MANGO FRUIT FLY MANAGEMENT IN UGANDA



By
C.M.K. Nankinga, A. Mayamba, F. Nampeera, W. Waswa and B.E. Isabirye

Second Edition June 2014

Summary

This brochure presents management options that have been validated under Ugandan farming conditions and found to reduce fruit fly pest damage in mangoes. Practicing male fruit fly mass trapping using methyleugenol (ME), orchard sanitation and fruit bagging can reduce fruit fly damage by more than 50%. When these fruit fly management options are applied on mango orchards where farmers practice appropriate pruning, tree nutrition, and apply insecticides or fungicides to control other pests and diseases, the combination of the practices improves the fruit yield, quality and further reduce the fruit damage. A brief on symptoms of selected economically important pests and diseases that are mistaken by mango growers to be due to fruit flies is also outlined. To achieve sustainable and long term control of the fruit flies, an Area-Wide Integrated Pest Management (AW-IPM) control program involving all the stakeholders: Research, Ministry of Agriculture, Farmers, Extension, Community Leaders and Private partners associated with the horticultural value chain, must be planned and implemented in order to successfully transfer the pest and disease control options to a wider community of farmers. Area-Wide Management (AWM) is an integrated approach in which pests are managed using an organised and coordinated attack on the pest populations over large areas rather than using an individual mango orchard approach

Acknowledgements

This work was funded by Government of Uganda, through the Agricultural Technologies, Agribusiness and Advisory Services (ATAAS) project. We wish to thank all the individuals, farmer groups and community leaders and Agricultural Extension staff that collaborated with the research team while conducting the field trials to develop the control measures presented in this brochure. We highly appreciate the support of the Laboratory and Field technicians; Wenene Agenes, Brian Sembatya and Joseph Rukeijakare.

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1.0 Introduction

In Uganda the fruits and vegetable sector provide promising areas for increasing house hold income in the rural areas. It also improves nutrition of the people, diversifies exports, and provides raw materials for agro-based industries thus creating employment especially for the women and youth.

Unfortunately, the threat of various pests and diseases especially the fruit flies is one of the main reasons why such opportunities are often not realized. Although, many insect pests and diseases are known to attack fruits, none has been more notorious than Tephritid fruit flies. Tephritids are recognized worldwide as the most important threat to the horticultural industry. Infested fruits quickly rot and become inedible and/or drop on the ground causing direct loss to the farmer. Besides the direct damage to the fruits, indirect loss is associated with quarantine restrictions that are imposed by fruits and vegetable importing countries. Recent findings in Uganda show that four genera including *Ceratitis, Bactrocera, Dacus and Trirhithrum* comprise the most significant species that cause economic damage to horticultural crops. Ten fruit fly species have so far been identified with *Bactrocera invadens*, an invasive species of the Asian origin being more prevalent and most destructive in mangoes. *Bactrocera invadens* is responsible for causing extensive economic loss since its first detection on the African continent in 2003 and currently reported in 28 African countries; attacking over 40 horticultural crops.

Export of several horticultural produce from Uganda and other developing countries has been severely hampered by the quarantine restrictions imposed on countries where *B. invadens* occurs. As the commercialization of fruits and vegetables rapidly grows, management of exotic pests and diseases attacking the commercial mangoes is imperative if growers are to meet the market quality standards and profitably earn from the enterprise.

This brochure outlines the control options that have been tested in Uganda and were able to reduce fruit fly infestation by more than 50%. The yield losses attributed to fruit flies is usually aggravated by the attack of other pests and diseases and if not controlled, they put the mango trees under significant stress that further reduce the mango yields and result in poor quality fruits with low market value. Therefore a brief on symptoms of selected economically important pests and diseases that are mistaken by mango growers to be due to fruit flies is also outlined.

