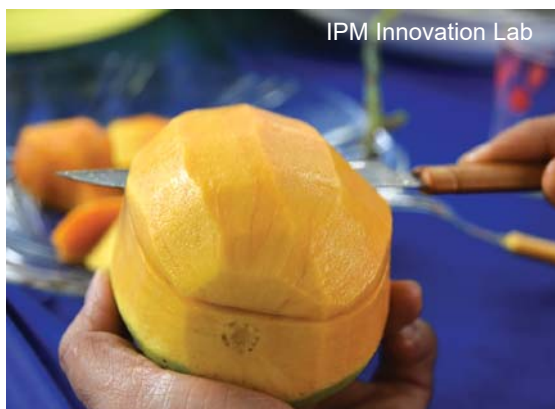


INTEGRATED PEST MANAGEMENT PACKAGE

mango package



Mango (*Mangifera indica* L.: Anacardiaceae) originated from the region between northwestern Myanmar, Bangladesh, and northeastern India, and is now distributed throughout the tropical and subtropical world. It is a highly cross-pollinated plant and most cultivars have arisen from selection of desirable types among naturally produced seedlings or seedlings selected from known mother trees. Only grafted plants are used for commercial cultivation for homogeneity. It is a perennial tree of medium to large size. Fruit is a source of vitamin A and C. It is used in preparations of chutneys, pickles, curries, syrups, nectars, jams, and jellies. Mango trees prefer well-drained, rich, and sandy loam soils. The optimum soil pH range is 5.5 to 7.5. Major abiotic stresses for this crop include salinity, flooding, and cold temperatures. Major biotic stresses include fungal diseases such as anthracnose, sooty mold, malformation, and stem end rot, and insect pests such as leafhoppers, weevils, red banded mango caterpillar, fruit flies, and mealybugs.

WHAT IS IPM?

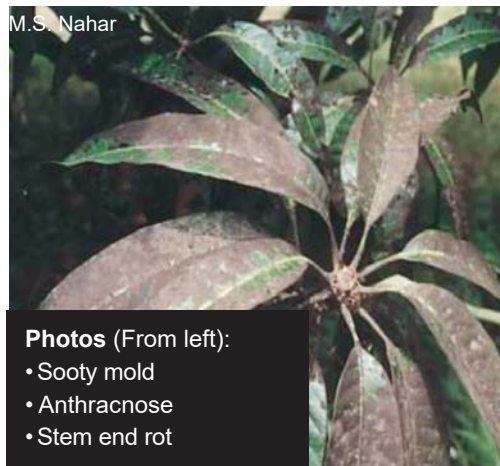
Integrated Pest Management (IPM), an environmentally sound and economical approach to pest control, was developed in response to pesticide misuse in the 1960s. Pesticide misuse has led to pesticide resistance among prevailing pests, a resurgence of non-target pests, loss of biodiversity, and environmental and human health hazards.

WHAT ARE IPM PACKAGES?

The IPM Innovation Lab has developed and tested robust IPM packages, holistic suites of IPM recommendations and practices for the production of vegetables and other crops. Farmers who use IPM packages in planting, production, and throughout the supply chain see enhanced profitability in their crops. The recommended practices in IPM packages cover economically significant pest species over a wide range of cropping systems across the tropical world, resulting in benefits to human health and the environment.

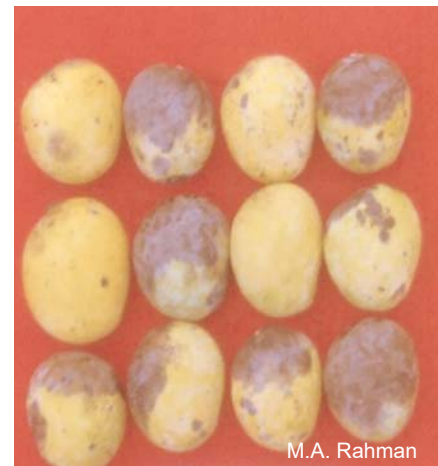
This brochure was created and distributed by the Feed the Future Innovation Lab for Integrated Pest Management (IPM IL) and its associate award Feed the Future Bangladesh Integrated Pest Management Activity. It was made possible through the United States Agency for International Development and the generous support of the American people through USAID Cooperative Agreement No. AID-OAA-L-15-00001 and Associate Award No. 72038821LA00001.

