A Training Manual for Training of Trainers on Integrated Disease Management of Tropical and Sub-tropical Fruit Crops

Volume 11

By

Zeraye Mehari (PhD)

Training Organized by
Ministry of Agriculture and Livestock Resources (MoALR),
Participatory Small-Scale Irrigation Development Program (PASIDP) and
Ethiopian Institute of Agriculture Research,

Melkassa Agricultural Research Center

08–14 Oct 2018

Melkassa, Ethiopia

Table of Contents

Contents

Integrated Disease Management of Tropical and Sub-Tropical Fruit Crops

Zeraye Mehari (PhD), Email: zermehari@gmail.com; Cell Phone: 0968096634
Ethiopian Institute of Agricultural Research, Melkassa Agricultural Research Center, P.O. Box 436, Tel. 251-022 2250210, Fax: 251-022225 0213

1. Introduction

Integrated disease management (IDM) is disease control method that uses a range of measures to prevent and manage diseases of agricultural importance. **IDM** does not promote **routine synthetic pesticide application**, but encourages the uses of **biological**, **cultural**, **physical** and **mechanical control practices**. Synthetic pesticides are indispensable inputs in modern agriculture to reduce yield loss caused by biotic factors. However, so much should they not be hazardous to human, non-target animals, and environment, but the improper handling and utilization ends up in escalating the potential risks of pesticides. The challenge is thus optimizing the benefit of pesticides while minimizing the consequential adverse effects. In areas of Ethiopia where commercial horticultural crops production is widely practiced, reports show that the farming system relies heavily in synthetic pesticide. The application practice is reportedly being very unsafe. Farmers apply pesticides indiscriminately and inappropriately, use unsafe storage facilities, ignore risks and safety instructions, do not use protective devices when applying pesticides, and dispose containers unsafely. Such practice is largely attributed to the low level of awareness of farmers and farm workers. The problems mentioned are actually problems shared by vegetable growers in developing countries where farmers:

- lack training on pesticide use and application;
- mix different products believing controls diseases better;
- apply lower (or higher) rates than specified on the label, to save for next round application (or hoping for better control or a more lasting effect);
- use what is available, i.e. wrong pesticide for the problem;
- poorly know application rates and timing, and re-entry periods after spraying;

- use pesticide containers for storage, or leave in fields, ditches and water courses.

The over reliance of the production system on pesticides is partly due to the high demand of vegetables in the urban market, which has necessitated production intensification with a concomitant increase in pesticides, coupled with susceptibility of vegetables to a wide range of insect pests and diseases.

2. Crop health management – A General Overview

Effective crop health management works toward ***minimizing initial inoculum***. Once the crop is in the ground, successful crop health management relies on **proper sanitation**, **appropriate fertilization**, and **other necessary agronomic practices**. Using pesticides may be one part of a crop health program, but it is never the sole strategy for crop health management. Therefore, good crop health management practices lies at the center of **integrating diseases management practices:**

- keep records of insect pest and disease incidence/severity of previous seasons;
- choose the right crop for the growing season;
- use resistant/tolerant varieties (if available);
- apply proper agronomic practices that help keep that plant healthy, i.e. water and fertilizer requirements of the crop, and field sanitation as well;
- employ strategies that help prevent insect pest and disease problems (use hedge plants, and work in group with neighboring farmers to eradicate volunteer plants that serve as alternate host in common areas, in order to prevent/delay primary infection);

Application of pesticides: - Apply only at the recommended application interval and number of application round of a pesticide (by the producer) per growing season. This helps to reduce the development of pesticide resistance.

Pesticides having different chemical groups must be chosen to avoid over reliance or continued use of any single chemical group, to reduce the emergence of pesticide resistance.

The basic tactics to minimize initial inoculums and suitability of the host and its environment for infection and reproduction, and curative approaches that shall be employed for effective disease management are:

2.1. Minimizing Initial Inoculum

Initial inoculum can be reduced by various ways:

Prevention of entry of pathogens in a farm

- Seeds shall be sorted and treated before used. Simple approaches like hot water or steam treatment, followed by drying, can be used. Immature or diseased seeds must be sorted and eliminated.
- Use seed dressing chemicals, Apron Star 42 WS.
- For vegetatively propagated plants, must start with clean planting materials.

