

Eco-friendly management of fruit fly for quality guava production

Guava is the most popular and remunerative fruit crop. It bears twice a year, the rainy season crop is normally discouraged since it bears fruits of poor quality having high fruit fly infestation (up to 86.0%). Hence, proper integrated care would yield quality fruits. Different IPM modules have been suggested which can be adopted by the guava growers, to enhance the yield of quality marketable fruits thus minimizing the use of harmful chemical insecticides. These IPM modules and other safe options need to be popularized amongst growers for producing residue-free fruits that would fetch higher market price.

GUAVA being the fifth most important fruit crops is grown extensively in India in an area of 287 thousand ha with an estimated annual production of 4,304 million MT (2019-20 second adv. estimate). The guava, often called the 'Apple of tropic' is a good source of vitamin C, pectin and minerals like calcium and phosphorus, besides, abundant dietary fibre and several health benefits. Fruit flies have been a major limiting factor in production of quality guava especially during rainy season. The infestation of fruit fly ranges from 5.0 to 86% leading to very high crop loss, which is a matter of serious concern for the growers. In some varieties the losses can go very high, almost 100% of yield. Though the rainy-season guava crop is severely infested by fruit fly (*Bactrocera correcta* Bezzi) but the healthy fruits produced during this season sell at a higher price compared to main season crop.

Fruit fly renders ripe fruits unfit for human consumption, and they are of very poor quality, thus the rainy-season crop is discarded by the growers. Among the insect pests, fruit fly especially *Bactrocera* spp. is the most important and invasive pest of guava. *Bactrocera correcta* is an economically important fruit fly species. In addition, there are also other economically important species of *Bactrocera*, namely, *B. dorsalis* Hendel, *B. cucurbitae* (Cog) and *B. zonatus* (Saouders) which are also found in guava orchards in the country. Under severe cases, the fruit damage may vary depending on the fruit fly population, locality, variety, season, presence of alternate host plants, etc.



Stages of fruit fly infestation in guava fruits



Fruit drop of fruit fly infested guava fruits

Adult fruit flies are similar in size to that of houseflies with reddish-brown to grayish black in colour. The wings are transparent having brown spots near the tips. The female has a pointed ovipositor; through which it punctures into healthy, early ripening fruits underneath the peel and lays six or more banana shaped eggs. The sting sites appear as discoloured or blackish spots, which may exude distinctive blobs or filaments of gum. As the fruit skin is breached, secondary infection by bacteria induces decaying of the pulp followed by light browning. Eggs hatch within two to three days and the maggots feed on the decaying fruit tissue affecting the fruit marketability. Hence, it becomes important that growers are provided with safe alternatives in integrated ways to manage this dreaded pest and harvest fruits which are safe for human consumption and also environmentally safe.

Bahar in guava and fruit fly intensity

The tropical and sub-tropical climates are suited for giving 2-3 crops in a year. These three crops are known as *Ambe bahar*, *Mrig bahar* and *Hast bahar*. In north India, two crops come in bearing, i.e. February flowering (*Ambe bahar*) fruiting of which can be obtained from June to September (Rainy season) and thereafter June flowering (*Mrig bahar*) have fruiting during November to March. In southern

India, a third flowering starts in October (*Hast bahar*), which is harvested during spring season. Among these flowering seasons in guava, fruiting during rainy season is more severely infested by fruit fly. Guava is the most favourable crop for completing growth stages (egg, larvae, pupa, and adult) of fruit flies. Rainy season produces a higher number of flowers and fruits in guava, while fruit weight during winter is higher. It has been revealed that 83% *Bactrocera zonata* can be trapped or eradicated in rainy season. Guava fruit fly is known to occur in states of Bihar, Tamil Nadu, Karnataka, South Gujarat, Madhya Pradesh, Haryana, Himachal Pradesh and Punjab. In India three *Bactrocera* species damage the guava crop, and they multiply fast in warm and humid climate. Fruit fly activity is also seen maximum at a height of 1.5 m, where the fruits are present in the canopy. In Northern India, guava fruit flies, namely *B. zonata*, *B. dorsalis*, *B. cucurbitae* are the prominent, which cause loss to the crop. In South India, *B. correcta* is one of the major fruit flies of guava causing up to 80% damage. In eastern India, *Bactrocera correcta* (Bezzi) invades wide variety of fruit in Jharkhand, West Bengal, while in south-western coastal regions, i.e. Kerala, Karnataka, Tamil Nadu, Maharashtra, Gujarat the fruit fly menace is going to increase.