2.0 Fruit Fly Biology and Damage

Fruit fly adults and larvae (maggots) cause fruit damage. Egg-laying females puncture the fruits leaving scars and holes on the fruit surface (Plate 1). The eggs hatch within 2-4 days and larva live and tunnel through the fruit (Plate 2). Larval feeding causes premature fruit drop and destroys the pulp of the fruit (Plate 2 & 3). The fruit eventually rots making it unsuitable for human consumption (Plate 3). When the larvae are ready to pupate, they emerge from the fruit and drop to the ground (Plate 4). Pupae develop in the soil beneath the host plant (Plate 4). The pupa stage lasts for about 10 days before emerging into adults and the cycle begins again. The whole life cycle will take between 28-35 days depending on the environmental conditions (Plate 4).



Plate 1: Female fruit fly lays eggs



Plate 2: Larva tunnels in the fruit



Plate 3: Fruit fly maggots in the-decaying mango.

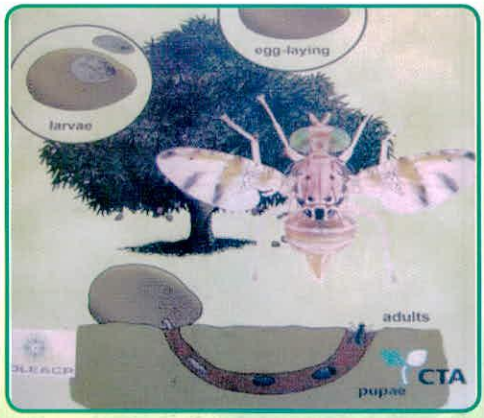

Plate 4: Fruit fly life cycle adopted from CTA.

3.0 Fruit Fly Management

There are several control options which when integrated and carried out diligently, can control fruit flies under economically damaging levels.

In our first edition of 2012 on Mango Fruit Fly Ecology and Management options in Uganda, we outlined options based on orchard sanitation, fruit fly traps baited with lures and application of protein bait. In this edition, another option of bagging is integrated into the control package.

3.1 Orchard Sanitation

Orchard sanitation controls fruit flies by disrupting the life cycle and discourage fruit fly breeding areas. The management practices are:

1. Remove fruits with dimples and oozing sap. This method is more effective although laborious than picking rotten fruits from the ground as the maggots may have left the fruits to pupate in soil.

2. Harvest the mango fruits when mature green. If the mango orchard is in the low fruit fly prevalence area or where control practices are practiced judiciously, some of these mature green fruits may have escaped fruit fly attack and you can get non infected fruits.

3. Pick over ripe fruits on the tree. These are good breeding sites for fruit flies.



Plate 5: Pit for burying fruits at 2ft deep.



Plate 6: Put fruits in plastic bags and expose to sun

4. Collect and destroy fallen and damaged ripe fruits by burying them at least 2ft deep (Plate 5) to eliminate the possible breeding sites. Alternatively, you can put the fruits in plastic bags and exposing them to the sun to suffocate young stages of the fruit flies (Plate 6).

You can also put the fruits in plastic drums, add water to suffocate the larvae and allow the fruits to decompose. Other green matter, weeds, ash, animal urine and molasses could be added to the plastic drums containing the rotting fruits and the mixture left to ferment for 30 days to form a bio-fertilizer that can be used to fertilize the mangoes and other crops on the farm. You can also feed the damaged fruits on pigs or poultry.



Plate 7: Trap made from locally available plastic container

3.2. Male Fruit Fly Mass Trapping

Mass trapping involves use of species-specific attractants/pheromones or lures. These are chemical compounds that are manufactured by international companies from China, Europe, USA, India, and South Africa and can be imported into Uganda. The lures are placed into already made manufactured imported traps or in locally fabricated traps. Fabricated traps can be locally made from empty used or new cheap plastic containers (Plate 7), bottles, or small jericans (Plate 8).



Plate 8: NARL locally fabricated trap.

Various lures can be placed in these traps depending on the fruit fly species one wants to trap. In Uganda, mass trapping has been practiced using Methyl-eugenol (ME) an attractant that specifically attracts *B. invadens* male fruit flies.

