

Management of fruit flies in litchi orchards

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The importance of fruit flies

Fruit flies belong to the family Tephritidae in the order Diptera. Tephritids are small to medium sized (2,5 to 10 mm) flies that are often colourful, and usually with pictured wings. Tephritid fruit flies include some of the world's most serious agricultural pests. Female fruit flies lay eggs under the skin of fruits. Besides causing direct damage, fruit flies limit the development of

agriculture in many countries because of the strict trade quarantines imposed to prevent their spread. Therefore fruit flies play an important role in commodity trade between countries.

Fruit fly species of importance for litchi production in South Africa

In South Africa, the Mediterranean fruit fly, *Ceratitis capitata*, the Marula fruit fly, *Ceratitis cosyra*, and the Natal fruit fly, *Ceratitis rosa*, are important pests for the production of subtropical crops. However, the Mediterranean fruit fly and the Natal fruit fly are associated with litchi production in South Africa. The Natal fruit fly was the abundant specie trapped in litchi orchards. The invader fruit fly, *Bactrocera invadens*, was detected in South Africa for the first time in 2010 in the northern regions of the country. The invader fruit fly is currently considered to be present only in the Vhembe district in the Limpopo province. However, the specie was also detected in other areas of Limpopo, Mpumalanga, North West, Gauteng and KwaZulu-Natal. Apart from these

areas, South Africa is still largely free of the invasive species. Therefore the invader fly was detected in the most important litchi production areas. Currently the litchi is not listed as a host for the invader fruit fly. Therefore at this stage it is not known whether the invader fruit fly will lay its eggs in litchi fruit. The litchi will most probably be a poor host for the development of the larvae of invader fruit fly as in the case of other fruit fly species.

How to recognise the Mediterranean fruit fly

Mediterranean fruit fly is smaller than the Natal fruit fly. The males can be separated from other by the pair of black kite-like orbital setae on the head. The females can be separated by the yellow wing pattern and the apical half of the scutellum being entirely black (Fig. 1).

How to recognise the Natal fruit fly

The Natal fruit fly can be recognised by its characteristic patterns of brown wing bands, three black areas on the apical half of the scutellum and by the



male having feathering on the mid tibia and no feathering on the mid femur (Fig. 2).

How to recognise the invader fruit fly

The shape of the fly almost resembles that of a wasp. The species has

transparent wings with no patterning, opposed to the *Ceratitis* species. Two narrow yellow stripes are present on the sides of the thorax. The colour of the thorax is variable, from dark-reddish to striped reddish and black to entirely black. The abdomen has an extended T-shaped marking (Fig. 3).

Litchi and fruit fly development
 Although the Mediterranean and Natal fruit fly females lay their eggs inside the fruit, fermentation at the sting mark forces the eggs and maggots out, with the effect that the larvae rarely develop inside the fruit. The same applies for other fruit fly species of the genera *Anastrepha* and *Bactrocera* in other part parts of the world.

Importance of monitoring fruit flies

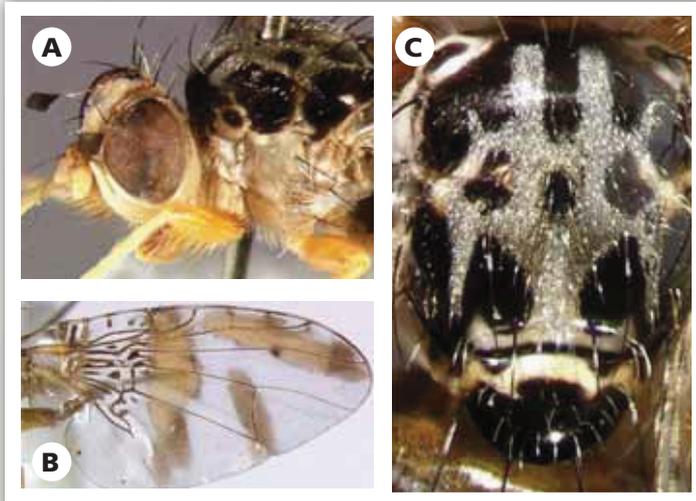
Monitoring of fruit flies is very important in the managing of the flies in litchi orchards. Monitoring helps to (1) identify species present in the orchard, (2) track changes in population levels, (3) give an indication of the numbers present, (4) determine the time for control actions to start and (5) determine the efficacy of control measures. Monitoring of fruit flies should commence just after fruit set and should continue until harvest.