Response of guava varieties to fruit fly infestation

It has been established that the popular varieties differ in their intensity for fruit fly damage during both the cropping seasons. Damage may vary from 10-100% in neglected plantations. During rainy season, the intensity of infestation has been very high.

Table 1. Response of different varieties to guava fruit fly infestation

Response	Varieties
Tolerant	Cattleya guava, Shilong-1, KG 1, Thai Pink, Thai White
Moderately tolerant (20-30%)	Chittidar, VNR Bihi, Nridula, MPUAT 1, Barafkhana, Arka Amulya, Punjab Pink, Sweta, Hisar Surkha, Pear Shaped, Behat Coconut
Less susceptible (<10% infestation)	Nasik, Allahabad Surkha, Kamsari, Spear Acid and Superior Sour, Arka Kiran, Arka Rashmi
Least susceptible (<4.8% infestation)	L-46, Lalit, Strawberry guava, Chinese guava
High incidence (>50%)	Sardar, Allahabad Safeda, Arka Amulya, Hisar Safeda, Banarsi Surkha, Pant Prabhat, Safed Jam, Kohir Safeda

Management strategies

Fruit flies are very difficult pests to manage because they are polyphagous and multi-voltine, as adults are highly mobile with high reproduction rate, and all the developmental stages are unexposed. In light of the quarantine importance of the fruit flies, several safe and novel management options have been suggested for adoption by growers. Since application of insecticides disrupts the agro-ecosystem, potential use of eco-friendly and novel technologies are need to be promoted.

Orchard sanitation: Collection and removal of damaged fruits and raking of soil around the tree canopy (30 cm) exposing the pupae to sunlight. Application of bio-agents reduces the fruit fly infestation significantly.

Biological control: Eggs and larvae are the major damaging stages in fruit fly. Hymenopteran parasitoids are generally in use, as biological control alone does not provide high degree of control on sustainable basis. Application of *Dirhinus* sp., carabid predator (*Pheropsophus sibirinus*) and Braconid larval endoparasitoid (*Biosteres longicaudatus*) attack and kill various stages of fruit fly, especially during July and August. The freshly reared insects can be applied to minimize the fruit fly population.

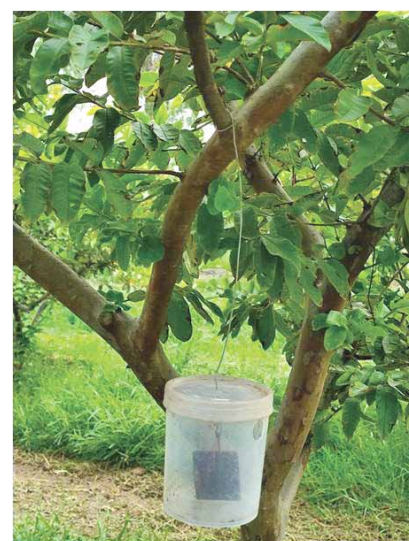
Insecticide application: This is adopted as the last option in fruit fly management; when severe infestation is observed. In early stage of fruit development Rogor @ 2/ ml/ litre water should be applied followed by spray at 21 days. Thereafter, neem oil based spray and botanicals must be sprayed towards fruit maturity. Amongst new molecules, spray of 1.25 L Sumicidin 20 EC (Fenvalerate) in 500 litres water at weekly interval in the early fruit growth stages is very effective.

Integrated pest management strategies

These strategies are required to be promoted for safe fruit production and they are more relevant for the rainy season crop. Some of the components of IPM modules are as given here.

