ISSN 2582-6611

Agriculture Observer

www.agricultureobserver.com

May 2021 Article No. :11

Eco-friendly Management of Mango Fruit Flies - A Review

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ABSTRACT

Mango, *Mangifera indica* L. described as the "king of fruits" known for its strong aroma, delicious taste and high nutritive value is a prominent horticultural crop of India. Fruit fly, *Bactrocera dorsalis* are the most serious pest of mango not only in India but also all over the world. Fruit flies are pests of quarantine importance and are difficult to control. Damage to semi ripe fruits is caused by both maggot and the adult. It pupates 3-7 inches below the soil. The oviposition punctures made by the female serves as entry for fermenting organisms. For the management of Fruit fly, application of insecticides is done by spray cover on the entire crop or trees. The potential negative impacts of common insecticides on humans and human health. So, an ecofriendly integrated management of *B. dorsalis* in mango is very useful like Attractants or lures are commonly used to trap fruit flies as they provide an easy way to collect large numbers of flies in a short period of time.

INTRODUCTION

Mango, *Mangifera indica* L. described as the "king of fruits" known for its strong aroma, delicious taste and high nutritive value is a prominent horticultural crop of India. It is the leading fruit crop of India and is attacked by about 492 species of insects, 17 species of mites and 26 species of nematodes, of which 188 species had been reported from India (Tandon and Verghese, 1985). Fruit flies are the most serious pest of mango not only in India but also all over the world. The fruit flies, *Bactrocera* spp. (Tephritidae: Diptera), are the most destructive pests of many fruits and vegetables all over the world. The Oriental fruit fly (OFF), *Bactrocera dorsalis* (Hendel) (Tephritidae: Diptera) is a direct pest on mango. Fruit flies are pests of quarantine importance and are difficult to control. They have great impact on Agri or Horti or Forest ecosystem and cause enormous damage to fruits and vegetables. In India, the loss in fruit yield ranges from 1 to 31% with a mean of 16% (Verghese *et al.*, 2002). The average damage of fruit fly was estimated at about 20-30 % loss in mango (Lux *et*

al., 2003). Vayssieres *et al.,* 2009 reported that fruit flies, *Bactrocera invadens* showed 10-57 % yield loss between month of April to June in Benin, Africa. The yield loss due to fruit fly damage may exceed 70 % in mango (Coleacp CIRAD, 2009). whereas in south Gujarat, damages to the tune of 16 to 40 and 4 to 2 per cent have been reported in mango and sapota, respectively (Patel and Patel, 2005).The attack of fruit flies reduces fruit yield and quality, besides rendering them vulnerable to secondary infections. Several workers have studied the biology of the fruit flies. The flies infest the fruits by inserting ovipositor and laying eggs beneath the skin. The maggots develop inside the fruits and eventually drill their way out for pupation in the soil and emerge as winged adult to begin the life cycle. They cause heavy losses in mango especially in late maturing varieties. Frequent and excessive use of insecticides leads to the control of major insect-pests. However, they do not manage fruit complex as the last application of insecticides do not coincide with initiation of fruit fly damage on one hand and completion of damaging stage of the pest inside the fruit on the other hand. Excessive application of insecticides also leads to many environmental hazards on the harvested fruits and also results in inadequate control. Therefore, there is an urgent need of an approach integrating bio-rational methods as one of the components to suppress the pest.

Life Cycle of Fruit Fly

Eggs are laid in small clusters of 2-15 just beneath the skin of the fruit. About 200 eggs are laid by a single female during a period of 1 month. Egg period is 2-3 days in March and April and prolonged up to 10 days in winter. Damage to semi ripe fruits is caused by both maggot and the adult. It pupates 3-7 inches below the soil. The oviposition punctures made by the female serves as entry for fermenting organisms.

The adult, which is noticeably larger than a house fly, has a body length of about 7.0-8.0 mm: the wing is about 7.3 mm in length. The color of the fly is very variable, but there are prominent yellow and dark brown black markings on the thorax (a). Generally, the abdomen has two horizontal black strips (b) and a longitudinal median stripe extending from the base of the third segment to the apex of the abdomen (c). These markings may from a T-shaped pattern, but the pattern varies considerably. The wings are clear (d). In females, the ovipositor is very slender and sharply pointed (e) (Fig, 2).