Sanitation

- Plant residues must be removed. Branches and residues shall be subjected for compost (instead of burning) to maintain soil fertility.
- Remove cull piles and remove volunteer plants and alternate hosts for pathogens.

Deep ploughing and Soil solarization

- Cover moist soil with transparent plastic and expose to sunlight for a few weeks, if possible.
- Or, expose ploughed under fields for sunlight for 3 - 4 weeks. Most plant-pathogenic fungi, bacteria, and nematodes are quite sensitive to increased temperatures.

- Deep ploughing and soil solarization can also enhance plant growth by increasing the availability of mineral nutrients and improving soil structure.

2.2. Temporal and Spatial Isolation

Isolation of plant host in time or space can help to form a barrier for the accumulation of pathogen propagules.

Temporal isolation

- Check pest status in the area throughout the year. Then adapt the crop planting time, choosing early maturing cultivars, or rotating with crops that are not susceptible to the pests involved.

- Adjust the planting time to avoid pest infestation or periods by the time the pest surges the crop grow enough to tolerate it.

Spatial isolation

Separate fields by natural vegetation or wind breaks and deep plowing of infected plant residues. Make regular scouting on the natural vegetation and weeds surrounding cropping areas for harboring pests.

2.3. Host Plant Resistance

- Cultivars that have more general resistance and mature early to avoid epidemic development shall be the first choice to be used if the compromise in quality and yield of the cultivar is minimal or none.
- Farmers are advised to take their own observation on pest and other stress factor (for example, moisture stress) reactions of the cultivars they are growing. This helps farmers to avoid using susceptible varieties.

2.4. Regulation of Establishment and Spread of Pathogens

Various conditions influence the establishment of a disease once a pathogen has entered a crop field.

Improving and maintaining soil quality

- Maintain and improve soil quality and health by crop rotations and applications of composted manure or plant materials.
- Improving and maintaining soil quality and health improves its microbial and faunal diversity.
- When microbial diversity in the soil increases, nonpathogenic strains of a particular pathogenic fungi or bacteria also increase. Such nonpathogenic strains are thought to be responsible for the suppression of pathogens of the same genus or species.
- Plants grown in healthy soil have better resistance to diseases.

Management of the aerial environment

- Control moist or humid conditions by thinning, pruning, leaf plucking, removing weeds, planting parallel to the wind direction, and optimal

fertilization. This helps not to create conducive environment for disease development.

Maintaining plant diversity

- More diversity can be obtained by intercropping and planting non-crop plants in hedgerows or field margins. Maintaining plant diversity minimizes the chance of disease development by acting as a barrier between susceptible plants.

2.5 Protective and curative control using pesticides

- Pesticide application should be the last option to be used after putting in place other crop health management practices mentioned above.

- Before proceeding with pesticide application, the problem must be properly diagnosed. After accurately diagnosing the problem, the next step is to identify which pesticide is best for the problem to be managed.

- Remember always to check the product label to be sure the plant you wish to treat is labeled and that no contraindications exist. The label provides important information about the "dos" and "don'ts".

3. Major diseases of tropical and sub-tropical fruits and their management

3.1. Avocado diseases and their management

i) Anthracnose

- Cause by the fungus *Colletotrichum gloeosporioides*

Some facts

- Avocado fruits may appear free of blemishes before they ripen, but latent fungal infections quickly result in symptoms after harvest.
- Infections create rounded, dark-colored, sunken lesions that expand rapidly on the fruit skin and into the pulp, causing rot.

- It is a common fruit disease but could also affect senescent leaves
- Anthracnose is the most severe postharvest disease of avocado

Diagnostic symptoms

- Black spot of senescent leaves
- Small light brown spot on fruits
- At fruit maturity spots enlarged and depressed lesions appear
- See **Figure 1**

Figure 1. Anthracnose lesions on senescent leaves (A), ripen fruits (B & C), and penetrated rot deep into the flesh (D)

Disease management

The critical phases for disease control are during flowering and fruit set, and after harvest. This disease is most severe during wet weather when new growth flushes are particularly susceptible.

