

Eco-friendly management of fruit fly in mango

Oriental fruit fly infestation causes severe loss of fruit damage (upto 90%) leading to high revenue loss to the mango growers under the congenial conditions. Such high financial loss is created due to the frequent erratic weather events and poor management of the orchard soils. Fruit fly infested fruits are inedible and application of chemicals though effective leads to residue issues thus restricting international trade. Safe and eco-friendly approaches are now available which farmers can adopt on community level so that the menace of fruit fly is minimized and the safe produce can be traded in domestic and export markets. Hence, integrated pest management strategies are being suggested for minimizing fruit flies in mango that would help in lowering the pest population by timely adoption of different safe options without destroying the other beneficial insects and diminishing fruit quality parameters.

MANGO (*Mangifera indica* L.) belongs to the family Anacardiaceae, which is known as the 'King of Fruits' in the Indian sub-continent. The global production of mangoes is estimated to be over 55.38 million metric tonnes per annum, while India topped with over 40% of the total production of 20.82 million tonnes from an area of 2.32 million ha (2019-2020). Mangoes are considered as a good source of dietary antioxidants, such as ascorbic acid, carotenoids and phenolic compounds. At present, India is exporting a huge chunk of fresh mangoes to different countries of the world. However, inherent infection of fruit fly, stone weevil etc. are considered as major hurdles since these pests are listed as the quarantine pests. Further, fruits infected with oriental flies are not permitted in several countries. During the past several decades, Indian mango growers are facing stiff competition in export of fresh mangoes mainly due to infection with such restricted quarantine pests.

Fruit flies (Diptera: Tephritidae) are the most serious and destructive pest species of global importance that causes direct damage to the fruits and thereby reducing the yields.



Adult fruit flies collected from the pheromone trap

Their attack not only reduces yield but also degrades the quality of the fruit, rendering it unfit for human consumption.

It causes significant economic losses by lowering the market value of fruits and, as a result, diminishing farmer's revenues. The total estimated losses caused by these fruit flies are up to 27-42% and in severe cases, it may reach upto 90% in mango, while upto 90% losses have been reported in guava. Furthermore, quarantine restrictions on fruit fly-infested produce limit exports to profitable international markets. For example, the European Union (EU) had decided to put ban on the import of Indian mangoes, which resulted in huge revenue loss (2013-2014).

Several fruit flies species are known to affect wide variety of horticultural crops across the globe. The most common species known to attack mangoes are *Bactrocera dorsalis* (oriental fruit fly), *B. zonata* (peach fruit fly), *B. correcta* (guava fruit fly) etc. Both adults and maggots cause damage to the fruits. The fruit flies lay eggs beneath the peel of physiologically mature fruits by puncturing with its needle like ovipositor. On hatching, the yellowish maggots feed on fruit pulp and jump out of the fruit when fully mature, drop to the ground, and pupate deep beneath the soil. Thus, the maggots, on consuming the pulp, render it foul-smelling and discoloured. Fruits that have been infected develop brown rotting spots on them and eventually fall to the ground. These fruits then become the source of population build up and spread to the entire orchard and also in the neighborhood. The differences in degree of infestation depends upon the cultivars. The data pertaining to natural fruit fly damage in mango cultivars under north Indian conditions is given in Table 1.



Mango fruits infested with fruit fly

Table 1. Field reaction of different mango varieties to natural fruit fly infestation under north Indian states

Degree of infestation	Varieties
Immune (< 10%)	Bhadauran, Langra, Olour
Highly resistant (1-10%)	Arka Neelachal Kesari, Neelum, Neelphonso, Pusa Arunima, Pusa Lalima, Pusa Shresth, Pusa Peetamber, Ratna, Sonpari, Rataul, Lucknow Safeda
Resistant (11-20%)	Amrapali, Dashehari, Gulab Khas, Pusa Surya, Rajapuri
Moderately resistant (21-30%)	Jardalu, Mallika, Maldah, Pusa Manohari
Susceptible (31-40%)	Alphonso, Banganpalli, Himsagar, Kesar, Sensation, Totapuri
Highly susceptible (≥40%)	Chausa, Fazli, Tommy Atkins

Management strategies

The management of fruit flies is challenging because of their adaptation to various regions, high polyphagia and rapid reproduction. To manage the menace of fruit flies, chemical pesticides are used all around the world. Chemical pesticides, on the other hand, are frequently linked to significant health and environmental hazards. Overuse of chemical pesticides has resulted in various horticultural produce being intercepted on the worldwide markets, notably mango fruits. Furthermore, pesticides are costly and often out of reach for the bulk of resource-poor farmers. The use of Integrated Pest Management (IPM) as a more environmentally friendly alternative to the widespread use of broad-spectrum conventional insecticides. Implementing the IPM plan would minimize mango losses due to fruit fly infestation, cut down production costs, boost producer income, and enhance market access and processing by increasing mango quality and productivity to satisfy the demands of both domestic and export markets. An IPM strategy is a broad approach that uses a combination of practices that complement each other rather than work as an individual management method. The efficiency of management strategies mainly depends on the natural fruit fly population, therefore

implementation of management strategies as such will aid in precise determination of the timings of treatments in order to maximize their effectiveness and minimize the number of insecticidal sprays. Therefore, constant monitoring of fruit fly populations in orchard and accurate forecasting of incidence forms the part of an effective management strategy.

The insect bio-control laboratory of IARI has been working on integrated management strategies and has also demonstrated the same in the institute adopted villages having substantial area under mango cultivation. The eco-friendly integrated management module having different options for minimizing fruit fly incidence in mango is given hereunder.

