



Late blight of potato



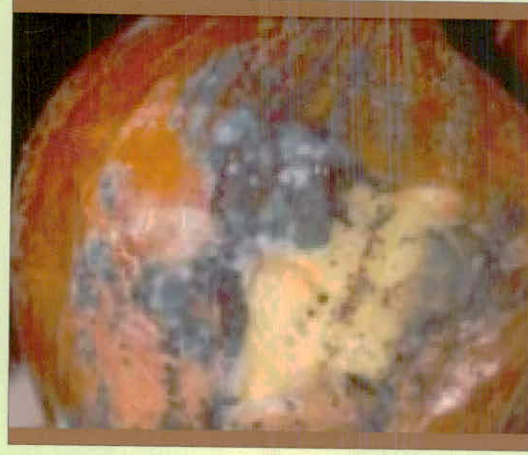
Common scab of potato



Black scurf of potato



Neck rot of onion



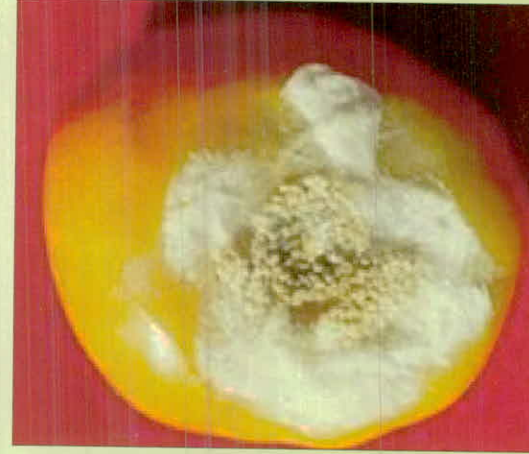
Blue mold of onion



Gray mold of tomato



Rhizopus rot of tomato



Southern blight of tomato



Early blight of tomato

# Practical Manual on Post Harvest Disease Management

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Anthracoese of citrus



Blue mold of citrus



Green mold of citrus



Sour rot of citrus



Anthracoese of papaya



Fruit rot of papaya



Anthracoese of banana



Cigar end rot of banana



Anthracoese of mango



Diplodia stem end rot of



Phomopsis soft rot of mango



Stem end rot of mango



Phomopsis fruit rot of papaya



Rhizopus rot of papaya



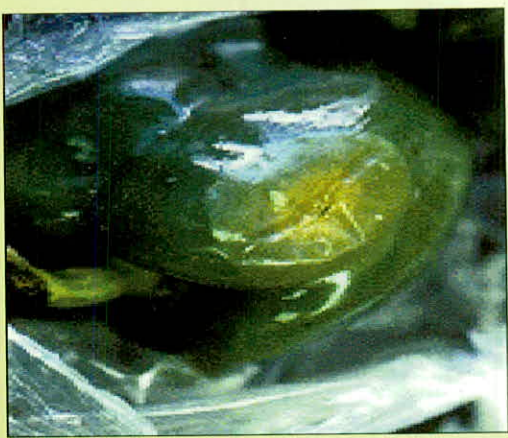
Stem end rot of papaya



Anthracoese of chilli



Gray mold of chilli



Soft rot of chilli

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**on**  
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## **CERTIFICATE**

This is to certify that Shri./Ku. ....  
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## Practical No.- 1

### Title - Post Harvest Diseases of Citrus

### Objective – 1. To study the Anthracnose disease of Citrus

#### Symptoms

1. Infected fruits show superficial leathery appearance.
2. Presence of silver/grey to dark lesions on pericarp.
3. Tear-staining pattern common on pericarp.
4. Pink tinge (spores) on infected portions appeared under humid conditions.

#### C.O.- *Colletotrichum gloeosporioides*

Kingdom	– Fungi
Sub-division	– Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Melanconiales
Form Family	– Melanconiaceae

**Mycelium** – Septate, inter and intra cellular, branched.

**Acervuli** – Cushion shaped, provided with short conidiophores and sterile setae.

**Setae** – Straight, un-branched, tapered towards the apex, brown to black, smooth, thick walled and septate.

**Conidiophore** – Hyaline to brown, septate, branched at the base, smooth, short, packed in acervuli.

**Conidia** – Falcate (sickle shaped), posses large oil globule in centre, hyaline, unicellular, borne singly on tip of short conidiophores.

#### Exercise- Draw the diagram of disease symptom and causal organism

Disease symptom	Causal organism

**Objective – 2. To study the Blue and Green mould disease of Citrus.**

**Symptoms**

1. Softening of damaged tissue.
2. White fungal growth, which gradually turns blue or green as spores develop.

**C.O. - *Penicillium digitatum* (green mould) and *P. italicum* (blue mould)**

Kingdom	– Fungi
Sub-division	– Ascomycotina
Class	– Ascomycetes
Order	– Eurotiales
Family	– Trichocomaceae

**Mycelium** – Highly branched, septate, hyaline, uninucleate.

**Conidiophore** – Simple, long, erect, branched, about 2/3 of the way to tip, branches (metulae), more or less parallel, each medulla bears a tuft of sterigmata or phialides on which conidia are produced.

**Conidia** – Globose to avoid, unicellular, hyaline, appear as glass beads, formed in basipetal succession on bottle shaped phialides. In abundance, they appear green, yellow or blue, responsible for colony colour in Petri-dishes.

**Ascocarp** – Cleistothecia are yellow or light brown, thick walled. The conidiophores with its branches (metulae), sterigmata (phialides) and conidia give the appearance of broom known as 'Penicillus'

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism



### Objective – 3. To study the Sour rot diseases of Citrus

#### Symptoms

1. Very soft, watery decay due to secretion of highly active macerating extracellular enzymes of the fungus.
2. Distinct margin appeared between decayed and healthy tissue.
3. Sour odour usually present.