- Control fruit-damaging pests such as fruit spotting bug and fruit fly.
- Prune out dead wood before flowering, and regularly remove infected fruit and dead leaves entangled in the canopy.
- Keep the canopy open by judiciously pruning and tree shaping, helps reducing the severity of infection.
- Harvest fruit when it is fully mature so that it will ripen quickly and evenly. The longer the period between harvesting and consumption the worse the disease, so minimize delays in marketing wherever possible.
- Handle fruit carefully to avoid damage that can initiate the onset of the disease.

ii) *Phytophthora* root rot

- Cause by the soil fungus *Phytophthora cinamomi*

Some facts

- Phytophthora root rot is the most destructive and important disease of avocado. Nursery plants and young replants are particularly sensitive to root rot and often die soon after infection.
- Root rot thrives in areas of excess soil moisture and poor drainage.
- The pathogen is easily spread through movement of contaminated nursery stock of avocado and other plants, on equipment and shoes, in seed from fruit lying on infested soil.

Diagnostic symptoms

- The first signs of the disease are observed in the tree canopy: small leaves, pale green in color, often wilted with brown tips and drop readily
- Unusually abundant small fruit
- Shoot dieback
- Rotting of small feeder roots
- Eventual death of the tree
- See **Figure 2**

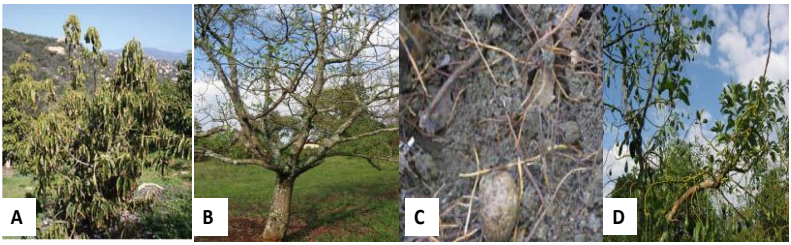

Figure 2. *Phytophthora* root rot symptom on a young tree (A), on an old tree (B), on feeder roots (C), and shoot dieback (D)

Disease management

There is no simple answer to Phytophthora root rot in avocados, but good horticultural management can minimize losses.

- Plant on well-drained soils or improve drainage using mounds.

- Increase the organic matter content of the soil using ground covers and mulch. Keep mulch away from tree trunks.
- Apply gypsum (or lime if pH needs correcting) under the canopy of the trees to suppress the formation of spores. High pH favours development of the disease.
- Prevent soil or water movement from infested areas
- Irrigate carefully, not too much water
- Use *P. cinnamomi*-tolerant root stocks, such as Duck-7
- Metalaxyl can be applied as granular, a drench or with irrigation water

3.2. Banana diseases and their management

i) Anthracnose

- Cause by the fungus *Colletotrichum gloeosporioides*

Some facts

- It is an important post-harvest problem of bananas especially during transport and storage
- Infection in young fruit is not always manifested until the fruit ripens
- Pulp of diseased fruit is usually not affected unless the fruit is over-ripe.

Diagnostic symptoms

- On yellow fruits brown blotches develop
- Patches increase in size and coalesce
- Mature lesions are dark brown
- Tip rot
- See **Figure 3**

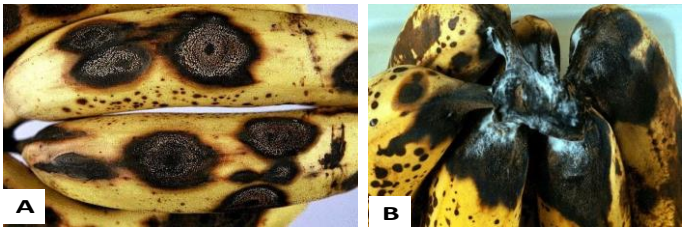

Figure 3. Anthracnose lesions on banana fruits. Coalesced and matured lesion (A), and tip rot (B).

Disease management

- Good field sanitation
- Minimize bruising during fruit handling

ii) Cigar-end rot disease

- Can be caused by *Verticillium theobromae, Trachsphaera fructigena*, and *Gloeosporium musarum*

Some facts

- The disease is more severe in areas with high rainfall and humidity
- Dense plantation and over irrigation create favorable condition for the disease
- Black necrosis spread from the perianth into the tip of immature fingers
- The rotted portion adhere to fruits (appears similar to the ash of a cigar)

Diagnostic symptoms

- Rotting at tips
- White powder like spores
- Grayish ashy appearance
- See **Figure 4**

