reduced infestation, and in Khorezm several emulsifiable concentrates achieved over 80% efficacy (Liu et al., 2025). Important caution: older products such as endosulfan are restricted or banned in many countries; in practice only products officially registered in Uzbekistan for cucurbits should be used, following label rates and pre-harvest intervals, and active-ingredient groups should be rotated to delay resistance.

Table 3. Examples of field results for chemical protection

Region / source	Scheme or product	Result
Kazakhstan (Toyzhigitova et al., 2017)	Enjio 247 SC (thiamethoxam + lambda-cyhalothrin) 0.25 L/ha at end of flowering → Nurelle D (chlorpyrifos + cypermethrin) 0.7 L/ha at fruit formation → Enjio 247 SC 0.25 L/ha at mass emergence of 2nd generation	Fruit infestation reduced by 89.0–91.3%
Kazakhstan (same source)	Nurelle D alone, 0.7 L/ha, same timing	Damage reduced by 83.9–90.4%
Pakistan (Abdullah et al., 2007)	Bait spray (protein hydrolysate + insecticide) on 5 m field-edge strip	Infestation reduced, yield increased
Khorezm (cited in Liu et al., 2025)	Belmak 5%, Detsis 2.5%, Tsipi 25% EC	Efficacy >80%; Belmak best

7.4. Biological and biotechnical methods

The sterile insect technique is theoretically possible, but the species' repeated mating complicates it (Movahedi Fazel and Mohammadipour, 2014). Cue-lure and methyl eugenol failed in Türkiye and Afghanistan, and of the baits tested only melon fruit consistently attracted flies (Stonehouse et al., 2006). The entomopathogenic nematode Heterorhabditis bacteriophora caused about 80% mortality of puparia in the laboratory (Alabouid et al., 2019). Three ant species (Cataglyphis bicolor, C. megalocola, Pheidole pallidula) are known to prey on larvae, but their field effect has not been quantified (Liu et al., 2025).

7.5. Host-plant resistance

Susceptibility is often linked to thin fruit skin, which the ovipositor penetrates more easily. In Iran's Sistan region the cultivars Sefidak and Firoozi99 showed 18–20% damage, and in Türkiye four cultivars and a local genotype were damaged below 10% (Alabouid and Bayhan, 2022; Liu et al., 2025); breeding for resistance is under way in Kazakhstan (Toyzhigitova et al., 2019). Testing local Central Asian melon cultivars in the field is a promising direction.

8. Discussion: an integrated protection system

No single method is sufficient. The soil-dwelling overwintering stage, the hidden larva inside the fruit and repeated mating require action on several stages at once. Table 4 proposes a system for Central Asian conditions; it rests on published data, but exact timings must be adjusted in each province using local monitoring results.

Table 4. Proposed protection system for Central Asian conditions

Period	Measure	Basis
Autumn–winter	Remove crop residues and infested fruit; deep ploughing; winter irrigation	Overwintering puparia in soil (Liu et al., 2025)
Spring	Crop rotation, early planting; set pheromone / yellow sticky traps and record first emergence	Kholbekov et al., 2023; Toyzhigitova et al., 2019
Flowering to fruit set	Bag young fruit; bait sprays on field margins; treat with a registered product at end of flowering	Liu et al., 2025; Toyzhigitova et al., 2017

Period	Measure	Basis
Summer (2nd generation)	Repeat treatment at mass emergence, rotating active-ingredient group; collect and bury infested fruit promptly	Toyzhigitova et al., 2017
Whole season	Prune dense foliage, control weeds; trial resistant cultivars	Alabouid and Bayhan, 2022

Limitations: much of the available evidence rests on regional reports and grey literature, and standardised multi-year measurements of phenology and losses for Uzbekistan are scarce. Priorities for future work are (1) local phenological monitoring and a warning model; (2) field evaluation of pheromone traps; (3) field testing of native nematodes and entomopathogenic fungi; (4) resistance screening of local melon cultivars; and (5) residue and insecticide-resistance monitoring.

9. Conclusions

- M. pardalina is a dangerous pest of cucurbits in Central Asia; adults are 5–7 mm yellow-brown flies with banded wings and a spotted mesonotum, and the species overwinters as puparia in the soil and has two to three generations a year.
- Larvae feed inside the fruit, so damage is hidden; reported crop losses range from 6.7% to 90%.
- The most effective approach combines monitoring, sanitation and soil measures, timed chemical treatment (end of flowering and second-generation emergence), fruit bagging and resistant cultivars.
- Local phenological and efficacy studies remain a priority need for the region.

Declarations

Funding: This work received no funding from any organisation or grant. **Author contributions:** The article was prepared by the sole author. **Conflicts of interest:** The author declares no conflict of interest. **Data availability:** No new data were created; all figures are taken from the cited literature.

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