

Root Rot & Damping off

Caused by a fungus *Rhizoctonia solani kuhn*

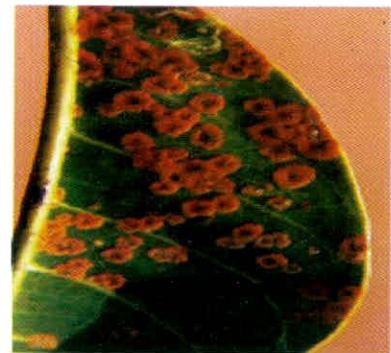
Symptoms: The disease is characterized by sudden dropping of leaves after the emergence of seedlings from the soil. During prolonged rainy and humid weather, infection occurs at / or below the ground level with circular to irregular water-soaked patches. These patches enlarge and ultimately girdle the entire base of the seedlings.

Management

- Care should be taken that water should not stagnate near the root zone.
- The nursery should be raised on elevated beds.
- Nursery beds should be fumigated before sowing.
- Application of Trichoderma in the affected nursery is effective.
- During the growing season, Bordeaux mixture (1.5%) should be sprayed on the plants and the soil at weekly intervals.



Mango growing in Uganda



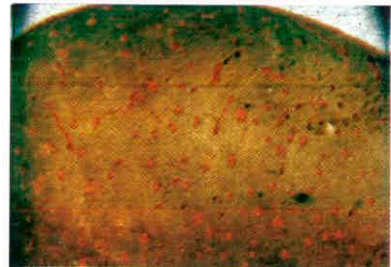
Red rust

Caused by a fungus *Cephaleuros virescens* Kunze

Symptoms: The disease is readily recognized by the presence of the rusty red fructification of the alga on the surface of the leaves, veins, petiole and young twigs and fruit. Initially, the spots are greenish gray in color and velvety in texture which finally turns into reddish brown in color.

Management

- If vigor of the plant is maintained by balanced nutrients, the disease is less.
- Spray Bordeaux mixture (5:5:50) or copper oxychloride (0.3%).
- As the disease starts on the onset of rain, it is desired to spray fungicide twice during the month of July/ August at 15 days intervals.



Lichens

Caused by a fungus *Strigula elegans* (Free.) Mull Arg.

Symptoms: Lichens are found on full grown trees of mango, mainly on trunks, branches, and twigs in the areas of high humidity, heavy rainfall, and poorly managed orchards. It is seen in the form of whitish, pinkish, superficial patches of different shapes on the main trunk, branches, leaves, and twigs of the trees



Mango growing in Uganda

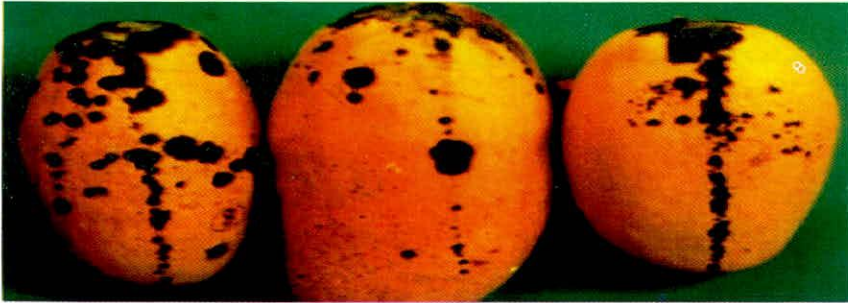
Management

- Field sanitation and balanced nutrition help in checking the disease.
- The lichens can be managed by gunny rubbing followed by spraying the trunk, branches, and twigs with commercial caustic soda (1.0%)

Post-harvest disease

Anthraxnose (*Colletotrichum gloeosporioides* Penz. = *Glomerella cingulata* (Stons.) Spauld & Schrenk)

Symptoms:- The post-harvest infection starts to form from the field as latent infection. On stored fruits, black spots are produced. Initially, the spots are round but later coalesce to form large irregular blotches. Sometimes, it covers the surface of the entire fruit. The spots have large deep cracks in which fungus penetrates deep into the fruit, causing extensive rotting. Under moist conditions, the blackened areas become covered with minute pinkish reproductive bodies of the fungus.



Management

- Pre-harvest sprays with thiophanate methyl or carbendazim (Topsin M or Bavistin 0.1%) in the field to reduce the latent infection.
- Hot water treatment along at 52°C for 3 minutes. However, the duration of hot water treatment can be reduced to 15 minutes by supplementing it with fungicides, viz. carbendazim or thiophante methyl (Bavistin or Topsin M 0.05%).

Stem end Rot (*Diplodia natalensis* Pole Evans)

Symptoms:- The disease starts with fruit at the base of the pedicel. A circular brown area develops near the stem end, which gradually starts developing as dark brown to black area towards the lower portion of the fruit and later even cover the entire fruit surface. The rotting is so fast that the entire fruit rots within 2-3 days. The disease is observed on ripe fruits only.



Management

- Preharvest sprays of carbendazim or thiophanate methyl (Bavistin or Topsin M 0.1%) 15 days before harvesting control the post-harvest rot due to stem end rot.
- Dipping the fruits in hot water 52± 1° C with 0.05% carbendazim for five minutes.

Black Banded

Caused by fungus *Rhinothidium corticolum* Masee, perfect stage *Peziotrichum corticolum* (Masee) Subramanian]

Symptoms: The disease is noticed on the midribs/ veins of the leaves, twigs, and branches as black velvety raise fungal outgrowth in the form of spots which gradually increase in size and encircle the trunk limbs, branches, and twigs. The incidence of the disease is very low on the main branches. The disease occasionally spread on the leaves and cause loss. It presents a characteristic and conspicuous black banded appearance and thus considered appropriate to name it as 'Black banded' diseases

Management

- Spraying of Bordeaux mixture (5:5:50) or copper oxychloride (0.3%).
- Gunny rubbing on twigs /branches to remove the black growth



Ganoderma root rot

Caused by a fungus *Ganoderma lucidum*

Symptoms: The leaves of affected tree area lustreless and sparse. Diseased tree wilts and dies. Infected roots are very light in weight and get easily crumbled and powdered with fingers. The fruiting bodies of the fungus (brackets) appear at the base of the tree in rainy season.

Management

- Collection of brackets and destruction.
- Exposure of roots and drenching with dinocap 2 ml/l and covering with soil and incorporation of green leaves in the tree basin effectively reduce disease.

Gummosis

Caused by a fungus: *Lasiodiplodia theobromae* (Pat.) Griffon and Mauble (Synonyms: *Botryodiplodia theobromae* Pat.) [Physalospora rhodina Cooke, perfect stage of *Botryodiplodia theobromae* Pat.]

Symptoms: The disease is characterized by the presence of profuse oozing of gum on the surface of the affected wood, the bark of the trunk and also on larger branches but more common on the cracked branches. In severe cases, droplets of gum trickle down on stem, bark turn dark brown with longitudinal cracks, rots completely and the tree dries up because of cracking, rotting and girdling effects.

Management

- The diseased bark/portion should be removed or cleaned and pasted with Bordeaux paste or copper oxychloride paste or cow dung paste.

- Application of Copper sulphate 500 gm/ tree (depending on the age of the tree) in the soil around the tree trunk is recommended. Gummosis is very less in the orchards receiving regular copper oxychloride sprays for control of leaf spot diseases.



Scab

Caused by a fungus: *Elsinoe mangiferae* Bitancourt and Jenkins = anamorph: *Sphaceloma mangiferae* (Betancourt and Jenkins)].

Symptoms: The scab fungus attack leaves, panicles, blossoms, twigs, the bark of stems and mango fruits. Spots are circular, slightly angular, elongated, 2-4 mm in diameter; brown but during the rainy season, lesions differ in size, shape, and color. Symptoms produced by the disease are very much like those of anthracnose. On young fruits, the infection is gray to grayish brown with dark irregular margins. As the fruit attains in size, spots also enlarge and the center may become covered with the crack fissure and corky tissues

Management

- Frequent sprays of copper oxychloride (0.3%) to protect new flushes of growth are effective for scab control in nurseries.



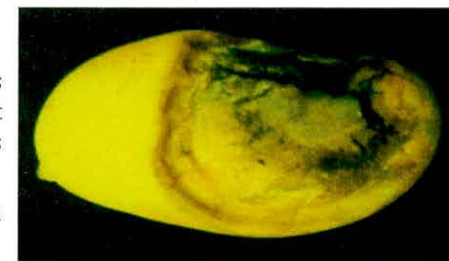
Black Rot (*Aspergillus niger* Van Tiegh)

Symptoms

Affected fruits show characteristic yellowing with irregular dull grayish spots, which develop into the black necrotic area with growth of black mold. Tissue below and around the spots disintegrate and emit a foul odor. The fruits rot very fast. The rotting may start from any point but the injury is essential for the start of rot. It may also start from the stem end as there remains natural opening.

Management

- It is desired that the harvesting of fruits is done carefully as any injury to fruit predisposes it to the attack of *Aspergillus* rot.
- Fruits should not be allowed to touch the soil.
- Fruit harvesting and handling should be done carefully in a clean manner.
- Dipping fruits in hot water $52 \pm 1^\circ\text{C}$ with 0.05% carbendazim for five minutes.



Useful tips for minimizing postharvest diseases

Tips	Reason
1. Start controlling post-harvest diseases before harvest	Many post-harvest diseases begin while the crop is still in the field. Some harvested fruits carry latent infection that may not be detected at harvest level.
2. Avoid injuring the fruits throughout from harvesting to marketing.	Bruises, wounds and other mechanical injuries serve as a portal of entry for microorganisms
3. Clean the containers as sources of infection after harvest.	These may carry the microorganisms from the field.
4. Keep the fruits dry after washing	Free moisture enhances the growth of spores
5. Separate ripe from unripe fruits	Ripe fruits serve as a source of inoculum (decay-causing microorganisms).
6. Handle the fruits carefully from harvesting to storage	Careless handling causes bruise on the fruits, thus, providing entry points for pathogens
7. Separate diseased fruits from healthy ones	Diseased fruits may contaminate healthy fruit when they come in contact with diseased ones.
8. Store fruits at the recommended temperature	Pathogens do not grow at low temperatures. Growth will resume at room temperature
9. Provide aeration in storage & keep the fruits free of excess moisture.	Moist conditions favor the growth and multiplication of disease-causing microorganisms
10. Practice sanitation and cleanliness at all times in transit	Dirty and unsanitary containers and areas may serve as sources of infection.