#### C.O. - *Galactomyces citri-aurantii* (formally, *Geotrichum candidum*).

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Hyphomycetidae
Form Order	– Moniliales
Form Family	– Moniliaceae

**Mycelium** – Septate, each cell contains 1-4 nuclei.

**Arthrospores** – Formed by the disarticulation of the terminal part of a hypha into a cylindrical segment.

#### Exercise- Draw the diagram of disease symptom and causal organism

Disease symptom	Causal organism

**Objective – 4. To study the Brown rot diseases of Citrus**

**Symptoms**

1. The infected fruits show water soaked patches on rind.
2. Later on these patches drip off and rot.

**C.O. – *Phytophthora nicotianae***

- Kingdom – Fungi  
Sub-division - Diplomastigomycotina  
Class – Oomycetes  
Order – Peronosporales  
Family – Pythiaceae

**Mycelium** – Hyaline, coenocytic and branched.

**Sporangiophore** – Hyaline, branched, indeterminate, sympodial branching, nodulate, terminates in a sporangium.

**Sporangia** – ellipsoid or spherical, papillate at apex, hyaline, single celled, multinucleate (7-30 nuclei), thin walled, size 38 X 40 um, bears bi-flagellated zoospores.

**Oospore** – Spherical, aplerotic, thick and smooth walled.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

## Management

1. Fruit should be harvested in dry weather and the nails of the harvesting persons should be well trimmed to avoid injuries to the fruit surface.
2. Harvested should be collected in plastic crates or the container having smooth walls and should be transported in well cushioned tightly stacked carriers to the packing house.
3. Washing and dipping of fruits in bleaching powder (2%) for five minutes or Flit 406 (0.2%) for 10 minutes and then thoroughly rinsed with fresh water to remove of traces of the chemicals used and subsequent storage at 2-4<sup>0</sup>C.
4. Under refrigeration storage, Thiabendazole (TBZ) incorporated in Waxol 0-12 or pre-storage dip in TBZ (500 ppm) for 2-3 minutes provide good control for short period of storage.
5. Imazalil (WP & EC) quite effective for long term storage exceeding 36 days.
6. Fungicide can be mixed with wax. The wax coating up to of the fruit not only reduces physiological weight loss but also provides extra shine to the fruit surface.
7. Fumigation of packing houses with Formaldehyde and Driol for 4 hours has been found effective.
8. Chemical impregnated wraps such as Diphenyl wraps (320 mg/300 ml Acetone, 40 mg/wrap) provide complete control.
9. Application of *Pseudomonas cepacia* and *Bacillus pumilus* gives significant control.

## Practical No.- 2

### Title - Post harvest diseases of Papaya

#### Objective – 1. To study the Anthracnose disease of Papaya

#### Symptoms

1. The spots on fruits first appear as brown superficial discolouration of the skin which develops into circular, slightly sunken areas and 1 to 3 cm in diameter.
2. Gradually the lesions coalesce and sparse mycelial growth appears on the margins of the spots.
3. Under humid conditions, an encrustation of salmon pink spores is released.
4. Infection at early stages of fruit results in mummification and deformation.

#### C.O.- *Colletotrichum papayae*

Kingdom	– Fungi
Sub-division	– Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Melanconiales
Form Family	– Melanconiaceae

**Mycelium** – Septate, inter and intra cellular, branched.

**Acervuli** – Cushion shaped, provided with short conidiophores and sterile setae.

**Setae** – Straight, un-branched, tapered towards the apex, brown to black, smooth, thick walled and septate.

**Conidiophore** – Hyaline to brown, septate, branched at the base, smooth, short, packed in acervuli.

**Conidia** – Falcate (sickle shaped), possess large oil globule in centre, hyaline, unicellular, borne singly on tip of short conidiophores.

**Exercise- Draw the diagram of disease symptom and causal organism**

<b>Disease symptom</b>	<b>Causal organism</b>

## Objective – 2. To study the Rhizopus rot disease of Papaya

### Symptoms

1. On fruits irregular, water-soaked lesions which gradually enlarge and get covered by white and dark brown fungal growth and sporangiophores.
2. The fruits become watery and emit a foul odour.
3. The rot rapidly destroys the entire fruit and quickly spread to other adjoining fruits.
4. Fruit fly punctures after harvest increase the disease incidence.

### C.O. - *Rhizopus stolonifer*

Kingdom	– Fungi
Sub-division	- Zygomycotina
Class	– Zygomycetes
Order	– Mucorales
Family	– Mucoraceae

**Mycelium** – Coenocytic, prominent branches called aerial stolons (often called sporangiophores) arise from root like rhizoids.

**Sporangia** - Terminal, dark, globular, have prominent columella.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

### Objective – 3. To study the Fruit rot disease of Papaya

#### Symptoms

It is characterized by grey-brown, circular to semi-circular patches on pericarp which covered with mycelium and conidiophores

#### C.O. - *Alternaria alternata*

- Kingdom – Fungi
- Sub-division - Deuteromycotina
- Form Class – Deuteromycetes
- Form Sub class - Hyphomycetidae
- Form Order – Moniliales
- Form Family – Dematiaceae

**Mycelium** – Frequently septate, intercellular, branched, light brown become darker with age.

**Conidiophore** – Short, dark coloured, simple, septate.

**Conidia** – Borne singly or in chains (acropetal succession), dark coloured, muriform (presence of 7-8 transverse septa and few longitudinal septa), obclavate.

#### Exercise- Draw the diagram of disease symptom and causal organism

Disease symptom	Causal organism

## Objective – 4. To study the Phomopsis fruit rot diseases of Papaya

### Symptoms

1. On infected fruit, water-soaked spot develops which increases in size.
2. The whole affected area becomes soft and pulpy.
3. The rotten area turns dark brown to black and get depressed and cracks at a later stage.
4. Around the diseased portion water-soaking is seen.

### C.O.- *Phomopsis caricae-papayae*

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Hyphomycetidae
Form Order	– Moniliales
Form Family	– Dematiaceae

**Mycelium** – Septate, branched and well developed.

**Pycnidium** – Globose to irregular, wide ostiole, brown to black.

**Conidiophores** – Hyaline, simple/branched, septate, bears conidia singly.

**Conidia** – 1. Alpha- Hyaline, fusiform, straight, aseptate.

2. Beta (Stylospores) – Hyaline, aseptate, filiform, curved or bent.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism



## Objective – 5. To study the *Ascochyta* rot diseases of Papaya

### Symptoms

1. Rotting occur on both fruits and trunk.
2. Rotting generally occurs on half grown or mature fruits.

### C.O. - *Ascochyta caricae*

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Sphaeropsidales
Form Family	– Sphaeropsidaceae

**Mycelium** – Septate, branched, intercellular.

**Pycnidium** – Globose, brown, with ostiole, produced below epidermis, later erumpent.

**Phialides** – Short, hyaline, unicellular, cylindrical or globose.

**Conidia** – Hyaline, smooth, thin walled, one septate, cylindrical to irregular, rounded to flattened apex and rounded to truncate base.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

## Management

1. Sorting out of rotting fruits and avoids bruising or injuries to the fruits.
2. Pre- harvest sprays of Ziram (0.2%), Ferbam (0.2%), Benomyl (0.1%), Manacozeb (0.2%), Chlorothaonil (0.2%), Borax and Difolaton control the rot in storage.
3. Dipping of fruits in hot water at 49<sup>0</sup>C for 20 min found effective.
4. Quarantine treatment by a forced hot air (48.5<sup>0</sup>C for 3-4 hours) combined with TBZ (4g ai/L) reduces the diseases.
5. To control rotting, dip the fruits in 2-aminobutane carbonated solutions (1%) or fumigate with 2- aminobutane.

