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Management of Fruit Fly under Organic Farming

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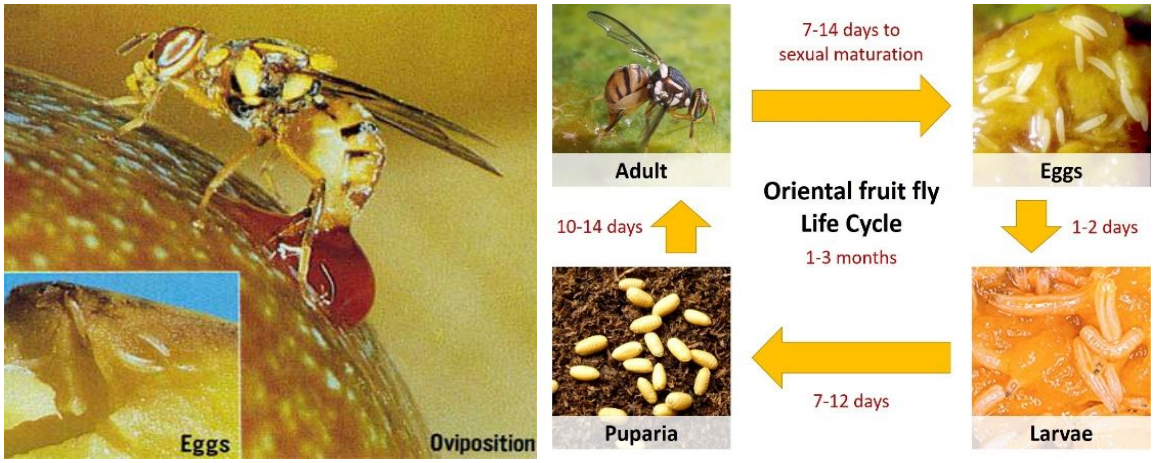
SUMMARY

The melon fruit fly, Bactrocera cucurbitae (Coquillett) (Diptera: Tephritidae) is distributed widely in temperate, tropical, and sub-tropical regions of the world. It has been reported to damage more than 100 host plants and is a major pest of cucurbitaceous vegetables and aslo heavily affect on Mango, grava and banana fruit. The extent of losses vary between 30 to 100%, depending on the cucurbit species and the season. Its abundance increases when the temperatures fall below 32° C, and the relative humidity ranges between 60 to 70%. The melon fruit fly can successfully be managed over a local area by bagging fruits, field sanitation, protein baits, cue-lure traps, growing fruit fly-resistant genotypes, augmentation of biocontrol agents and botanical compounds.

INTRODUCTION

The importance of horticulture is characterised by its high export value, higher yield and return per unit area besides subsequently prone to several pest attack, among them fruit flies are important one. Several species of fruit flies (Diptera: Tephritidae) are invasive pests of horticultural crops worldwide, due to their adaptation to various regions, high polyphagia and rapid reproduction rate. Among the fruit fly complex *Bactrocera spp*. is more harmful especially in Indian climatic conditions and cause lot of loss to the various fruits, vegetables, oilseeds and ornamental plants etc. Fruit flies cause damage to important export crops leading to losses of 40% to 80%. Direct damage to fruits and vegetables by the puncture for oviposition by the female and the larval development inside the fruit (Aluja, 1994) while secondary damage due to bacterial and fungal infection at the infection site. The management of fruit flies is quite challenging because third-instar larvae came out from decaying fruits and drop down to the ground and pupate inside the soil; consequently, both larvae and pupae in fruits and soils are protected from surface-applied insecticides. The control of fruit flies is becoming increasingly difficult in many countries, as formerly effective broad-spectrum and systemic-acting insecticides are removed from the market (Böckmann *et al*., 2014) and due to progressively more stringent restrictions on the use of insecticides and the increasing demand for healthy food around the world, sustainable cost effective techniques for fruit fly control are demanding among the growers.



