EPPO Datasheet: *Ceratitis capitata*

Last updated: 2021-04-28

IDENTITY

Preferred name: *Ceratitis capitata*
Authority: (Wiedemann)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Diptera: Tephritidae
Other scientific names: *Ceratitis citriperda* Macleay, *Ceratitis hispanica* de Breme, *Pardalaspis asparagi* Bezzi, *Tephritis capitata* Wiedemann
Common names: Mediterranean fruit fly, medfly
view more common names online...
EPPO Categorization: A2 list
view more categorizations online...
EPPO Code: CERTCA

more photos...

HOSTS

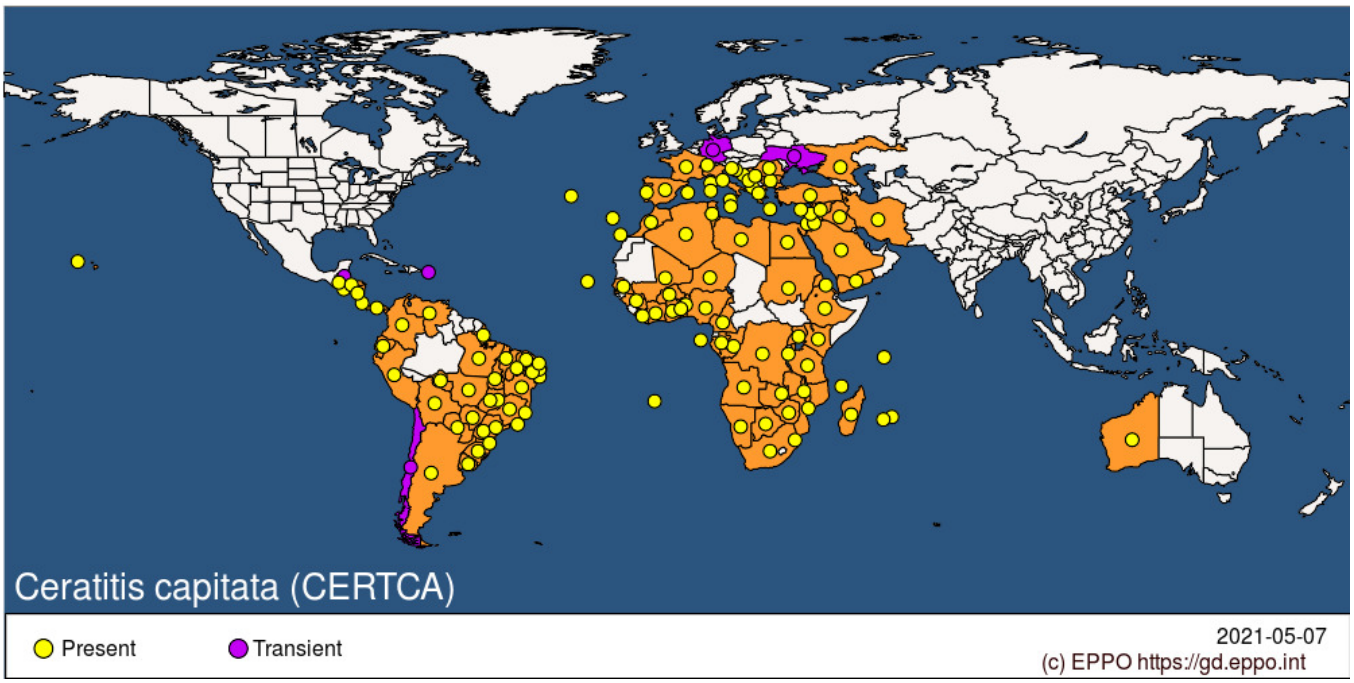
C. capitata is a highly polyphagous species whose larvae develop in a very wide range of unrelated fruits. It is recorded from more than 350 different confirmed hosts worldwide, belonging to 70 plant families. In addition, it is associated with a large number of other plant taxa for which the host status is not certain. The USDA Compendium of Fruit Fly Host Information (CoFFHI) (Liquido *et al.*, 2020) provides an extensive host list with detailed references.

