

## DEPARTMENT OF PLANT PATHOLOGY

### UNDER GRADUATE EDUCATION

**PAT 401      Diseases of Horticultural Crops and Mushroom cultivation  
(2+1)**

**COURSE TEACHER      : Dr. V. PRAKASAM, PROFESSOR**

#### **THEORY**

Etiology, symptoms, mode of spread, survival, epidemiology and management of diseases of following crops.

**Fruit Crops :** Mango, banana, citrus, grapes, guava, sapota, pomegranate, annona, papaya, jack, pineapple, ber, aonla, apple, pear, peach, plum, **Vegetable Crops :** Brinjal, tomato, bhendi, cucurbits, crucifers beans, peas, and tuber crops, **Spices and condiments:** Onion, garlic, chillies, betelvine, cardamom, pepper, clove, nutmeg, cinnamon, turmeric, ginger, coriander **Plantation Crops :** Tea, coffee, cocoa, rubber, coconut, oilpalm, arecanut and vanilla, **Ornamental Crops :** Jasmine, rose, crossandra, chrysanthemum, Orchids and Carnation. Post harvest diseases of major fruits and vegetables and their management. **Mushroom :** Cultivation - production constraints of edible mushrooms, including pests, diseases and nematodes. *Pleurotus*, *Calocybe* and *Volvariella* – Nutritional status and uses.

#### **PRACTICAL**

Study of symptoms and host – parasite relationship of important diseases of fruits, vegetables, spices and condiments, plantation and ornamental crops. Cultivation of *Pleurotus*, *Volvariella* and *Calocybe*. Study tour to hot spot areas and plantations. Herbarium collection (50 Nos.).

#### **LECTURE SCHEDULE**

##### **THEORY**

Etiology, symptoms, Mode of spread, survival, Epidemiology and management of diseases of the following crops.

1. Mango
2. Banana – fungal diseases
3. Banana – Bacterial and viral diseases.
4. Citrus – fungal diseases
5. Citrus – bacterial, viral, phytoplasmal and viroid diseases.
6. Grapes
7. Guava, Sapota, Pomegranate, annona, jack
8. Papaya, pineapple, ber, aonla

9. Apple, pear, plum, peach
10. Brinjal, bhendi
11. Tomato – fungal diseases
12. Tomato – bacterial, viral diseases
13. Cucurbits, crucifers
14. Beet root, bean, peas
15. Potato - fungal diseases
16. Potato – bacterial , viral diseases
17. Mid semester examination
18. Tapioca, sweet potato, yam, colocasia, onion , garlic
19. Chillies
20. Betelvine, pepper
21. Cardamom, cinnamon, clove, nutmeg, coriander
22. Turmeric, ginger
23. Tea
24. Coffee
25. Rubber, cocoa
26. Coconut, arecanut
27. Oil palm , vanilla
28. Jasmine , rose, crossandra
29. Chrysanthemum, orchids, carnation
30. Postharvest diseases – Mango, banana, citrus, grapes
31. Postharvest diseases – Tomato, potato, carrot, onion.
32. Differentiation of edible and poisonous mushrooms, 0 Cultivation of *Pleurotus*,
33. Cultivation of *Calocybe*, *Volvariella*
34. Constraints in mushroom cultivation – Pests and diseases, Nutritional and medicinal values of mushrooms.

## **PRACTICAL**

Study of symptoms and host parasite relationship of

1. Diseases of mango and banana
2. Diseases of Citrus and Grapes
3. Diseases of Guava, sapota, . pomerganate, anona, jack papaya, pineapple, ber, aonla.
4. Diseases of apple, pear, plum, peach
5. Diseases of tomato, brinjal
6. Diseases of to cucurbits, crucifers
7. Diseases of bean, peas, potato
8. Diseases of tapioca, sweet potato, yam, colocasia.
9. Diseases of onion, garlic, chillies
10. Diseases of betelvine, pepper, cardamom, coriander, turmeric, ginger
11. Diseases of tea, coffee, rubber
12. Diseases of coconut, arecanut, oilpalm, vanilla
13. Diseases of rose, jasmine, crossandra, chrysanthemum, orchids, carnation
14. Post harvest diseases of fruits – mango, banana, citrus, grapes
15. Post harvest diseases of vegetables – carrot, potato, tomato, onion and garlic.
16. Cultivation techniques of *Calocybe*, *Pleurotus* and farm visit.
17. Practical Examination.

## REFERENCES

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3. Singh, R.S.1999. Diseases of Vegetable Crops. Oxford & IBH Publications, New Delhi. 247.
4. Pathak, P.N. 2001. Diseases of Fruit Crops. Oxford & IBH Publications, New Delhi. 350.
5. Agarwal, R.K. and C.L. Jandaik. 1986. Mushroom cultivation in India. Indian Mushroom Growers Association, Solan, Himachal Pradesh p-83.
6. Bahl, N. 1988. Hand book of Mushroom II Edn. Oxford & IBH Publishing Co., New Delhi.
7. Chang, S.T. and T.H. Quinio. 1982. Tropical Mushrooms. The Chinese University Press, Hong Kong.
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## DISEASES OF MANGO

1. Anthracnose : *Colletotrichum gloeosporioides*
2. Powdery mildew : *Oidium mangiferae* (*Acrosporium mangiferae*)
3. Mango malformation : (*Fusarium moniliforme* Var. *subglutinans*)
4. Stem end rot : (*Botrydiplodia theobromae*)
5. Die-back : (*Botrydiplodia theobromae*)
6. Black Tip : *Physiological disorder*
7. Red rust : *Cephaleuros mycoides*
8. Blight : (*Macrophom mangiferae*, (*Pestalotia mangiferae*)
9. Black spot : (*Xanthomonas campestris* pv. *mangiferae indicae*)
10. Sooty mould : *Capnodium mangiferae*

### 1. Anthracnose : *Colletotrichum gloeosporioides*

#### Symptoms :

This disease produces leaf spots, blossom blight, wither tip, twigs blight and fruit rot.