Figure 4. Damage symptom of cigar-end rot of banana

Disease management

- Optimum density and avoid excessive suckers to reduce humidity
- Remove floral remains on tip of fingers (8-11 days after bunch formation)
- Harvest at maturity to reduce susceptibility to the disease
- Minimize bruising of the fruits during harvesting and transportation
- Remove infected fruits
- Good field sanitation
- Minimize bruising during fruit handling

iii) Sigatoka Disease

- There exist different types of Sigatoka diseases:

Black Sigatoka or black leaf streak *(Mycosphaerella fijiensis /Paracercospora fijiensis*)

Yellow Sigatoka (*Mycosphaerella musicola /Pseudocercospora musae*)

Eumusae leaf spot (*Mycosphaerella eumusae*)

Some facts

- High humidity, heavy dew and rainy weather favor the disease
- Poor drainage, low soil fertility, and closer planting also favor the disease
- The disease is mostly seen in leaves with prolonged wetness
- Under sever condition, fruit set will be poor with reduced size, uneven ripening, and fruits with discolored flesh

Diagnostic symptoms

- Early symptoms appear on the lower leaves
- Initially small specks develop on leaves near the tip or margin of lamina or near the midrib
- Spots coalesce and the entire spotted area appears dried
- See **Figure 5**

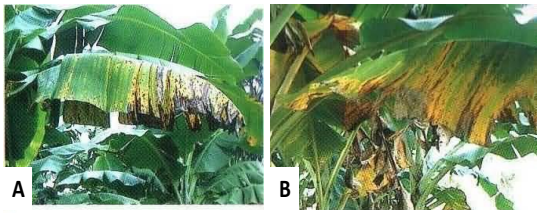

Figure 5. Damage symptom of banana Sigatoka disease. Black Sigatoka disease (A), and Yellow Sigatoka disease (B)

Disease management

- Plant banana in well drained soils
- Plant at recommended density
- Prune suckers periodically to avoid overcrowding in the field
- Remove affected leaves
- Chemicals:
  - Carbendazim
  - Benomyl
  - Mancozeb
  - Copper oxychloride
  - Chlorothalonil

iv) Banana wilt diseases

There are at least three kind of wilts affecting banana production

A) Panama disease or *Fusarium* wilt

- Caused by *Fusarium oxysporum* f.sp. *cubense*

Some facts

- The incidence is common in poorly drained heavy soils
- Infection by burrowing nematode, *Radopholus similis*, predisposes the plants to the disease
- The fungus grows and blocks the vascular system resulting in wilting of the plant

- Young suckers develop the disease but rarely develop external symptoms

Diagnostic symptoms

- The earliest symptoms are faint yellow streaks on the petiole of oldest, lower most leaves
- Affected leaves show progressive yellowing, break at the petiole and hang down along the pseudostem
- Longitudinal splitting of pseudostem is very common
- Light yellow to dark brown discolouration of vascular strands in pseudostem. Usually the discolouration appears first in the outer or oldest leaf sheath and extends in to the inner sheaths
- Vascular discolouration in cross sections of rhizome appears reddish brown towards periphery progressing in to centre of rhizome
- Affected plants do not produce bunches. Even if produced, fruits are malformed and ripen prematurely or irregularly. However, the pathogen does not infect the fruits

- See **Figure 6**

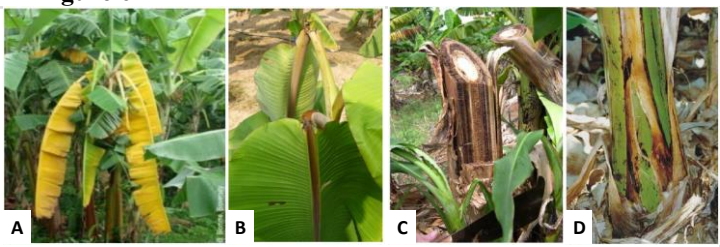

Figure 6. Symptom of *Fusarium* wilt on banana. Leaf yellowing (A), petiole breakage (B), vascular discoloration (C), and splitting of pseudostem (D)

- **B) Banana *Xanthomonas* wilt**
- Caused by *Xanthomonas vasicola* pv. *Musacearum* (also known as *Xanthomonas campestris* pv *musacearum*)

Some facts

- Identified in Ethiopia in 1960's on *Ensete* (*Ensete ventricosum*)
- The pathogen spreads through infected plant parts, infested soil, water run-off, animals and farm tools