Integrated Pest Management Module

- Growing of resistant/ tolerant varieties
- Early harvesting of mature fruits. As this stage of fruit maturity, crops are not susceptible to fruit fly attack.
- Collect and dispose all infested fruits on trees and fallen fruits on the ground every alternate day and bury in trench.
- Removal of all wild trees in the orchards that might serve as a breeding ground for pests.
- Ploughing the top soil to a depth of 10 cm to expose the pupae to sunlight and killing them, preventing the infestation from spreading.



Fixing of pheromone trap on mango tree

- Install methyl eugenol plywood traps at the rate of 6 per acre during the fruit development stage till final harvest and, if necessary, minimal application of chemical insecticides.

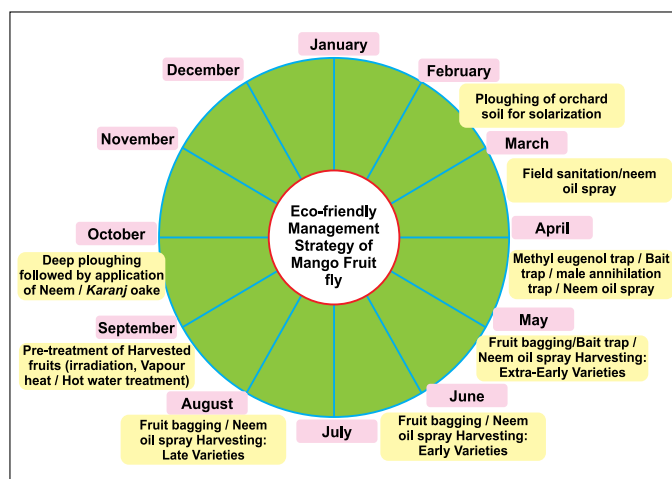
Fixing of pheromone trap on mango tree

- Use of bait traps with 100 ml of 0.1% methyl eugenol (1 ml/litre) and 0.05% Lambda-cyhalothrin 5% EC @ 2 ml/litre in 250 ml wide mouthed bottles with hanging mechanisms for male annihilation.
- Another poison bait made up of 100 g of jaggery and 2 ml of decamethrin 2.8 EC in one litre of water is sprayed near the tree trunks once a week. The bait should also be sprayed on all the adjacent plants and hedges.
- Fruits bagging will result in zero incidence of disease along with protection against fruit fly leading to agro-chemical residue-free fruit production.

Use of fruit bag in mango tree

- Spray with decamethrin 2.8 EC @ 0.5 ml/litre + azadirachtin (0.3%) (Neem oil) 2 ml/litre, three weeks before harvest and all mature fruits need to be harvested on time.
- The harvested fruits should be followed by adopting the postharvest protocol and making the graded fruits for either hot water, vapour heat or low dose gamma irradiation as per requirement of the importing countries.
- Use of new molecules: Spray of Lambda-cyhalothrin 5% EC @ 2 ml/litre (Karate®) or thiamethoxam (12.6%) + Lambda-cyhalothrin (9.5%) ZC (Alik® @ 0.4 ml/litre or Quinalphos 25% EC (Ekalux® @ 2 ml/litre + neem oil (Econeem Plus @ 0.3%) will help in controlling fruit flies under their high population situation in mango.
- Breaking the life cycle of the fruit fly. Once the mango season is over, the fruit flies look for alternate host for completing their life cycle. Growing vegetables like watermelon, muskmelon, gourds, lemons, guava, papaya, okra, etc. in the vicinity prove to act as alternate host and adults after hatching infect the developing fruits.
- Community based integrated pest management schedules are to be adopted for effective implementation of IPM module and thus need to be followed for effective control of fruit fly.

In the wake of health conscious population, integrated pest management strategies need to be promoted. For



Yearly integrated fruit fly management strategy for pesticide-free mango production

managing the menace of fruit fly in mango, a bouquet of safe practices need to be adopted by the mango growers right from the fruit development stage to minimize the pesticide residue. The safe integrated package for insecticide-free mango production is suggested, which controls infestation upto 95-98%.

The Indian Agricultural Research Institute, New Delhi is providing the low cost pheromone trap technology to different fruit growers including mango who have been immensely benefitted by it. The integrated approach suggested break of life cycle of this insect pest, which is the major quarantine pest apart from stone weevil and thus lead to eco-friendly safe production. The IPM modules though added to the cost of production varying from ₹ 500-2500/ha related with different IPM components but the gain was realized in terms of improved fruit grade, size and quality, which led to the better price on farm realization quantified to the tune of ₹ 2,000 to 7,500 extra per hectare basis with B:C ratio of 1:1.51 to 1:3.65.

SUMMARY

Fruit fly infestation is the major concern in mango production in tropical and sub-tropical regions of the country. The adult flies infest by puncturing the surface of the mature fruits and lay the eggs that hatch into maggots. These maggots feed on flesh of fruits thus make them unmarketable and unfit for human consumption. Depending upon the intensity of infestation, damage to fruits could be as high as 90%. Further, there is difference in intensity of infestation among the cultivars. Chemical control of fruit fly has been proposed but it do have health risks. Hence, the integrated pest management strategies of fruit flies in mango should be promoted which involves orchard sanitation, use of methyl-eugenol traps, application of neem based oil sprays, protein bait spray, a male annihilation technique (MAT) with methyl-eugenol traps to kill males, need-based insecticidal cover sprays and integrated practices during fruit maturity.

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