Host list: *Acca sellowiana*, *Acokanthera abyssinica*, *Acokanthera oppositifolia*, *Acokanthera sp.*, *Actinidia chinensis* , *Actinidia deliciosa*, *Anacardium occidentale*, *Annona cherimola*, *Annona muricata*, *Annona reticulata*, *Annona senegalensis*, *Annona squamosa*, *Antiaris toxicaria*, *Antidesma venosum*, *Arbutus unedo*, *Arenga pinnata*, *Argania spinosa*, *Artabotrys monteiroae*, *Artocarpus altilis*, *Asparagus sp.*, *Astropanax volkensii*, *Atalantia sp.*, *Averrhoa bilimbi*, *Averrhoa carambola*, *Azima tetracantha*, *Berberis holstii*, *Berchemia discolor*, *Blighia sapida*, *Bourreria petiolaris*, *Brucea antidysenterica*, *Brucea sp.*, *Butia capitata*, *Butia eriospatha*, *Byrsonima crassifolia*, *Calophyllum inophyllum*, *Calophyllum tacamahaca*, *Calotropis procera*, *Campomanesia sessiliflora*, *Cananga odorata*, *Capparicordis crotonoides*, *Capparis duchesnei*, *Capparis mariana*, *Capparis sepiaria var. citrifolia*, *Capparis sepiaria*, *Capparis sp.*, *Capparis spinosa*, *Capparis tomentosa*, *Capsicum annuum*, *Capsicum baccatum*, *Capsicum cardenasii*, *Capsicum chinense*, *Capsicum frutescens*, *Capsicum pubescens*, *Carica papaya*, *Carissa bispinosa*, *Carissa carandas*, *Carissa macrocarpa*, *Carissa spinarum*, *Carissa tetramera*, *Carya illinoinensis*, *Cascabela thevetia*, *Casimiroa edulis*, *Celtis tala*, *Cestrum nocturnum*, *Chrysobalanus icaco*, *Chrysophyllum cainito*, *Chrysophyllum gonocarpum*, *Chrysophyllum oliviforme*, *Chrysophyllum viridifolium*, *Cinnamomum verum*, *Citharexylum myrianthum*, *Citrus aurantiifolia*, *Citrus aurantium*, *Citrus deliciosa*, *Citrus latifolia*, *Citrus limon*, *Citrus lumia*, *Citrus maxima*, *Citrus medica*, *Citrus paradisi*, *Citrus reshni*, *Citrus reticulata*, *Citrus sinensis*, *Citrus unshiu*, *Citrus x nobilis*, *Clausena anisata*, *Clausena lansium*, *Coccinia grandis*, *Coccinia microphylla*, *Coccoloba uvifera*, *Coffea arabica*, *Coffea canephora*, *Coffea liberica*, *Cola natalensis*, *Corallocarpus ellipticus*, *Cordia sebestena*, *Corynocarpus laevigatus*, *Crataegus azarolus*, *Crataegus gracilior*, *Crateva tapia*, *Cucumis dipsaceus*, *Cucurbita sp.*, *Cucurbitella asperata*, *Cyclanthera pedata*, *Cydonia oblonga*, *Dimocarpus longan*, *Diospyros abyssinica*, *Diospyros decandra*, *Diospyros ebenum*, *Diospyros hebecarpa*, *Diospyros kaki*, *Diospyros mespiliformis*, *Diospyros pallens*, *Diospyros pubescens*, *Dovyalis caffra*, *Dovyalis hebecarpa*, *Drypetes floribunda*, *Drypetes gerrardii*, *Drypetes natalensis var. leiogyna*, *Drypetes natalensis*, *Ehretia cymosa*, *Ekebergia capensis*, *Elaeodendron schweinfurthianum*, *Englerophytum magalismontanum*, *Eriobotrya japonica*, *Euclea divinorum*, *Euclea racemosa subsp. schimperi*, *Eugenia dombeyi*, *Eugenia involucrata*, *Eugenia lambertiana*, *Eugenia myrcianthes*, *Eugenia pyriformis*, *Eugenia uniflora*, *Ficus carica*, *Filicium decipiens*, *Flacourtia indica*, *Flagellaria guineensis*, *Flueggea virosa*, *Fortunella japonica*, *Fragaria chiloensis*, *Fragaria x ananassa*, *Frangula californica*, *Garcinia acuminata*, *Garcinia brasiliensis*, *Garcinia livingstonei*, *Garcinia mangostana*, *Garcinia xanthochymus*, *Geoffroea decorticans*, *Gmelina arborea*, *Gossypium*, *Grewia tembensis*, *Grewia trichocarpa*, *Guettarda speciosa*, *Hancornia speciosa*