To make the trap, heat an iron rod to make holes on the bottom that will allow rain water to drain through. Also make windows into the sides through which the flies will pass to enter the trap.

Make a hole in the middle of the plastic container/bottle/jerrican lid, big enough for the string or wire to pass through. In our trials we used Methyl eugenol lure formulated as a MAT block (5cm x 5cm wooden block) impregnated with a contact insecticide. Insert a string or wire at the lid's hole of the fabricated trap and tie the block onto the wire and hang the trap in a shady part of the tree just above the lower leaves. This trap works as an attract and -kill bait station for male *Bactrocera* fruit fly species. Other forms of Methyl eugenol formulations (on surgical gauze, cotton wool etc) can also be used but have been observed to be less potent than the MAT blocks and more frequent servicing of traps will be required to have a potent trap. In case of MAT blocks, six blocks are used per acre of the mango orchard and are replaced every 8 weeks.

3.3. Bagging of Fruits

Bagging is a physical protection technique (Plate 9 and 10), commonly applied to many fruits, which not only improves their visual quality by promoting peel colouration and reducing the incidence of fruit cracking, but can also change the micro-environment for fruit development that results into multiple effects on internal fruit quality. Bagging creates a fruit fly free zone that protects the developing fruit from the female flies that pierce the fruits to deposit eggs into the fruit. This option can be applicable to orchards with short trees and relatively small orchards or home compound trees (Plate 9 and 10),



Plate 9: Bagging of mango fruits



Plate 10: Mango fruits bagged with Mafuco brown paper bags

The brown paper bags (Plate 10) are locally available in various sizes (size 2, 3, 5, 6, 7, up 28) in wholesale shops in Kikuubo or in supermarkets. To bag a fruit, blow in the bag to inflate it. Insert one

fruit per bag then close the bag by stapling or firmly tie the top end of bag with a string or wire. Push the bottom of the bag upwards to prevent the fruit from touching the bag. Use a ladder to reach as much fruits as possible. Secure the ladder firmly on the ground and for bigger and higher fruits trees, secure or tie the ladder firmly on big branches. Start bagging the mango fruit 55-60 days from flower bloom or when the fruits are about the size of a chicken egg for medium sized early maturing fruits: such as Bire, Kate, and Apple mango varieties. Remove the bags during harvest and dispose of them properly.

The bags can be purchased in bundles/Kilograms or as a single piece. A kilogram of paper bags comprising of 70-100 small to medium sized bags, can cost UGSH 7,000/= to 10,000/= depending on whether you purchase from whole sale or retail shops.

Mafuco paper bags (Plate 9 and Plate 10) have been used to bag fruits on farmers' fields in Kasese, Iganga and Luwero districts. Bagging of fruits has been observed to reduce fruit fly infestation from 54 pupae/kg of fruit in un-bagged mangoes to 0.9-15 pupae/kg in bagged mango fruits (Figure 1). Farmers in Iganga found the bagged fruits with very smooth skin and could be marketed at a higher price.