Young leaves wither and dry up.

Sometimes leaf margins darken, dry up, may fall out, giving the leaf a ragged appearance.

Tender twigs wither.

Affected branches ultimately dry up.

Spots appear on fruits when they are more than half c.m. near the stem end as small brown areas that enlarge rapidly and become black.

In some cases the areas involved are in the form of streaks running down from the stem end.

The affected areas usually crack and sink slightly.

The decay is confined to the skin of the fruit except in late stages when it penetrates the flesh in shallow areas.

The latent infection is carried from the field and develops further which causes rotting in the storage.

#### Mode of survival and spread

Contact with diseased fruit during transport and storage

The inoculum remains on dried leaves, defoliated branches mummified flowers and flower brackets.

The secondary spread is through rain drops.

#### Favourable conditions :

Temperature of 25°C and R.H 95-97%

#### Management

Spray carbendazim or Topsin M. (0.1%) or Chlorothalonil (0.2%), Micop, Blitox and Dithiocarbamate at 14 days intervals until harvest.

Before storage, treat with hot water, (50-55°C) for 15 minutes or dip in Benomyl solution (500ppm a.i.) or Thiobendazole (1000ppm) for 5 minutes or expose them to ammonia, sulphur dioxide and Carbon dioxide gases.

## **2. Powdery mildew : *Oidium mangiferae* (*Acrosporium mangiferae*)**

### **Symptoms**

It attacks the leaves, flower scales, buds stalks and fruits.

It manifests itself by the appearance of wefts of white mycelium on the affected parts.

The whole surface is later on covered with a powdery substance which is brown away by even a slight disturbance caused by winds.

The affected fruits do not grow in size and may drop before attaining pea size.

### **Favourable conditions**

Warm temperature with heavy morning dew and cloudy weather.

### **Management**

Dusting the plants with fine sulphur (250-300 mesh) at the rate of 0.5 kg/tree.

The first application may be soon after flowering, second 15 days later followed by a third one or spray Guesarol (40-50%), benlate (0.2%) or wettable sulphur (0.2%), Carbendazim (0.1%), microsul (0.2%) butrimate, Tridemorph (0.05 to 0.1%), Karathane 0.07%.

## **3. Mango malformation : (*Fusarium moliliforme* Var. *subglutinans*)**

### **Symptoms**

There are two types of symptoms namely floral malformation and vegetative malformation.

There is a proliferation of infected tissue

The flowering panicles instead of coming out as a normal one turns into just compact bunch of hard flowers.

Individual flower is greatly enlarged and has a large disc.

The inflorescence gets hypertrophied.

The percentage of bisexual flowers in malformed panicles is very low.

In bunchy top, compact leaves are formed in a bunch at the apex of shoot or in the leaf axil.

A similar bunch consisting of small rudiments crowded together on short shootlets is seen in Vegetative malformation in which the growth of shootlet is arrested.

Vegetative malformation is more pronounced in young seedling and seedling trees.

The malformed heads dry up in black masses and persist on the trees for a long time.

### **Management**

Incidence reduced by spraying 100-200ppm NAA during October.

Use of disease free planting material and prophylactic spray of insecticides and fungicides.

Diseased plants should be destroyed

Certification of plants used for propagation by nurseries should be made compulsory.

Pruning of diseased parts along the basal 15-20 cm apparently healthy portions.

This is followed by the spraying of Carbendazim (0.1%) or Captan (0.2%).

#### **4. Stem and rot (*Botryodiplodia theobromae*)**

##### **Symptoms**

The dark epicarp around the base of the pedicel in the initial stage

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.

The pulp becomes brown and somewhat softer.

##### **Mode of survival and spread**

Dead twigs and bark of the trees, spread by rains

##### **Management**

Dip mangoes in 6 percent borax solution at 43°C for 3 minutes

Harvest mangoes on clear dry day.

Care should be taken to prevent shapping off of the pedicels.

Injury should be avoided to fruits at all stages of handling

Carbendazim or Topsin-M (0.1%) or Chlorothalonil (0.2%) spraying in the field before harvesting give very effective control.

#### **5. Die-back (*Botryodiplodia theobromae*)**

##### **Symptoms**

Discolouration and darkening of the bark some distance from the tip.

The dark area advances and young twigs wither

The affected leaves turn brown and margins roll upward.

At this stage, the twig or branch dies, shrivels and falls

This may be accompanied by exudation of gum

The infected twigs show brown streaks of vascular tissues on splitting the twigs lengthwise.

##### **Favourable conditions**

Relative humidity above 80 percent and temperature of 25-31°C and rains

##### **Management**

Prune and destroy infected twigs and spray Carbendazim or Thiophanate Methyl (0.1%) or Chlorothalonil (0.2%) as fortnightly interval during rainy season.

## **6. Black-Tip (*Physiological disorder*)**

### **Symptoms**

Occur in orchards located in close proximity to a brick kiln. Small etiolated areas appear at the distal end of the fruit, gradually spread, turn nearly black and cover the tip completely.

Isolated grayish spots appear which become dark brown, enlarge and coalesce into a continuous necrotic area.

In severe cases the necrosis extends to the endocarp.

### **Management**

Keeping the brick kilns away from the mango orchards, use a telescoping chimney 40-45 ft high, spraying Borax (0.6%) at 10-14 day intervals.

## **7. Red-rust (*Cephaleuros mycoides*)**

### **Symptoms**

The algae attack foliage, bark and twigs.

The bark thickens, the twigs get enlarged and remain stunted and the foliage becomes sparse and finally dries up.

Initially the spots are greenish-grey in colour and vary in texture, but later on the surface bears reddish-brown appearance.

The algal spot is circular to irregular in shape, slightly elevated with a diameter of 2-10mm.

### **Management**

Bordeaux mixture (0.6%), or Copper oxychloride 0.25%

## **8. Blight (*Macrophoma mangiferae*, (*Pestalotia mangiferae*)**

### **Symptoms**

Yellowish, pin-head like spots appear on leaves and twigs and enlarge.