## Practical No.- 3

### Title - Post harvest diseases of Banana

#### Objective – 1. To study the Anthracnose disease of Banana

#### Symptoms

1. Small, black, circular specks appears on the fruit skin and later become sunken and coalesce to form large spots.
2. Bright salmon-coloured conidial mass appears on the spots.
3. Severely infected fruits become dark due to blemishes.
4. Acervuli also develop on the skin and the pulp becomes partially soft.
5. Non-latent infection usually starts during or after the harvest of bunches in small peel wounds and it continues to develop without a dormant period.
6. Many latent infections at the time of harvest show large number of appressoria on the surface of the peel.

#### C.O.- *Colletotrichum musae*

Kingdom	– Fungi
Sub-division	– Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Melanconiales
Form Family	– Melanconiaceae

**Mycelium** – Septate, inter and intra-cellular, branched.

**Acervuli** – Cushion shaped, provided with short conidiophores and sterile setae.

**Setae** – Straight, un-branched, tapered towards the apex, brown to black, smooth, thick walled and septate.

**Conidiophore** – Hyaline to brown, septate, branched at the base, smooth, short, packed in acervuli.

**Conidia** – Falcate (sickle shaped), posses large oil globule in centre, hyaline, unicellular, borne singly on tip of short conidiophores.

## Management

1. Storage of fruits at 10<sup>0</sup>C can prevent the disease.
2. Post harvest dipping of fruits in Carbendazim 400 ppm, or Benomyl 1000 ppm or Aureofunginsol 100 ppm.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

## Objective – 2. To study the Cigar-end rot disease of Banana

### Symptoms

1. Infection starts from tip of immature fruit and spreads upward.
2. Imparting burnt ashy cigar-end appearance with a dark border.
3. Decay may extend up to one-third of the fruit but internal tissues develop a dry rot.
4. Ashy conidia and conidiophores cover the infected and rotted portion.

### C.O.- *Verticillium theobromae*

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Hyphomycetidae
Form Order	– Moniliales
Form Family	– Moniliaceae

**Mycelium** – Hyaline at first and later become cream to black, regularly septate, becoming swollen between the septa so as to appear torulose in parts.

**Conidiophore** - More or less erect, hyaline, vertically branched, two to four phialides arising at each node, in one or more whorls, dark at the base.

**Conidia** – Arises singly at the apices of the phialides, held in a glistening droplet of liquid, ellipsoidal or sub cylindrical, hyaline, mainly aseptate.

### Management

1. Frequent manual removal and burning of dead flower parts and infected fruits.
2. Use of fungicide to control the disease.
3. In the packhouse, care should be taken to cull infected fruits to avoid contaminating the washing water with spores.
4. Cigar-end rot is effectively controlled by covering the flower (immediately after emergence) with a polyethylene bag before the hands emerge.

**Exercise- Draw the diagram of disease symptom and causal organism**

<b>Disease symptom</b>	<b>Causal organism</b>

## Practical No. – 4

### Title - Post harvest diseases of Mango

#### Objective – 1. To study the Anthracnose disease of Mango

#### Symptoms

1. Infection occurs on all aerial parts like leaves, stems, young flowers and fruits.
2. At ripening, sunken black spots appear on the surface of the fruit.
3. The spots frequently coalesce over large area, have large, deep cracks, penetrate deeply into the fruit, causing extensive rotting.
4. Infection on fruit is usually latent and manifests itself only as the mango begins to ripen.
5. The disease is most severe in wet weather.

#### C.O.- *Colletotrichum gloeosporioides*

Kingdom	– Fungi
Sub-division	– Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Melanconiales
Form Family	– Melanconiaceae

**Mycelium** – Septate, inter and intra cellular, branched.

**Acervuli** – Cushion shaped, provided with short conidiophores and sterile setae, size- 115-467 X 22-95 um.

**Setae** – Straight, un-branched, tapered towards the apex, brown to black, smooth, thick walled and septate, size – 40-90 X 4-6 um.

**Conidiophore** – Hyaline to brown, septate, branched at the base, smooth, short, packed in acervuli.

**Conidia** – Falcate (sickle shaped), posses large oil globule in centre, hyaline, unicellular, borne singly on tip of short conidiophores, size – 8-26 X 5-7 um.

#### Management

1. Two pre-harvest sprays of Thiophanate–methyl (0.1%) at 15 days interval starting from 3<sup>rd</sup> week of May.

2. Dipping of fruits at 55°C for 5 minutes in water having Benomyl or Thiobendazole.
3. Dipping of fruits at 55°C for 5 minutes in water having Prochloraz (81g ai/100 L).
4. Dipping of fruits at 55°C for 5 minutes in water followed by wax + prochloraz + *Bacillus licheniformis*.
5. Dipping of fruits in Benomyl (500 ppm), TBZ (500 ppm) or Thiophanate methyl (1000 ppm) solution.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism



## Objective – 2. To study the Stem end rot disease of Mango

### Symptoms

1. In fruits, the pericarp darkens near the base of the pedicel.
2. The affected area enlarges to form a circular, black patch which under humid atmosphere extends rapidly and turns the whole fruit completely black within two or three days.
3. The pulp becomes brown and softer.

### C.O. – *Botryodiplodia theobromae*

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Sphaeropsidales
Form Family	– Sphaeropsidaceae

**Mycelium** – Septate, branched and well developed.

**Pycnidia** - Flask shaped, slightly sub-cuticular having small neck and ostiolate, erumpent, stromatic, setose and black walls measuring 250-300 um in size. The pycnidia may be found in groups or singly.