Lures and traps for monitoring Mediterranean and the Natal fruit fly

Various types of traps and lures are available for the monitoring of fruit flies. Male lures are specific and are known to have a high efficacy in attracting male fruit flies over a long distance. Food baits attract both males and females. They are not species specific, do not attract flies over a long distance and give an indication of fruit flies present in the vicinity of the trap. Food baits, however, can also attract a number of non-target insects.

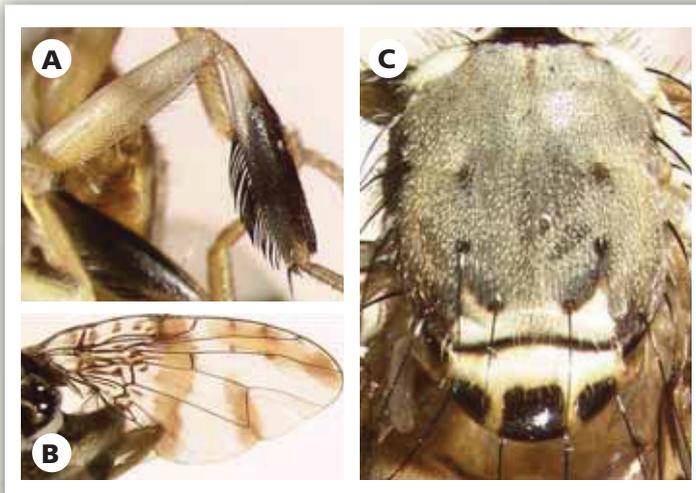
Capilure, Chempac Fruit Fly Lure, E.G.O. Pherolure® and Trimed Phero-

Figure 1. Mediterranean fruit fly.
 (images from <http://projects.bebif.be/fruitfly/>)



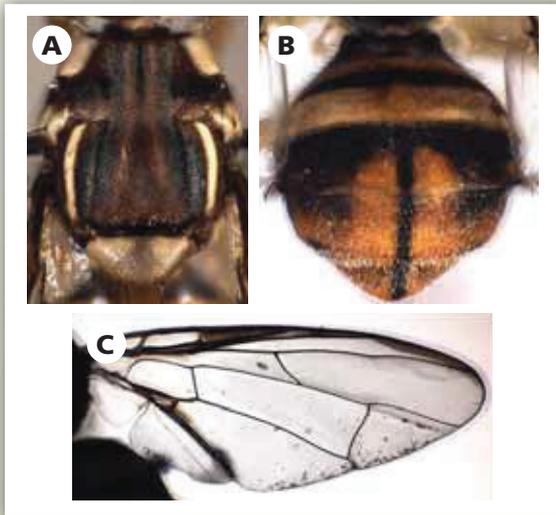
A. Thorax B. Wing C. Male head with kite-like setae

Figure 2. Natal fruit fly.
 (images from <http://projects.bebif.be/fruitfly/>)



A. Male mid leg with feathering B. Wing C. Thorax

Figure 3. Invader fruit fly.
 (images from <http://www.africamuseum.be/fruitfly/AfroAsia.htm>)



A. Thorax B. Abdomen with T-shaped marking C. Wing



Figure 4. Yellow Delta Trap.