PHYSIOLOGICAL DISORDER

Black Tip (Chimney disease)

Symptoms: Symptoms become visible when the mango fruits attain some size. Small etiolated area develops near the distal end of the fruit which gradually spreads, turns nearly black and covers the tip of the fruit completely. The black area remains hard and the growth of the fruit is checked



The reason for high severity:

1. The proximity of Orchard to brick kilns.
2. The deleterious effect of gases from brick kilns operating in the vicinity of a nearby Orchard.
3. Wind direction (western winds) and velocity play important role in severity
4. Lack of timely control measures.

Mode of Spread

Through toxic gases viz. Sulphur dioxide, ethylene, carbonmonooxide, and fluoride-emitting from brick kilns operating a near by orchard.

Management

- It can be minimized by the spray of borax (1%) or other alkaline solution like caustic soda and washing soda. The first spray should be done positively at peak stage followed by two more sprays at 15 days interval.
- Planting of mango orchard in anorth-south direction and 3 km away from the brick kilns reduce the incidence.

The reason for high severity:

Growing of susceptible varieties in and around Orchard 2. Disease development is favored by high humidity (90% RH), moderate temperatures (25-30°C), high wind velocity is congenial for severity of disease 3. Lack of wind-breaks to reduce wounding and removal of an asymptomatic portion of trees to reduce inoculums in the orchard. 4. Lack of removal of collateral hosts in the area.

Management

- Regular inspection of orchards, sanitation and seedling certification are recommended
- Mango stones for raising seedlings (root stock) should always be taken from healthy fruits.
- Use of wind-breaks helps in reducing brushing/ wounding.
- Three sprays of Streptocycline (200 ppm) at 10 days intervals reduce fruit infection.
- In severe infection, spraying of Streptocycline (300 ppm) or copper oxychloride (0.3%) is more effective.
- An antagonistic phytoplane bacterium, *Bacillus coagulans*, is found effective.



Malformation

Caused by a fungus *Fusarium subglutinans*

Symptoms: Vegetative malformation: Vegetative malformation is pronounced in young seedlings. The affected seedlings develop vegetative growths which are abnormal growth, swollen and have very short internodes.

Floral malformation: The flower buds are transformed into vegetative buds and a large number of small leaves and stems, which are characterized by appreciably reduced internodes and give an appearance of witches' broom. The flower buds seldom open and remain dull green.

Management

- The floral malformed panicles/ vegetative malformed shoots should be pruned and burnt which reduces the incidence of malformation.
- Application of NAA (200 ppm) or planofix (90 ml/ 20 l) in the first week Before bud differentiation stages followed by deblossoming
- Spray chelated Zn++ (100 ppm) and Cu++ (40 ppm) during flower bud differentiation and flowering stage combined with spray of carbendazim (0.1%)



Phoma blight

Caused by a fungus *Phoma glomerata*

Symptoms: The disease is noticed on matured / old leaves only. Fully developed spots are characterized by a dark margin and dull gray necrotic center. In severe cases, spots coalesce to form patches, which result in withering and defoliation of infected leaves.

Management

- Spray copper oxychloride (0.3%).
- Balanced nutrition provides resistance to phoma blight.

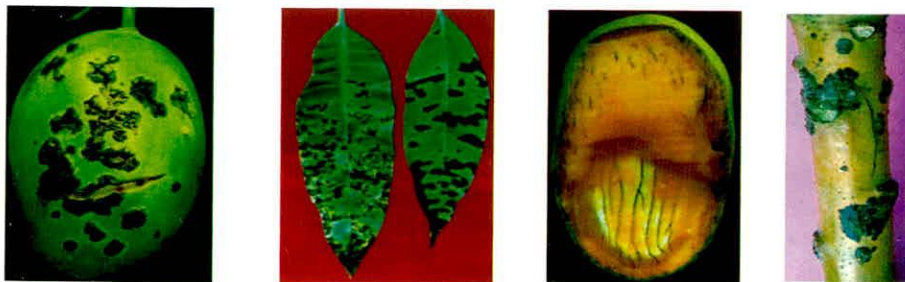


Mango growing in Uganda

Bacterial canker disease

Caused by a bacterium *Xanthomonas campestris* pv. *mangiferae indicae*

Symptoms: The disease is noticed on leaves, leaf stalks, stems, twigs, branches, and fruits, initially producing water soaked lesions, later turning into typical canker. On leaves, water soaked irregular satellite to angular raised lesions measuring 1-4 mm in diameter is formed. These lesions are light yellow in color, initially with yellow halo but with age enlarge or coalesce to form irregular necrotic cankerous patches with dark brown color.



On fruits, water-soaked, dark brown to black colored lesions are observed which gradually developed into cankerous, raised or flat spots. These spots grow bigger usually up to 1 to 5 mm in diameter, which covers / almost the whole fruit. These spots often, burst extruding gummy substances containing highly contagious bacterial cells.

Mode of spread:

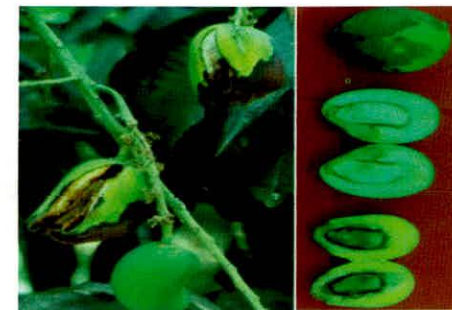
Long distance spread is through planting material and infected mango stones. In the orchard, wind splashed rains. Infection is enhanced when rains occur in concert with the wind which promotes wounding of leaf surface.

Internal Necrosis (Boron deficiency)

Symptoms: First, water soaked grayish spots develop on the lower side of the fruit. Late, the spots enlarge and develop into the dark brown necrotic area. The internal tissue starts disintegrating. The pericarp and mesocarp are disintegrated exposing the flesh. Yellow colored droplets also come out and such affected fruits drop easily.

Management

- Foliar spray of borax (1%) at peak stage followed by two more sprays at 15 days interval.
- Application of 250 gm. boron per tree (10-15 year old) around the tree basin.



Mango growing in Uganda



Fruit Clustering

Symptoms: This abnormality is characterized by the formation of several fruit lets at the tip of the panicle. The fruits are darker green in color and their shape is slightly curved than the normal fruits. These fruits generally hang for more time compared to some normal fruits, which subsequently dropped due to other fruit drop reasons. However these fruitless do not grow more and later drop. The fruits do not have formation of seeds

Management

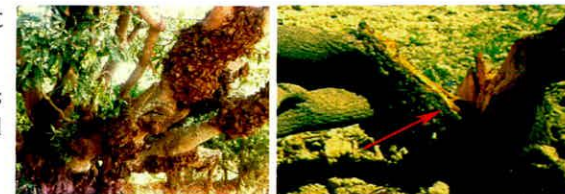
- During flower opening or pollination stages, a spray of insecticides and fungicides should be avoided.
- The population of pollinators should be kept more during the flowering season.
- Pollinating cultivars should be planted in the orchard.
- Increase pollinator's population by keeping bee hives in the orchards.

Woody Stem gall (Cause not known)

Symptoms: Woody galls of 10-15 inches diameter are formed on limbs and branches.

Management

- Remedy lies in removal of galls using saw and applying Bordeaux paste to cut surface.



Red nose / soft nose (Cause not known)

Symptoms: The malady is severe in late maturing varieties particularly in delayed harvest leading to a substantial loss. The fruits with red nose are unfit for export. Numerous red nosed fruits are seen on the tree. Red nose gradually becomes soft and rot.

Management

- Timely harvesting of fruit.
- Proper nutrition to the plant.

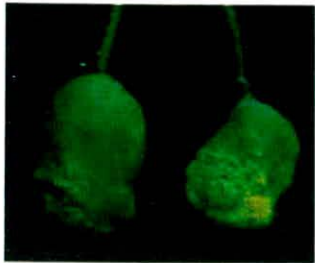


Fruit tumors (Cause not known)

Symptoms: Tumours of apple to marble size develop on fruit and are very ugly to look at. The stylar end part is much affected while stem end is practically free from tumors.

Management

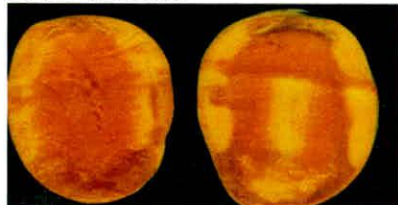
- Removal of affected fruits from the tree and buried in the soil.



Softening of tissue (Jelly seed)

In this disorder, the pulp near the stone becomes jelly like with tissue disintegration while the outer pulp near the peel is normal. The taste of fruit becomes repulsive and loose table quality. From the outer appearance, fruits look normal.

Most of the prone orchards of this disorder have been found with an imbalance of nutrients. Among the nutrients, P and Zn deficiency were more prevalent. The slow movement of nutrients particularly Ca^{++} to the fruits from soil and leaf through transpiration stream at maturity was found to be one of the reasons for this disorder.



Management

- An integrated approach includes application of black plastic mulch (100 u thick) in the basin of tree and foliar spray of calcium chloride dehydrate (2%) and potassium sulphate (1%), one month before harvesting of fruits along with application of 250 g Borax per tree in soil.
- It is desirable to harvest fruits at proper maturity (not late) and make it to ripe in storage rather than to allow on plants.

Sooty mould

Caused by a fungus *Capnodium mangiferae*

Symptoms: It is very common wherever honeydew-secreting insects, viz. mango hopper, scales, coccids, and mealybugs are found. The black velvety thin membranous covering on leaves, stems, and fruits are its symptoms. In severe cases, trees appear black and look ugly.