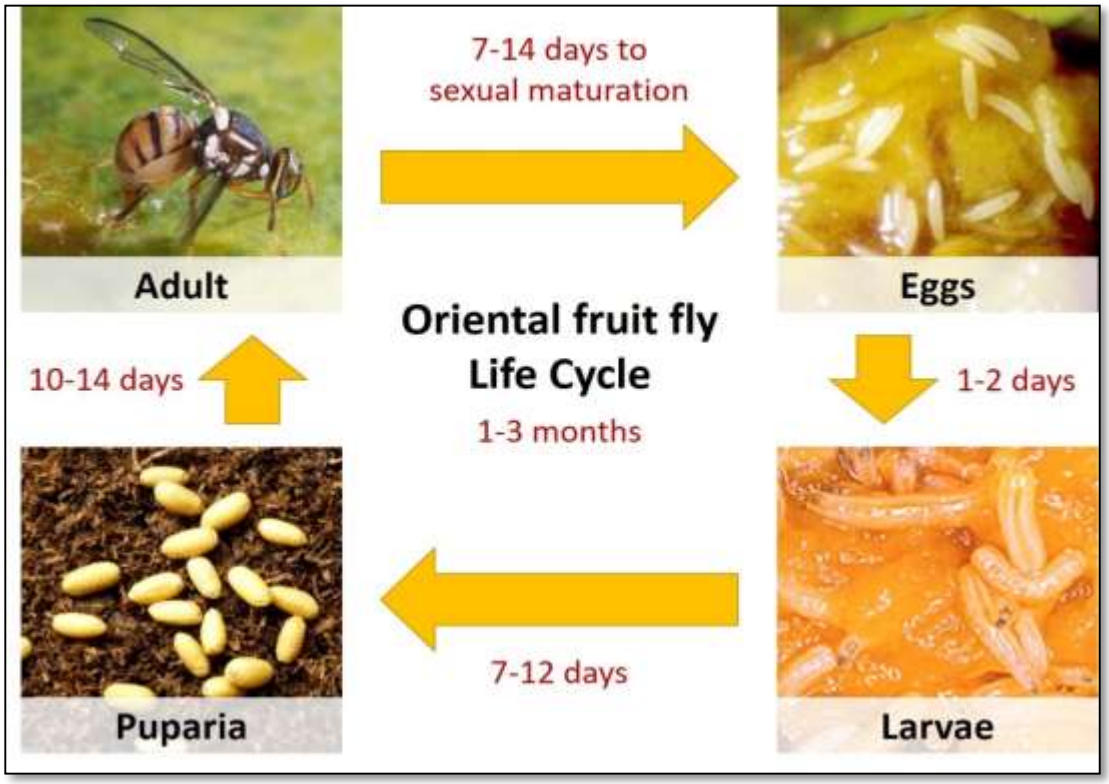

Figure 1: Life cycle oriental fruit fly

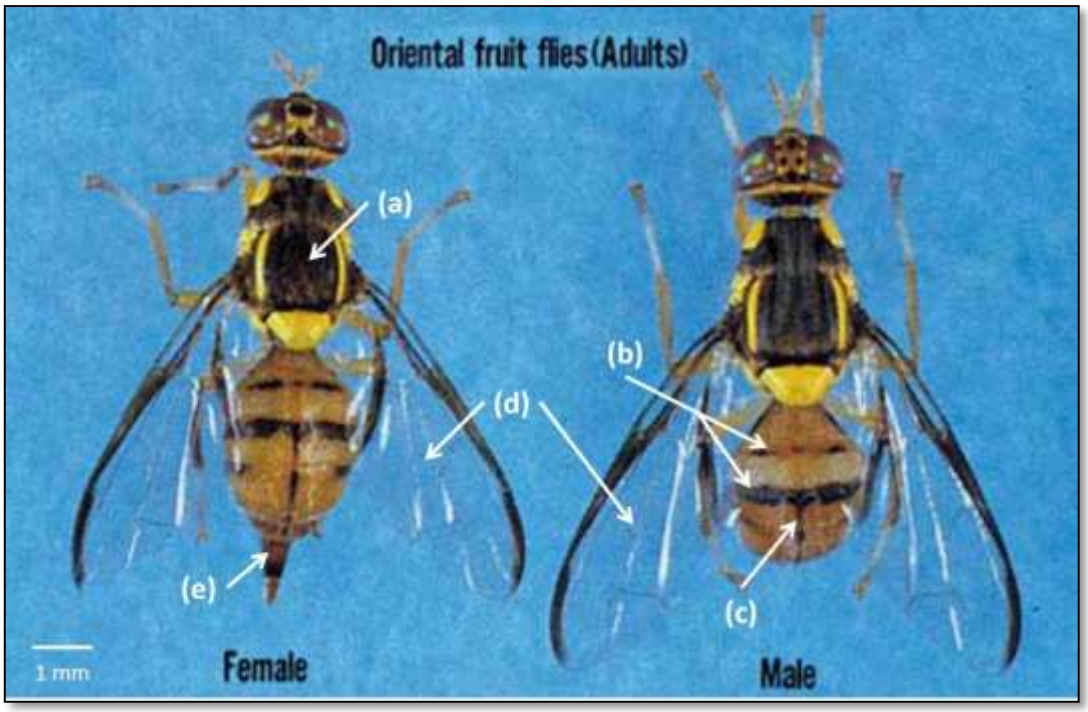

Figure 2: Adults of the Oriental fruit fly

Signs of Infestation

Infested fruits usually show a 'sting' mark (see arrow above), but visibility largely depends on the species of fruit. A shallow cut through the fruit can identify the sting and the egg cavity containing eggs, larvae or the remains of hatched eggs. Fruit will fall from the tree due to larval infestation Larvae usually burrow towards the center of the fruit. This causes decay and potential secondary infection with fungi responsible for green mould in citrus (see image above) and brown rot in stone fruit.

Fruit Fly Management

Attractants:

Attractants or lures are commonly used to trap fruit flies as they provide an easy way to collect large numbers of flies in a short period of time. Males of many species respond to chemicals referred to as parapheromones. These lures attract flies from large distances. Cue lure (CUE) and methyl eugenol (ME) (Figure b below) are two male attractants widely used in collecting *Bactrocera* spp. fruit flies. Most species appear to be attracted to one lure or the other, however other species are attracted to a combination of both lures (Dominiak et al., 2011). Trimedlure/capilure is used to trap *Ceratitis* spp. All three lures are used in Lynfield and Steiner traps. These attractants are generally highly volatile chemicals and need only to be used in small amounts to be effective. ME is naturally present in many plants and can be extracted from e.g., basil. Extracts may contain as much as 80% ME, and concentrations of around 0.2 ml per bloc or cotton ball have been found useful. Another