The surrounding tissue first becomes light brown and then dark brown.

The leaf tip dries up and infection spreads down towards petioles.

On stem, elliptical lesions appear which later girdle the stem.

On fruit, water-soaked, round lesions are formed which enlarge rapidly and cause rot, particularly in storage.

### **Mode of survival and spread**

Survive on mango leaves for over a year.

### **Favourable conditions**

Heavy infection is noticed during the monsoon.

### **Management**

Remove and destroy infected plant parts.

Spraying copper oxychloride 0.25 mangozes 0.25%.

## **9. Black Spot (*Xanthomonas campestris* pv. *mangiferae* indicae)**

### **Symptoms**

If affects leaves, petioles, fruits and tender stems.

Small, water soaked lesions appear in groups towards the tip of the leaf blade.

They increase in size, turn brown to black and get surrounded by a distinct halo.

On young fruits water-soaked lesions develop which also turn dark brown to black.

Infected fruits may show crack in the skin and badly affected ones drop prematurely.

### **Mode of spread and survival**

Spread during the rains and becomes severe in July-August.

### **Management**

Orchard sanitation and seedling certification.

Spray Agrimycin-100, Plantomycin (200 ppm) or Carbendazim 0.1%.

## **10. Sooty mould : *Capnodium mangiferae***

### **Symptoms**

Black encrustation seen on upper surface of the leaves.

Superficial growth of the fungus

Affect photosynthetic activity.

Yield will be reduced.

### **Favourable conditions**

The fungus grows on the leaf surface on the saliva produced by Jassids, Aphids and scale insects.

### **Management**

Controlling of insect by spraying systemic insecticides like monocrotophos or methyl dematon.

Spraying starch solution (1kg Starch/maida/Jack seed flour 5 litres of water.

Boilet and add 15 litres of water).



Starch dries and forms a flake which are removed along with the fungus.

## DISEASES OF GRAPE VINE

1. Downy mildew	:	<i>Plasmopara viticola</i>
2. Powdery mildew	:	<i>Uncinula necator</i>
3. Bird's eye spot/Anthracnose	:	<i>Gloeosporium ampelogum</i>
4. Black rot	:	<i>Guignardia bidwelli</i>
5. Rust	:	<i>Phakospora vitis</i>
6. Brown spot	:	<i>Cercospora viticola</i>
7. Root diseases	:	<i>Rosellinia necatrix/ Poria barbaeformis</i>

### 1. Downy mildew : *Plasmopara viticola*

#### Symptoms

Irregular, yellowish, translucent spots on the upper surface of the leaves.  
Correspondingly on the lower surface, white, powdery growth on fungus appear.

Affected leaves become, yellow, brown and gets dried.

Premature defoliation.

Dwarfing of tender shoots.

Brown, sunken lesions on the stem.

White growth of fungus on berries which subsequently becomes leathery and shrivels.

Later infection of berries result in soft rot symptoms.

No cracking of the skin of the berries.

#### Mode of spread and survival

**Spread** : Through sporangia by wind, rain etc.

**Survival** : As oospores present in the infected leaves, shoots and berries. Also as dormant mycelium in infected twigs.

#### Favourable conditions

Optimum temperature : 20-22°C

Relative humidity : 80-100 per cent

Dew

#### Management

Bordlax mixture 1%, metalaxyl + mancozeb 0.3 to 0.4% copper oxychloride 0.25%.

### 2. Powdery mildew : *Uncinula necator*

## Symptoms

Powdery growth mostly on the upper surface of the leaves.  
Malformation and discolouration of affected leaves.  
Discolouration of stem to dark brown.  
Floral infection results in shedding of flowers and poor fruit set.  
Early berry infection results in shedding of affected berries.  
Powdery growth is visible on older berries and the infection results in the cracking of skin of the berries.

## Mode of spread and survival

Through air-borne conidia  
Through dormant mycelium and conidia present in the infected shoots and buds.

## Favourable conditions

Sultry warm conditions with dull cloudy weather, highly favourable.

## Management

Spraying wettable sulphur 0.2%  
Carbendazim 0.1%  
Karathane 0.07%

## 3. Bird's Eye Spot/Anthracnose : *Gloeosporium ampelophagum*

### Symptoms

Visible on leaves, stem, tendrills and berries.  
Young shoots are more susceptible than leaves.  
Circular, greyish black spots with yellow halo appear.  
Later the centre of the spot becomes grey, sunken and fall off resulting in a symptom called 'shot hole'.  
Black, sunken lesions appear on young shoots.  
Cankorous lesions are formed on older shoots.  
Subsequently girdling and death of shoots occur.  
Infection on the stalk of the bunches and berries result in the shedding of bunches and berries respectively.  
Sunken spots with ashy grey centre and dark margin, resembling that of a bird's eye are produced.  
Severe infection results in mummification and shedding of berries.

**Etiology** : Fungus – Anamorph – *Gloeosporium ampelophagum*

- produce hyaline, single celled conidia.

Teleomorph : *Elsinoe ampelina*

- Produces hyaline 4 celled ascospores

**Mode of spread and survival**

Seed-borne-infected vine, cuttings and air-borne conidia  
As dormant mycelium in the infected stem-cankers

**Favourable conditions**

Warm wet weather  
Low lying and badly drained soils.

