How to Control the Mango Fruit Fly
Fruit flies

The mango tree suffers from numerous phytosanitary problems. In West Africa, the economic importance of the damage caused by fruit flies (Diptera tephritidae) is growing in home garden mango trees as well as in small-scale and industrial mango orchards. The introduction and pan-African propagation of Bactrocera invadens, a fly species from Sri Lanka, first spotted in East Africa in 2003, then discovered in West Africa by IITA in Benin in 2004, could jeopardise the recent commercial success of the whole mango sector.

Since fruit flies are classified as ‘quarantine insects’, if a consignment of mangoes containing even a single fruit infested with the Tephritidae larvae is exported to Europe, the whole batch may be rejected and totally destroyed by the European phytosanitary services.

Each year, whole containers of fruit from Africa are intercepted, confiscated and destroyed in incinerators in European harbours and airports because of these quarantine insects, thereby causing major economic losses for many exporters and, therefore, the entire mango sector – the main economic generator for the West African horticultural sector.

The local and regional mango market is also deeply affected by this issue; during the lean season, mangoes provide a fundamental nutritional intake for rural populations.

What are fruit flies and how do they proliferate in mango fruit?

Out of 12 Tephritidae dipteria species that attack mangoes in Benin and West Africa, the two considered most harmful are Ceratitis cosyra and Bactrocera invadens – even though two other Ceratitis species also cause economically significant damage.
The life cycle of most Tephritidae species is similar. The female generally implants its eggs in the ripening fruit of the host plant, but also in the young fruit which have fallen post abscission. The larvae or maggots develop in the flesh of untreated fruit by digging tunnels which provide opportunities for secondary infections when the larvae emerge from the fruit.

The growth of the larvae accelerates the maturation of the fruit, which detaches and falls to the ground. The larvae leave the fruit and the pupae develop in the top layer of the soil. Upon emergence, the adult soon starts looking for the nourishment it needs to reach sexual maturity, couple, and lay eggs. And so forth...

**Mango production loss estimates due to fruit flies**

Due to attacks mainly by C. cosyra and B. invadens, harvest losses that are held down to 10% at the beginning of the growing season, can reach 80% by the end of the season. In Guinea and Mali, losses for the main commercial cultivars (Irwin, Amélie, Kent, Smith, Keitt) can reach 40% in the middle of the season, and can exceed 60% for later maturing varieties such as Brooks.

**What are the methods for controlling fruit flies?**

Prevention is crucial. If the fly population becomes too large, there is no control method that will be genuinely effective and profitable. The only effective way for interrupting the fly’s development cycle is to implement a combination of control measures and, if possible, to the entire production area. These include (1) removing and destroying fallen fruit, (2) spot treatments using Success Appat (GF-120) or any other food attractant system, (3) biological control with Oecophylla ants and parasitoids, (4) mass capturing of the male flies (M.A.T) with specific attractants. The success of each measure depends on the motivation of all those concerned, public or private, in the mango sector.
The fruit fly can proliferate under the following conditions:

<table>
<thead>
<tr>
<th>The fruit fly can proliferate under the following conditions:</th>
<th>Actions to take:</th>
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</thead>
<tbody>
<tr>
<td>Extended presence in orchard of larvae-infested fruit fallen from trees. Larvae will complete their growth cycle in the soil and create outbreak sites.</td>
<td>Pick up dropped fruit every day. Quickly remove the fruit from the orchard and destroy by: For e.g. collecting fruit in a black plastic bag, exposed to the sun for two days, burying fruit deeply in a pit, putting them in an “augmentorium” so as to prevent the insects from flying away but letting their natural enemies do so. Till the top soil (5-10 cm deep) in the orchard to expose the pupae to the sun, parasites and predators such as birds.</td>
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<tr>
<td>Presence of cultivated plants (which can be alternative hosts to the flies) in the orchard or in nearby orchards</td>
<td>Avoid growing or keeping nearby host plants whose fruit attract flies (citrus, guava, papaya, anona, melons, etc.) A large number of host plants nearby may result in large populations of fruit flies at the start of the mango harvesting season. Manage orchards using the same rules as for mangoes (picking up, sorting, destroying) since flies are very polyphagous.</td>
</tr>
<tr>
<td>Presence of abandoned, untended orchards or wild trees near the cultivated plot</td>
<td>Avoid leaving such trees nearby, since this is where infestations break out. Success in controlling fly populations in cropping zones requires information and collective responsibility.</td>
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<tr>
<td>Presence of weeds (which can be alternative hosts)</td>
<td>Weed carefully around the trees; weeding makes it easy to see and pick up fallen fruit. Till the top soil (5-10 cm deep) to clean the orchard.</td>
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<tr>
<td>Presence of several varieties (with successive harvesting dates) in the orchard</td>
<td>Avoid growing mango varieties with very different growth cycles in the same orchard; since fly populations grow during the production period, the late-maturing varieties are often infested the most. If market demand allows, produce the early-maturing varieties so that the fruit ripens when fly populations are low.</td>
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<tr>
<td>Presence of infested fruit in the plot or near the fruit-packaging station</td>
<td>Sort the fruit and quickly eliminate any fruit with traces of fly attack (consume or destroy immediately). Do not leave any rejected fruits, since they are ideal infestation sites, near the orchard or the packaging station. This includes ungraded, infested fruit and infested fruit eliminated during sorting.</td>
</tr>
<tr>
<td>Transport of infested fruit to local or regional markets</td>
<td>If possible, avoid selling infested fruit or fruit discarded during sorting; alternatively, ensure immediate consumption and proper destruction of unsold fruit. Avoid transporting punctured fruit from infested zones to less infected zones.</td>
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</table>

**How to decrease fly populations by capturing male Bactrocera invadens flies in orchards**

Parapheromone traps are used to capture male flies of certain species. At present, they are the best tool for detecting flies and, if used on a large scale and in large quantities, can contain population growth early in the season.