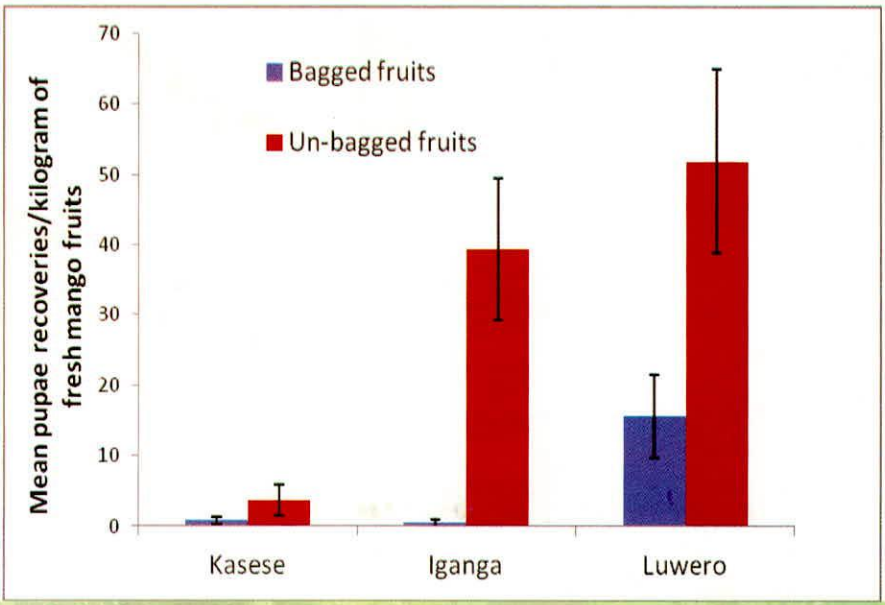

Figure 1: Reduction in fruit fly infestation due to bagging of the mango fruits

A farmer growing high value exotic mango fruits such Tommy artikins, Apple mango, Zillate, Keitt, Palvin or Kent could incur a cost of UGSH 70/= to 150/= on bagging (i.e. 70/= to 100/= for purchasing the bag and an extra 50/= for labour cost for bagging per fruit). If a farmer can sell at UGSH 500/= to 1500/= per fruit, then such a farmer would earn a profit of UGSH 300/= to 1000/= per fruit.

Farmers can also make their own bags, if they are unable to buy them. One can use old newspapers or any other used paper at home. To make the mango wrapping bags, measure 15 x 22 cm or 12.5 x 27.5 cm depending on the size of the fruit that needs bagging. Double the layers, as a single layer breaks apart easily. Fold and stitch or staple the sides and the bottom of the sheets to make a rectangular bag.

3.4. Bait Sprays

Fruit fly bait is an autolysed protein with an odour attractive to both male and female flies but particularly immature females searching for protein food that they need to develop their eggs. The protein bait is mixed with an insecticide and spot sprayed in small quantities onto the leaves of the trees at the rate of 60ml/tree. The bait spray should be applied early in the morning (before 10 am) at seven to ten day intervals from two weeks after fruit set until harvest. This is so because fruit flies are present in the orchard even when the mango fruits are absent. It is advisable to start control intervasions before the fruit fly breeding population builds up.

Bait sprays offer many advantages over the use of insecticide cover sprays; in that less material is used per hectare so costs are reduced, are less harmful to beneficial insects and the hazard effects to the operator is considerably reduced. Regular treatments of baits and integration with other options are essential for this method to succeed.

3.5. Chemical Cover Sprays

Conventional chemicals, although used by farmers, are very destructive and often lead to an upsurge of pests. These chemicals should be used according to the manufacturers' recommended rates outlined on the packaging. Commonly used insecticides that farmers apply to reduce fruit fly infestation include Organophosphates and Cypermethrin. It is advisable to spray the trees before flowering to suppress the flower and pod sucking insects and not to spray with insecticides during the flowering period. This is because the chemical pesticides

will kill the pollinators, disrupt the pollination process and reduce fruit setting in the orchard. If it is inevitable to spray during flowering, one should do the spraying very early in the morning before 8am or after 6pm in the evening but never during the hot day sunshine.

3.6 Integrated Fruit Fly Management:

It is advised to practice integrated fruit fly management as using only one option will not be sufficient to bring the fruit fly under control. Orchard sanitation should be practiced all the time to reduce the breeding sites for the females and disrupt life cycle development. Orchard sanitation needs to be integrated with management options that suppress the female and male flies.