**Conidia**- produced on short conidiophores which are bicelled, straight and brown in colour measuring 25x15 um.

### Management

1. Avoid harvesting immature fruit.
2. Postharvest treatment with hot water and Carbendazim is partially effective.
3. Two pre-harvest sprays of Thiophanate–methyl (0.1%) at 15 days interval starting from 3<sup>rd</sup> week of May.
4. For control of stem end rot during controlled atmosphere storage, a dual treatment of hot Carbendazim followed by Prochloraz.
5. Fruit from orchards with a history of stem end rot losses should be rejected for long term storage.
6. Dipping of fruits in 6% Borax solution at 43<sup>0</sup>C for 3 minutes.

7. The severity of stem end rot can be assessed as follows.
- a. Harvest 100 mature fruit at random from throughout the orchard.
  - b. Leave them untreated and store at 25°C until they are fully ripe. Ideally, less than one-tenth and certainly no more than one-third of the fruit should develop symptoms of stem end rot by the time they are fully ripe.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

**Objective – 3. To study the *Diplodia* stem end rot disease of Mango**

**Symptoms**

1. Epicarp darkens around the pedicel base.
2. Circular, black patch appeared under humid atmosphere.
3. Soft rot occurs due to pectinolytic and cellulolytic enzymes.
4. Infected portions of fruit turns black and soften.

**C.O. - *Diplodia natalensis***

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Sphaeropsidales
Form Family	– Sphaeropsidaceae

**Mycelium** – Septate, branched and well developed.

**Pycnidia** - Black, single, globose, immersed, erumpent and ostiolate.

**Conidiophores** - Slender

**Conidia** - Dark, bi-celled, ellipsoid or ovoid conidia.

**Management**

1. Pre-harvest spray of Carbendazim (0.1%) or Two pre-harvest sprays of Thiophanate–methyl (0.1%) at 15 days interval starting from 3rd week of May.
2. The exposed surface of the pedicel or stem end scar can be coated with Chaubattia paint.
3. Post harvest dip with borax at 43<sup>0</sup>C for 3 minutes.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

## Objective – 4. To study the Black soft rot disease of Mango

### Symptoms

1. Discrete and discoloured areas all over the fruits.
2. At maturity these areas turn dark brown or black.
3. Black fruiting bodies of pathogen appear on the spots.

### C.O. - *Phomopsis mangiferae* and *Rhizopus arrhizus*

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Sphaeropsidales
Form Family	– Sphaeropsidaceae

**Mycelium** – Septate, branched and well developed.

**Pycnidium** – Globose to irregular, wide ostiole, brown to black.

**Conidiophores** – Hyaline, simple/branched, septate, bears conidia singly.

**Conidia** – 1. Alpha- Hyaline, fusiform, straight, aseptate.

2. Beta (Stylospores) – Hyaline, aseptate, filiform, curved or bent.

### *Rhizopus arrhizus*

Kingdom	– Fungi
Sub-division	- Zygomycotina
Class	– Zygomycetes
Order	– Mucorales
Family	– Mucoraceae

**Mycelium** – Coenocytic, prominent branches called aerial stolons (often called sporangiophores) arise from root like rhizoids.

**Sporangia** - Terminal, dark, globular, have prominent columella.

### Management

1. Two pre-harvest sprays of Thiophanate–methyl (0.1%) at 15 days interval starting from 3<sup>rd</sup> week of May.

2. Fruit dip in 2-aminothiazole (5%) with 2-aminopyridine (5%) protect for 20 days.
3. Dipping of fruits in a combination of oils like mustard oil, castor oil and paraffin each at 75% with 1% soap solution is found effective.

**Exercise- Draw the diagram of disease symptom and causal organism**

<b>Disease symptom</b>	<b>Causal organism</b>

## Objective – 5. To study the Black mould rot disease of Mango

### Symptoms

1. Yellowing of base – development of irregular, hazy, grayish spots and coalesce into dark brown or black lesions.
2. Mesocarp of the rotted area becomes soft depressed.
3. The fruit surface is covered with blackish fungal growth.

### C.O. - *Aspergillus niger*

Kingdom	– Fungi
Sub-division	– Ascomycotina
Class	– Ascomycetes
Order	– Eurotiales
Family	– Trichocomaceae

**Mycelium** – Well developed, profusely branched, septate, multinucleate, hyaline.

**Conidiophores** – Arise singly at right angle from thick walled hyphal cells called 'foot cell', non-septate, erect, long terminating in a bulbous shaped head 'vesicle'.

**Vesicle** – Spherical usually, occasionally hemispherical or elliptical, with bottle shaped sterigmata or phialides arise in one or two layers as primary and secondary sterigmata.

**Conidia** – Formed in chains (basipetal succession), single celled, typically Globose with outer roughened walls.

### Management

1. Hot water dip at 55<sup>0</sup>C for 5 minutes delay the rot for 6 days.
2. Storage at 10-15<sup>0</sup>C prevents development of disease.
3. Fruit dip in Benomyl (1500 ppm), Triforin (100 ppm) or Delan (1200ppm).

### Exercise- Draw the diagram of disease symptom and causal organism

Disease symptom	Causal organism

## Management

### Pre-harvest control

Spray with Mancozeb (2 g/L) weekly during flowering and then monthly until harvest. Stop spraying 14 days before harvest. During dry weather, flower sprays may be reduced to fortnightly intervals.

Should rain occur during flowering, apply Prochloraz (462 g/kg) (Octave), using 1 g product/L in a tank mix with Mancozeb. Prochloraz only needs to be applied every 3-4 weeks.

Copper oxychloride sprays (4 g/L) used for bacterial black spot control also control anthracnose, however Copper oxychloride should not be used during flowering. Where bacterial black spot is serious, Copper oxychloride can be substituted for Mancozeb sprays after flowering.

### Postharvest control

Dip fruit within 24 hours of harvest by totally submerging them for 5 minutes in **hot water (52°C)** to which has been added 100 ml product /100 L water. Lowering the temperature of the dip below 52°C will reduce the effectiveness of the treatment.

Temperature must be carefully controlled to within 0.5°C to prevent fruit damage. Use an accurate thermometer to monitor temperatures in various parts of the dip during use, especially near the heat source. Many growers use specially designed tanks heated by gas or electricity with manual or thermostatic temperature control. With an approximate ratio of 3 litres of dip to 1 kg of fruit, no appreciable temperature drop occurs when fruit is added to the tank. This dip also partially controls stem end rot.