**Management**

Removal of infected twigs  
Spraying Bordeaux mixture 1%  
Copper oxychloride 0.2%  
Captafol 0.2%  
Mancozeb 0.2%

## DISEASES OF CITRUS

- |                              |   |   |
|------------------------------|---|---|
| 1. Gummosis                  | : | <i>Phytophthora parasitica, P. palmivora, P. citrophthora</i> |
| 2. Diplodia gummosis         | : | <i>Diplodia natalensis</i>                                    |
| 3. Powdery mildew            | : | <i>Oidium tingitaninum</i>                                    |
| 4. Scab/Verucosis            | : | <i>Elsinoe fawcetti</i>                                       |
| 5. Canker                    | : | <i>Xanthomonas campestris pv. citri</i>                       |
| 6. Tristeza or quick decline | : | <i>Virus</i>  |
| 7. Exocortis or scaly butt   | : | <i>Viroid</i>   |
| 8. Greening                  | : | <i>Spiroplasma citri</i>                                      |
|                              |   |   |
| 1. Gummosis                  | : | <i>Phytophthora parasitica, P. palmivora, P. citrophthora</i> |

### Symptoms

First symptoms are dark staining of bark which progresses into the wood. Bark at the base is destroyed resulting in girdling and finally death of the tree. Bark in such parts dries, shrinks and cracks and shreds in lengthwise vertical strips. Laterk profuse exudation of gum from the bark of the trunk. Infection extends to crown roots.

### Favourable conditions

Prolonged contact of trunk with water as in flood irrigation; water logged areas and heavy soils.

### Mode of spread and survival

Soil inhabitants.  
Sporangia spread by splashing rain water, irrigation water and wind.  
Irrigation water and wind.

### Management

Injuries to crown roots or base of stem during cultural operations should be avoided.  
If lesion has girdled less than ½ the girth, remove the diseased bark with a knife along with ½” of uninvaded bark.  
Bark of trunk should be coated with ZnSO<sub>4</sub>, CuSO<sub>4</sub>, lime (5:1:4) with the consistency of a wash.

### 2. Diplodia gummosis : (*Diplodia natalensis*)

## Symptoms

Affects sweet orange and mandarings.  
Gum oozes from one or two spots near forks or bigger limbs.  
Infection is usually high above the ground.  
Infection starts at growth cracks or ridges at crotches.  
Bark is killed, gum oozes out and dries becoming black.  
Exudation may stop after sometime.  
They may be confined to certain seasons of the year.  
Wood becomes discoloured into shades of brown.  
Large limbs are killed and if left unchecked the whole tree may be killed in course of time.  
Sometimes branches break at the infected portion.

## Favourable conditions

Reduced tree vigour, insect damage, malnutrition, old age.

## Mode of spread and survival

Conidia produced inside pycnidia are spread by wind and rain splashes.

## Management

The tress should be kept in a vigorous growing condition. Wound in the brak especially on limbs and forks should be scraped and protected with Bordeaux paste.  
Broken limbs to be cut clean.

## 3. Powdery mildew : *Oidium tingitaninum*

### Symptoms

Main cause of mandarin decline in Karnataka.  
White powdery on young twigs and leaves.  
Leaves turn yellow and are distorted and even shed.  
Tree vigour reduced.  
New flush highly susceptible.  
Die-back after young leaves are shed.

### Mode of survival and spread

Dormant mycelium on twings.  
Conida spread by wind and rain.

### Management

Apply 350 mesh sulphur dust in the early morning so that it will stick to the

leaves, when young leaves have half developed before disease appears or spray 0.5% wettable sulphur at fortnightly intervals.

#### **4. Scab/Verucosis : *Elsinoe fawcetti***

##### **Symptoms**

Attacks leaves, twigs and fruits of mandarin.  
Sour orange, lemon, mandarin, tangelos extremely susceptible Grapefruit, Sweet oranges and acid lime highly resistant.  
Severe in rainy seasons.  
On the leaves the disease starts as small pale orange coloured spots.  
The leaf tissue is distorted to form hollow conical growths with the lesion at the apex. The crest of these growth becomes covered with scabby corky tissue colour at first but later becomes dark olive with age.  
Lesions most common on undersurface of leaf.  
They penetrate leaf and are later visible on both sides.  
Infected areas run together and cover large area.  
Leaves wrinkled, distorted and stunted.  
On twigs similar lesions are produced.  
They form corky outgrowths.  
On fruits irregular scabby spots or caked masses produced.  
Cream colour in young fruits; dark olive grey in old fruits.  
Fruits attacked when young become misshapen with prominent warty projections.  
They drop prematurely.

##### **Management**

Carbendazim 0.1%

#### **5. Canker : *Xanthomonas campestris* pv *citri***

##### **Symptoms**

Acid lime, lemon and grapefruit are affected.  
Rare on sweet oranges and mandarins.  
Affects leaf, twig and fruits.  
In canker, leaves are not distorted.  
Lesions are typically circular with yellow halo; appear on both sides of leaf, severe in acid lime (difference from scab) When lesions are produced on twigs, they are girdled and die. On fruits, canker lesions reduce market value.

##### **Favourable conditions**

Free moisture for 20 minutes, 20-30°C.

##### **Mode of survival and spread**

Wind and rain splashes.  
Survives in infected leaves for 6 months.  
Injury caused by leaf miner helps the entry of the bacterium.

## Management

Streptomycin sulphate 500-1000 ppm; or Phytomycin 2500 ppm or Copper oxychloride 0.2% at fortnight intervals.

Control leaf miner when young flush is produced.

Prune badly infected twigs before the onset of monsoon.

## 5. Tristeza or quick decline : *Virus*

### Symptoms

Lime is susceptible both as seedling or budding on any root stock.

But mandarin and sweet orange seedlings or on rough lemon, trifoliate orange, citrings; Rangpur lime root stocks tolerant; susceptible root stocks are grapefruit and sour orange.

In sweet orange or mandarin on susceptible root stocks, leaves develop deficiency symptoms and abscise.

Roots decay, twigs die back.

Fruit set diminishes; only skeleton remains.

Fine pitting of inner face of bark of sour orange stock.

Grapefruit, and acid lime are susceptible irrespective of root stock.

Acid lime leaves large number of vein flecks (elongated translucent area).

Tree stunted and dies yield very much reduced.

Fruits are small in size.

### Mode of spread

Use of infected bud wood *Toxoptera citricida* (aphid) is the important vector.

Not seed-borne.

## Management

For sweet orange and mandarin. avoid susceptible root stocks.

For acid lime, use seedling preimmunised with mild strain of tristeza.