effective attractant is so-called 'protein bait', which consists of hydrolysed (wet) protein, commonly encountered for instance as a byproduct of the brewing industry (e.g., yeast autolysate concentrate with about 400g protein litre-1). This attractant is very important in the control of both female and male fruit flies. However, protein bait may also attract non-target species and trapping efficacy is usually lower when compared to ME or CUE. A typical working dilution of the above mentioned protein is 50 ml autolysate plus 950 ml water. Dilutions may vary depending on the type and concentration of protein bait.

Trapping

Trapping can be carried out either for purposes of monitoring or mass-trapping/management of fruit fly populations. After emergence, the adults need to feed regularly on carbohydrates and water to survive and the females require proteinaceous materials for the development of their gonads (Bateman, 1972; Fletcher, 1987).

Attractants are commonly combined with insecticides (e.g., protein bait with spinosad or fipronil), following an 'attract-and-kill' approach, for instance by spot spraying on the crop. However, we recommend here to avoid insecticides and use traps for mass trapping, killing the flies in a water reservoir of the trap. Commercial wood blocs impregnated with ME and hung inside a trap have been shown to be highly effective to lure fruit flies inside. Additionally, cotton wads can be laced with ME (in Indonesia, growers use basil oils, which contain ME). Cotton wads are renewed about every 2 weeks, ME blocs should be replaced every 1-2 months, depending on the product. Traps are placed over the crop canopy, or at a height at which they can be serviced conveniently (e.g. 1.5-2.0 m).