This technique, called M.A.T (Male Annihilation Technique) consists in installing, at the beginning of the season, a device impregnated with a specific attractant and a contact insecticide (generally malathion or deltamethrin). The traps should be installed in the orchard at least two months before the fruit becomes appealing. It is advisable to install these traps in other orchards with fly-attractant fruit trees (citrus) and in zones known to provide refuge during dry seasons.

Generally, at least 10 traps per hectare are fixed to the trees. However, the exact density depends on the type of device, which should be defined based on the agro-climatic, agro-ecologic and economic conditions.

Such devices can be found commercially (for e.g. Timaye solution registered in CILSS countries). Count 10g of Timaye per trap (trap = for e.g. a water bottle containing the bait, with holes to let fruit flies enter and suspended on a branch of a tree) and 45 traps per hectare throughout the plantation. In cases of high infestation, they can be increased to 75 traps/ha. The bait needs to be renewed every 30 days. Depending on meteorological conditions and parasite pressure, it can be renewed sooner or later; bearing in mind that experience is the best renewal barometer according to local conditions. One should not forget that this technique, and the others described in this document, if used alone cannot reduce the percentage of infested fruit. It must be used in conjunction with other control methods.
Intervention strategies using food attractants

Population control strategies using these products are based on infestation observation during the stages noted below (detection trapping) and an intervention based on an economic damage threshold, i.e. the number of flies captured in one or two traps per hectare.

As an example, the following threshold values are applied in Benin and devised by IITA:

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Economic infestation threshold per ha for minimum price of mango</th>
<th>Economic infestation threshold per ha for maximum price of mango</th>
<th>Economic infestation threshold per ha for average price of mango</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amelie</td>
<td>269</td>
<td>107</td>
<td>153</td>
</tr>
<tr>
<td>Kent</td>
<td>75</td>
<td>30</td>
<td>43</td>
</tr>
<tr>
<td>Keitt</td>
<td>57</td>
<td>24</td>
<td>33</td>
</tr>
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</table>

Localised treatment in orchards

Detection trapping. How and when?

Traps are installed in the orchards (1 or 2 per hectare), such as Tephritrap containing an attractant (Met (Methyl Eugenol)), Ter (Terpenyl) and Tri (Trimedlure) and insecticide mats (for e.g. DDVP). Treatment should be started as soon as the threshold values have been reached (see table above). Refer to the date sheet WAFFI N° = 7, called “Evaluating the damages caused by fruit flies on mango trees and calculating Benin’s economic threshold values”:


Should the threshold be reached, one can start treatment using Success Appat or a similar product (the benefits will outweigh production costs). On the other hand, below said threshold, one should refrain from using treatments because these would not be profitable in this case.
Using products based on food attractants – Which products and how?

SUCCESS APPAT® produced by Dow AgroSciences (1 l/ha of CS – concentrated suspension – with a base of 0.24 g/l of Spinosad and an incorporated foodstuff attractant) can be used for localised treatment in mango orchards. The treatments are approved in various African countries and Spinosad is authorised in organic production. These types of treatments are very effective if the protocol is followed rigorously.

If fly captures in traps continue (depending on the threshold), treatment should be renewed every 7 days. They should be renewed in the event of rainfall of over 10–15 mm. This type of treatment has very little effect on the orchard’s natural enemies.

The product should be applied by using a knapsack or towed sprayer equipped with a hose and a 1–2 mm diameter nozzle. The nozzle disc should be removed so that droplets are between 1 and 15 mm (do not use an atomiser, lower pressure as much as possible). The spray volume should be between 4 and 10 l/ha.

Apply the mixture to the top layer of leaves (about one m²), rotating around the tree (do not always treat the same leaf areas) and try to penetrate the foliage slightly. It is better not to treat the fruits. This type of localised application using a knapsack sprayer is acceptable just prior to harvest, and even during harvest since the operator can avoid spraying the fruit.

An illustrated brochure on the use of Success Appat is available on http://afrifly.wordpress.com/

Full treatment throughout the orchard

A product based on Thiacloprid and Deltamethrin (Proteus 170 0-TEQ) used in Côte d’Ivoire against fruit flies for full treatment throughout. A 15-day delay period prior to harvest must be respected in order to avoid residue on the fruit at harvest – therefore, its use is limited to the growth phase of the fruit. Many bio-control agents (i.e. natural enemies) have been identified in the orchards, such as Oecophylla ants and parasitoids. These natural enemies can be used to restrict pest development.

Full treatment (throughout the orchard) using a large spectrum insecticide can potentially destroy a major part of the bio-control agents and could trigger an upsurge of certain pests that, until then, have been of lesser importance. In order to protect the auxiliaries, it is best to limit the number of large spectrum insecticide treatments and to favour IPM and organic control.

The best solution remains integrated management, as mentioned previously.
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