Oviposition of Fruitfly and Complete Life Cycle

Bioecology and Life cycle:

Fruit flies belong to the holometabolous group of insects which contains four stages of life cycle i.e. - Egg, larvae (maggot), pupae and adult. The female fruit fly lays singly or in groups of 4-10 eggs into the tender fruit that are elongated, white to creamy yellow in colour, they become darker before hatching and slightly curved and tapering at both ends. Eggs are 1.0 - 1.5 mm long. Full grown larvae measured 5 - 10 mm long, cylindrical in shape, tapering anteriorly, blunt at posterior end and pale-white in colour. Pupae are 5 - 8 mm long, barrel shaped and brown to coriaceous in colour. The fully fed larvae come out of the fallen fruits and

pupate 10 - 15 cm soil depth. Pre-oviposition, egg, larvae (maggot) and pupal periods last for 9 - 21, 1 - 1½, 3 - 9 and 6 - 8 days respectively. During winter the larval and pupal stages are extended up to 3 and 4 weeks, respectively. A single life-cycle is completed in 10 - 18 days but it takes 12 - 13 weeks to complete a single life-cycle in winter. Adults occur throughout the year is generally low during dry weather and increases rapidly with adequate rainfall. Adult with hyaline wings with costa band broad and prominent, anal stripes well developed and hind cross veins thickly margined with brown and grey spots at the apex and face with two black spot. They starts mating after 8-12 days of emergence (usually between 7:00 to 10:00 A.M). Adult flies primarily feed during the morning hours. Adult flies may survive for 1-4 months (up to 12 months in cool conditions) depending on species, climatic conditions and presence of hosts. In winter, the flies may become inactive or congregate beneath large leaves and with the onset of summer adults become active.

Management Practices

Cultural Methods

Field sanitation and Soil solarization: Fruit fly lays eggs in fruits/vegetable and the larvae hatch inside. Generally such fruits fall down to ground and larvae crawl out of the fruit and enter into the soil for pupation. Therefore, the collection and destruction of fallen, damaged, over-ripe and excess ripe fruits is strongly recommended to reduce resident populations of fruit flies. Larvae of fruit flies not only pupate inside the soil but also overwinter in pupal stage under unfavourable conditions. The pupae of fruit flies can be easily destroyed by raking/ploughing of the soil followed by soil solarization.

Early harvesting: Avoidance of fruit fly infestation is possible by harvesting crops before maturity stage when fruits or vegetables are not susceptible to fruit fly attack. Some fruits like some mango, banana, papaya and guava varieties remain free from fruit fly infestation at green mature stage or colour-break stage. In certain parts of country, the fruits are harvested well before the fly population starts damage.

Wild host destruction and maintaining crop hygiene: Polyphagous fruit fly species survive on non-cultivated wild hosts during dearth period when cultivated hosts are not available. Elimination/destruction of such non-hosts and weed host would certainly reduce the reproductive potential of pest species.

Mechanical Method

Bagging of fruits: Bagging of fruits on the tree (3 to 4 cm long) with 2 layers of paper bags at 2 to 3 day intervals minimizes fruit fly infestation and increases the net returns by 40 to 58% (Fang, 1989). The bag provides a physical protection, preventing adult female flies to lay eggs.

Destruction of adult flies: During winter a number of adults congregate below large leaves during morning hours, such adult flies can be easily collected and destroyed.

Wire netting: Fine wire netting of small orchard is another way of protecting fruits from fruit fly; however, this is a costly in term of cultivation.

Physical Methods

Hot water treatment: Hot water dipping technique is an effective treatment used for post-harvest treatment for mango and some other tropical fruits. Dipping of mango fruits within 24 hours after harvest at 48^{o}C temperature for an hour results in 100 per cent mortality of immature stages of fruit flies.

Cold treatment: Cold storage at temperatures at 2° - 3°C can effectively kill immature stages of fruit flies in citrus stored for 14 to 16 days. However, cold treatment at these temperatures provides greater market flexibility and reduces problems associated with cold chilling such as internal fruit and skin damage.

Vapour heat treatment (VHT): Vapour heat treatment is mostly performed under a state of high temperature and saturated water vapours with the goal to kill the insects without injuries to the hosts. The treatment has advantages over chemical fumigation as there is no necessity for anxiety about chemical residues.