In trials conducted in Kasese, Iganga and Luwero, an integration of orchard sanitation, mass trapping using the MAT blocks, and fruit bagging, significantly reduced fruit fly damage as shown in Figure 2. The reduction in fruit fly damage was higher in Kasese where most of the commercial mango farmers spray the tress with insecticides

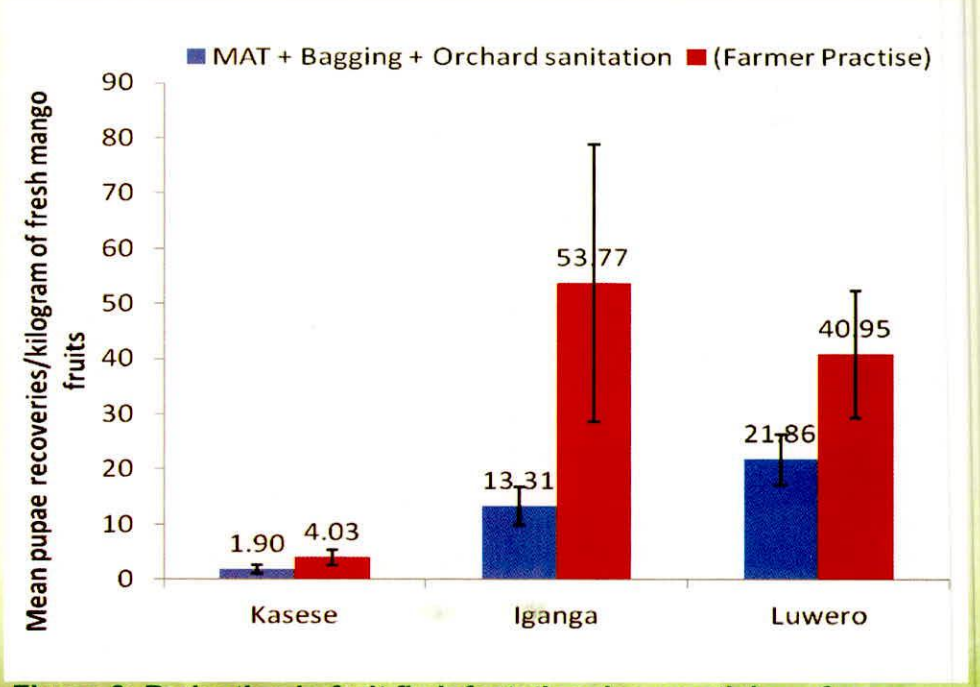

Figure 2: Reduction in fruit fly infestation due practicing of mass trapping with ME-MAT traps, orchard sanitation and bagging of the mango fruits

and fungicides to control pests and diseases than in Luwero and Iganga where chemical spraying was less used.

4.0 Other Pests and Diseases

4.1 Mango Seed Weevil.

The adult of the mango seed weevil, *Sternochetus mangiferae (Fabricius),* is 8 mm in length and 4 mm in width. This is a short, compact weevil typical with the basic pattern made up of coloured scales (reddish to greyish with variable light markings) usually similar to that shown in Plate 11 and Plate 12. The adult weevil feeds on leaves and tender shoots of mangoes. The weevil is nocturnally active, and usually feed, mate and lay eggs at dusk. Eggs are laid singly on all areas of half mature (green) to ripe mango fruit. The newly hatched larva burrows through the pulp and into the seed where it will develop until it becomes an adult. As the fruits mature, the tunnels are eliminated and it is not possible to distinguish between infested and non-infested seeds, unless they are cut open. The infected fruits usually ripen prematurely and also drop on the ground. Seed weevil infestation has been observed to be very common in Kagoogwa and other local or semi-exotic mango varieties. Losses to the mango seed weevil are very much felt with the nursery operators that graft mango seedlings as many of the root stock seed of Kagoogwa fail to germinate as result of seed weevil damage. Orchard sanitation is used to manage this pest.



Plate 11. Pupae, larva and adult weevil in mango seed



Plate 12. Adult seed weevil

4.2 Flower and Fruit Diseases

A number of flower and fruit diseases are also observed in different intensities in mangoes in Uganda. Among the diseases, **Anthracnose *(Colletotrichum gloeosporioides)*** causes serious losses to young shoots, flowers and fruits under high humidity, frequent rains and the temperature range of 24- 32°C. The disease produces leaf spots; blossom blight, withered tip, twig blight and fruit rot symptoms (Plate 13 a and b). Young infected fruits develop black spots (Plate 13 a and b), shrivel, cracking (Plate 13 and Plate 14) that leads to rotting which attracts fruit fly attack and other secondary invaders like the blue flies and microorganisms (Plate 15). The fly maggots accelerate the rotting and eventually the rotting fruit drop on the ground. Some farmers mistake the blue flies to be the fruit flies.