, Harpephyllum caffrum, Harrisonia abyssinica, Inga feuillei, Inga laurina, Inga sellowiana, Juglans australis, Juglans neotropica, Juglans nigra, Juglans regia, Lagenaria siceraria, Lamprothamnus zanguebaricus, Latania loddigesii, Litchi chinensis, Ludia mauritiana, Lycium chinense, Lycium europaeum, Lycium ferocissimum, Malpighia emarginata, Malpighia glabra, Malus domestica, Malus floribunda, Malus sylvestris, Mangifera indica, Manilkara butugi, Manilkara sansibarensis, Manilkara sulcata, Manilkara zapota, Matisia cordata, Mespilus germanica, Miliusa brahei, Mimusops bagshawei, Mimusops caffra, Mimusops elengi, Mimusops kummel, Mimusops obtusifolia, Mimusops zeyheri, Momordica charantia, Monodora grandidieri, Moquilea tomentosa, Morus alba, Morus nigra, Morus rubra, Mouriri elliptica, Muntingia calabura, Murraya paniculata, Musa acuminata, Musa x paradisiaca, Myrcianthes pungens, Myrciaria cauliflora, Myrciaria glomerata, Myrianthus arboreus, Mystroxylon aethiopicum, Neocarya macrophylla, Noronhia emarginata, Ochrosia elliptica, Olea europaea subsp. africana, Olea europaea, Olea woodiana subsp. disjuncta, Olea woodiana, Opilia amentacea, Opuntia ficus-indica, Opuntia monacantha, Oxyanthus zanguebaricus, Parinari curatellifolia, Parmentiera aculeata, Passiflora alata, Passiflora caerulea, Passiflora edulis, Passiflora foetida, Passiflora ligularis, Passiflora suberosa, Passiflora tripartita, Pentarhopalopilia umbellulata, Peponium mackenii, Pereskia aculeata, Pereskia bahiensis, Persea americana, Phoenix dactylifera, Phyllanthus acidus, Physalis peruviana, Pithecellobium dulce, Podocarpus elongatus, Polysphaeria parvifolia, Poncirus trifoliata, Pouteria caimito, Pouteria campechiana, Pouteria lucuma, Pouteria ramiflora, Pouteria sapota, Pouteria viridis, Prunus africana, Prunus armeniaca, Prunus avium, Prunus cerasifera, Prunus cerasus, Prunus domestica, Prunus dulcis, Prunus ilicifolia, Prunus mume, Prunus persica, Prunus salicina, Prunus serotina var. salicifolia, Prunus, Psidium cattleyanum, Psidium friedrichsthalianum, Psidium guajava, Psidium guineense, Punica granatum, Pyrus communis, Pyrus pyrifolia var. culta, Pyrus pyrifolia, Rawsonia sp., Rubus fruticosus, Rubus hybrids, Rubus idaeus, Rubus lucidus, Rubus sanctus, Rudgea verticillata, Salacia elegans, Salpichroa origanifolia, Sandoricum koetjape, Santalum album, Santalum ellipticum, Sarcomphalus joazeiro, Scaevola plumieri, Scaevola taccada, Sideroxylon foetidissimum, Sideroxylon inerme subsp. diospyroides, Sideroxylon inerme, Sideroxylon polynesicum, Simmondsia chinensis, Solanum aethiopicum, Solanum betaceum, Solanum elaeagnifolium, Solanum glaucophyllum, Solanum incanum, Solanum linnaeanum, Solanum lycopersicum, Solanum macrocarpon, Solanum mauritianum, Solanum melongena, Solanum muricatum, Solanum nigrum, Solanum pimpinellifolium, Solanum pseudocapsicum, Solanum scabrum, Solanum seaforthianum, Solanum sessiliflorum, Solanum sisymbriifolium, Solanum torvum, Sorocea bonplandii, Spondias dulcis, Spondias mombin, Spondias purpurea, Spondias tuberosa, Spondias venulosa, Sterculia apetala, Strychnos decussata, Strychnos henningsii, Strychnos potatorum, Strychnos pungens, Syngonium podophyllum, Synsepalum dulcificum, Syzygium cordatum, Syzygium cumini, Syzygium jambos, Syzygium malaccense, Syzygium paniculatum, Syzygium samarangense, Terminalia catappa, Terminalia chebula, Terminalia petiolaris, Theobroma cacao, Toddalia simplicifolia, Triphasia trifolia, Vaccinium corymbosum, Vangueria infausta, Vasconcellea quercifolia, Vepris lanceolata, Vepris nobilis, Vepris trichocarpa, Vitellaria paradoxa, Vitex gigantea, Vitis labrusca, Vitis vinifera, Wikstroemia phillyreifolia, Ximenia americana, Ziziphus jujuba, Ziziphus lotus, Ziziphus mauritiana, Ziziphus mucronata, Ziziphus spina-christi, x Citrofortunella microcarpa