Fig.3 Fruit fly trap

However, mass trapping is a technique best applied at low pest levels and continued over long periods of time. Thus, it is a preventative approach to which the concept of threshold levels and re-active insect control does not apply. Furthermore, fruit fly management is most effective if implemented over a wide area and under participation of as many growers and farmers as possible. Mass trapping of males reduces their proportion in a population to a low level and therefore mating does not occur. Experience in field demonstrated that the level of infestation in mango for instance could be reduced to 5% by using ME blocs, from levels of infestation between 17% and 66%.

Integrated Management

Fruit fly management can be divided in 3 main categories: chemical, cultural, and biological.

Chemical control

It is widely used among farmers. The first synthetic chemical insecticide used to control fruit flies was DDT, which was later replaced by organophosphates. Where by application of insecticides is done by spray cover on the entire crop or trees. Overuse of insecticides is rampant, for instance in citrus, which contributes to the regular emergence of insecticide resistance. The potential negative impacts of common insecticides on humans (farm workers, based on time of exposure), on human health and consumption and leaching (e.g. contamination of groundwater), and non-target effects in the environment (e.g., on fish, bees, birds, beneficial arthropods). The significant impact of insecticides on natural enemies is often under estimated, but also the influence on organisms that contribute to soil´s fertility.

Male Annihilation Technique (MAT)

Insecticides can also be used in a mix with attractants like cue lure and methyl eugenol. This is a technique called Male Annihilation Technique (MAT) and consists of many bait stations throughout the field. The mixture can be applied in Steiner traps or other devices. Insecticides can also be mixed with protein bait, which controls both, male and female fruit flies. A hydrolysed protein insecticide mix is applied on spots (spot technique) on the crop canopy.

An ecofriendly integrated management of *B. dorsalis* in mango has been standardized, which is mentioned below. The Following Precautions Need To Be Taken

- Destroy all fallen fruits at weekly intervals.
- Install six methyl eugenol plywood traps per acre.
- Plough the soil at the tree basin at frequent intervals.
- Three weeks before the harvest, Spray Decamethrin 2.8 EC @ 0.5 Ml/L + Azadirachtin (0.3%) 2 Ml/L and take up timely harvest.
- If fruit fly is very serious (> 5/surveillance trap), give bait sprays on the tree trunks at weekly interval: (bait spray is prepared by mixing 100g of jaggery in one litre of water to which 2 ml of Deltamethrin (2.8 EC) Is Added).
- The harvested fruits may be treated with hot water for 1 hour at 48^0C.

Cultural control

A mainstay of cultural control is sanitation: Infested fruit have to be removed before they fall to the ground (where larvae usually have left when picked up). Furthermore, early harvesting of fruit, where possible, greatly reduces infestation levels. Bagging of single fruits or clusters helps preventing infestation. Bags can be made out of paper, plastic, cloth, or even banana leaves. Using resistant crops is another way to reduce fruit fly attack; certain resistant varieties of fruit crop are available in Southeast Asia.

Biological control

Biological control such as the introduction of parasitoids to infested fields has given good results in management of fruit flies (e.g. in Hawaii). However, parasitoids appear to have little impact on populations of most fruit flies, with 0-30% levels of parasitism typical (CABI 2007). In Thailand, parasitation rates of *B. dorsalis* by the wasps *Fopius arisanus* and *Diachasmimorpha longicaudata* were only 2%-9% in rose apple orchards. As residues of synthetic pesticides in the environment may hamper this approach, it might be possible that biological control was more effective under a zero-spray approach.

CONCLUSION

Studies on fruit flies continue to increase and provide useful knowledge to those working in the areas of monitoring and control tactics. From the 1950s to the present day, there has been an emphasis on chemical control research, especially the use of baits. However, the continued use of insecticides is increasingly limited, making it necessary to evaluate other control strategies for inclusion in fruit fly management. The future of fruit fly management research will require a continued emphasis on the principles of Integrated Pest Management (IPM) and a broadening of the focus beyond pest control. We highlight several recommendations that may improve future studies on fruit fly management:

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