Diagnostic symptoms

- See **Figure 7**

Figure 7. Symptom of Banana *Xanthomonas* wilt on pseudostem (A), and fruits (B)

- Caused by *Ralstonia solancearium*

Some facts

- The pathogen spreads through infected plant parts, including root, trunk, bunch, fruit, peel, sucker or leaf material
- Spread through infested soil on hands, tools, shoes, machinery, animals and water run-off
- Warm temperature and high soil moisture favor the disease
- The disease is prevalent on plants grown on slightly acidic soils
- Infection by nematode predisposes the plants to the disease

Diagnostic symptoms

- Characteristic discoloration of vascular strands, wilting and blackening of suckers
- Vascular discolouration (pale yellow to dark brown or bluish black) is concentrated near the **centre** of the pseudostem, becoming less apparent on the periphery
- Greyish brown bacterial ooze is seen when the pseudostem of affected plant is cut transversely
- A firm **brown dry rot** is found within fruits of infected plants
- Death of whole plant occurs under severe infection.

- See **Figure 8**

Figure 8. Different symptoms of Moko disease

Disease management

- Avoid ill drained soils and use disease free suckers
- Dipping of suckers in carbendazim (0.1%) solution before planting (for *Fusarium* wilt)
- Eradicate infected plants and suckers and disinfect farm tools

v) Burrowing nematode

Some facts

- Tiny, colorless, unsegmented roundworms
- They usually live on wet surfaces in the spaces between soil particles
- Feed on fibrous roots, bulbs, and corms
- Nematodes use a needlelike stylet to puncture the cells in host tissues and suck out the contents

Diagnostic symptoms

- The most obvious symptom is the toppling over of plants, especially those bearing fruit
- Lengthened the vegetative cycle and reduces bunch weight
- Macroscopically, several dark red lesions appear on the outer part of the root, adjacent lesions may coalesce and the cortical root tissue turns black

- See **Figure 9**

Disease management

- Non-infected planting material/ use in vitro-produced plants
- Hot water treatment of rhizomes (15-20 min at 55 ^{o}C)

- Nematicide (dipping, coating)

Figure 9. Symptom of burrowing nematode

3.3. Citrus diseases and their management

i) Leaf and fruit spot

- Caused by *Phaeoramularia angolensis*

Some facts

- The disease is widespread to the South, South West and North West of Ethiopia.
- It attacks leaves, twigs and fruits of all citrus species including grape fruit, orange, lemon, lime and mandarin.

Diagnostic symptoms

- On leaves, the fungus produces circular spots that are up to 10 mm in diameter with light brown or grayish center. Each spot is surrounded with a prominent yellow halo.

- On fruits, the spot is circular to irregular and surrounded by yellow halo.
- See **Figure 10**

Figure 10. Symptom of leaf and fruit spot of citrus

Disease management

- Sanitation measures such as timely removal of infected twigs, leaves and fruits
- Timely pruning, water management and optimum fertilization are important cultural practices to reduce the build-up of the pathogen
- Fungicide sprays with Benlate, Chlorothalonil, Copper hydroxide

ii) Foot rot

- Caused by *Phytophthora spp*.

Some facts

- It is the most serious soil borne disease of citrus. It is widely distributed wherever the crop is grown and causes citrus production losses under irrigated as well as in areas with high rainfall
- Infection on seedlings causes damping-off
- On mature trees the fungus attacks the root cortex and causes a decay of fibrous roots

Diagnostic symptoms

- Gummosis (when infection is on the trunk) and foot rot, mostly above the bud union
- Leaves yellow and drop
- Beads of sap ooze from trunk lesions
- Bark can dry, harden, and crack, and overall decline of tree
- See **Figure 11**

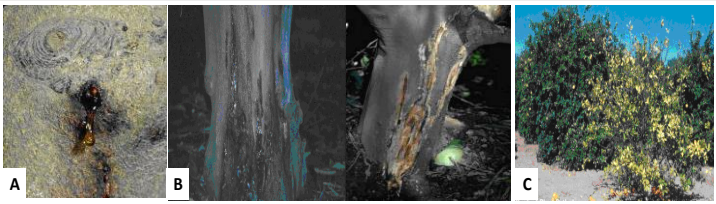

Figure 11 Symptoms of Citrus foot and root rots. Gumosis (A), bark crak (B), and total tree decline (C)