GEOGRAPHICAL DISTRIBUTION

Ceratitis capitata is of Sub-Saharan African origin (probably Eastern or Southern Africa, see De Meyer *et al.*, 2004) and is found throughout the whole of Sub-Saharan Africa where it appears to be less abundant in wetter, and colder conditions but prevalent in dry, hot environments. From Africa is has spread to different parts of the world, first the Mediterranean Basin, and afterwards to Latin America, Australia and Hawaii. It is also introduced on all islands in the Western Indian Ocean. For a recent worldwide phylogeography based on mitochondrial DNA, see Ruiz-Arce *et al.* (2020). In California (US), *C. capitata* is regularly detected but is systematically subject to eradication campaigns. However, the complete elimination of populations has been queried by Papadopoulos *et al.* (2013) who considered that barely detectable populations are established and reappear regularly. In addition, there are intermittent records from several countries outside the established range.



EPPO Region: Albania, Algeria, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, France (mainland, Corse), Germany, Greece (mainland, Kriti), Israel, Italy (mainland, Sardegna, Sicilia), Jordan, Malta, Montenegro, Morocco, Portugal (mainland, Azores, Madeira), Romania, Russia (Southern Russia), Serbia, Slovenia, Spain (mainland, Islas Baleares, Islas Canárias), Switzerland, Tunisia, Turkey, Ukraine
Africa: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Comoros, Congo, Congo, Democratic republic of the, Cote d'Ivoire, Egypt, Eritrea, Eswatini, Ethiopia, Gabon, Ghana, Guinea, Kenya, Liberia, Libya, Madagascar, Malawi, Mali, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Saint Helena, Sao Tome & Principe, Senegal, Seychelles, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe
Asia: Iran, Iraq, Israel, Jordan, Lebanon, Saudi Arabia, Syria, Yemen
North America: United States of America (Hawaii)
Central America and Caribbean: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Puerto Rico
South America: Argentina, Bolivia, Brazil (Alagoas, Amapa, Bahia, Ceara, Distrito Federal, Espirito Santo, Goias, Maranhao, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Para, Paraiba, Parana, Pernambuco, Piaui, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Rondonia, Santa Catarina, Sao Paulo, Tocantins), Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela
Oceania: Australia (Western Australia)

BIOLOGY

The general life cycle is similar to those of other *Ceratitis* species infesting fruits: eggs are laid below the skin of the host fruit. Three larval stages develop inside the fruit, feeding on the plant tissue. Once mature the third instar larva will leave the fruit, dig down into the soil and turn into a pupa enclosed in a puparium. The adult fly will emerge from the puparium. Adult *Ceratitis capitata* flies have been recorded to have an average life span for males of 11 weeks and for females of 9 weeks (Carey *et al*. 2008), although some individuals can live longer. Females start laying eggs in fruit between 3-6 days after adult emergence (Manrakhan & Lux, 2006; Vargas *et al.*, 1984, but see Diamantidis *et al*., 2009 mentioned below). The larval duration varies from 5 to 21 days at 30°C-15°C (Duyck & Quilici, 2002). The pupal stage lasts for 8-35 days at 30°C-15°C Duyck & Quilici, 2002). It can complete a full life cycle in about 32 days at 25°C (Vargas *et al*., 1984). Diamantidis *et al.* (2009) have shown that *C. capitata* populations have evolved resulting in different life history strategies (with regard to longevity, reproductive maturity, and fecundity) under different environmental conditions. Resistance to effects of climate stress (e.g. cold and heat, desiccation, starvation), demography, population fluctuations and number of annual generations also differ according to the environmental situation and local bioclimate conditions (Nyamukondiwa *et al*., 2013; Weldon *et al.*, 2018).

DETECTION AND IDENTIFICATION

Symptoms

Attacked fruit have tiny oviposition punctures, but these and other symptoms of damage are often difficult to detect in the early stages of infestation. Considerable damage may occur inside the fruit before symptoms are visible externally, often as networks of tunnels accompanied by rotting.

Morphology

Larva

Fruit fly larvae in general have a typical shape, i.e., cylindrical maggot-shape, elongate, anterior end narrowed and somewhat recurved ventrally, with anterior mouth hooks, and flattened caudal end. Their length varies from 5 to 15 mm. Identification to species level is not possible based on larvae. The 3rd-instar larvae have been described by White & Elson-Harris (1992), and Carroll *et al.* (2004). The former work provides a key to 3rd-instar larvae which is useful for an identification to genus level. Furthermore, a key to this and other tephritids for the 3rd-instar larvae is available in Balmès & Mouttet (2017) and White & Elson-Harris (1992).