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Figure 5. Chempac bucket trap – McPhail type trap.

lure® are male lures and can be used for monitoring *Ceratitis* species. Capilure, Chempac Fruit Fly Lure and Trimed Pherolure® contain trimedlure and attract males of the Mediterranean and Natal fruit fly. Capilure can be used together with a Sensus trap. Chempac Fruit Fly Lure can be used together with a Chempac Yellow Delta Trap with a Chempac Sticky Pad. Trimed Pherolure® can be used together with a McPhail trap or a Yellow Delta Trap with a sticky liner. E.G.O. Pherolure® contains enriched ginger root oil and attracts predominately males of the Mediterranean, Natal and Marula fruit fly. E.G.O. Pherolure® can be used together with a McPhail trap or a Yellow Delta Trap with a sticky liner (Fig. 4).

Questlure and Biolure® Fruit Fly are food baits that can be used for monitoring *Ceratitis* species. Questlure contains protein hydrolysate and plant extracts

and attracts both sexes of the Mediterranean, Natal and Marula fruit fly and can be used together with a Sensus trap. Biolure® Fruit Fly contains ammonium acetate, trimethylamine hydrochloride and 1,4-diaminobutane (putrescine) and attracts both sexes of the Mediterranean, Natal and Marula fruit fly. Biolure® Fruit Fly can be used together with a McPhail type trap (Fig. 5).

Dichlorvos containing blocks must be placed in the Chempac Bucket Trap, the McPhail trap and the Sensus trap. Replacing of food attractants, male lures and dichlorvos blocks is important – follow the directions for use. Usually one trap is placed per two hectares of orchard after flowering until harvest. Traps must be hung on the shady side of trees between 1,5 to 2 m above the ground. Ensure that the trap entrance is free from the foliage in order to allow free air movement and easy access for flies. Traps should not be exposed to the sun, wind or dust. The wire of the trap must be coated with a sticky barrier to avoid the access of ants. To avoid damage to traps, do not hang them in the working space of tractors and spray machines. Trap counts should be taken every seven days.

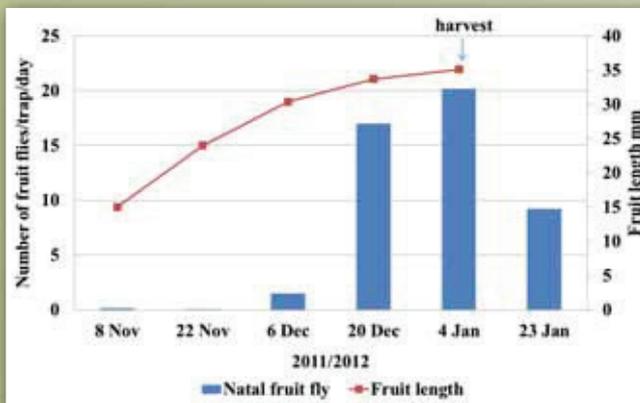


Figure 6. Seasonality of the Natal fruit fly in a litchi orchard in Limpopo province.

Lures and traps for monitoring the invader fruit fly

Various types of traps and lures are available for the monitoring of the invader fruit fly. Male lures and food baits can be used for monitoring the invader fruit fly. Invader Lure™, M.E. Pherolure® and Chempac ME Lure are male lures



Figure 7. M3 fruit fly bait station.



Figure 8. Fiber block impregnated with methyl eugenol and mercaptothion for control of the invader fruit fly.



and contain methyl eugenol and attract the invader fruit fly. Chempac Bucket, Lynfield, McPhail or Moroccan trap can be used together with the methyl eugenol.

Biolure® Fruit Fly is a food bait and can be used for monitoring females and males of the invader fruit fly. A McPhail type trap can be used with Biolure® Fruit Fly.

Dichlorvos containing blocks must be placed in the traps. Replacing of food attractants, male lures and dichlorvos blocks is important – follow the directions for use. Traps must be hung as previously described. In areas where the invader fly is not present, one methyl eugenol containing trap must be placed per 100 hectares for surveillance purposes. If the invader fruit fly becomes established in an area, one trap per 25 hectares can be used.