Mode of Spread:

The disease spreads by insect excreting honeydew or sugary substances. The growth of the fungus is associated with the infestation of scale insects.

Reason for high severity

- Closer spacing where light penetration is low.
- High humidity favors the development of honeydew insects and disease development.
- Lack of timely control of honeydew exerting insects
- Disease incidence is associated with insect severity.

Management

- If honeydew-secreting insects are controlled by suitable insecticides, the mold dies out for want of a suitable growth medium. Spraying of monocrotophos (0.05%) at 10-15 days intervals is quite effective.
- Spraying of starch @2% is effective.
- Spray wettable sulphur + monocrotophos + gum acacia (0.2+0.05+0.3%) or Indian oil formulation No. 1 & 2 (4%) at 15 days interval.
- Application of pesticides should cover both sides of the leaf.



Dieback

Caused by a fungus *Lasiodiplodia theobromae*

Symptoms: The pathogen causing dieback, tip dieback, graft union blight, twig blight, seedling rot, wood stain, stem-end rot, black root rot, fruit rot, dry rot, brown rot of panicle etc. It is characterized by drying back of twigs from top downwards, particularly in older trees followed by drying of leaves which gives an appearance of fire scorch. Internal browning in wood tissue is observed when it is still open along with the long axis. Cracks appear on branches and gum exudes before they die out. When graft union of nursery plant is affected, it usually dies.



Mode of spread

By planting material containing diseased foliage. Disease twigs bearing fruiting bodies are the main source for the perpetuation and spread for the next season. By using infected bud sticks to new areas. By inoculums already present in the orchard. By contaminated garden tools.

Reason for Severity

- Lack of timely control of stem borer which helps in making the tree holes.
- Lack of proper cultural practices (pruning) and application of fungicide.
- Due to lack of application of copper around the tree trunk in sandy soil.
- Tree damaged by gummosis, insects, drought and lack of nutrition
- High temperature predisposes the plant to the attack of pathogen

Management

- Scion wood selected for propagation should be free from infection
- Prevent the introduction of disease in newly planted orchards.
- Any infected portion should immediately be pruned, followed by spraying/ pasting with copper oxychloride (0.3 %) or pasting with cow dung at the cut ends.
- Pruning should be done in such a way that some healthy portion is also removed, to ensure complete eradication of pathogen (3 "below the infection site).
- The affected branches should be collected and burnt.



Spongy tissue

Internal breakdown in the ripe fruits. This disorder renders the fruit unfit for consumption. There are many biochemical changes associated with spongy tissue; however, no conclusive results have been obtained to control this malady. Convicting heat arising from soil and intense solar radiation is reported to be the main cause for this disorder.



Management

- Mulching with paddy straw and dry leaves was found effective for its control

Fungicides

Trade Name / Formulation(s)	Chemical name	Pest control
Dinocap / Karathane - Wettable powder, liquid concentrate, dust	2,4-dinitro-6-octylphenyl crotonates and 2,6-dinitro-4-octylphenyl crotonates, octyl, 1-methylheptyl-1-ethylhexyl-and 1-propylpentyl-isomers	Powdery mildew
Tridemorph-75% emulsifiable concentrate	Mopholines	Powdery mildew
Bavistin/ Carbendazim - water dispersible granule	Benzimidazole (MBC).	Anthraco
copper oxychloride- water dispersible granule	Dicopper Chloride Trihydroxide	Canker, Melanose
Bordeaux mixture (Bordo Mix) - Wettable Powder	Copper(II) sulfate (CuSO ₄) slaked lime (Ca(OH) ₂	Powdery mildew, Downy mildew



INSECT PESTS

There are a number of insect pests that affect mango production in Uganda. A description of each of these pests in terms of damage caused and possible control measures are outlined below

Hopper (*Idioscopus clypealis*, *I. nitidulus*, and *Amritodus atkinsoni*)

Symptoms: The wedges shaped Nymphs and adult insects puncture and suck the sap of tender parts, reducing the vigor of plants and particularly destroying the inflorescence and causing fruit drop. Heavy puncturing and continuous draining of sap cause curling and drying of infested tissue. They also damage the crop by excreting a sweet sticky substance facilitates the development of sooty mold.



Hoppers damaging inflorescence



Fruit drop by hoppers

Management

- Avoid dense plantings, maintained open canopy; prune overcrowded overlapping branches after the rainy season.
- Orchards should be kept clean by regular ploughing and removal of weeds.
- Spraying of 0.2% Nimbecidine or Azadirachtin 3000 ppm@2m/l at the initial stage of hopper population.
- Spray Lambda-cyhalothrin 5% EC@ 0.5 ml or Imidacloprid 200 SL @ 0.25 ml/l or Thiamethoxam (0.05%) or propanophos (0.05%). The first spray should be done at a nearly stage of panicle formation if hopper population, is more than 5-10 panicle, second spray at the full-length stage of panicle and the third spray after fruit setting (at pea size).
- The chemical spray is to be minimized and should be need based.
- A rational rotation of insecticide is desirable to counteract the tendency of a pest to develop field resistance.
- Conservation of bio control agents like predator, *Mallada boninensis*, *Chrysopa lacciperda*, egg parasite, *Polynema* spp. *Gonatocerus* sp. *Tetrastichus* sp. and fungus, *Verticillium lecanii*

Anthracnose

Caused by a fungus *Colletotrichum gloeosporioides*

Symptoms: The pathogen causes leaf spot/leaf blight, wither tip, blossom blight, and fruit rots. On leaves, characteristic symptoms appear as oval or irregular vivacious brown to deep brown spots of various sizes scattered all over the leaf surface. Later lesions get blighted and rupture and show **shot hole' symptom**



Young leaves are more prone to attack than older ones. Petiole, when affected, turns gray or black. The disease also produces elongated black necrotic areas on twigs. The tips of young branches start dying from tip downwards. On blossom small black spots appear on panicles and open flowers, which gradually enlarge and coalesce to cause the death of flowers. The infected flowers fall off, leaving more persistent spikes on peduncles. On fruits, it is more common during transit and storage

The reason for severity:

- Closer spacing, no pruning, and negligence of orchard hygiene
- Due to lack of regular spraying against the disease

Mode of Spread:

Disease spread by rain splash, spores infect all above healthy tissues on the host. Free moisture available in the orchard enhances disease spread. Movement of planting material/ fruits containing infected foliage/fruits.

Management:

- Diseased plant parts should be collected and burnt.
- Blossom infection can be controlled by spraying Carbendazim at 15 days interval.
- Foliar infection can be controlled by spraying of copper oxychloride (0.3%)
- Preharvest sprays of hexaconazole (0.01%) or Carbendazim (0.1%) at 15 days interval
- Hot water treatment at $52 \pm 1^\circ\text{C}$ for 20 minutes. The duration can be reduced to 10 minutes by supplementing Carbendazim or prochloraz both (0.05%) in hot water.
- Covering the fruits on the tree, 15 days prior to harvest with news or brown paper bags.
- Use biocontrol agent viz *Streptosporangium pseudovulgare*.



Major Diseases of Mango

Powdery mildew

Caused by a fungus. *Oidium mangiferae*

Symptoms: Pathogen attacks the inflorescence, leaves, stalk of inflorescence and young fruits with the white **superficial powdery growth of fungus** resulting in its shedding. The sepals are relatively more susceptible than petals. The affected flowers fail to open and may fall prematurely. Dropping of unfertilized infected flowers leads to serious crop loss. Initially, young fruits are covered entirely by the mildew. When fruit grows further, the epidermis of the infected fruits cracks and corky tissues are formed. Fruits may remain on the tree until they reach up to marble size and then they drop prematurely.



Infection is noticed on young leaves when their color changes from brown to light green. Young leaves are attacked on both the sides but it is more conspicuous on the grower surface. Often these patches coalesce and occupy larger areas turning into purplish brown in color. The pathogen is restricted to the area of the central and lateral veins of the infected leaf and often twists curl and gets distorted.

The reason for severity:

- High humidity, cloudy weather & high wind velocity for 3-4 day.
- Minimum temperature (10-13°C), maximum 27-31°C and RH 82-91%
- Lack of timely fungicidal Schedule
- Close planting without canopy management.

Mode of spread.

The disease spread through wind-borne spores.

Management

- Prune diseased leaves and malformed panicles
- Foliar application of potassium dihydrogen phosphate & potassium-phosphate fertilizer
- Spray wettable sulphur (0.2%) when panicles are 3-4" in size.
- Spray fungicides dinocap/ Karathane (0.1%) 15-20 days after the first spray.
- Spray tridemorph (0.1%) 15-20 days after the second spray.
- Spraying at full bloom needs to be avoided.



Mealy bug (*Drosicha mangiferae*)

Symptoms: The adult bugs are covered with whitish powder and colonize between the bark of tree trunk, young shoots, and panicles. The nymphs' ascent the trees and settle on inflorescence causing flower drop, affecting fruit set. They also excrete honeydew, a sticky substance, which facilitates the development of sooty mold.

Management

- Flooding of the orchard with water to kill the eggs.
- Thoroughly ploughing of orchard
- Raking of soil around the tree trunk to expose the eggs to natural enemies and sun, removal of weeds and mixing with chlorpyrifos dust 1.5% @250 g/ tree.
- After mud plastering, banding of tree trunk with alkathene (400 gauge), 25 cm wide sheets should be fastened to the free trunk with the help of sutli, 30 cm above ground level and application of *Beauveria bassiana* product (2g/litre 1x10⁷ spores/ml)
- Conservation of biocontrol agents, *Beauveria bassiana*, predators, *Menochilus sexmaculatus*, *Rodolia fumida* and *Sumniusrenardi*.
- Releasing 10-15 grubs of acoccinellid predator, *C. montrozieri* per tree
- If nymphs ascended on tree spray Dimethoate (0.04%)



Inflorescence / leaf/ twig midge (*Erosomyia indica*, *Dasineura*, *amraramanjarae*, *Procystiphovra mangiferae* and *Procontarinia*, *matteriana*)

Symptoms: The larvae tunnel the axis of inflorescence and destroy it completely. Damage by *E. indica* causes bending and drying of the inflorescences. Second attacks start at fruit setting as young maggots bore into these tender fruits which slowly turn yellow and finally drop. The third attack is on tender 'new leaves encircling inflorescence. The most damaging one is the first attack in which the entire inflorescence is destroyed. The inflorescence shows stunted growth and its axis bends, at the entrance point of the larva.