Adult (after redescription given by De Meyer, 2000)

Male

Head. Antenna yellow to yellow-orange; first and second segment and base of third segment sometimes darker. Third antennal segment twice as long as second segment. Arista with short hairs, mainly on base and only distinct dorsally. Frons convex to flat; yellow, sometimes with darker orange or orange-brown patches including darker band near antennal implant, occasionally with faint silvery shine; with short scattered hairs which are largely the same colour as frons. Frontal and ocellar bristles black; lower orbital modified, stem pale and shorter than arista with apical end dark and diamond-shaped; upper orbital weakly developed, black. Face yellow-white. Genal bristle pale, genal setulae pale or reddish, weakly developed. Postocellar and outer vertical pale.

Thorax. Postpronotum white, with distinct black spot. Mesonotum: ground colour black, microtrichiae pattern silvery with ashgrey shine, spots black except sutural white spots, prescutellar white markings merged. Scapular setae pale. Scutellum yellow-white, basally with two dark spots, separate or narrowly touching, apically with three merged spots, only slightly incised. Anepisternum pale with lower half darker yellow, pilosity variable but at least partly dark in lower half.

Legs. Yellow; setation typical for subgenus, mainly pale especially on femora. Fore femur posterodorsally with bush of longer orange hairs along entire length, basally these hairs darker red or brown but not distinct black; posteriorly hairs much shorter; ventral spines yellow-orange; anteroventral row of hairs short and yellow-orange. Hind femur with longer hairs dorsally and ventrally on apical fourth.

Wing. marginal band usually with clear and complete interruption, occasionally narrowly or partly touching; cubital band free; medial band absent; crossvein r-m at or near middle of discal cell. Vein R1 beyond or equal with crossvein r-m. Orientation crossvein dm-cu variable.

Abdomen. Yellow. Setation and banding typical for subgenus.

Female

As in male except for the following characters: Third antennal segment in general darker than in male. Frons sometimes with darker hairs; darker patches never as apparent as in male. Orbitals not modified, well developed. Genal setulae darker and strongly developed. Anepisternum without darker pilosity. Legs without bush of longer hairs; ventral spines on fore femur sometimes partially dark. Oviscape shorter than abdominal terga. Aculeus pointed.

DNA barcoding

The molecular identification of *C. capitata* through DNA barcoding is potentially problematic as this species cannot be properly distinguished from *C. caetrata* (Barr *et al.*, 2012). However, the fact that *C. caetrata* has a restricted distribution and host range (only known from Kenya and not recorded from any commercially grown fruits, see De Meyer *et al.*, 2002) may limit the risk of misidentification. The presence of unidentified / possibly misidentified reference sequences in Barcoding Index Number Systems (BINs) in which this species is represented, might also bias its molecular identification. Sequences are available in the **Barcode of Life Data Systems (BOLD)** and **EPPO-Q-bank**.

Detection and inspection methods

Males are attracted to trimedlure and enhanced ginger oil (EGO) lure. Both sexes can be monitored by traps baited with protein-based attractants. Detection is also possible by examination of fruit for oviposition punctures and then rearing the larvae through to the adult stage.

PATHWAYS FOR MOVEMENT

Transport of infested fruits is the main means of movement and dispersal to previously uninfested areas. In a mark recapture trial, Meats & Smallridge (2007) showed that the majority (90%) of flies displaced only 400-700 m, and that any incursion would most likely be limited to within 1 km of the incursion point. Only very small proportion of flies disperse beyond 10 km.

PEST SIGNIFICANCE

Economic impact

The species is considered to be one of the major pest insects of a number of commercial fruits. Globally it has a massive economic impact, in particular where the species has been introduced (see for example IAEA, 1995, Enkerlin *et al.*, 2017). In Africa it seems to be in competition with other native and exotic fruit flies and its impact is more limited (Mwatawala *et al.*, 2009; Vayssières *et al.*, 2015), except for parts of South Africa where it is the major pest in several regions, in particular the Cape Region (Barnes, 2016).

Control

Management for this species includes the general control measures for fruit flies (see Vargas *et al.* 2015 for an overview of management options specifically for *Bactrocera* which also applies to *C. capitata*). These include sanitation (to gather all fallen and infested host fruits and destroy them). Insecticidal protection is possible by using a cover spray or a bait spray. Bait sprays work on the principle that both male and female tephritids are strongly attracted to a protein source from which ammonia emanates. Bait sprays have the advantage over cover sprays in that they can be applied as a spot treatment so that the flies are attracted to the insecticide and there is minimal impact on natural enemies and other beneficials. For *C. capitata* control, the use of bait stations, rather than bait sprays, has been suggested to be equally effective and more cost efficient (Pinero *et al.*, 2014). Applying Male Annihilation Technique (MAT) for *C. capitata* is less applicable than for some *Bactrocera* species because the main lure, trimedlure, is less effective, although suppression using trimedlure dispenser has been proposed (Vargas *et al.*, 2014).