### Notes on dipping

- Vigorous agitation before and during dipping by means of a powerful re-circulating pump is recommended to keep the fungicide suspended. This is preferable to stirring or paddling. Agitation also helps distribute heat from the heating element.
- Bleed sap from fruit before dipping. Mango sap affects the stability of the fungicide suspension.
- Replace the dip once it becomes contaminated by sap and dirt or after 3 days continuous use or after 4000 trays have been treated. Prewashing fruit helps to prolong dip life.
- Dipping temperatures should not exceed 52°C as this may result in skin damage. Allow fruit to cool before brushing. During wet weather, reduce the dipping temperature to 50° as susceptibility to skin damage increases. Disease control will be reduced at these lower temperatures.

### Unheated prochloraz

- Unheated Prochloraz spray to control anthracnose can be used as an alternative to dipping in hot Carbendazim.
- Prochloraz is not effective against stem end rot.

- Apply Prochloraz 45% at 55 ml/100 L of water at ambient temperature. Prochloraz has been approved for use only as a non-recirculated spray over fruit. Complete coverage of the fruit is essential for effective control.
- Fenthion may be mixed with Prochloraz for fruit fly treatment for Victoria, provided fruit remain wet for one minute.
- Postharvest treatments will not provide complete disease control.



**Title - Post harvest diseases of Chilli**

**Objective – 1. To study the Anthracnose disease of Chilli**

**Symptoms**

1. Symptoms on fruit initially begin as water-soaked lesions that become soft, slightly sunken and become tan coloured.
2. The lesions can cover most of the fruit surface and multiple lesions occur.
3. The surface of the lesion becomes covered with the wet, gelatinous spores from salmon-colored fungal fruiting bodies (acervuli) with numerous black spines (setae).
4. Fruit lesions are surrounded by concentric rings of the acervuli are common.
5. In some cases, the lesions are brown, not orange, and then black from the formation of setae and sclerotia (a dark, fungal survival structure).

**C.O.- *Colletotrichum capsici***

Kingdom	– Fungi
Sub-division	– Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Melanconiales
Form Family	– Melanconiaceae

**Mycelium** – Septate, inter and intra cellular, branched.

**Acervuli** – Cushion shaped, provided with short conidiophores and sterile setae, 350 um in diameter.

**Setae** – Straight, un-branched, tapered towards the apex, brown to black, smooth, thick walled and 1-5 septate, rigid, 250 x 5 - 8 um in size.

**Conidiophore** – Hyaline to brown, septate, branched at the base, smooth, short, packed in acervuli.

**Conidia** – Falcate (sickle shaped), posses large oil globule in centre, hyaline, unicellular, uninucleate, borne singly on tip of short conidiophores, 18-23 x 3.5 – 4 um in size.

**Exercise- Draw the diagram of disease symptom and causal organism**

<b>Disease symptom</b>	<b>Causal organism</b>

## Objective – 2. To study the Gray mould disease of Chilli

### Symptoms

1. Symptoms on fruit appeared as water-soaked lesions that rapidly expand into large yellowish-green or grayish-brown, irregular lesions.
2. The lesions are soft and spongy in texture.
3. Velvet-like fungus mycelium and spores are produced on the lesion surface under cool and humid conditions.
4. Small pieces of infected plant tissue or fungal spores are disseminated shorter distances by splashing rain.

### C.O.- *Botrytis* sp.

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Hyphomycetidae
Form Order	– Moniliales
Form Family	– Moniliaceae

**Mycelium** – Septate, inter and intra cellular, branched, white at first and dark later on.

**Conidiophore** – Erect, Tall, branching irregularly or dichotomously, dark, septate, terminal cells swell to produce sporogenous ampullae.

**Conidia** – Hyaline or tinted, aseptate and globose to ovoid, produced as grape bunch like fashion, size -11-15 x 8-11 um.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

## Objective – 3. To study the Bacterial soft rot disease of Chilli

### Symptoms

The fleshy fruit peduncle is highly susceptible and is frequently observed the initial point of infection.

1. Both ripe and green fruits may be affected.
2. Initially, the lesions on the fruits are light to dark-colored, water-soaked, and somewhat sunken.
3. The affected areas expand very rapidly, particularly under high temperatures, and tissues lose their texture.
4. In later stages, bacterial ooze may develop from affected areas followed by secondary infection, often invading the rotted tissue.
5. After harvest softening of stem end of fruit occur.
6. The affected fruit hang from the plant like a water-filled bag.

### C.O. *Erwinia carotovora* subsp. *carotovora*

Kingdom	– Prokaryotae
Division	- Gracilicutes
Class	– Proteobacteria
Family	- Enterobacteriaceae

Bacterium is rod shaped, occurring singly, in pairs or in chains and produce no spores or capsule, peritrichously flagellate and Gram-negative. On nutrient medium, produce white to grayish-white, round, raised, smooth, glistening colonies.

### Management

1. Use chlorinated wash water to reduce populations of soft rot bacteria and to reduce the risk of infection during washing.
2. This will not reduce soft rot development in fruit infected with the bacterium prior to harvest.
3. Fruits should be dried thoroughly.
4. During packing and storage, the fruit should be kept clean and maintained in a cool, dry place.

**Exercise- Draw the diagram of disease symptom and causal organism**

<b>Disease symptom</b>	<b>Causal organism</b>

## Practical No. - 6

Title - Post harvest diseases of Potato

Objective – 1. To study the Late blight disease of Potato.

### Symptoms

1. Water soaked spots appear on leaves, increase in size, turn purple brown and finally black colour. White growth develops on under surface of leaves.
2. This spreads to petioles, rachis and stems.
3. It frequently develops at nodes. Stem breaks at these points and the plant topples over.
4. In tubers, purplish brown spots and spread to the entire surface on cutting, the affected tuber show rusty brown necrosis spreading from surface to the center.

### C.O.- *Phytophthora infestans*

Kingdom	– Fungi
Sub-division	- Diplomastigomycotina
Class	– Oomycetes
Order	– Peronosporales
Family	– Pythiaceae

**Mycelium** – Hyaline, coenocytic and branched.

**Sporangiophore** – Hyaline, branched, indeterminate, sympodial branching, nodulate, terminates in a sporangium.

**Sporangia** – Lemon or pear shaped, papillate at apex, hyaline, single celled, multinucleate (7-30 nuclei), thin walled, size 22-32 x 1624 um, bears bi-flagellated zoospores.