Management

- Collection and disposal of infested panicles leaves and twigs.



- Deep ploughing of orchard to expose pupae and diapausing larvae to sun's heat which kills them.
- Monitoring of larval population on white paper and apply chlorpyrifos (1.5%) dust based on population.
- Spray dimethoate (0.05%) at bud burst stage.

Fruit flies (*Bactrocera dorsalis*, *B. correctus* and *B. zonatus*)

Symptoms: The female punctures outer wall of mature fruits with the help of its pointed ovipositor and inserts eggs in small clusters inside mesocarp of mature fruits. On hatching, the maggots feed on fruit pulp and the infested fruits start rotting due to further secondary infection.



Management

- Prior to harvest (30-40 days) collect and dispose of off infested and fallen fruits to prevent further multiplication and carry over of the population.
- Ploughing of orchard to expose pupae to sun's heat which kills them.
- Hanging of methyl eugenol wooden block traps soaked in ethanol, methyl eugenol and Malathion (6:4:1) during the fruiting period @10 traps/ ha tie them tightly at 3-5 feet above ground level.
- To control adult flies during severe infestation placing poison bait viz Protein hydrolysate + Malathion 50 ml + 200 ml molasses in 2 liters of water be sprayed adding an additional 18 liters of water to bait poison. Commencing at the pre-oviposition period and repeat at 15 days interval. The addition of 10 ml methyl eugenol in place of molasses is also recommended.
- Hot water treatment of fruit at $48 \pm 1^\circ\text{C}$ for 60 min.
- Three weeks before harvesting, spray Deltamethrin 2.8 EC @ 0.5 ml/l + Azadirachtin (3000 ppm) or 2 ml/l.
- Irradiation of fruits 400 G- rays using cobalt 60 to control fruit fly.
- If the infestation is heavy, bait splash on the trunk only, once or twice at the weekly interval is recommended. To prepare bait splash, mix 100 gm. of jaggery in one liter of water and add 1 ml of Deltamethrin by using an old broom.
- Managing fruit flies also reduces anthracnose disease and prevents late fruit fall.



Mango Varieties

Attributes	Kent	Tommy Atkins	Keitt	Zillate	Parvin
Flavor	Sweet & rich	Mildly & sweet	Sweet & Fruity	Juicy	Mild Sweet, pleasant aroma
Texture	Juicy, tender flesh with limited fibers	Firm flesh due to fibers throughout	Firm, Juicy, Limited fiber	Firm, juicy, flesh relatively free from fiber	Firm & Juicy with deep yellow color
Scanty fiber in flesh	Unripe	10-11	4-9	1-2	3.2-3.3
Colour	Dark green & often dark red blush	A dark red blush	Dark to Medium green	An intensive red blush	Greenish- Yellow with bright red blush
Shape	Large Oval	Oval	Large oval	Medium sized oblong	Ovoid to Oblong
Fruit weight (kg)	0.55	0.52	0.70	0.50	0.47
Yield (Ton/ha)	9.9	17.0	12.0	15.0	19.5



Major Diseases of Mango

Powdery mildew

Caused by a fungus. *Oidium mangiferae*

Symptoms: Pathogen attacks the inflorescence, leaves, stalk of inflorescence and young fruits with the white **superficial powdery growth of fungus** resulting in its shedding. The sepals are relatively more susceptible than petals. The affected flowers fail to open and may fall prematurely. Dropping of unfertilized infected flowers leads to serious crop loss. Initially, young fruits are covered entirely by the mildew. When fruit grows further, the epidermis of the infected fruits cracks and corky tissues are formed. Fruits may remain on the tree until they reach up to marble size and then they drop prematurely.



Infection is noticed on young leaves when their color changes from brown to light green. Young leaves are attacked on both the sides but it is more conspicuous on the grower surface. Often these patches coalesce and occupy larger areas turning into purplish brown in color. The pathogen is restricted to the area of the central and lateral veins of the infected leaf and often twists curl and gets distorted.

The reason for severity:

- High humidity, cloudy weather & high wind velocity for 3-4 day.
- Minimum temperature (10-13°C), maximum 27-31°C and RH 82-91%
- Lack of timely fungicidal Schedule
- Close planting without canopy management.

Mode of spread.

The disease spread through wind-borne spores.

Management

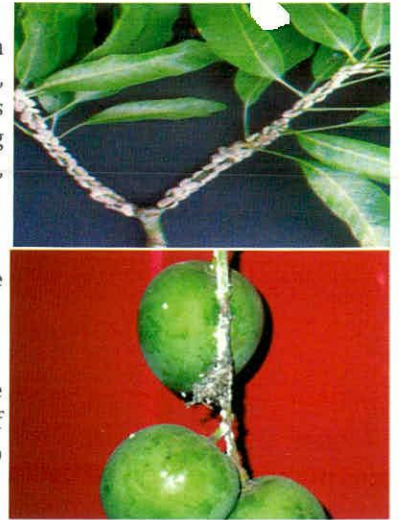
- Prune diseased leaves and malformed panicles
- Foliar application of potassium dihydrogen phosphate & potassium-phosphate fertilizer
- Spray wettable sulphur (0.2%) when panicles are 3-4" in size.
- Spray fungicides dinocap/ Karathane (0.1%) 15-20 days after the first spray.
- Spray tridemorph (0.1%) 15-20 days after the second spray.
- Spraying at full bloom needs to be avoided.

Mealy bug (*Drosicha mangiferae*)

Symptoms: The adult bugs are covered with whitish powder and colonize between the bark of tree trunk, young shoots, and panicles. The nymphs' ascent the trees and settle on inflorescence causing flower drop, affecting fruit set. They also excrete honeydew, a sticky substance, which facilitates the development of sooty mold.

Management

- Flooding of the orchard with water to kill the eggs.
- Thoroughly ploughing of orchard
- Raking of soil around the tree trunk to expose the eggs to natural enemies and sun, removal of weeds and mixing with chlorpyrifos dust 1.5% @250 g/ tree.
- After mud plastering, banding of tree trunk with alkathene (400 gauge), 25 cm wide sheets should be fastened to the free trunk with the help of sutli, 30 cm above ground level and application of *Beauveria bassiana* product (2g/litre 1x10⁷ spores/ml)
- Conservation of biocontrol agents, *Beauveria bassiana*, predators, *Menochilus sexmaculatus*, *Rodolia fumida* and *Sumniusrenardi*.
- Releasing 10-15 grubs of acoccinellid predator, *C. montrozieri* per tree
- If nymphs ascended on tree spray Dimethoate (0.04%)



Inflorescence / leaf/ twig midge (*Erosomyia indica*), *Dasineura*, *amraramanjarae*, *Procytiphovra mangiferae* and *Procontarinia*, *matteriana*)

Symptoms: The larvae tunnel the axis of inflorescence and destroy it completely. Damage by *E. indica* causes bending and drying of the inflorescences. Second attacks start at fruit setting as young maggots bore into these tender fruits which slowly turn yellow and finally drop. The third attack is on tender 'new leaves encircling inflorescence. The most damaging one is the first attack in which the entire inflorescence is destroyed. The inflorescence shows stunted growth and its axis bends, at the entrance point of the larva.

Management

- Collection and disposal of infested panicles leaves and twigs.



- Deep ploughing of orchard to expose pupae and diapausing larvae to sun's heat which kills them.
- Monitoring of larval population on white paper and apply chlorpyrifos (1.5%) dust based on population.
- Spray dimethoate (0.05%) at bud burst stage.

Fruit flies (*Bactrocera dorsalis*, *B. correctus* and *B. zonatus*)

Symptoms: The female punctures outer wall of mature fruits with the help of its pointed ovipositor and inserts eggs in small clusters inside mesocarp of mature fruits. On hatching, the maggots feed on fruit pulp and the infested fruits start rotting due to further secondary infection.



Management

- Prior to harvest (30-40 days) collect and dispose of off infested and fallen fruits to prevent further multiplication and carry over of the population.
- Ploughing of orchard to expose pupae to sun's heat which kills them.
- Hanging of methyl eugenol wooden block traps soaked in ethanol, methyl eugenol and Malathion (6:4:1) during the fruiting period @10 traps/ ha tie them tightly at 3-5 feet above ground level.
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Nutrient composition of Mango varieties

Variety	Ripeness	Moisture content	Crude Ash (%)	Crude Fat (%)	Crude protein (%)	Crude Fibre (%)	Vitamin C (mg/100g, FW)		
Apple mango	Unripe	81-82	0.26-0.32	0.02-0.17	0.02-0.04	0.89-0.91	100-110		
	Ripen	79-80	0.24-0.26	0.07-0.25	0.08-0.11	0.26-0.42	45-55		
Ngowe	Unripe	80-81	0.31-0.4	0.03-0.09	0.02	0.16-0.45	75-85		
	Ripen	83-85	0.25-0.35	0.36-0.41	0.07-0.11	0.16-0.25	10-12		
Kent	Unripe	84-85	0.24-0.30	0.19-0.20	0.02	0.62-0.77	35-45		
	Ripen	85-86	0.16-0.32	0.27-0.32	0.06-0.08	0.37-0.39	5-10		
Variety	Ripeness	Fructose (mg/ml)	Sucrose (mg/ml)	Glucose (mg/ml)	pH	TTA (%)	T.S.S (Brix)	T.S.S/ TA	Beta carotene (Ug/ml)
Apple mango	Unripe	10-11	5-6	0.2-0.8	3.0-3.1	0.21-0.24	7.01-7.03	29.3-33.4	4-5
	Ripen	21-23	68-70	8-9	4.6	0.04	13.4-19.5	487-495	33-35
Ngowe	Unripe	10-11	4-9	1-2	3.2-3.3	0.27-0.30	7.3-8.0	26-27	5-6
	Ripen	16-17	72-88	5-7	4.6	0.07-0.08	16.0-16.4	205-229	24-25
Kent	Unripe	9-12	7-8	7-8	3.2	0.13-0.15	6.5-7.0	16.7-50.0	5-8
	Ripen	22-23	38-43	12-13	3.9-4.0	3.9-4.0	14.0-14.50	155-156	14-21

N.B

- total titratable acidity (TTA)
- total soluble solids (TSS)
- sugar: acid (TSS/TTA)
- Fruit weight (FW)



Apple Mango



Ngowe



Kent

Mango growing in Uganda

Leaf Webber (*Orthogae uadruisalis*)

Symptoms: Initially caterpillars feed on leaf surface gregariously by scrapping/Later they make aweb of tender shoots and leaves together and feed within. Several caterpillars may be found in a single webbed up cluster of leaves.