diseases



Photos (From left):

- Sooty mold
- Anthracnose
- Stem end rot



M.A. Rahman

DISEASES

Sooty mold [*Capnodium* sp. (Capnodiales: Capnodiaceae)]

This fungus develops on leaves, inflorescences, and fruits of mango that are attacked by sap-sucking leafhoppers and mealybugs. These insects excrete honeydew that nourishes sooty mold. Although it does not cause direct damage, it reduces photosynthetic surface of leaves. By controlling these insects, this fungus could be managed.

Anthracnose [*Colletotrichum gloeosporioides*] (Glomerellales: Glomerellaceae)]

It is a fungal disease that affects leaves, tender shoots, and fruits. Brown or dark circular or irregular spots are formed on the leaves. Consequently, normal development is prevented and leaves become crinkled. On young green twigs, dark-brown lesions are formed and eventually the twigs dry up. Flowers wither and shed when flower stalks are infected.

When tender fruits are infected, they turn black and fall off. On mature fruits, black, round, irregular, or sometimes sunken spots are formed on the skin. Considerable spoilage of ripe fruits often results. Wet conditions increase its infection rates. Proper sanitation, aeration, and reduced humidity by pruning decreases disease incidence.

Malformation [*Fusarium subglutinans* (Hypocreales: Nectriaceae)]

Malformation affects inflorescence and new shoots of mango. Apical or axillary buds produce misshaped shoots with shortened internodes and dwarfed leaves, which are brittle and recurved towards the supporting stem. Shoots may not expand fully, resulting in a bunched appearance on these portions of the plant. Malformed panicles may produce as many as three times the normal number of flowers, and these are usually enlarged. Inflorescences may also have an increased proportion of male vs. perfect flowers and may produce dwarfed and

distorted leaves (exhibit phyllody).

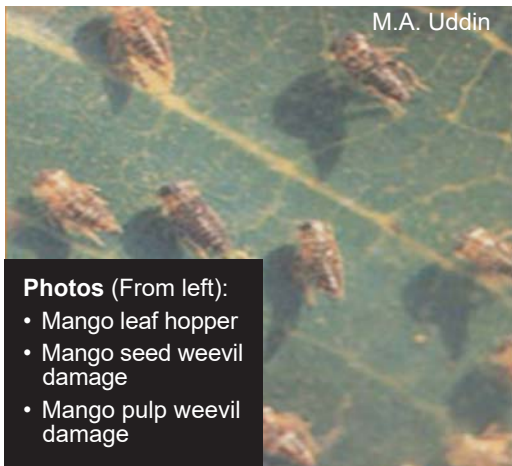
Stem end rot [*Colletotrichum gloeosporioides*, (Glomerellales: Glomerellaceae); *Dothiorella* spp. and *Lasiodiplodia theobromae* (Botryosphaerales; Botryosphaeriaceae)]

Stem end rot is usually a post-harvest disease of mango fruit. In general, the stem ends of affected fruit appear dark brown and water soaked, and the affected areas may extend internally well into the fruit.

MINOR DISEASES

Some of the minor diseases of mango in Bangladesh include: powdery mildew (*Oidium mangiferae*), Alternaria leaf spot (*Alternaria alternata*), blossom blight/grey mold (*Botrytis cinerea*), die back (*Botryosphaeria theobromae*), mango scab (*Elsinoe mangiferae*), and leaf red rust (*Cephaleuros virescens*).

insect pests



Photos (From left):

- Mango leaf hopper
- Mango seed weevil damage
- Mango pulp weevil damage



INSECTS

Leaf hoppers [*Idioscopus clypealis*, *Idioscopus nagpurensis*, *Amritodus atkinsoni* (Hemiptera: Cicadellidae)]

Nymphs and adults feed by sucking the sap on tender plant parts like shoots, inflorescence, and fruits. Feeding causes necrosis in young twigs and leaves, withering of flowers, and fruit drop. Infestation is more prevalent during flowering stage in the spring season and on young leaves on other times of the year. When disturbed, adults make a short flight, but quickly settle back on the plant. They excrete honeydew, leading to the development of sooty mold on leaves. Heavy infestation can cause 100% yield loss.