**Oospore** – Spherical, thick and smooth walled.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

**Objective – 2. To study the Black scurf disease of Potato.**

**Symptoms**

1. On tubers symptoms like black speck scab and russet scab appeared.
2. At the time of sprouting, dark brown colour appear on the eyes
3. Affected xylem tissue causes to wilting of plants
4. Infected tuber contains russetting of the skin
5. Hard dry rot with browning on internal tissue
6. Spongy mass appear on the infected tuber.

**C.O.- *Rhizoctonia solani***

- Kingdom – Fungi
- Sub-division - Deuteromycotina
- Form Class – Deuteromycetes
- Form Sub class - Hyphomycetidae
- Form Order – Agonomycetales
- Form Family – Agonomycetaceae

**Mycelium** – Stout, branching more or less at right angles, white when young and brown when old, constricted at the point of origin, multinucleate, cells are barrel shaped.

**Sclerotia** – Brown to black, uniform texture, more or less loosely packed, irregular in size, usually spherical.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

**Objective – 3. To study the Common scab disease of Potato.**

**Symptoms**

1. Corkiness of the tuber periderm is the characteristics symptoms.
2. Russet appearance is 1/4 inch into the tuber surface.
3. Slightly pitted on the infected tuber.
4. Light brown to dark brown lesion appears on the infected tuber.
5. Affected tissue attracts insects.

**C.O. - *Streptomyces scabies***

Kingdom – Prokaryotae  
Division - Firmicutes  
Class – Thallobacteria

These bacteria resemble fungi in that they produce segmented hypha like threads and conidia like structures. Segmentation of hyphae forms spore in chain which break loose.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism



## Objective – 4. To study the Soft rot disease of Potato.

### Symptoms

1. Infection at two phases is black leg and soft rot.
2. Black lesion appears on the base of plant.
3. Systemic and browning of infected tubers.
4. Yellow appearance of the plant.
5. Finally the plants wilt and die.
6. Lenticels (water soaked brown rot).
7. Rotting and collapse of tubers.
8. Soft, reddish or black ring appear on the infected tuber.
9. Infected tubers attract the flies (*Hymelia* and *Phorlin* sp.).

### C.O. - *Erwinia carotovora* subsp. *caratovora*

Kingdom	– Prokaryotae
Division	- Gracilicutes
Class	– Proteobacteria
Family	- Enterobacteriaceae

Bacterium is rod shaped, occurring singly, in pairs or in chains and produce no spores or capsule, peritrichously flagellate and Gram-negative. On nutrient medium, produce white to grayish-white, round, raised, smooth, glistening colonies.

### Management

1. Use disease free seed tubers to minimize the disease incidence.
2. Before planting the seed tubers are treated with Boric Acid (3% for 30 minutes) and dried in shade.
3. Following crop rotations with wheat, pea, oats, barley, lupin, soybean, sorghum and bajra to reduce the disease development.
4. In plains, treatment of the seed tubers with TBZ + acetic acid + 0.05% Zinc Sulphate solution or Carbendazim 1% for 15 minutes effectively controls the disease.
5. Soaking of tubers in Mercuric chloride 0.1%.

**Exercise- Draw the diagram of disease symptom and causal organism**

<b>Disease symptom</b>	<b>Causal organism</b>

## Practical No. 7

### Title - Post harvest diseases of Onion

Objective – 1. To study the Neck Rot disease of Onion.

#### Symptoms

1. Symptoms usually appear after harvest, although infections originate in the field.
2. Symptoms are first appeared as a softening of the tissues around the neck of the bulb, or more rarely, at a wound.
3. A definite margin separates diseased and healthy tissues.
4. Infected tissues become sunken, soft and appear brownish to grayish in color, as if they had been cooked. These symptoms progress gradually to the base of the bulb.
5. The entire bulb may become mummified followed by secondary infection by soft rot bacteria causes watery rot.
6. Irregularly shaped kernel-like hard bodies, sclerotia, may form between scales, especially at the neck region.

#### C.O.- *Botrytis allii*, *B. squamosa* and *B. cinerea*

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Hyphomycetidae
Form Order	– Moniliales
Form Family	– Moniliaceae

**Mycelium** – Septate, inter and intra cellular, branched, white at first and dark later on.

**Conidiophore** – Erect, tall, branching irregularly or dichotomously, dark, septate, terminal cells swell to produce sporogenous ampullae.

**Conidia** – Hyaline or tinted, aseptate and globose to ovoid, produced as grape bunch like fashion, size -11-15 x 8-11 um.

**Exercise- Draw the diagram of disease symptom and causal organism**

<b>Disease symptom</b>	<b>Causal organism</b>

**Objective – 2. To study the Blue mould rot disease of Onion.**

**Symptoms**

Blue mold generally appears during harvesting and storage.

1. Initial symptoms include water soaked areas on the outer surface of scales.
2. Later, a green to blue-green, powdery mold may develop on the surface of the lesions. Infected areas of fleshy scales are tan or gray when cut open.
3. In advanced stages, infected bulbs may disintegrate into a watery rot.
4. Once inside the bulb, the mycelium grows through the fleshy scales, eventually sporulating profusely on the surface of lesions and wounds.

**C.O.- *Penicillium* sp.**

Kingdom	– Fungi
Sub-division	– Ascomycotina
Class	– Ascomycetes
Order	– Eurotiales
Family	– Trichocomaceae

**Mycelium** – Highly branched, septate, hyaline, uninucleate.

**Conidiophore** – Simple, long, erect, branched, about 2/3 of the way to tip, branches (metulae), more or less parallel, each medulla bears a tuft of sterigmata or phialides on which conidia are produced which gives the appearance of broom known as 'Penicillus'.

**Conidia** – Globose to avoid, unicellular, hyaline, appear as glass beads, formed in basipetal succession on bottle shaped phialides. In abundance, they appear green, yellow or blue, responsible for colony colour in Petri-dishes.

**Ascocarp** – Cleistothecia are yellow or light brown, thick walled.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

### Objective – 3. To study the Smudge disease of Onion.

#### Symptoms

1. Small, dark-green to black dots on the outer scales.
2. Small dot may group together to form a concentric rings or blotches, giving a smudge (minute stroma of the fungus) appearance.
3. In moist conditions acervuli of the fungus develop on the infected areas.
4. Inner scales are also attacked if the outer scales have been peeled off.
5. Lesions are small, sunken and yellow.