Management

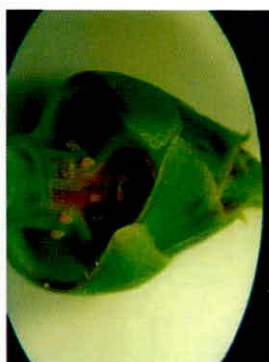
- Pruning of overcrowded and overlapping branches.
- Mechanical removal of infested webs by leaf web removing and burning them.
- Ploughing of Orchard done earlier for mealy bug control checks its population.
- Two to three sprays with carbaryl (0.2%) or Quinalphos (0.05%). This spray will also take care of mango psylla (*Apsylla cistellata*).
- The use of the same chemical for every spray should be avoided.

Shoot gall psylla (*Apsylla cistellata*)

Symptoms: Nymphs emerge and suck cell sap from adjacent buds. As a result of feeding, buds develop into hard conical green galls. Consequently, there is no flowering and fruit setting.

Management

- Galls with nymphs should be collected and destroyed.
- Spray dimethoate (0.06%) or Quinalphos (0.05%) at fortnightly interval.
- New mango orchard in the humid region needs to be discouraged.



Mango growing in Uganda

Stem-borer (*Batocera rufomaculata*)

Symptoms: The damage is caused by grubs either to roots or stems. The grubs after hatching from eggs first feed on bark and make irregular cavities. It makes tunnels which may either be in boring upward, resulting in drying of branches



Management

- Keep orchard clean and healthy.
- Cut and destroy affected branches with grubs and pupae.
- Clean hole and insert cotton wool soaked in the emulsion of Dichlorvos (0.05%) or kerosene or petrol in each hole and plug them with mud.
- Use of green muscardine fungi, *Metarhizium anisopliae* or *Beauveria bassiana*.



Shoot-borer (*Chlumetia transversa*)

Symptoms: Larvae bore into young tender leaves and freshly hatched caterpillar bore into midrib. After a couple of days, they bore into tender shoots near the growing point tunnelling downward, throwing their excreta resulting in dropping of leaves and wilting of terminal shoots

Management

- Attacked shoots should be clipped off and destroyed.
- Spray Carbaryl or Quinalphos (0.05%) at fortnightly interval from the commencement of new flush.

Bark-eating caterpillar (*Inderbella quadrinotata*)

Symptoms: The caterpillar spins a brown zigzag ribbon-like silken web on the tree which consists of their excreta and wood particles. Larvae also make shelter tunnels inside where they rest.



Management

- Keep orchard clean and healthy.
- Clean hole and put emulsion of Quinalphos (0.05%) in each hole and plug them with mud.
- Drench stem thoroughly with Quinalphos (0.05%) when incidence is high.



Table 1. Average mango tree water requirements in liters per tree per week. Based on canopy cover and tree density.

Canopy cover m ² /ha	Tree per Ha						
	80	100	130	140	160	180	200
1,000	490	390	330	280	250	220	200
2,000	980	780	650	560	490	440	390
3,000	1,470	1,180	980	840	740	650	590
4,000	1,960	1,570	1,310	1,120	980	870	780
5,000	2,450	1,960	1,630	1,400	1,230	1,090	980
6,000	2,940	2,350	1,960	1,680	1,470	1,310	1,180
7,000	3,430	2,740	2,290	1,960	1,720	1,520	1,370
8,000	3,920	3,140	2,610	2,240	1,960	1,740	1,570

Fruit Development: Mango flower buds begin to form in about 2.5-3.0 years. Most flowers don't result in the formation of fruit because more than 99% of them usually fall off because of high temperature and moisture stress. Ensure adequate water during and immediately after flowering.



Yield. Depending on the variety, the time from flowering to maturity is 100-150 days. Under good management, 400-600 fruits per tree per year can be produced. Yield range is 10-16 ton/ha depending on management, variety, and age of orchard. In the case of improved varieties, fruits can weigh 0.3 – 2 kg each.



The present irrigation input recommendations are based on a replacement rate (crop factor) of 0.70. Irrigation rates (Appendix 1) per tree depending on the size of the tree. Planting density and pattern interacts with tree size. Maximum percentage canopy cover in the orchard should be between 60% and 70%. This can be achieved by a few large trees (e.g. 100 trees/ha 10 x 10 m) or many smaller trees (e.g. 200 trees/ha 10 x 5.0 m).

Many growers choose to water for 24 or 36 hours at the start of the irrigating season. This may not be necessary particularly if using low radius (2.0-3.0 m) sprinklers because tree water requirement is lower during the first month of flower and fruit development. The use of a hand auger to establish watering depth is recommended, particularly during the first few weeks after irrigation commences. The wetted zone should be at least 40% of the under tree canopy area and good soil moisture should occur down to 60-80 cm. Saturated soil beyond 80 cm suggests that trees are being over watered.

Phase Three

Irrigation normally ceases a few weeks prior to harvest and is not recommended until flowering in the following year. In years where the wet season begins late (late January, early February) the new vegetative flush may be delayed. This may influence the following flowering date with the most likely consequence being a later flowering. In situations where trees are grown on light soils and the build-up rains and wet season are late, trees should be irrigated to promote an early flush of growth. This should occur after pruning and fertilizer operations have taken place.

IRRIGATION FREQUENCY

In simple terms, the more sandy and gravelly the soil, the more frequent irrigations should be. Two to three times per week will be appropriate for most sandy sites. Long irrigations on a sandy soil result in water draining beyond the depth of the effective root zone which is a waste of water and leaches away nutrients. The use of a hand auger to determine irrigation depth can quickly alert you to potential deep watering problems. Moisture monitoring will allow an appropriate irrigation schedule to be established.

WATER REQUIREMENTS AND FRUIT DRY MATTER MANIPULATION

Some growers encourage the earlier development of 14% fruit dry matter (minimum market standard) by manipulation of irrigation inputs and cut off prior to harvest. This practice should be carried out with caution as low water inputs (less than 60% replacement) and early cut off (four weeks prior to harvest) will reduce fruit size and fruit quality and delay the development of fruit peel color.

Research shows that fruit size increases with increasing amounts of water up to 100% evaporation replacement. Dry matter development is delayed with increasing water inputs. The current recommendation of 70% evaporation replacement is a compromise in terms of balancing the requirements for adequate fruit size, fruit quality and time to maturity.

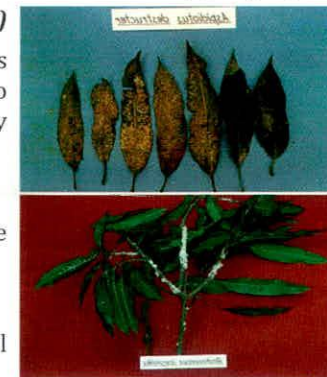


Scale (*Chloropulvinaria polygonata*, *Aspidiotus destructor*)

Symptoms: The nymphs and adult scale suck the sap of leaves and other tender parts reducing the vigor of plants. They also excrete honeydew which helps in the development of sooty mold on leaves and other tender parts

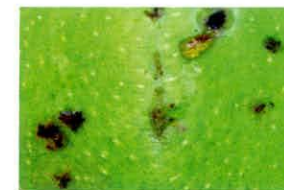
Management

- Prune heavily infested plant parts to open the tree canopy and destroy them immediately.
- Spray dimethoate (0.06%) at 21 days interval.
- Removal of attendant ants may permit natural enemies to control the insect



Mango Seed Weevil / Stone weevil (*Sternuchetus mangiferae*)

Symptoms: Adult weevils (5-8 mm) are stout and dark brown, grubs are white legless and stumpy. Eggs are laid singly on the pericarp of tender marble-sized fruits. On hatching, grubs bore through the pulp, feed on seed coat and later damage the cotyledons. Pupation is inside the seed. The pulp adjacent to the affected stone is seen discolored when the fruit is cut open.



Management

Cultural:

- Collection and destruction of infested and fallen fruits at weekly interval till harvest fruit.
- Ploughing of orchard after harvest to expose hibernating adults, reduce, infestation levels.
- Destroy all left over seeds in the orchard and also in the processing industries.

Chemical:

- Spraying Dimethoate (0.1%) twice at 15 days interval when fruits are of marble size.
- Spray main trunk, primary branches and the junction of branches prior to flowering with carbaryl (0.2%) or Fenthion (0.1%) or chlorpyrifos 20 EC @ 2.5 ml/l to control beetles hiding in the bark.
- Spray Acephate 75 SP @ 1.5 g/l when fruits are of lime size (2.5-4 cm diameter) followed by Deltamethrin 28 EC @ 1ml/l after two or three weeks.
- Vapour heat treatment of fruits.
- Irradiation of fruits with 0.25-0.75 KGY to control stone weevil.



Biological:

Parasitoids are unknown on stone weevil. The natural enemies recorded on *S. gravis* include a mite *Rhizoglyphus* sp, ants (*Camponatus* sp., *Monomorium* sp. and *Oecophylla smaragdina*) and fungus *Aspergillus* sp, *Beauveria bassiana* has been found to be pathogenic on mango weevil.