## 6. Exocortis of scaly butt : *Viroid*

### Symptoms

Affects only Rangpur lime, Trifoliate orange and citrange root stocks.

Vertical cracking and scaling of bark in the entire, root stock portion, yellow blotching twigs, extreme stunting of plant.



When citrange root stocks are used, there is no bottleneck at the stock-soion union.

### Mode of spread

Use virus-free certified budwood; use tolerant stocks like rough lemon, cleopatra.

Avoid susceptible root stocks.

Periodically wash budding knife with Tisodium Phosphate solution.

### 7. Greening : *Liberobacter asiaticum* ( Phloem limited Bactria- like- organism)

#### Symptoms

This disease affects almost all citrus varieties irrespective of root stock.

Stunting of leaf, sparse foliation, twig die back, poor crop of predominantly greened, worthless fruits.

Sometimes only a portion of tree is affected.

A diversity of foliar chlorosis.

A type of mottling resembling zinc deficiency often predominates.

Young leaves appear normal but soon assume on outright position, become leathery and develop prominent veins and dull olive green colour.

Green circular dots on leaves.

Many twigs become upright and produce smaller leaves.

Fruits small, lopsided with curved columella.

The side exposed to direct sunlight develops full orange colour but the other side remain dull olive green.

Low in juice and soluble solids, high in acid.

Worthless either as fresh fruit or for processing.

Seeds poorly developed, dark coloured, aborted.

#### Mode of spread

Infected budwood; psyllid vector-*Diaphorina citri*

#### Management

Control psyllids with insecticides.

Use pathogen free bud wood for propagation.

500 ppm tetracycline spray though effective, requires fortnightly application which is not economic.

It only inhibits the pathogen but does not kill.

## DISEASES OF BANANA

- |                          |   |   |
|--------------------------|---|---|
| 1. Panama wilt disease   | : | <i>Fusarium oxysporum f.sp cubense</i>                        |
| 2. Sigatoka leaf spot    | : | <i>Cercospora musae</i><br>( <i>Mycosphaerella musicola</i> ) |
| 3. Anthracnose           | : | <i>Gloeosporium musarum</i>                                   |
| 4. Freckle or Balck spot | : | <i>Phyllostictina musarum</i>                                 |
| 5. Banana bunchy top     | : | <i>Virus disease</i>  |

6. Cucumber mosaic virus	:	<i>Virus disease</i>
7. Mokowilt	:	<i>Pseudomonas solanacearum</i>
8. Tip over or Heat rot	:	<i>Erwinia cerotovora</i>
9. Pseudostem rot	:	<i>Corticium rolfsii</i>

**1. Panama wilt disease : *Fusarium oxysporum* f. sp. *cubense*.**

### Symptoms

Yellowing of the lower most leaves  
 Yellowing extends upwards and finally heart leaf alone remain green  
 The leaves break near the base and hang down around pseudostem  
 Longitudinal splitting of pseudostem  
 Discolouration of conducting vessels  
 Reddish brown radiating mycelial strands in c.s of corms

### Survival and spread

Survives in soil as chlamydospores for longer periods  
 The fungus also spread through irrigation water  
 Continuous cultivation results in build up of inoculum

### Management

Variety Poovan shows resistance, Rasthali and monthan susceptible to the disease.

Capsule application of carbendazim @ 40 mg/capsule/tree on  
 The capsule is applied in the corm by making a hole 45° of 10 cm depth  
 Second application is done if needed after one month (or)  
 Adopt corm injection 3 ml of 2% carbendazim injected by making hole at hole  
 as mentioned earlier.  
 Flooding the infected fields  
 Raise paddy crop for one season to suppress pathogen.

**2. Sigatoka leaf spot : *Cercospora musae* (*Mycosphaerella musicola*)**

### Symptoms

First symptoms are seen on the leaves  
 Yellow elongated spots on leaves  
 Spots surrounded by yellow halo  
 Number of spots cause drying of leaves.

### Survival and spread

The fungus survives in the infected banana leaves  
 Secondary infection is by the windborne conidia of the fungus

## Management

Removal of the affected leaves, Avoid night irrigation.  
Spraying copper oxychloride 2kg or Carbendazim 500g or Mancozeb 1.25kg  
or Captan 1.25kg or Ziram 1.25kg / per ha. In severe case Tridemorph  
0.1% Carbendazim 0.1% combination may be sprayed  
Wetting agent such as teepol or sandovit added at the rate of 1ml/lit of water.

## 3. Anthracnose

**Symptoms :** *Gloeosporium musarum*

The skin at the distal ends of the fingers turn black  
The fungus produces masses of conidia which form a pinkish coat  
The entire fruit, stalk and buds are affected  
The bunch becomes black  
Fruits get shrivelled

## Survival

Optimum temperature for disease development 30-35°C and relative humidity  
of above 85%  
The incidence was severe during June-September when the temperature was  
high

## Management

Spraying copper oxychloride 0.25% or Bordeaux mixture 1%.

## 4. Freckle or Black Spot : *Phyllostictina musarum*

### Symptoms

Minute blackspots on leaves and fruits  
The spots are brown to dark brown initially  
Spots are abundant on the upper surface and are raised  
Leaf become yellow in colour in advance stage  
On the fruits the pathogen is confined to the skin.

### Spread

The fungus produces pycnidium pycnidiospores  
Spores are disseminated by wind

## Management

Spraying copper oxychloride 0.25% or Bordeaux mixture 1%

## 5. Banana bunchy top : *Virus disease*

## Symptoms

- Plants are extremely stunted
- Leaves are reduced in size and chlorotic
- Leaves stand upright and become brittle
- Many leaves are crowded at the top
- Dark broken bands of green tissues on the veins, leaves and petioles
- Produce white shooting due to later infection

## Spread

The disease is transmitted primarily by infected suckers  
Secondary spread is through the aphid vector *Pentalonia nigronervosa* var *typica*.