Sterile Insect Technique (SIT) is extensively used in several countries and regions and for different strategic options (prevention, containment, eradication and suppression). One of the most extensive uses of SIT against *C. capitata* is carried out in Mexico and Central America, specifically in southern Mexico and Guatemala to prevent the fly moving northwards. An extensive review of the program (Programa Moscamed) can be found in Enkerlin *et al.* (2017). SIT as a suppression method is used within the EPPO region, i.e. in Portugal, Spain and Israel. See Enkerlin

(2005) for a review on SIT programs worldwide against this and other tephritid pest species. SIT is considered effective when applied in an integrated way in an area-wide Integrated Pest Management (IPM) program and when the actual population level has been reduced drastically prior to the SIT application (Hendrichs *et al*., 2005).

Phytosanitary risk

C. capitata is a known pest of several commercial fruit crops in the area where it is present. It can be moved in trade with infested fruit. Several studies on the climatic suitability of particular regions have been published (e.g. De Meyer *et al*., 2008; Vera *et al*., 2002).

C. capitata is present in the EPPO region mainly around the Mediterranean Basin. However, in recent years a number of cases have been recorded of sites in Central Europe where it has been trapped over successive years including areas with relatively low temperatures during winter months. It is currently not clear whether these are records of isolated populations or recurrent introductions at the same sites over several years, but a northward expansion due to climatic change cannot be excluded.

PHYTOSANITARY MEASURES

Consignments of fruits from countries or regions where *C. capitata* occurs should be inspected for symptoms of infestation and those suspected should be cut open in order to look for larvae. Possible measures include that such fruits should come from an area where *C. capitata* does not occur, or from a place of production found to be free from the pest by regular inspection in the 3 months before harvest. Plants transported with roots from countries or regions where *C. capitata* occurs should be free from soil, or the soil should be treated against puparia. The plants should not carry fruits. Cold treatment, hot water immersion, high temperature forced air, vapour heat treatment and fumigation can be performed on fruit commodities. Detailed information on these treatments and possible combinations of treatments for different species of fruits is available in USDA treatment manual (USDA, 2021) and in Annex 24 to 30 of ISPM 28 *Phytosanitary treatments for regulated pests* (FAO, 2011 and 2017 a to g).

REFERENCES

Balmès V & Mouttet R (2017) Development and validation of a simplified morphological identification key for larvae of tephritid species most commonly intercepted at import in Europe. *EPPO Bulletin* **47**, 91-99.

Barnes BN (2016) Sterile Insect Technique (SIT) for fruit fly control – the south African Experience. IN *Fruit Fly Research and Development in Africa – Towards a Sustainable Management Strategy to Improve Horticulture*, pp 435-464 (Eds Ekesi S, Mohamed SA & De Meyer M) Springer Verlag, Dordrecht (The Netherlands)

Barr NB, Islam MS, De Meyer M & McPheron BA (2012) Molecular identification of *Ceratitis capitata* (Diptera: Tephritidae) using DNA sequences of the COI barcode region. *Annals of the Entomological Society of America* **105**, 339-350.

Carey JR, Papadopoulos NK, Muller HG, Katsoyannos BI, Kouloussis NA, Wang JL, Wachter K, Yu W & Liedo P (2008) Age structure changes and extraordinary lifespan in wild medfly populations. *Aging cell* **7**, 426-437.

Carroll LE, Norrbom AL, Dallwitz MJ & Thompson FC (2004). Pest fruit flies of the world – larvae. Version 9th April 2019. https://www.delta-intkey.com/ffl/www/bac_zona.htm [accessed 22/11/2020]

De Meyer M (2000) Systematic revision of the subgenus *Ceratitis* MacLeay s.s. (Diptera, Tephritidae). *Zoological Journal of the Linnean Society* **128**, 439-467.

De Meyer M, Copeland RS, Lux S, Mansell M, Wharton R, White IM & Zenz N (2002) Annotated check list of host plants for Afrotropical fruit flies (Diptera: Tephritidae) of the genus *Ceratitis*. *Zoologische Documentatie Koninklijk Museum voor Midden Afrika* **27**, 1-92.

De Meyer M, Copeland RS, Wharton RA & McPheron BA (2004) On the geographical origin of the medfly, *Ceratitis capitata* (Wiedemann). *Proceedings 6th International Symposium on Fruit Flies of Economic Importance (Stellenbosch, South Africa),*

45-53.