#### CO. *Colletotrichum circinans*

Kingdom	– Fungi
Sub-division	– Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Melanconiales
Form Family	– Melanconiaceae

**Mycelium** – Septate, inter and intra cellular, branched, hyaline when young becoming darker with the age.

**Acervuli** – Cushion shaped, provided with short conidiophores and sterile setae.

**Setae** – Straight, un-branched, tapered towards the apex, brown to black, smooth, thick walled and septate, size 80-315 um long.

**Conidiophore** – Hyaline to brown, septate, branched at the base, smooth, short, packed in acervuli.

**Conidia** – Falcate (sickle shaped), posses large oil globule in centre, hyaline, unicellular, borne singly on tip of short conidiophores, size 14-30 x 3-6um.

#### Management

1. The drying of bulbs should be done by hot air at 37- 48<sup>0</sup>C before storage.
2. Chemical treatments of the bulbs before storage can be done with 0.2% suspension of Thiram, Captan or Difolatan.

**Exercise- Draw the diagram of disease symptom and causal organism**

<b>Disease symptom</b>	<b>Causal organism</b>

## Practical No. 8

Title - Post harvest diseases of Tomato

Objective – 1. To study the Gray Mould disease of Tomato.

### Symptoms

1. On fruits Lesions appeared as watery area with a light brown or tan-colored central region.
2. These lesions converted into a soft, watery mass within a few days.
3. Skin is broken, the grayish mycelium and spore clusters develop within a few hours.
4. Small whitish rings (Halo) forms around the point of entry, develop on young green fruit.
5. "Ghost spots" are usually single rings but may be solid white spots, the center of which contain dark-brown specks.

### C.O.- *Botrytis cinerea*

Kingdom	– Fungi
Sub-division	- Deuteromycotina
Form Class	– Deuteromycetes
Sub class	- Hyphomycetidae
Form Order	– Moniliales
Form Family	– Moniliaceae

**Mycelium** – Septate, inter and intra cellular, branched, white at first and dark later on.

**Conidiophore** – Tall, erect, branching irregularly or dichotomously, dark, septate, terminal cells swell to produce sporogenous ampullae.

**Conidia** – hyaline or tinted, aseptate and globose to ovoid, produced as grape bunch like fashion, size -11-15 x 8-11 um.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism



**Objective – 2. To study the Rhizopus rot disease of Tomato.**

**Symptoms**

1. Rhizopus rot appeared as water-soaked lesions on fruits and may exude a clear liquid.
2. Lesion surface may be covered with thin, cotton-like fungal structures (especially under humid conditions).
3. Lesions are soft and somewhat watery.
4. Dark sporulation may crown the white tuft of *Rhizopus*.
5. Mycelium can infect adjacent fruit through natural openings or mechanical wounds, creating nests of mold and diseased fruit.

**C.O.- *Rhizopus stolonifer***

- Kingdom – Fungi
- Sub-division - Zygomycotina
- Class – Zygomycetes
- Order – Mucorales
- Family – Mucoraceae

**Mycelium** – Coenocytic, prominent branches called aerial stolons (often called sporangiophores) arise from root like rhizoids.

**Sporangia** - Terminal, dark, globular, have prominent columella.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

**Objective – 3. To study the Anthracnose disease of Tomato.**

**Symptoms**

1. Disease is severe on ripe to over ripe fruits and can cause serious losses.
2. Fruit infections occur during green stages but disease develop symptoms during ripening.
3. On ripe fruits as small, slightly depressed, circular lesions appears which gradually enlarge to greater than 12 mm in dia. with concentric ring markings.
4. Centre of the lesion is usually tan and as the lesions mature become dotted with small black specks.
5. Lesion surface may appear salmon-colored due to spore production.

**C.O.- *Colletotrichum coccoides*, *C. gloeosporoides*, *C. dematium***

Kingdom	– Fungi
Sub-division	– Deuteromycotina
Form Class	– Deuteromycetes
Form Sub class	- Coelomycetidae
Form Order	– Melanconiales
Form Family	– Melanconiaceae

**Mycelium** – Septate, inter and intra cellular, branched.

**Acervuli** – Cushion shaped, provided with short conidiophores and sterile setae.

**Setae** – Straight, un-branched, tapered towards the apex, brown to black, smooth, thick walled and septate.

**Conidiophore** – Hyaline to brown, septate, branched at the base, smooth, short, packed in acervuli.

**Conidia** – Falcate (sickle shaped), posses large oil globule in centre, hyaline, unicellular, borne singly on tip of short conidiophores.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

**Objective – 4. To study the Early blight disease of Tomato.**

**Symptoms**

1. The fruit become infected-through the calyx or stem attachment, either in the green or ripe stage. Concentric ring present on the fruit surface.
2. Appear leathery and may be covered by a velvety mass of black spores.
3. Infected fruit frequently drop, and losses of 50% of the immature fruit may occur.

**C.O.- *Alternaria solani***

- Kingdom – Fungi
- Sub-division - Deuteromycotina
- Form Class – Deuteromycetes
- Form Sub Class - Hyphomycetidae
- Form Order – Moniliales
- Form Family – Dematiaceae

**Mycelium** – Frequently septate, intercellular, branched, light brown become darker with age.

**Conidiophore** – Short, 50-90 um, dark coloured, simple, septate.

**Conidia** – Borne singly, dark coloured, muriform (presence of 5-10 transverse septa and few longitudinal septa), obclavate, 120-296 x 12-20 um, beaked.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

**Objective – 5. To study the Southern blight disease of Tomato.**

**Symptoms**

1. Fruits are severely attacked when they come in contact with the soil.
2. Slightly sunken, yellow spots develop on invaded fruit, which rapidly decay, collapse, and become covered by a white fungal mass with numerous sclerotia.

**C.O. - *Sclerotium rolfsii***

- Kingdom – Fungi
- Sub-division - Deuteromycotina
- Class – Deuteromycetes
- Sub class - Hyphomycetidae
- Order – Agonomycetales
- Family – Agonomycetaceae

**Mycelium** – Septate, white cottony, thin walled.

**Sclerotia** – Spherical, small as mustard seed, hard, dark brown.

**Exercise- Draw the diagram of disease symptom and causal organism**

Disease symptom	Causal organism

## Management of post harvest diseases of vegetables

### 1. Physical treatment

- a. Exposing the produce to higher temperature (38°C for 24-48 hr)
- b. Fruit dip at 52°C for 5 min.
- c. Combination of hot water-Mancozeb (500 ppm) treatment at 52°C for 5 minutes.
- d. Field heat should be lower down before packing and transport (reduces the respiration and thereby reduces the microbial infection).
- e. Drying of onions within 48 hr of topping, reduces the infection of neck rot.
- f. Storage atmosphere containing 5-10% CO (Carbon monoxide) and 4% O<sub>2</sub> reduces the decay.
- g. Ultra violet irradiation suppressed the development of dry and soft rots.
- h. Bell paper fruits packed in wooden boxes with iodine and diphenylamine impregnated liners reduced the soft rots.