Mango nut/seed weevil [*Sternochetus mangiferae* (Coleoptera: Curculionidae)]

The female weevil scoops out the surface of the young mango fruit and deposits the egg singly. The liquid that oozes from the fruit covers the egg, dries up, making it hard to recognize. The grub that hatches, tunnels through the pulp, the seed coat, and then reaches the cotyledons to feed. Pupation takes place inside the seed.

The adult that emerges from pupa also feeds on the cotyledons. Often, the adult weevil emerges from the discarded seeds after the fruit is eaten or used. There is one brood per year and the weevils remain dormant from July-August until the following March-April.

Mango pulp weevil [*Cryptorhynchus (Sternochetus) frigidus* (Coleoptera: Curculionidae)]

The pest is more prevalent in the eastern districts of Bangladesh. Eggs are laid singly on the epicarp of partially developed fruits or under the rind of ripening fruits. The grubs feed on the flesh and pupate in small chambers up to one cm in diameter. There are no signs of the weevil on the outside of the fruit. The adult weevil exits the fruit, making a small hole in the skin. The mango pulp weevil looks similar to mango stone weevil, but the pulp weevil attacks pulp, causing it to rot. It does not enter the seed.

Red banded mango caterpillar [*Deanolis sublimbalis* (Lepidoptera: Pyralidae)]

It is a recent introduction to the country from Southeast

Asia. The caterpillars feed on pulp and tender mango seeds and attack the mango fruits at marble stage to fruit maturity. The caterpillars feed within the fruit and make a series of tunnels. Because it attacks young fruits, few of them reach maturity. The caterpillar has red and white bands across the body and a dark collar behind the head, which makes it easy to identify.

Leaf cutting weevil [*Deporaus marginatus* (Coleoptera: Curculionidae)]

The adult female slit is made alongside of the midrib at the back of the leaf, and the egg is inserted into the slit. It lays 10-20 eggs in a leaf. The leaf containing eggs is cut off near its base and the leaf drops to the ground. Grubs mine the fallen leaf, giving rise to irregular blotch mines. Full grown grubs emerge from the mines and pupate in the soil. Emergence of adults usually synchronize with rainfall so as to coincide with new flush of mango leaves.

Oriental fruit fly [*Bactrocera dorsalis* (Diptera: Tephritidae)]

Fruit flies appear late in spring on fruits that are about to ripe and population

increases rapidly during summer. The female flies lay eggs just below the fruit epidermis one to four mm deep. Maggots tunnel into the pulp and cause rotting and premature dropping of fruits. The maggots emerge from these fallen fruits to pupate in the soil. Pupation takes place 80 to 160 mm below the soil surface.

Mango mealybug [*Drosicha mangiferae* (Hemiptera: Monophlebidae)]

It is a polyphagous pest that attacks a wide variety of trees, including mango, jack fruit, banyan, guava, litchi, citrus, and pomegranate. This pest is seasonal. Eggs are laid in clusters of 300 to 400 inside a cottony white ovisac in the soil below the trees in May and they undergo diapause until November. Upon hatching, nymphs crawl up the trees. The nymphs and female adults suck plant sap from inflorescences, tender shoots, and fruit peduncles. As a result, the infested inflorescences dry up and result in reduction in fruit production. Nymphs and adult females exude honeydew which encourages sooty mold development and in turn reduces the photosynthetic efficiency of leaves.

insect pests, mites, and weeds

Pest and Diseases Image Library, Bugwood.org

Arun T.P., Bugwood.org



Photos (From left):

- *Bactrocera zonata*
- *Euthalia aconthea*

MINOR INSECT AND MITE PESTS

Some of the minor pests of mango in Bangladesh are: mango stem/trunk borer (*Batocera rufomaculata*), mango fruit fly (*Bactrocera tau*), guava fruit fly (*Bactrocera zonata*), mango leaf gall midge (*Procontarinia matteiana*), mango common scale insect (*Coccus mangiferae*), mango shoot gall (*Apsylla cystellata*), mango defoliator (*Cricula trifenestrata*), mango fruit borer (*Citripestis eutrapphera*), mango leaf webber (*Orthaga exvinacea*), mango leafminer (*Acrocercops syngamma*), mango leaf caterpillar (*Euthalia aconthea*), pink gypsy moth (*Lymantria mathura*), fruit piercing moth (*Eudocima phalonia*), mango shoot caterpillar (*Penicillaria jocosatrix*), red banded thrips (*Selenothrips rubrocinctus*), coconut scale (*Aspidiotus destructor*), and mango eriophyid mite (*Aceria mangiferae*).