## Management

- Select suckers from disease free areas
- Spraying dimethoate 500ml or monocrotophos 250ml/ha to control the vectors
- Infected plants destroyed in situ using 4ml of 2, 4, D (50g in 400 ml of water) solution.

## 6. Infectious chlorosis      *Cucumber mosaic virus*

### Symptoms

Chlorotic or yellow green lands on leaves, upward curling of leaves, mottling of young leaves.  
Sometime heart rot symptom  
Diseased plants do not reach maturity.

### Spread

Through infected sucker and *Aphis gossypii*

### Control

- Destroy infected plants
- Use disease free suckers
- Arrest vector by systemic insecticide
- Dry heat treatment of sucker at 40°C for 1 days.

## 7. Moko wilt : *Pseudomonas solanacearum*

### Symptoms

Rapid wilting and collapse of the leaves  
Discolouration in vascular region  
Leaves turn dingy yellow or whitish yellow petiole breaks at junction with pseudostem.

Blackening of the suckers  
Discolouration in fruits  
Reddish tinge in vascular strand is typical of this disease  
Death of whole plant.

### **Spread**

Occur in poorly drained soil.  
Primary infection through injured roots.  
Transfer to healthy plants through implements and by insects.

### **Control**

Erradicate infected plant.  
Expose soil to direct sunlight.  
Use of clean planting material  
Fallowing and crop rotation is advisable  
Disinfection of implements  
Providing good drainage.

## **8. Tip over or Head rot : *Erwinia carotovora***

### **Symptoms**

Small sword leaves deviated from normal one  
Rot occur in the middle tender leaf  
Pseudostem easily come out from corm portion on exerts slight pressure.  
Oozing visible on the edge of corm and pseudostem confirm bacterial infection.

### **Spread**

Severe during summer  
Through soil and infected sucker.

### **Control**

Plant disease free suckers.  
Remove infected plants and destroy  
Drench methoxy ethyl mercuric chloride (Emisan-6) 0.1%  
Avoid drenching (Emisan-6) after shooting  
Poovan is resistant Robusta is susceptible to this disease.

## **9. Pseudostem rot : *Corticium rolfsii***

### **Symptoms**

Water soaked lesion at the base of the Pseudostem  
Develop into a necrotic zone with yellow center and dark brown margin

Advance stage sclerotia along with white mycelium seen Pseudostem rot and finally death occur.

### **Control**

Removal of severely infected plant  
Apply Bordeaux paste in the affected region.

## DISEASES OF GUAVA

- |                |   |  |
|----------------|---|--|
| 1. Wilt        | : | <i>Fusarium oxysporum f. sp. Psidi</i> |
| 2. Stem Canker | : | <i>Physalospora psidi</i>              |
| 3. Red rust    | : | <i>Cephaleuros virescens</i>           |

1. **Wilt** : *Fusarium Oxysporum f. sp. psidi*

### Symptoms

Leaves turn pale green  
Yellow to reddish discolouration  
Premature shedding of leaves  
Fruits produced in the affected plants are very small  
Diseased plants fail to produce new flush and flowers  
Plants dries within a year  
Rotting of roots at the basal region  
Bark turn light brown

### Favourable conditions

Trees of age 5 years are normally affected  
10-20 years are highly susceptible  
Alkali soils favours the pathogen.

### Mode of spread

Survives as saprophytes and chlamydospores which remain dormant for several years.

### Management

Removal of infected brancher, uproot wilted plants.  
Add green manure, oil cake  
Avoid low lying area and water logging  
Use resistant varieties like  
Banarasi Doalka, Nasik and white guava.

2. **Stem Canker** : *Physalospora psidi*

### Symptom

Causes cracks in branches wilting of branches due interference of translocation of water and nutrients.

### Mode of spread

Primary spread through conidia and secondary spread through ascospores (perithecia)

**Survival**

As dormant mycelium below the bark

**Management**

Removal of dead stem paint the cut end with bordeaux paste

**Red rust** : *Cephaleuros virescens*

**Symptom**

Affect leaves and fruits

On fruits the lesions are small, dark green to brown or black some times.

On the leaves small brown specks are seen in patches.

Raised brown algal growth also seen.

Wind borne zoospores.

**Favourable conditions**

Bright sunlight

**Management**

Bordeaux mixture 0.6% or Copper oxychloride 0.2 to 0.3%.



## DISEASES OF PEACH

1. Leafcurl : *Taphrina deformans*  
2. Powdery mildew : *Sphaerotheca peronospora*

1. Leafcurl : *Taphrina deformans*

### Symptom

Discoloured, wrinkled leaves  
Deformation of tender leaves turn into deep red colour  
Covered with whitish gloom  
Leaves are thickened  
Puckering along mid ribs  
Veins do not grow properly  
Leaves become necrotic and fall off  
Twigs swell in size, gummy exudation and finally die  
Fruit setting is very poor  
Premature drop

### Survival and spread

High humidity and temperature 18°C are favourable

### Control

Spraying with 0.2% captan or 0.1% carbendazim before bud burst and full bloom.

2. Powdery mildew : *Sphaerotheca pannosa*

### Symptom

Powdery growth on upper surface  
Leaves become narrowed and curled  
Shoot also covered with white coatings  
On fruits white round spots occur.  
Fruits become pink to dark brown in color  
Epicarp becomes leathery and hard.

### Control

Spraying carbendazim 0.1%  
Dusting with sulphur

## DISEASES OF APPLE

<b>1. Scab</b>	:	<i>Venturia inaequalis (Spilocaea pomi)</i>
<b>2. Root rot</b>	:	<i>Dematophora necatrix</i>
<b>3. Pink disease</b>	:	<i>Corticium Salmoni color</i>
<b>4. Powdery mildew</b>	:	<i>Podosphaera leucotricha</i>
<b>5. Silver leaf</b>	:	<i>Chondrostereum purpureum</i>
<b>6. Mosaic</b>	:	<i>Virus</i>

### **1 Scap : *Venturia inaequalis***

#### **Symptom**

##### **Leaves**

Large brown olivaceous spot on lower surface of leaves  
 Ultimately got wavy margin  
 Later lesion on upper surface of leaves  
 Lesion become velvety with slight derpession on upper surface  
 Lower surface is convex  
 Leaf become curled and fall off.