### 2. Chemical treatment

- a. Disinfecting fresh tubers with formalin and Sodium o- phenylphenate (SOPP)
- b. Fruit dip in SOPP (0.5%) and Sodium lauryl sulfate (0.3%)
- c. Wax formulation containing Dichloran coating for protection from rots.
- d. Benzimidazole and Imazalil inhibited the infection
- e. Surfactants or surface active agents (reduce the surface tension) like Santamerase F 85 when added to Cholrine or Naconol used for fruit washing reduces the rotting.
- f. Fruit dip in Indole-3- butyric acid or Naphthalic acid (200 mg/l) for 30 min. delay the rotting.

### 3. Biological control

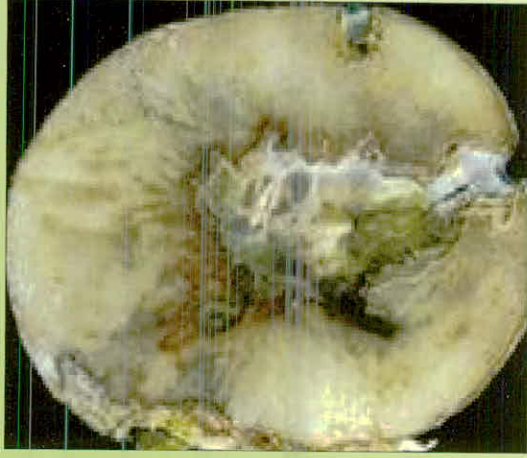
- a. Bacterization of seed potato before and after harvest with *Pseudomonas putida* against *Erwinia* sp. reduces the infection.
- b. *P. aeruginosa* and *Acinetobacter* *genospecies* found effective against *E. carotovora* subsp. *carotovora*.

## Glossary

- Acervulus** – A saucer shaped fructification, deep in origin, bearing short conidia and conidiophore.
- Acropetal** – Produced apically i.e. in a chain where youngest member at the apex.
- Basipetal** - Produced basically i.e. in a chain where youngest member at the base.
- Biological control** – Control of plant diseases by utilizing other organisms.
- Coenocytic** – Aseptate or non septate i.e. without cross walls.
- Conidia** – A non motile asexual spores usually formed at the tip or side of a sporogenous cell of conidiophore.
- Conidiophores** – A simple or branched hypha arising from a somatic hypha and bearing conidia.
- Filiform** – Thread like.
- Fusiform** – Spindle shaped.
- Hyaline** – Transparent or colour less.
- Hypha** – The unit of structure in most fungi, a tubular filament.
- Muriform** – A spore with both transverse and longitudinal septa.
- Mycelium** – Mass of hyphae constituting the body of a fungus.
- Ostiolate** – Possessing an ostiole.
- Ostiole** – A neck like structure, the opening of a pycnidium.
- Parasite** – An organism living on or in and deriving its nourishment from the host.
- Pathogen** – A parasite that causes diseases in plants.
- Phialides** – A general type of conidiogenous cell that is open at the end and may produce basipetal chain of conidia without increase in length.
- Pycnidium** – Asexual flask shaped fruiting body containing conidia and conidiophores.
- Rot** – Disintegration and decomposition of cells.
- Saprophyte** – An organism deriving its nourishment from dead organic matter.
- Sclerotium** – A hard rounded mass of hyphae (resting structure).
- Subsp.** – A generic or specific name given to imperfect fungi (class Deuteromycetes).

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Late blight of potato



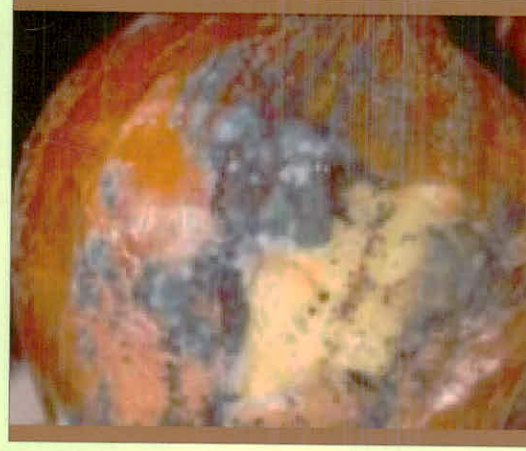
Common scab of potato



Black scurf of potato



Neck rot of onion



Blue mold of onion



Gray mold of tomato



Rhizopus rot of tomato



Southern blight of tomato



Early blight of tomato

कृषि मद्राविद्यालय

# Practical Manual

on

# Post Harvest Disease Management

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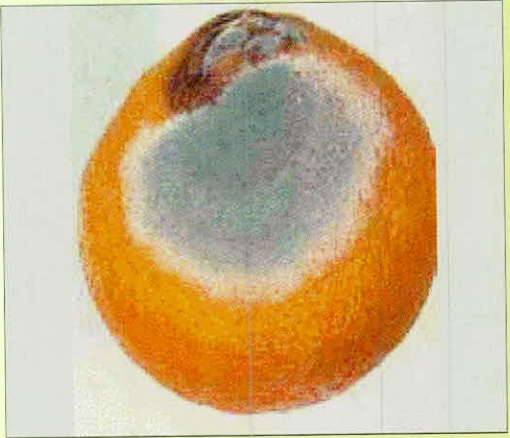
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Anthracoze of citrus



Blue mold of citrus



Green mold of citrus



Sour rot of citrus



Anthracoze of papaya



Fruit rot of papaya



Anthracoze of banana



Cigar end rot of banana



Anthracoze of mango



Diplodia stem end rot of



Phomopsis soft rot of mango



Stem end rot of mango



Phomopsis fruit rot of papaya



Rhizopus rot of papaya



Stem end rot of papaya



Anthracoze of chilli



Gray mold of chilli



Soft rot of chilli