Biological Control

Predators and Parasitoids: Parasitoids of the Braconidae family are the main natural enemies of fruit flies included *D. longicaudata* and *Psyttalia spp*. The egg parasitoid, *Fopius arisanus* (Sonan) (Hymenoptera:

Braconidae), and the pupal parasitoids *Coptera haywardi* Loiácono (Hymenoptera: Diapriidae) and *Aganaspis daci* (Weld) (Hymenoptera: Figitidae) are considered as alternative species to fruit fly biological control with larval parasitoids.

Fungal Parasites: The control with entomopathogenic fungi has shown interesting results. For *Rhagoletis cerasi* (L.), the control with *Beauveria bassiana* (Balsamo) Vuillemin, *Isaria fumosorosea* (Wize) and *Metarhizium anisopliae* Sorokin caused 90–100% mortality and had the strongest influence on fecundity in laboratory (Daniel and Wyss, 2009).

Entomopathogenic Nematodes (EPN): *Heterorhabditis spp*. and *Steinernema spp*. were used for control of larvae and pupae of various fruit fly species.

Genetic control:

Genetic control involved the use of RNA interference (RNAi), which is a mechanism of gene regulation and an antiviral defense system in cells, resulting in the sequence-specific degradation of mRNAs (Huvenne and Smagghe, 2010). As with mechanical control, the PCA showed separation of genetic control from the other methods.

Bait Application Technique:

Fruit fly suppression is mainly based on the use of food baits mixed with a killing agent that attract both male and female flies; however, such baits are not species-specific. A number of locally derived baits, e.g. protein, sugar, jaggery, molasses, fruit juice, fermented materials, toddy, yeast, etc. have been used as baits against fruit flies. Spraying of a mixture consisting of 1 ml malathion 50 EC + 10 g crude sugar or jaggery in 1 liter water is recommended for spraying and are mostly popular among farmers.

Male Annihilation Technique:

Methyl eugenol: Use of combination consisting of ethanol + methyl eugenol or cue-lure + malathion 50 EC (6:4:1) can be successfully used in annihilation of male flies from the environment. Such mixture should be soaked in ply wood blocks (5 x 5 x 1.2 cm) and suspended in self-made plastic bottle traps (made of 1 litre mineral water bottle).

Control with natural product insecticides:

Natural product insecticides containing mainly plant and fungi extracts have been used against fruit flies. Plant-derived insecticides, such as azadirachtins. Ali *et al*. (2011) used different plant extracts and minimum percent damage (41.94%) was found in neem seed extract treated plots. The results of the experiment revealed that botanicals can be replaced for the management of melon fruit flies instead of using the synthetic pesticides in order to save the environment from their hazards. The soil can also be inoculated with neem cake and other botanical formulations to kill pupating larvae (Ekesi and Billah, 2006).

Local area management:

Local area management means the minimum scale of pest management over a restricted area such as at field level/crop level/village level, which has no natural protection against reinvasion. The aim of local area management is to suppress the pest, rather than eradicate it. Under this management option a number of methods such as bagging of fruits, field sanitation, protein baits and cue-lure traps, host plant resistance, biological control, and soft insecticides, can be employed to keep the pest population below economic threshold in a particular crop over a period of time to avoid the crop losses without health and environmental hazards, which is the immediate concern of the farmers.

CONCLUSION

Keeping in view the importance of the pest and crop, the fruit fly can be managed or suppressed locally at the growers fields using any of the option combinations available including, bagging of fruits, field sanitation, cue-lure traps, spray of protein baits with toxicants, growing fruit fly-resistant genotypes, augmentative releases of biological control agents, and soft insecticides. On the other hand, the incorporation of a number of different

techniques including the sterile insect technique, transgene based embryo-specific lethality system, and quarantine, in addition to the available local area management options, could be exploited for better results in wide area management of melon fruit fly. The local area management aims mainly at suppression, rather than eradication. Use of wide area management to coordinate and combine different parts of an insect eradication program over an entire area, within a defensible perimeter, can subsequently protect against reinvasion by quarantine controls.

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