A seed weevil adult is captured by the ant *Oecophylla smaragdina* on mango tree bark.

Thrips (*Coliothrips indicus*, *Rhipiphorothris cruentatus*, *Scirtothrips dorsalis*)

Symptoms: Nymphs and adults lacerate the tissues and suck the oozing cell sap. *C. indicus* and *R. cruentatus* feed on leaves and *S. dorsalis* on inflorescence, and young fruits. Leaf feeding species feed on mesophyll near leaf tips. Affected leaves show silvery sheen and bear small spots of fecal matter

Management

If the infestation is severe, can be controlled by either dimethoate (0.1.5%) or Monocrotophos (0.1%)



Tea -Mosquito Bug: (*Helopeltis antonii*)

Symptoms: A major pest of cashew, occasionally damages mango and other fruit crops. The adult is a reddish brown bug with a black head, red thorax, and black and white abdomen. Eggs are inserted into the epidermis of tender shoots and axis of inflorescence. Adult and nymphs feed on petioles, tender shoots and leaf veins causing necrotic lesions.

Management

Spray Dimethoate (0.05) or Quinalphos (25 EC) 2 ml/ liter.



Irrigation management guidelines:

New planting

In a new planting, trees must be irrigated throughout the year, including dry periods which occur during the wet season, to enable the rapid establishment of the tree. Water inputs should be appropriate to tree size. In general, up to 100 L/tree/week should be sufficient for the first two years. The radius of the sprinkler should be appropriate to tree size. Many growers find that a sprinkler with a distributor plate (radius of 1.0 to 1.5 m) is adequate for up to three years. In subsequent years sprinkler radius should be less than 3 m to ensure that the water is delivered to the root zone under the canopy edge which also helps to reduce weed growth around trees. After the second wet season trees are generally only irrigated during the flowering and fruit development period.

The soil type determines how early continuous irrigation can cease. Trees grown on light sandy and gravelly soils may require continuous irrigation for a longer period to allow them to develop an appropriate size canopy.

Fruiting trees

In fruiting orchards, there are three phases of the annual growing cycle where distinct irrigation management options need to be exercised.

• Phase One

Pre-flowering, from the end of the wet season to the commencement of flowering.

• Phase Two

Flowering and fruiting, from visible panicle bud differentiation to harvest.

• Phase Three

Post-harvest to the end of the wet season

Phase one

In mature orchards (established fruiting trees) water is normally withheld from the end of the wet season until flowering. This period of low soil moisture is believed to encourage earlier and more synchronous flowering. Experimental evidence is still inconclusive but it is thought that cool weather (several weeks with night temperatures less than 15°C) is the main flowering trigger. However, irrigation withdrawal is thought to enhance the flowering trigger, particularly in a year where there is an inconsistent run of cool nights.

Phase Two

Irrigation is highly recommended from flowering until late fruit maturity. Some growers prefer to start irrigating after 50% of the tree is in flower and at least 50% of the flowers are open. Other growers will start irrigating from the commencement of visible flower panicle development in an attempt to speed up the flowering and fruit setting process. The present recommendation is to start irrigating when at least 60% of the flower buds are visible.

The amount of irrigation is dependent on tree size (canopy cover), evaporation rates and evaporation replacement rate. Irrigation frequency is dependent on soil type (water holding capacity) and effective root depth.

Mulching- Helps in conserving moisture and suppressing weeds. It is advisable to mulch the plants immediately after transplanting. Mulch should be added every time the crop is weeded. This encourages continuous growth in plants and brings forth good output. Place the mulch at least 1 foot away from the plant.

Maintain a basin around the plant- This basin is important especially in the districts that experience prolonged periods of harsh dry weather. Its purpose is to harvest and hold water for the plant so that plants have enough water for production.



Training/Pruning- It consists of the removal of dead, dry wood and water sprouts. All branches lower on the trunk should be removed. Shoots below the graft/bud union should also be removed. Mangoes respond very well to pruning. Mangoes grow terminal flowers (they flower at the tip of a branch), so the more branches you have the better the crop. You can encourage lateral branching with tip pruning. (Only taking off the tips of branches.) You should also aim for an open crown, taking out whole branches if the center becomes too crowded so that air and light can penetrate. You can use pruning to keep your tree at a manageable size & nice shape. Usually, mango pruning is done after harvest, though in some cooler areas the preferred time is just before flowering. Ideally, you prune only a little bit every year.



Allowing the trees to branch at 3 feet's height ensures even distribution of leaves. To have a tree, which is easy, to manage and to encourage lateral growth the apex is decapitated at 50 cm from the ground.

Irrigation: Many farmers in Uganda cannot afford irrigation equipment so they should use cultural practices such as mulching, use of organic manure and maintain a basin around each plant, to conserve water. There are irrigation methods that are relatively cheap. An example is filling jerry cans with water and perforating them at the bottom and in the lids. A jerry can is placed near the stem of each tree. Water will be dripping continuously into the soil around the tree. When the water is finished in the jerry can, it should be refilled.

Mango Seed borer/ Fruit borer: (*Deanolis albizonalis*)

Symptoms: Adults lay eggs on fruits. After hatching larvae bore into fruits. Fully grown caterpillars (25 mm) have red bands on body alternating with white bands caterpillars bore into the fruit at the bottom (beak region) and feed inside reaching Kernels. The entrance hole is plugged with excreta. Affected fruits rot and fall prematurely.

Management

- Collection of fruits and dead wood after fruit harvest.
- Destroy all fallen fruits.
- Spray Fenthion (0.1%) at marble size onwards and repeat with Deltamethrin 28 EC @ 1ml/l after two weeks in case of heavy infection
- No spray should be given in fortnight before harvest.



Leafminer: (*Acrocercops syngamma*)

Symptoms: Tiny caterpillars mine under the dorsal epidemics of tender leaves and feed within as a result greyish white blisters appear on leaves.

Management

- Clipped off destroy the affected shoots.
- Spray Quinalphos (0.05%) or Fenthion (0.1%) from the emergence of new flush.



Red tree ant (*Oecophylla smaragdina*)

Symptoms: The ants web and stitch together a few leaves, usually at the top of the branches and build their nests. The ants are carnivorous and prey upon small insects. However, indirect damage is caused by protecting insects like aphids and scales, which excrete honeydew.

Management

- Nests should be removed and destroyed mechanically by web cutting device.
- Spraying any contact insecticides, Dimethoate 1.5 ml/l after disturbing the nest.



Inflorescence caterpillars [*Eucrostus* sp. (*Geometridae*); *Argyroploce aprobola* / *Meyrick* (*Eucosmidae*); *Euproctis fraterna* Moore (*Lymantriidae*)].

Symptoms: The caterpillars attack inflorescence and if not controlled cause heavy loss through reduced fruit bearing.



Management

- For efficient management spray Monocrotophos or Dimethoate 1ml/l at early panicle emergence.

Termites (*Odontotermes* sp.)

Symptoms: Termites are white in color, shy to light and remain underground. They feed on a root or move upward making the tunnels. They construct mud galleries on tree trunk and under the protection of these galleries; they feed on the bark of the trunks.

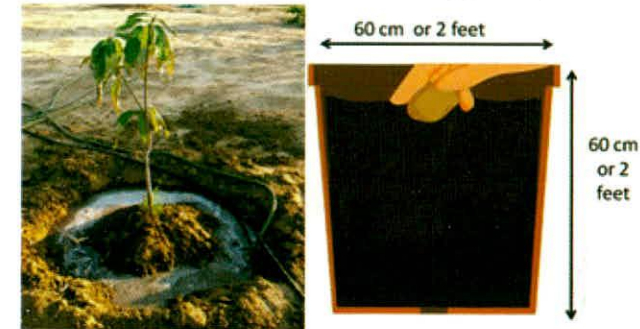


Management

- Remove the mud galleries on trunk and swab or spray the trunk with Malathion (1.5 ml/l).
- After two months, drench the soil at the base of the tree with chlorpyrifos (1.5 ml/l).

Planting

Dig holes 60 cm deep and 60 cm wide while separating top soil from sub (red) soil. Mix about 10 kg of well-decomposed manure with top soil and put back into the hole to cover the first 30 cm. The plastic bags used for potting should be removed before planting of rains. When covering the hole a basin should be made around each plant for harvesting water. Each plant should be mulched around and a cage or perimeter fencing put in place to avoid damage by animals.



Management in the field: Remove grafting tape a month after transplanting. If this tape is not removed it will cut into the plant tissues, retard growth and eventually kill the scion part of the plant. Remove shoots which grow below the graft union. The shoots if not removed will retard growth or kill the scion part of the grafted plant. Plants will also take a long time to produce fruits, as the shoots below the graft union will take up most nutrients.

Weeding

Farmers are advised to keep their fruit fields weed free. Ring weed around the trees and slash the rest of the orchard. Weeding is important because.

- Weeds compete for food and light with young mango.
- Weed before the weeds flower to prevent the production of more seeds.
- Ring weed around the plants to get a weed-free area for irrigation and application of manure or other fertilizers.
- Keep the fields weed free to avoid fruit and leaf spots diseases.

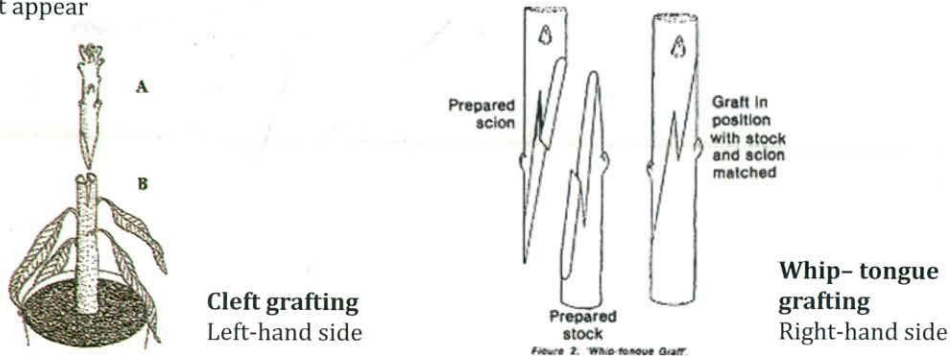
In case an herbicide is to be used, technical advice must be sought from extension staff but in any case, should not be directed onto the mango tree. Intercrop at the young stage with annual crops e.g. beans and groundnuts. The intercrop should be planted away from the basin around the plant. Keep the plants and the intercrop weed free. After the crop is fully grown leave it as a mono-crop. Mango is easily affected by root rot when other intercrops are being cultivated.