WEEDS

Loranthus/Indian mistletoe (*Dendrophthae falcata*: Loranthaceae)
It is a parasitic weed that grows on the branches of the trees. At the point of attachment, haustoria penetrate into the tissues of the host for the absorption of nutrients. It is not specialized to mango but it could be found on many other trees. Birds help in the dispersal of the fruits. The damage caused depends on the intensity of infestation. Though it has green leaves, a large amount of nutrients is removed from the host, resulting in the cessation of growth of the affected branches.

mango ipm techniques



Photos (From left):
• Mango bagging
• Grafted mango

- Select scions from mango varieties that have good market value and are resistant to pests and diseases and graft on compatible rootstock.
- Protect young shoots of the seedlings with sleeves made of mosquito/nylon net or perforated plastic bags to prevent leaf cutting beetle attack.
- Collect leaves cut and dropped by the leaf cutting beetle from the ground and dispose to prevent emergence of beetle from them.
- Trim and prune trees to maintain manageable height, proper ventilation, and ease of crop protection operations.
- Proper sanitation, aeration, and reducing humidity by pruning decreases incidence of mango leafhoppers.
- Prune severely affected shoots such as the ones with leaf webs and destroy them.
- Maintain a clean field free of weeds.
- Cut and remove parasitic plants from the trees.
- Set up physical barriers with sticky traps on stems of mango trees in November to prevent mango mealybug nymphs from crawling up from the ground.
- Bag fruits to protect them from fruit flies, fruit borers, birds, and bats.
- Set up Methyl eugenol traps to attract and kill male Oriental fruit flies.
- Apply insecticide-treated protein bait to attract and kill fruit flies.
- Remove and bury fallen fruit fly, red banded caterpillar, and/or mango pulp weevil infested fruits in pits of at least 0.3 m deep in the soil.
- Harvest mango with pedicel and apply hot water treatment to protect from stem end rot disease.
- Apply need-based pesticides at the various stages of growth to manage diseases and pests. Use bio-pesticides such as *Beauveria bassiana* and *Metarhizium anisopliae*; botanicals such as neem; and opt for safe chemical pesticides as a last resort. Do not use pesticides with the same mode of action continuously to avoid resistance development in pests.
- Avoid spraying with chemical insecticides when trees are in full bloom to prevent killing of pollinators.
- Conserve natural enemies: Predators such as coccinellids *Coccinella septempunctata*, *Coccinella transversalis*, *Chilocorus nigritus*, *Scymnus sp.*, *Menochilus sexmaculatus*, *Rodolia cardinalis*, and *Cryptolaemus montrouzieri*; predatory mites such as *Amblyseis spp.*, *Phytoseilus sp.*; predatory bugs such as *Orius spp.*; spiders and lacewings; and egg and larval parasitoids of lepidopterans *Trichogramma spp.*, *Ooencyrtus sp.*, and *Telenomus sp.* *Euplectrus sp.*, *Echthromorpha sp.*, and *Winthemia sp.*; fruit fly parasitoids *Fopius arisanus*, *Fopius vandenboschi*, and others; parasitoids of mealybugs *Gyranusoidea tebygi* and *Anagyrus mangicola*; parasitoids of scale insects *Aphytis spp.*, and others.

FOR MORE INFORMATION

The Feed the Future Innovation Lab for Integrated Pest Management (IPM IL) develops sustainable and economical pest control methods to improve livelihoods for farmers worldwide. The program's work is based in seven countries and is engaged with scientists, extension agents, students, and farmers in the tropical and subtropical world. The IPM IL is funded by the U.S. Agency for International Development (Lead award number: AID-OAA-L-15-00001) and housed at Virginia Tech. The Feed the Future Bangladesh Integrated Pest Management Activity (Associate Award No. 72038821LA00001) is an associate award of IPM IL.

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