Plate 13 a: Black and rusty spots on Zilate mango fruits



Plate 13 b: Black and rusty spots on Kate mango fruit



Plate 14: Cracked Kate fruits due to anthracnose attack



Plate 15: Damaged Zillate mango with blue flies

Such diseased and damaged fruits are very vulnerable to fruit fly attack and are usually found with female flies depositing the eggs into the already diseased fruits. This is why many cracked rotting fruits are normally found with fruit fly maggots and farmers attribute all symptoms to the fruit flies. Some of the infected fruits may carry the disease to maturity but due to cracking, the market value of the fruit is reduced. A farmer having a combination of the fruit flies and anthracnose attack will experience higher fruit losses.

Powdery Mildew *(Oidium mangiferae)* is one of the most serious diseases of mango affecting almost all the varieties. The characteristic symptom of the disease is the white superficial powdery fungal growth on flowers, leaves, stalk of panicles, and young fruits (Plate 16). The affected flowers and fruits drop pre-maturely reducing the mango fruit load considerably or might even prevent fruit set (Plate 17). Rains or mists accompanied by cooler nights during the flowering stage create a conducive environment for Powdery Mildew spread. A wide range of fungicides containing Mencozeb are used against mango fungal diseases. It is advisable to spray with preventive fungicides before flower set and continue the spraying at 14 day intervals during flowering if the disease symptoms are observed. Application can be increased to 7-10 day intervals if high disease prevalence is observed. It is very difficult to contain powdery mildew if spraying is done after the flowers have been attacked and show powdery symptoms.



Plate 16: White superficial powdery fungal growth on the flowers



Plate 17: Flowers and young fruits dropped due to powdery mildew infestation leaving bare flower stalks

5.0 Conclusion

An Integrated approach involving a number of control options is strongly recommended due to the fact that most mango growing regions in Uganda are endemically infested with *B. invadens*, and no single control option can be reliably depended on to sufficiently manage the fruit fly problem.

Integrated Pest Management based on Orchard sanitation, combined with male fly mass-trapping, bagging and timely use of bait sprays or chemical sprays can be provisionally used to manage the fruit flies in localised conditions.

In order to achieve sustainable and long term control of the fruit flies in Uganda, an Area-Wide Integrated Fruit Fly Control Program involving all the stakeholders: Research, Ministry of Agriculture, Farmers, Community Leaders, Agricultural Extension, and Private partners associated with the fruits and vegetable value chain must be planned and implemented to successfully disseminate the tested and proven control options to a wider community of farmers.

Countries that have adopted area-wide integrated pest management (AW-IPM) programs have been successful in alleviating the fruit fly pest problems. Community awareness campaigns should therefore be enforced to sensitize farmers on the losses caused by the fruit fly, and a complex of other pests and diseases found on farmers' fields so as to trigger action for control.

There is need to mobilise more funding that will facilitate the scaling out of the proven effective management practices to all major mango producing areas in the country.

Furthermore, other pests and diseases that have been observed to aggravate the fruit fly problem should not be ignored if sustainable control of the fruit is to be attained. The cultural control options for major mango diseases should be validated and a wide range of insecticides and fungicides on the Uganda market should be screened to identify the most cost effective, environmentally acceptable and safe pesticides that should be recommended to farmers.

A comprehensive package for mango pest and disease management should therefore be developed and disseminated to the farming community.



For Further Information Contact:
National Agricultural Research Laboratories - Kawanda
P.O.Box 7065 Kampala Tel: +256-414-566381
Email: karidir@imul.com
Printed by: Facts Stationery Investments Limited. +256 777 912558 / 772 524951