Manure application. This is important for:

- faster growth
- helping to fend off some diseases and other stresses
- to build productive capacity



In case where the polyethene was used for covering, it should also be removed immediately shoot appear



Planting Mango Seedlings: Perquisites'

Climate

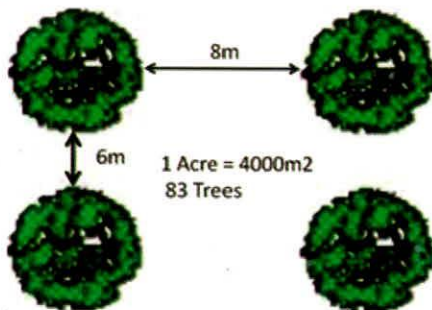
Mangoes adapted to both tropical and subtropical conditions. Temperature requirement ranges from 21-25°C. Rainfall of at least 600 mm/year and an altitude of 0-600 m are ideal for the crop. A dry period of at least 3 months is necessary for flowering. The tree requires plenty of sunshine for optimum growth and fruiting. Mangoes love the tropics. The best climate to grow mangoes is frost free, with cool, dry winters and steamy, hot summers.

Soils and site selection

Mangoes require soils with good drainage not necessarily fertile. Mangoes like growing in light and free draining soils, they don't need rich soil. You actually get the best crops on soils of somewhat lower fertility.

Spacing

Mango spacing depends on the rainfall pattern and soil fertility. In Uganda, the recommended spacing for optimum plant population is 8 m x 8 m giving 156 plants per hectare (62 plants per acre) or 8 m x 6 m giving 208 plants per hectare (83 plants per acre).



Nutrient deficiencies in mango and their management.

Mineral	Deficiency	Corrective action
Nitrogen - Yellow undersized leaves, severe retardation of growth, twigs become yellow in color. - Fruits smaller and mature early. Leaves small with general yellowing		- Application of recommended nitrogenous fertilizers (80 kg N/ha) - Foliar application of Urea 2-4% at fortnightly intervals.
Manganese - Deficiency appears on the middle of the plant. Intervetinal chlorosis of leaves - Reduced growth leaf symptoms appear very late leaves show a yellowish green background with a fine network of green veins on the upper surface and disappearing after a few weeks mature leaves thicker and blunted. - Specks of light gray to grayish brown color appear under mild deficiency.		Foliar application of MnSO₄ 0.2% at fortnightly intervals.
Phosphorus - Overall yellowing along the edges of the leaf blade - Retarded growth premature dropping of older leaves partial die-back from the tip small green younger leaves are borne at the tips of the branches. - Some branches show die back. Leaf tip necrosis and premature abscission of leaves.		- Soil application of single super phosphate - Foliar application of orthophosphoric acid 0.5 % thrice
Calcium Abnormal growth of young leaves and growing points resembling boron deficiency severe deficiency leads to the death of the bud.		Application of gypsum at 50 kg/ha.

Potassium - Scorching of leaf margins is the characteristic symptom of potassium deficiency. - Scorching starts from tip downwards. Fruit quality is reduced. Trees with potassium deficiency are easily prone to pest and disease attack - Darkening of leaves reduced growth and vigor. The appearance of white, yellow or orange chlorotic spots in older leaves and distributed irregularly over both under and upper leaf surfaces. Necrotic areas develop along the leaf margins. Poor growth of roots. Dieback with tip burn with small leaves.		- Application of 1 kg Murate of potash or sulphate of potash along with 2 kg urea and 6 kg super phosphate in the basin could rectify potassium deficiency. - Dropped leaves should also be incorporated along with manures to enrich the soil health and fertility. - Foliar spray of KCl 2% at fortnightly intervals.
Magnesium - Symmetry of the yellowing across the midvein and the dark triangle at the base - Reduction in growth premature defoliation yellowish brown chlorosis featured by a green wedge down the central part of the leaf bronzing starting from the edge of the leaf rounded margin between each pair of lateral veins.		Soil application of $MgSO_4$ 5-10 kg/ha a foliar spray of $MgSO_4$ 2% at fortnightly intervals.
Iron - The leaves lose green color and turn white and are called "Bleaching". The size of the leaf is reduced. In severe cases of iron deficiency, the leaves dry from tip downwards. - The deficiency is common in soils with high calcium content. Hence, the effect is known as "calcium-induced iron chlorosis"		Two sprays at fortnight interval with ferrous sulphate 2.5 g per liter.
Sulphur Symptoms first appear on young leaves with fading of green color. Growth is stunted. Leaf tip remains green and with severe deficiency, the whole leaf turns yellow.		Soil application of sulphur fertilizer

Getting started with growing mangoes

There are two ways to get started: **you can buy a grafted mango tree at a nursery or you can grow your own from seed.** The seed grown tree will take a lot longer to bear fruit. (Unless you know how to graft them or know someone who does.) Mango trees that are grown in a nursery are usually grafted and should fruit within 2-3 years. Seedling trees may take 5-8 years. **Seedling mango trees grow much bigger and stronger than the nursery trees** and have an indestructible root system. Grafted trees are of a more manageable size. Another advantage is that you know you will get a reliable bearing tree. If you grow amango from seed you need to know exactly which tree your mango seed came from or you won't know what you are getting until 8 years later..



Selection: The first step toward successfully growing mango trees is to take the time to find out which varieties grow best in your area. If possible, buy from a nursery that grows their own trees or at least find out where the trees were grown. This will help ensure that the variety you select will grow well in your area.

Grafting Mangoes.

(a) To graft mangoes, you need a mango plant raised for about 6-8 months old (root stock). The preferred quality of the root stock is that:

- Should be tolerant to soil borne diseases
- Compatible with improved varieties
- Seed should be readily available & cheap
- Has a strong root system with a long tap root
- Should be vigorous in growth, uniform and able to induce regular bearing

(b) You need a scion which should be in the phase of growth approaching a new flush, with buds swollen but not open. Select scions from high quality and disease-free plants. Scions are harvested in the cool hours of the day. Leaves are removed to minimize water loss. Scions are stored in a misting environment such as a gunny bag or banana fibers. If harvested and preserved well, scions will remain viable for a maximum of 3 days. Remember to label the scions as per variety

The method of Grafting: There are two basic methods for grafting: **Whip or splice and Cleft /wedge** methods. Use clear plastic tape (or cut up plastic bags) to wrap firmly around the graft. Do not remove the tape until the budstick begins to grow – showing the graft has been successful. Remove any buds which grow below the graft.

All grafted plants must be labeled according to varieties and date of grafting. Plants must be removed from the humid chamber as soon as shoot grow. Mangoes will produce shoots in 2-3 weeks after grafting. Mango seedlings should not overstay in the humid chamber after production of new shoots as these need exposure to sunlight to start manufacturing food for the new plant

Introduction

The Mango, *Mangifera indica* L, is an evergreen fruit tree which belongs to the family of *Anacardiaceae*, is one of the most important tropical and subtropical fruits of Uganda and is popular both in fresh and processed forms. It flourishes in districts that are too dry for orange, and in these areas, the fruit ripens to a yellow or orange color and develops its full flavor. It is called as the king of fruits on account of its nutritive value, taste, attractive fragrance and health promoting qualities. In Uganda, mangoes are by far the most common fruit country-wide. They are 'volunteer' fruits growing in all parts of the country by the gift of nature and adapt to all ecological zones of the country, dry or humid, montane and lake shoreline. However, areas of highest intensity are those in the relatively hot and dry Northern, Northeastern and West Nile zones.

Most of the varieties grown in Uganda are consumed locally and are of inferior quality with little commercial value. In the early 1990's many improved varieties were introduced from Puerto Rico and are being promoted countrywide. Some of the exotic mango varieties grown in West Nile zone of Uganda include; Tommy Atkins, Kent, Haden, Keitt, Zillate, Palvin, Palmer, Alphonso, and Irwin among others. In 2012 government officially released 5 mango varieties through its organs –MAAIF- NARO and these included: Kent, Keitt, Zillate, Parvin and Tommy Atkins

Mango Production

Varieties are grown in Uganda: In 2012 the government officially released 5 mango varieties through the agricultural ministry (MAAIF) after adaptation trials conducted by NARO and these included: Kent, Keitt, Zillate, Parvin and Tommy Atkins however in the country several varieties are grown. The central region and eastern Uganda are the main sources of mangoes. Local cultivars of mangoes produced include Ddodo, Bire, Sejembe Naruzale, Asanti and Kakola (Masaka) and other indigenous cultivars mainly identified by production areas. The key producing areas of local cultivars are Luwero and Masaka districts between June-July and December to February and Kamuli, Iganga districts between April-August and December-February. Luwero, Iganga, Kamuli and Masaka districts supply the Kampala markets and several roadside sellers in the producing areas. For the western region of the country, the main source of mangoes is Masaka, Kanungu and Ntugamo districts.

The most common varieties on the market are Tommy Atkins, Apple Mango (Haden), Keitt, Kent, Ngowe (Sabre), Vandyke and Boribo. Uganda has only recently introduced some of these cultivars and the technology required to multiply improved cultivars is largely unknown to Ugandan growers. The offseason period for the imported mangoes is March as some varieties, Apple mangoes and Ngowe are available throughout the year.