Disease management

- Use moderately tolerant rootstocks (Cleopatra mandarin, sour orange, rough lemon)
- Good nurseries management to avoid infection
- Avoid excess water, keep trunk dry; keep mounded soil and water away from trunk

3.4. Mango diseases and their management

i) Anthracnose

- Caused by *Colletotrichum gloeosporioides*

Some facts

- An important disease of mango, as both pre- and post-harvest problem
- Under damp conditions, the fungus grows rapidly. Young leaves are more prone to attract than the older ones. Insect attack may facilitate the entry of pathogen resulting into heavy incidence of disease
- The disease is more common in areas where there is rain, fog and high humidity in the early dry season. Symptoms are worse in stressed trees.
- The pathogen survives between seasons on infected and defoliated branch terminals and mature leaves

Diagnostic symptoms

- Initial symptoms on leaves appear as dark brown spots
- Severe infection can cause twig dieback and blossom blight
- Green fruit develop minute spot

- Symptoms on fruits are clearer after harvest
- Cause large lesions on fruit surface and decay
- See **Figure 12**

Figure 12. Symptoms of anthracnose on mango. Leaf lesion (A-B), twig dieback (C), blossom blight (D), and fruit lesion (E)

Disease management

- Field sanitation (removal of defoliated/infected leaves, twigs and fruits)
- Use of disease-free planting materials
- Application of registered fungicides (Ridomil, Mancozeb)

ii) Powdery mildew

- Caused by *Oidium mangiferae*

Some facts

- Powdery mildew is more common in lower-rainfall areas than in higher-rainfall areas
- It infects panicles and leaves (mostly) and fruits (rarely)
- The affected flowers and fruits drop pre-maturely reducing the crop load considerably or might even prevent the fruit set

Diagnostic symptoms

- The characteristic symptom of the disease is the white superficial powdery fungal growth on leaves, stalk of panicles, flowers and young fruits
- See **Figure 13**

Figure 13. Symptoms of powdery mildew on mango inflorescence (A), fruitlets (B), and leaves (C & D)

Disease management

- Sanitation measures
- Canopy management for free aeration
- Application of fungicides (Sulphure and Mancozeb)

3.5. Papaya diseases and their management

i) Anthracnose

- Caused by *Colletotrichum* spp

Diagnostic symptoms

- Development of round water soaked sunken spots on ripening fruits
- As fruits ripe, lesions get enlarged and cause fruit rot
- See **Figure 14**


Figure 14. Symptoms of anthracnose on papaya

Disease management

- Sanitation and canopy management/free aeration
- Remove infected plant parts and control fruit-injuring insect pests
- Minimize bruising during fruit handling

ii) Black spot

- Caused by Asperisporium *caricae*

Some facts

- Previously it was considered as a minor problem on papaya; however, currently it is becoming a major one
- The characteristic damage symptoms include numerous black spots on leaves and fruits
- During severe infection the whole fruit surface covered with black spores of the fungus that causes high quality loss and also fruit rotting
- The disease is worse in wet weather

Diagnostic symptoms

- Leaf spots, round to irregular, develop on the older leaves; they are pale brown above with a yellow margin; below, spores develop turning the spots to dark brown or black
- If the leaves are severely infected they turn brown and die
- Spots on the fruit are also brown to black and slightly sunken
- See **Figure 15**

Figure 15. Symptoms of black spot of papaya on under(A) and upper(B) side of leaf, and on fruits(C)

Disease management

- Remove infected leaves and fruit as soon as they are seen
- Fungicides- Mancozeb, Ridomil Gold, Agrolaxyl, and chlorothalonil

iii) Powdery mildew

- Caused by *Oidium caricae*

Some facts

- Powdery mildew of papaya thrives in humid areas with warm days and cool nights
- The disease frequently infects immature leaves but can also attack unripe fruits. It also appears on papaya petioles, pedicels, and peduncles
- In advanced stages, white fungal growth will develop on the upper leaf surface.