##### **Fruits**

Brown lesion initially, then turn black and corky with white halo surrounds  
 Cracks developed in the lesion area  
 In cracks secondary saprophytic infection seen  
 Market value and keeping quality reduced

#### **Control**

- 1) Collect all infected leaves in winter and burn it (Breaking of life cycle)
- 2) Spray schedule
 

1 <sup>st</sup> spray - Silver tip stage	-	0.2% captofol (or) 0.3% captan (or) 0.4% mancozeb
IInd spray pinkbud	-	0.2% captan (or) 0.3% mancozeb
IIIrd spray petal ball	-	0.5% carbendazim
IVth spray - after 10 days	-	0.2 captan & mancozeb 0.3
Vth spray - 15 days after fruit set	-	0.15% captafol

### **2. Root rot : *Dematophora necatrix***

#### **Symptom**

Yellowing of leaf and drop prematurely  
 Lateral roots turn into brown  
 Fibrous roots completely destroyed  
 White fluffy mycelium on lateral roots in advanced stage  
 Common in forest tree and is act as source of inoculum  
 5-20 year old trees are susceptible.

**Survival** : Survive well in 6.1 - 6.5 pH.

**Control**

Disinfect the field with 3% H<sub>2</sub>O<sub>2</sub> (Hydrogen peroxide)  
Dig trenches around infected tree to prevent further movement  
Planting root stocks near the affected tree and make approach grafting later  
Apply heavy organic matter.

**3. Pink disease : *Corticium salmoni color***

Refer Jack disease

**Powdery mildew : *Podosphaera leucotricha***

**Symptom**

White greyish growth on lower surface  
Leaf is distorted become hard and brittle  
Branches also affected and young twigs die  
Flowers blighted and dropped  
Fruit set also affected.

**Control**

Spray 0.1% wettable sulphur or  
0.075% karathane

**5. Silver leaf disease : *Chondrostereum purpureum***

**Symptom**

Leaf show a metallic lusture similar to shiny sliver  
Affects heart root - turn dark brown color

**Control**

Remove affected branch  
Apply Bordeaux paste at cut end  
*Trichoderma viride* spore suspension are used for coating cut ends

**6. Mosaic : *Virus***

**Symptom**

Creamy white patches on leaf  
Yellow band along the vein on both sides  
Leaf whether in advanced stage

**Spread**

No insect vector

Spread through infected bud woods

### **Control**

Use certified virus free buddings

## **DISEASES OF PAPAYA**

- |                            |          |   |
|----------------------------|----------|---|
| <b>1. Foot or stem rot</b> | <b>:</b> | <b><i>Pythium aphanidermatum</i></b>                                  |
| <b>2. Leaf spot</b>        | <b>:</b> | <b><i>Phyllosticta swata</i></b><br><b><i>Myrothecium roridum</i></b> |
| <b>3. Dry root rot</b>     | <b>:</b> | <b><i>Macrophomina phaseolina</i></b>                                 |
| <b>4. Mosaic</b>           | <b>:</b> | <b><i>Virus</i></b>   |
| <b>5. Leaf curl</b>        | <b>:</b> | <b><i>Virus</i></b>   |

- 1. Foot or stem rot : *Pythium aphanidermatum***

### **Symptom**

Water soaked lesion near the base level  
Affected tissue turn dark brown or black  
Terminal leaves droop, wilt, turn yellow and fall  
Fruit if formed also drop  
Finally whole plant will die  
This pathogen also cause damping off in nursery

### **Survival and spread**

Pathogen survive in the soil  
Spread through irrigation water

### **Control**

Remove affected plants and burn  
Avoid water logging condition  
Drench the soil with 1% Bordeaux mixture.

- 2. Leaf spot : *Myrothecium roridum***

### **Symptom**

Small dirty yellow water soaked spots on the leaves  
Having brown to violet periphery with chlorotic halo  
Spots coalesced and leaf dries.

### **Survival**

Survive in infected leaf and fruit

Spread through wind borne conidia

### **Control**

Spray 0.2% mancozeb or 0.25% copper oxychloride.

## **2. Leaf spot : *Phyllosticta sulata***

### **Symptom**

Round irregular oval or elongated spots on the leaves  
White in centre bounded by yellowish or brownish margin  
Centre of the spot thin and papery.

### **Survival**

Survive in plant debris  
Spread through wind

### **Control**

Three spraying with 1% Bordeaux mixture

## **3. Dry root rot : *Macrophomina phaseolina***

### **Symptom**

Yellowing and dropping of leaves  
Red to black wet rot developed just before death  
Disintegration of tissue in advanced stage especially near soil level.

### **Survival**

Soil borne and in debris  
High temperature induce the disease development.

### **Control**

Removal of affected plants  
Drench with 1% Bordeaux mixture or Carbendazim 0.1%

## **4. Mosaic : *Virus***

### **Symptom**

Mottling, puckering, chlorotic and malformed appearance of leaf  
Increase in number of leaves  
Leaves are reduced in size  
Old leaves get defoliated leaving tuft of small one at the top  
New leaves formed after infection showing yellow mosaic symptom.

## Spread

Through *Aphis gossypii* and also by *myzus persicae*

## Control

Removal of affected plant.

Check the insects by spraying systemic insecticide.