The longevity of any mango tree is dependent on a combination of factors namely

- Selection of a good quality tree on a favorable root stock
- Correct planting in a suitable location
- Providing the right amount of water & fertilizers
- Protecting the trees from diseases, pests, and harsh weather changes

Boron

- Cracking of fruit is the characteristic symptom of boron deficiency.
- Lusterless leathery leaves with thickened veins are the other associated symptoms.
- Brown areas in yellow fruit pulp are conspicuous



- Application of 250gm boron per tree (10-15-year-old) with recommended dose of manures
- Application of 5-10 kg Borax/ha a foliar spray of 0.25% Borax at 10 days interval or solubor at 300 gm. / 100 litres of water.

Zinc

- The leaves become small and narrow with leaf margins bent upward or downward. Internodal length is reduced drastically and the twig with crowded leaves gives rosette appearance.
- Pale inferential areas and green veins are typical of zinc deficient leaves. The tree with zinc hunger does not grow well and the yield, size, and quality of the fruit are reduced. Small plants with severe zinc deficiency may die. Zinc deficiency is conspicuously seen in alkaline, saline and sandy soils



- Zinc deficiency can be rectified by spraying of zinc sulphate 5 g +10g Urea /1 litre of Water twice at 15 days
- Soil application of ZnSO₄ 10 kg/ha or foliar spray of ZnSO₄ 0.5% or nitrozinc at 150 ml /100litres of water

Copper

- Symptoms frequently develop on young trees which generally occur due to heavy nitrogenous fertilization. It may also be accompanied by Zinc deficiency symptoms.
- The appearance of weak terminal shoots followed by defoliation and dieback of branches, on the top of long drooping or shaped branches of the proceeding cycle of growth usually makes evident that copper is needed



- Application / spraying of Copper (250 g/ 10 years tree) or Copper oxychloride (0.3%) at monthly interval.

Salt injury /toxicity

- The leaves are scorched due to excess salt in soil or irrigation water. The leaves lose their natural color and turn to bronze color. Tip burning is also seen in severe cases of salt injury



- Farmyard manure and compost should be applied adequately every year.
- Gypsum filled gunny bag if kept in flowing irrigation water will reduce salt effect

Fertilization of Mango Orchards

Why Improve Nutrient Management in Mango?

Fertilizer recommendations for mango have been one of the concerns of mango experts, technologists, and growers. Local fertilizer recommendations have been formulated, although some give standards regardless of the wide variations of the agro-ecological conditions under which the trees are grown.

The life cycle of mango may be divided into five stages: the nursery, the establishment in the field, the non-bearing period, the bearing period, and the aging trees. The nutritional requirements in each of these periods differ.

- Speedy growth of rootstock seedlings and proper establishment of grafts are the chief objectives in the nursery.
- At the time of establishment in the field, it is necessary to ensure the least mortality.
- The main requirements in the pre-bearing age are the rapid growth of the tree and the development of a sound and strong framework.
- During the bearing period, good cropping, regular bearing and high quality of fruit are expected.
- When the trees are aged, rejuvenation or reinvigoration is desired.

These objectives have to be met by different prescriptions.

Nursery and Transplanting Stage

Nursery Stage

- It is usual to keep the nursery fields rich in humus for improving their water-holding capacity and promoting root growth.
- Normally, 25-40 tons of farmyard manure is applied to a hectare where mango stones are sown or the grafts are planted after severance from the trees.
- When pots are used, they are generally filled with a mixture of leaf mold, topsoil, and sand in the ratio of 8:8:1.
- For improving the growth of seedlings, light doses of inorganic fertilizers, viz., ammonium sulphate and calcium ammonium nitrate, at the rate of 22 to 27 kg of N or 247 to 309 kg of fertilizer per hectare are applied either once or twice at an interval of about 20 days.

Transplanting Stage

- It is generally advisable not to apply any manure at the time of planting. Almost all soils selected for planting mangoes have enough nutrients available to support the growth of the trees at least for a year. If the soils are too poor to sustain them even over such a short period, they are best not utilized for mango cultivation.
- Further, the application of manure at the time of transplanting can prove harmful. It may attract white ants.

Non-Bearing Stage

This stage extends from the time the plant gets established in the field.

- In this period the need for calcium, nitrogen, and phosphorus is high.

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● Potassium is also required in reasonable amounts.

● In soils with a high calcium content and pH ranging from 7.0 to 8.0, surface application of calcium may not be necessary but in soils where pH is low, 5.5 to 6.5, it may be necessary to add calcium in the form of dolomitic lime.

● The quantities required to be applied would depend on the soil reaction and, in certain cases, may run as high as 2,200 to 3,300 kg. Per hectare.

● During the non-bearing period, nitrogen is particularly required in sufficient amounts to induce vigorous growth.

● It would be better if some part of N is derived from organic matter so that soil texture, moisture-holding capacity and ultimately the growth and development of roots improve.

● Phosphorus would be required to cope with high respiration rates and for translocation of carbohydrates.

● Potassium would also be required to meet the need of photosynthesis but its need during the non-bearing period would be comparatively less than that during the bearing period when it is required for sugar and starch synthesis in greater quantities.

These needs will be met roughly in N, P and K are applied at the rate of 75, 110 and 55 gm. Of N, P₂O₅ and K₂O for each year of age of the tree with 40 to 80 percent N derived from an organic source.

Bearing Stage

The mango is a terminal bearer. The fruit-bud differentiation takes place about four to five months before flowering.

● In the year of heavy flowering and fruiting, the vegetative growth is limited which, in turn, affects the next crop, because the shoots from the earlier flushes are the ones to flower in the next season.

● If the early flush of vegetative shoots is not put out by the tree owing to heavy flowering and fruiting, there would be very few mature shoots available at the time of bud differentiation or formation of floral buds; hence, there would be no flowering in the next season.

● The manuring of the bearing tree is thus faced with certain complex problems which the grower must keep in mind in order to adjust his practices fruitfully.

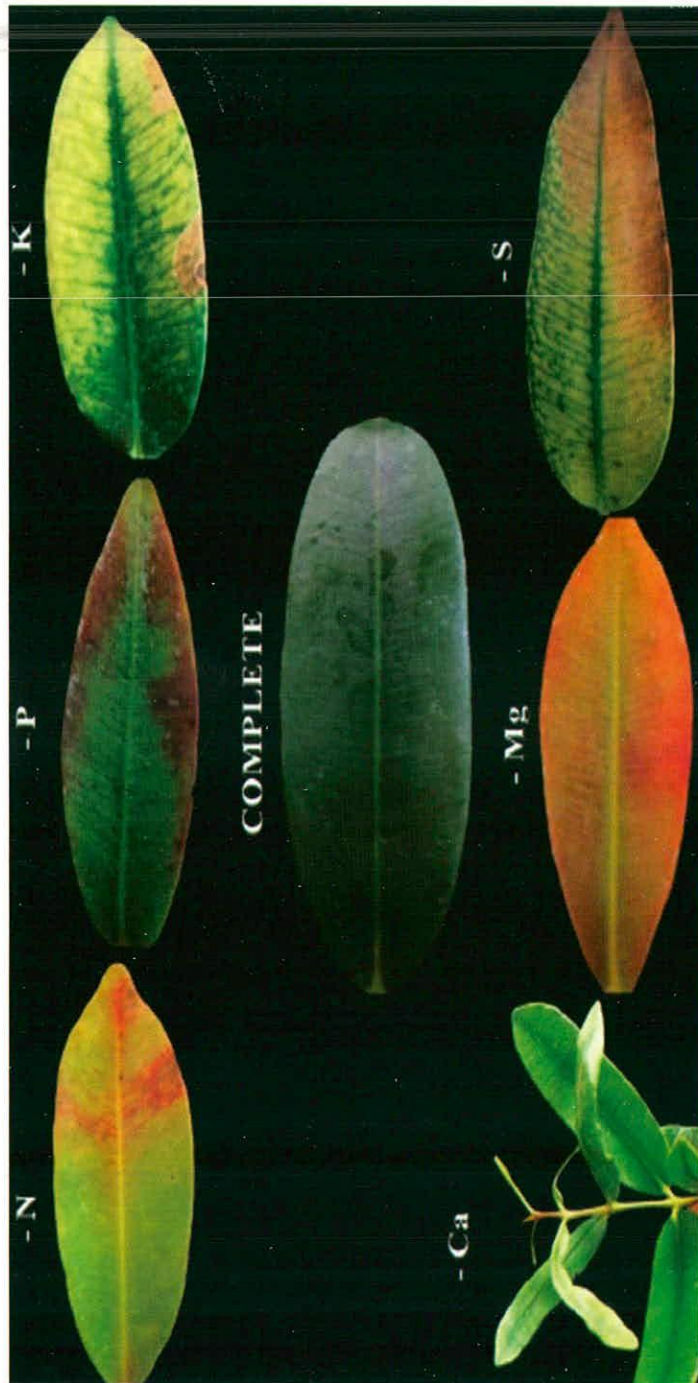
● In heavy crop years, thus, the objectives should be:

- securing sufficient vegetative growth early in the season for the next year's cropping,
- maintenance of tree vigor, and
- Improving the quality of fruit.

These can be partially achieved

● By application of a heavier dose of nitrogen a little earlier than flowering in the 'on' year to initiate vegetative growth. The suppression of bud differentiation in the 'off' year so that the cropping in the 'on' year is reduced and the production of vegetative shoots is promoted.





Nutrient deficiencies of mango: (Complete) Normal leaf, (N) Nitrogen deficiency, (P) Phosphorus deficiency (Mg) Magnesium deficiency, (K) Potassium deficiency, (Ca) Calcium deficiency, (S) Sulphur.

Identification Guide to Major Diseases, Insect Pests and Nutrient Deficiencies Of Mango (*Mangifera Indica* (L.))

Author

Idd Ramathani

Pathologist

The purpose of this guide is to help extension staff, mango growers and academicians to properly provide guidance's in mango production, how to recognize diseases, insect pests, and nutrient deficiencies of mango as well as provide appropriate management control towards the biotic stresses.

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MANGO MANUAL

Production, Identification of Major Diseases, Insect Pests, and Nutrient Deficiencies



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