Seasonality of the Natal fruit fly in litchi orchards

Fig. 6 shows the number of Natal fruit fly/trap/day during the fruiting period. More fruit flies were trapped the end of the fruiting period. From the middle of the fruiting period, a rapid increase was present towards to the end. Therefore more fruit flies were present towards the end of the fruiting period when fruits were mature and fully coloured. Various factors play a role in the process of leading a female fruit fly to a host plant. Visual cues such as plant colour, silhouette of tree against the sky, size and the volatile components of fruit are factors.

SUPPRESSION OF FRUIT FLIES Bait sprays

Control is based on the use of hydrolysed proteins in combination with an insecticide. The method targets adult flies, especially females, and aims to

attract and kill them before they can lay eggs in the fruit. Bait sprays suppress *Ceratitis* fruit fly species as well as the invader fruit fly. The bait attracts the fruit flies to the spot of application where they feed on the bait, ingest the insecticide and die. The spray should be targeted to lower surfaces of the leaves to enhance the persistence of the bait and reduce exposure to the sun and the chances of washing off by rain. This is applied when monitoring data indicates that fruit flies are present in high numbers. Bait applications can be applied weekly, depending on monitoring data. The bait is applied to the tree in the form of coarse droplets with a tractor operated bait applicator. Baiting can also be done by the use of knapsack sprayers.

Litchi fruit is a poor host for the development of fruit flies. Examples of protein hydrolysates are Hym lure RFU, Lok-Lure, Buminal and Hym lure Paste. These protein hydrolysates can be used in combination with trichlorfon or mercaptothion. There are restrictions on the use of trichlorfon and mercaptothion on export fruit. GF-120™ NF is a bait spray that contains spinosad and a protein and is also registered for fruit fly control. Mercaptothion or GF-120™ NF can also be applied by an aircraft. This method allows for the treatment of a wide area in a short time interval. If a considerable amount of rain occurs after bait application, the procedure has to be repeated to replace the bait that could have been washed off.

M3 Fruit Fly Bait Station

The M3 Fruit Fly Bait Station is registered for the control of fruit flies in subtropical fruit orchards (Fig. 6). A high number of plastic fruit fly stations consisting of sponge impregnated with protein hydrolysate and alpha-cypermethrin are deployed in the orchard. Four hundred per hectare are deployed in litchi orchards. The technique is less harmful to the non-target organisms and the environment and, as the insecticide is not directly applied to the fruit, problems with residues are minimised. M3 Fruit Fly Bait Stations suppress *Ceratitis* and *Bactrocera* species.

Natural enemies

Parasitoids and predators are present in litchi agro-ecosystems and can contribute to the suppression of fruit flies. Efforts to conserve natural enemies in commercial orchards through more efficient management, may contribute to the overall suppression of fruit flies.

Eradication of useless host plants

Useless host plants serve as a breeding ground and source of fruit flies and must be eradicated when found in the vicinity of the orchard. An example of such a plant is the bug tree, *Solanum mauritianum*, which is an excellent host for the Natal fruit fly. Wild growing guavas are another example of a weed that hosts fruit flies.

Male annihilation technique

The male annihilation technique involves the attraction and killing of male fruit flies using a high density of bait stations or substrates. It consist of a male lure combined with an insecticide to reduce the male population to such a low level that mating does not occur. This suppression method is recommended for control of the invader fruit fly in areas where the fly is being detected in monitoring traps. The male annihilation technique must be used in combination with the application of bait sprays or with the use of bait stations.

For the invader fruit fly, methyl eugenol is used in combination with an insecticide. Males are attracted to the bait stations or substrate and die if they come into contact with the insecticide. Fiber blocks impregnated with methyl eugenol and mercaptothion can be used and examples of products available in South Africa are the B.I. Toolkit and Invader-b-Lok. Chempac Methyl Eugenol Liquid can be used together with mercaptothion and fibre blocks can be impregnated with the mixture. Static Spinosad ME and Last Call B.I. are also two products available in South Africa. Static Spinosad ME is a ready-to-use insecticidal bait substrate for selective attraction and control of the invader fruit fly males. Last Call B.I. contains methyl eugenol and a contact insecticide in a protective, slow-release, paste-like matrix which attracts male of the invader fly and kill them. 