De Meyer M, Robertson MP, Peterson AT & Mansell MW (2008) Ecological niches and potential geographical distributions of Mediterranean fruit fly (*Ceratitis capitata*) and Natal fruit fly (*Ceratitis rosa*). *Journal of Biogeography* **35**, 270-281.

Diamantidis AD, Papadopoulos NT, Nakas CT, Wu S, Müller HG & Carey JR (2009) Life history evolution in a globally invading tephritid: patterns of survival and reproduction in medflies from six world regions. *Biological Journal of the Linnean Society* **97**, 106-117.

Duyck PF & Quilici S (2002) Survival and development of different life stages of three *Ceratitis* spp. (Diptera: Tephritidae) reared at five constant temperatures. *Bulletin of Entomological Research* **92**, 461-469.

Enkerlin WR (2005) Impact of fruit fly control programmes using the sterile insect technique. In *Sterile Insect Technique. Principles and Practice in Area-Wide Integrated Pest Management*. (Eds Dyck VA, Hendrichs J & Robinson AS), pp 651-676. Springer Verlag, Dordrecht (The Netherlands)

Enkerlin WR, Gutiérrez Ruelas JM, Pantaleon R, Soto Litera C, Villasenor Cortés A, et al. (2017) The Moscamed regional programme: review of a success story of area-wide sterile insect technique application. *Entomologia Experimentalis et Applicata* **164**, 188-203.

FAO (2011) ISPM 28. Annex 14. Irradiation treatment for Ceratitis capitata. Rome, IPPC, FAO. https://www.ippc.int/en/publications/625/

FAO (2017a) ISPM 28. Annex 24. Cold treatment for Ceratitis capitata on Citrus sinensis. Rome, IPPC, FAO. https://www.ippc.int/en/publications/84350/

FAO (2017b) ISPM 28. Annex 25. Cold treatment for *Ceratitis capitata* on *Citrus reticulata* × *C. sinensis*. Rome, IPPC, FAO. https://www.ippc.int/en/publications/84351/

FAO (2017c) ISPM 28. Annex 26. Cold treatment for *Ceratitis capitata* on *Citrus limon*. Rome, IPPC, FAO. https://www.ippc.int/en/publications/84352/

FAO (2017d) ISPM 28. Annex 27. Cold treatment for *Ceratitis capitata* on *Citrus paradisi*. Rome, IPPC, FAO. https://www.ippc.int/en/publications/84353/

FAO (2017e) ISPM 28. Annex 28. Cold treatment for *Ceratitis capitata* on *Citrus reticulata*. Rome, IPPC, FAO. https://www.ippc.int/en/publications/84354/

FAO (2017f) ISPM 28. Annex 29. Cold treatment for *Ceratitis capitata* on *Citrus clementina*. Rome, IPPC, FAO. https://www.ippc.int/en/publications/84355/

FAO (2017g) ISPM 28. Annex 30. Vapour heat treatment for *Ceratitis capitata* on *Mangifera indica*. Rome, IPPC, FAO. https://www.ippc.int/en/publications/84356/

Hendrichs J, Vreysen MJB, Enkerlin WR & Cayol JP (2005) Strategic options in using sterile insects for area-wide integrated pest management. In *Sterile Insect Technique. Principles and Practice in Area-Wide Integrated Pest Management*. (Eds Dyck VA, Hendrichs J & Robinson AS), pp 563-600. Springer Verlag, Dordrecht (The Netherlands)

IAEA (1995) Economic evaluation of damage caused by, and methods of control of the Mediterranean fruit fly in the Maghreb. An analysis covering three control options including the sterile insect technique. Vienna: International Atomic Energy Agency, 72pp. http://www-naweb.iaea.org/nafa/ipc/public/ipc-ecnomic-medfly-maghreb-TECDOC830.pdf [accessed on 2021-04-23]

Liquido NJ, McQuate GT, Hanlin MA & Suiter KA (2020) Host plants of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), Version 4.0. Available online at: *USDA Compendium of Fruit Fly Host Information* (CoFFHI), Edition 4.0. https://coffhi.cphst.org/ [accessed on 2021-04-23]

Manrakhan A & Lux SA (2006) Contribution of natural food sources to reproductive behavior, fecundity and longevity of *Ceratitis cosyra*, *C. fasciventris* and *C. capitata* (Diptera: Tephritidae). *Bulletin of Entomological Research* **96**, 259-268.