Choice of variety: It has been suggested that smooth skinned varieties, namely Red Flesh, Allahabad Safeda and Local are highly susceptible to fruit fly (infestation range from 64.2 to 80.4%), whereas rough skinned pear shaped variety are least susceptible (<35.1%). Similarly, fruit fly incidence on different white pulped cultivars/ genotypes revealed higher infestation, i.e. damage ranging from 37.2 to 53.5%. Commercial cultivars, viz. Sardar, Allahabad Safeda and Arka Amulya had high incidence of fruit fly, whereas, Arka Kiran, Shillong-1 and Arka Rashmi had relatively less fruit fly damage.

Fruit bagging: Recently, fruit bagging has emerged as one of the most effective approaches for controlling fruit fly. In all the high density and hedge row panting systems, it is very effective and widely adopted by growers. It improves the visual appearance, increment in fruit size and pulp quality. Despite being laborious/ manual process, it is widely used across the country for meeting the export quality. Bagging of guava fruits has been found certainly successful in increasing the yield and net income of growers. Different



Installation of fruit fly trap in guava tree



Bagging of fruits in guava (A) polythene bag, and (B) Net bags

types of bags such as newspaper, perforated polyethylene, muslin cloth, netted cloth, nylon nets, polypropylene non-woven, butter paper, brown paper, polypropylene bag (20 μ gauge with and without paper pieces inside and non-woven polyfabric bags of white, green and blue colour with 20 and 40 gsm thickness can be adopted for fruit bagging atleast 30 days prior to harvest (at egg stage).

Wrapping of individual fruit with transparent polypropylene (20 μ) bag and paper piece within the polypropylene bag for partial cover to sunlight is one of the options for guava fruit fly management leading to minimal fruit fly incidence during the rainy season crop.

Bait Application Technique (BAT): Female fruit flies are attracted to the baits, including liquid solution of protein and fermenting sugar(s), which kills them. In addition, protein baits attract both male and female fruit flies, making them more effective than the Male Annihilation Technique (MAT). GF-120 NF naturalyte protein fruit fly bait has been approved for organic production against fruit flies in USA. An effective substitute can supplement this practice in India too. Bait application (feeding stimulant + insecticide) on the tree during the emergence of adult fly is also an effective strategy. Similarly, fruit pulp of banana and guava in poison baits and a bait spray solution consisting of 0.025% deltamethrin and 10% jaggery or 10% pulped ripe banana + water have been recommended for preparation.

Male Annihilation Technique (MAT): This technique is eco-friendly and very effective technique against *Bactrocera* spp. It includes use of different types of traps with para-pheromone; methyl eugenol ether (male fly attractant) and cue lure used together with an insecticide impregnated into suitable substrate. Methyl eugenol has both olfactory as well as phago-stimulatory action and is known to attract fruit flies from a distance of 800 m in an orchard.

Trap crops: Fruit fly is polyphagous and feeds on alternative hosts found in the vicinity of main crop. The crop that is most affected by fruit flies could be grown in guava orchard. They include cucurbitaceous vegetables (79% infestation) followed by fruits (14%) (sweet