Diagnostic symptoms

- See **Figure 16**

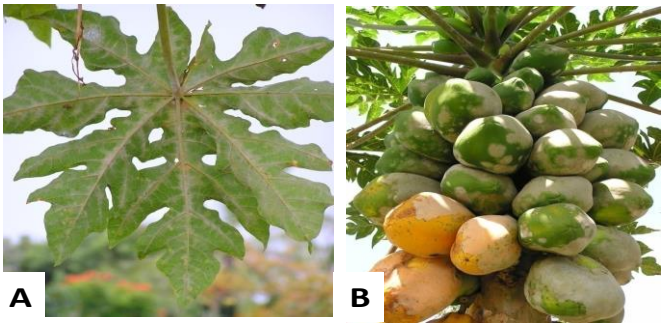

Figure 16. Symptoms of powdery mildew on papaya leaf (A) and fruits (B)

Disease management

- Periodically remove and destroy heavily mildewed leaves; do not compost the material
- Ensure adequate nutrition but avoid excessive nitrogen, which can cause a flush of succulent, vulnerable plant growth

iv) Phythophthora rot

- Caused by *Phythophthora.* spp

Some facts

- Root and fruit rot caused by *Phytophthora sp*. is a major disease of papaya. During favorable conditions the disease can cause a complete crop loss
- High soil moisture, high rainfall and furrow irrigation without double ring basin aggravates the development and spread of the disease

Diagnostic symptoms

- Symptoms include root rot, yellowing and die back of leaves
- During severe conditions the fruits can be covered by the fungus mycelium and finally rots

- See **Figure 17**

Figure 17. symptoms of *Phytophthora* root and fruit rot

Disease management

- Field sanitation (removal of defoliated/infected leaves, twigs and fruits)
- Use of disease-free planting materials
- Irrigation water management (double ring basin) and proper drainage system
- Application of registered fungicides (Ridomil, Agrolaxyl)

4. Note on pesticide use

Practices that are recommended while using pesticides, to maximize the benefit while minimizing the negative effects, are presented below.

***Best management practices for pesticide use - GENERAL POINTS TO CONSIDER*:**

- Obtain thorough training prior to applying any pesticide.
- Always follow pesticide label directions and read all instructions, particularly precautionary statements, prior to chemical mixing and application. Pesticide applications must follow label specifications and be applied only to the crops for which the product is registered for use.
- Keep accurate and timely pest and pesticide records.
- Consider the effects of pest control measures on the environment and non-target organisms. Minimize chemical reliance by rotating crops and using physical or cultural pest management controls whenever feasible.
- Pesticides use practice must avoid or delay resistance development in target pests.

***Best management practices of pesticide use - PESTICIDE SELECTION*:**

- Avoid overuse of pesticide treatments with common modes of action.
- Base pesticide application decisions on site-specific pest scouting.
- Select least toxic and less persistent pesticides when feasible.

***Best management practices of pesticide use - PESTICIDE APPLICATION*:**

- Maintain application equipment in good working condition and calibrate equipment frequently to ensure that pesticides are applied at recommended rates. Replace all worn components of pesticide application equipment, especially nozzles, prior to application.

- Ensure that the pesticide applicator applies the pesticide on fields to be treated. Follow the established re-entry interval as stated on the pesticide label.
- Avoid unnecessary and poorly timed application of pesticides. Optimize pesticide timing, and placement to avoid the need for re-treatment.
- Avoid overspray and chemical drift. Avoid applications if wind speed favors drift beyond the intended application area. Increasing nozzle size and lowering boom pressure will increase droplet size and help reduce drift. Always recalibrate following equipment adjustments or modifications.
- Time pesticide application in relation to soil moisture, anticipated weather conditions, and irrigation schedules to achieve the greatest efficiency and reduce the potential for off-site transport. Avoid pesticide application when soil moisture status or scheduled irrigation increases the possibility of runoff or deep percolation. After application, manage irrigation to reduce the possibility of erosion, runoff and/or leaching, which may transport pesticide from the target site.
- Apply pesticides in a manner that will minimize off-target effects.
- Avoid repetitive use of the same pesticide or pesticides of similar chemistry and modes of action to reduce the potential for pesticide resistance development and shifts in the pest spectrum.

***Best management practices of pesticide use - PESTICIDE SAFETY*:**

- Read and follow label safety directions.
- Wear the appropriate protective equipment to minimize unnecessary exposure to pesticide. Be sure to clean protective gear after each day's use.
- Provide emergency hand and eye wash water and detergents for personnel working in chemical storage, mixing, and treatment areas.