Meats A & Smallridge CJ (2007) Short- and long-range dispersal of medfly, *Ceratitis capitata* (Dipt., Tephritidae), and its invasive potential. *Journal of applied Entomology* **131**, 518-523.

Mwatawala M, De Meyer M, Makundi R & Maerere A (2009) Host range and distribution of fruit-infesting pestiferous fruit flies (Diptera, Tephritidae) in selected areas of Central Tanzania. *Bulletin of Entomological Research* **99**, 629-641.

Nyamukondiwa C, Weldon CW, Chown SL, le Roux PC & Terblanche JS (2013) Thermal biology, population fluctuations and implications of temperature extremes for the management of two globally significant insect pests. *Journal of Insect Physiology* **59**, 1199-1211.

Papadopoulos NT, Plant RE & Carey JR (2013) From trickle to flood: the large-scale, cryptic invasión of California by tropical fruit flies. *Proceedings of the Royal Society B Biological Sciences* **280**, 20131466

Pinero JC, Enkerlin W & Epsky ND (2014) Recent developments and applications of bait stations for integrated pest management of tephritid fruit flies. In *Trapping and the detection, control, and regulation of tephritid fruit flies*. (Eds Shelly T, N Epsky, EB Jang, J Reyes-Flores & R Vargas), pp 457-492.Springer Verlag, Dordrecht (the Netherlands)

Ruiz-Arce R, Todd TN, Deleon R, Barr NB, Virgilio M, De Meyer M & McPheron BA (2020) Worldwide phylogeography of *Ceratitis capitata* (Diptera: Tephritidae) using mitocondrial DNA. *Journal of Economic Entomology* **20**, 1-16.

USDA (2021) United States Department of Agriculture Treatment Manual. https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf [accessed on 2021-04-23]

Vargas RI, Miyashita D & Nishida T (1984) Life-history and demographic parameters of three laboratory-reared Tephritids (Diptera: Tephritidae). *Annals of the Entomological Society of America* **77**, 651-656.

Vargas RI, Leblanc L, Pinero JC & Hoffman KM (2014) Male annihilation, past, present, and future. In *Trapping and the detection, control, and regulation of tephritid fruit flies*. (Eds Shelly T, N Epsky, EB Jang, J Reyes-Flores & R Vargas), pp 493-511.Springer Verlag, Dordrecht (the Netherlands)

Vargas RI, Pinero JC & Leblanc L (2015) An overview of pest species of *Bactrocera* fruit flies (Diptera: Tephritidae) and the integration of biopesticides with other biological approaches for their management with a focus on the Pacific region. *Insects* **6**, 297-318.

Vayssières JF, De Meyer M, Ouagoussounon I, Sinzogan A, Adandonon A, Korie S, Wargui R, Anato F, Houngbo H, Didier C, De Bon H & Goergen G (2015) Seasonal abundance of mango fruit flies (Diptera: Tephritidae) and ecological implications for their management in mango and cashew orchards in Benin (Centre & North). *Journal of Economic Entomology* **108**, 2213-2230.

Vera MT, Rodrigues R, Segura DF, Cladera JL & Sutherst RW (2002) Potential geographical distribution of the Mediterranean fruit fly, *Ceratitis capitata* (Diptera: Tephritidae), with emphasis on Argentina and Australia. *Population Ecology* **31**, 1009-1022.

Weldon CW, Nyamukondiwa C, Karsten M, Chown SL & Terblanche JS (2018) Geographic variation and plasticity in climate stress resistance among southern African populations of *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). *Scientific Reports* **8**, 9849.

White IM & Elson-Harris MM (1992) *Fruit flies of economic significance: their identification and bionomics*. CAB International, Wallingford (UK), xii+601pp

CABI resources used when preparing this datasheet

CABI Datasheet on Pest http://www.cabi.org/isc/datasheet/12367

ACKNOWLEDGEMENTS

This datasheet was prepared in 2021 by Dr M. De Meyer. His valuable contribution is gratefully acknowledged.

How to cite this datasheet?

EPPO (2021) *Ceratitis capitata*. EPPO datasheets on pests recommended for regulation. Available online. https://gd.eppo.int

Datasheet history

This datasheet was first published in the EPPO Bulletin in 1981 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2021. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

CABI/EPPO (1992/1997) *Quarantine Pests for Europe (1st and 2nd edition)*. CABI, Wallingford (GB).

EPPO (1981) Data Sheet on Quarantine Organisms no 105: *Ceratitis capitata*. EPPO Bulletin **11**(1), 1-6. https://doi.org/10.1111/j.1365-2338.1981.tb01739.x

Co-funded by the European Union