Table 2. Management options for controlling guava fruit fly infestation

S. No.	Management measure	Practice
1	Sanitation	Collect, remove, destroy/ bury infested fruits in trenches.
2	Para-pheromone lure/ Trap	Methyl eugenol: Mix ethyl alcohol 60 ml + methyl eugenol 39 ml + Spinosad (pesticide) 1 ml Commercial Cue lure: Mix ethyl alcohol 60 ml + Cure lure 39 ml + Spinosad (pesticide) 1 ml
3	Bait sprays	About 100 g jaggery + 2 ml of Decamethrin 2.8EC in 1 L water; sprayed on the tree trunks at weekly interval; Azadirachtin 10,000 ppm @ 1.0 ml/L during the fruiting stage.
4	Chemical insecticide	Deltamethrin (0.025%) thrice at least 15 days interval commencing 45 days after fruit set.
5	Botanicals	Neem based (Azadirachtin) (10-20 ml/L), karanjoil (5-10 ml/ L water) and tobacco extract (250 g dry leaf / 1000 ml) mixed in 5 litre water. The methanolic leaf extracts diluted to 5% (v/v) of lantana, karanj, tulsi and datura at 7 day interval is also very effective.
6	Cultural methods	(i) Deep soil treatment/ tillage, (ii) Removal of co-host plants, like cucurbits, solanaceous; (iii) Crop rotation, (iv) Clean cultivation, regular weeding, (v) Pruning, (vi) Conservation of natural insect enemies, (vii) Early harvesting, (viii) Placing Traps, (ix) Planting repellent crops, and (x) Soil raking around the tree and drenching with chlorpyrifos @ 4.0 ml/l.
7	Bagging of fruits	Wrapping of individual fruits with transparent polypropylene (20 μ gauge) bag, newspaper bag, and fruit fly net bag at egg stage until ripening.
8	Exclusion measures	Netting of whole plants up to trunk gives effective control.
9	Food lure/ Protein hydrolysate	Ripened fruits (pumpkin, banana + insecticide) as bait, protein hydrolysate (Nu-lure®) + Livestock/ poultry manure. Nu-lure combined with borax in an aqueous solution containing 9% Nu-lure (vol: vol) with 3% borax (wt: vol)+ propylene glycol (10% vol: vol) to prepare the bait solution.
10	Bio-pesticides/ Bio-agents	<i>Metarhizium anisopliae</i> (2 x 10 ⁸ cfu / g commercial powder @ 2 tsp in 1.0 litre water), release of parasitoids and weaver ants.

Note: POP, Package of practices.

orange, mandarin, mango, peach and pomegranate) and solanaceous vegetables (6%). It is an effective method to minimize infestation of guava. The infested fruits on trap crops must be collected and destroyed regularly.

Application of botanicals: Neem Seed Kernel Extract (NSKE) is an efficient ovipositional deterrent for the oriental fruit fly when applied at 0.2 to 4.0% thus



Bagged (left) vs unbagged (right) fruits of guava produced during rainy season

reducing the number of eggs from 87.5 to 99.2%. Spray of 0.5 to 1.0% neem oil (v/v) has also been found effective in reducing egg-laying by the fruit fly in guava. It is always better to apply repeat sprays after 10 day interval towards maturity so that issue of pesticide residues could be minimized. Similarly, *karanj* oil, neem leaf methanolic extracts can be applied.

The different control measures for managing fruit flies infestation are given in Table 2.

The fruit quality in rainy season guava is greatly improved by bagging and timely application of nutrients spray yielding quality guava fruits.

Eco-friendly management strategies in organic production

In organic fruit production systems, following management strategies are permitted as shown in the figure.

May	• Hoeing at 15 day intervals during March & October • Apply neem / <i>karanj</i> cake to soil @ 250 kg/ acre • Clean cultivation. • Timely and regular removal of fallen fruits and burying them. • Spray Neem oil 0.2% @ 7 day interval (May to August).
June end	• Use of methyl eugenol @ 5 traps/ acre (sex pheromone traps) • Bagging of fruits • Neem oil spray, <i>Tulsi</i> or datura leaf extract (5% w/v) spray
End July	• Alternative bait spray. • Use of methyl eugenol @ 5 traps/ acre • Bagging of fruits • Neem oil spray, <i>Tulsi</i> or datura leaf extract (5% w/v) extract spray
August	• Collection and destruction of fallen fruits • Clean cultivation • Spray of Neem oil 0.2% @ 7 day interval (May to August).

Organic and eco-friendly management of fruit fly for quality guava production in rainy season

SUMMARY

Guava is one of the most remunerative fruit crops. Since it yields twice in a year, the rainy season crop, though considered of poor quality having high infestation of fruit fly, if can be taken with proper integrated care as suggested above, would yield quality fruits without infestation. Different IPM modules suggested above can be adopted by the guava growers, which would increase the yield of quality marketable fruits thus reducing the dependence on application of harmful insecticides. The IPM modules encompassing annual ploughing, floor sanitation, fruit bagging, biological control with application of parasitoids and predators, botanical sprays, male annihilation technique (methyl eugenol based traps), bait sprays (protein hydrolysate + Spinosad, sugar spray), release of sterilized flies and safe chemical insecticides can be used for producing pesticide-free fruits that would fetch higher market price.

For further information, please write to:

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