## 5. Leaf curl : *Virus*

### Symptoms

Curling, crinkling and distortion of leaves

Vein clearing and reduction in leaf size

Inverted cup due to inward and downward rolling of leaf margin

Veins thicken and turn dark green color, petioles get twisted in a zig-zag manner

Affected plants do not flower or bear few fruit

Defoliation occur

### Spread

*Bemisia tabaci* transmit this disease and also through mechanically

### Control

Uproot the affected plants

Avoid growing collateral hosts (Tomato, tobacco) near papaya

Insect vectors can be checked with 0.1% malathion, Dimethoate at 10-12 days interval

## DISEASES OF JACK

- |                       |   |                                  |
|-----------------------|---|----------------------------------|
| 1. Pink disease       | : | <i>Pellicularia salmonicolor</i> |
| 2. Rhizopus fruit rot | : | <i>Rhizopus atrocarpi</i>        |
| 3. Leaf spot          | : | <i>Colletotrichum lagenaria</i>  |

- |                 |   |                                  |
|-----------------|---|----------------------------------|
| 1. Pink disease | : | <i>Pellicularia salmonicolor</i> |
|-----------------|---|----------------------------------|

### Symptoms

Affects young branches and pinkish out growth are seen on the surface

Further penetrates bark and grows inside and subsequently enters cortex

Due to interruption of flow nutrients, leaves become yellow

Leaf crinkle and sheds and twigs get dried.

### Mode of spread and survival

Conidia spreads by wind.  
Survives as dormant mycelium

### Management

Removal of affected branches and application of Bordeaux paste on the cut end.

### 2. Rhizopus fruit rot : *Rhizopus atrocarpi*

#### Symptom

In young fruit rots begins in the stalk and covered by the mycelium.  
The fruits are mumified and drops down.

#### Mode of Spread

The pathogen lives in the debris

#### Management

Improve sanitation  
Spraying Bordeaux mixture 0.4% or copper oxychloride 0.2%

### 3. Leaf spot : *Colletotrichum largenaria*

#### Symptom

Spots produced are roundish or circular 10-30 mm in size  
Lesions are dark brown or reddish brown  
In extreme case defoliation occurs.

#### Management

Spraying mancozeb 0.25%.

## DISEASES OF CASHEW

- |                         |   |                                      |
|-------------------------|---|--------------------------------------|
| 1. Pink disease         | : | <i>Corticium salmoni color</i>       |
| 2. Decline              | : | <i>Pythium spinosum</i>              |
| 3. Inflorescence blight | : | <i>Gloesporium manigiferae</i>       |
| 4. Powdery mildew       | : | <i>Acrosporium canacardii</i>        |
| 5. Anthracnose          | : | <i>Colletotrichum gloesporioides</i> |
| 6. Damping off          | : | <i>Phytophthora palmivora</i>        |

- |                 |   |                                |
|-----------------|---|--------------------------------|
| 1. Pink disease | : | <i>Corticium salmoni color</i> |
|-----------------|---|--------------------------------|

(Refer Jack fruit)

- |            |   |                         |
|------------|---|-------------------------|
| 2. Decline | : | <i>Pythium spinosum</i> |
|------------|---|-------------------------|

### **Symptoms**

Tree vigour is reduced and production also reduced  
The fungus infects fibrous roots of the plant and it turn brown

Leaf starts withering and dropping of leaves results.

### **Mode of spread**

The fungus infects during rainy season  
But the symptoms comes or seen during summer season.

### **Favourable conditions**

Ill drained and water logged area

### **Management**

Improving drainage  
Give forking of soil at base of the plant with digging fork for free aeration  
Drench the soil with 0.3% cheshunt compound  
Adequately fertilize with 40 kg compost 1kg Amso4 and 750gm  
superphosphate before the rain commence

## **3. Inflorescence blight : *Gloesporium manginererae***

(Complex of pest and pathogen)

### **Symptoms**

Inflorescence turns black and no fruit set

### **Mode of spread**

The pathogen enters the wound caused by tea  
Mosquito (*Helopeltis antoni*)

### **Management**

Spraying endosulphan 0.05% just before inflorescence emergence and second  
spray by a week later



#### 4. Powder mildew : *Acrosporium anacardii*

##### Symptoms

Affects young developing twigs surface of twig is glistery and plant exudate resin and makes it sticky  
Lesion extends downward and twigs die  
Rotting of fruits and nuts  
If left unchecked the trees die in a year.

##### Management

Remove the affected twigs and spray 1% Bordeaux mixture.

#### 6. Damping off : *Phytophthora palmivora*

##### Symptom

In cashew nursery it causes pre emergence damping off (failure of germination)  
The base of the seedlings infects and topples

##### Favourable conditions

Flooded condition, ill drained soil and over crowded seedlings

##### Management

Spraying with metalaxyl + mancozeb 0.4% and drenching the same.

### DISEASES OF PINE APPLE

- |                       |   |                                |
|-----------------------|---|--------------------------------|
| 1. Leaf and fruit rot | : | <i>Ceratocystis paradoxa</i>   |
| 2. Root rot           | : | <i>Phytophthora parasitica</i> |

- |                         |                              |
|-------------------------|------------------------------|
| 1. Leaf and fruit rot : | <i>Ceratocystis paradoxa</i> |
|-------------------------|------------------------------|

##### Symptoms

The spots are produced on leaves and fruits  
The spots vary in size and are grey with dark margins and later turning olive brown or white  
As the disease advances the tissues become dry and the leaves become distorted.  
Diseased suckers rarely put forth the complement of the root and their leaves are chlorotic and reduced in size  
On the water soaked lesions appear which turn yellowish; then dark.

The tissues becomes soft and rotting soon set in when the ripened fruits are affected a characteristic smell or odors develops.

### **Mode of Spread**

Both micro and macro conidia invades through wounds, cut end of suckers

### **Management**

The diseased plant must be destroyed  
Avoiding suckers from the infected area for planting.

## **2. Root rot : *Phytophthora parasitica***

### **Symptom**

Yellowing of leaves which later turns above brown coloured  
Fruit development is arrested and entire plant wilts from the tip downward  
The fruits exhibits spongy texture  
When the plant is pulled out the roots appear dark and in the process of decaying.

### **Favourable conditions**

Excess moisture.

### **Mode of spread**

Through irrigation water (zoospores)

### **Management**

Prophylactic treatment with 1% Bordeaux mixture (or) metalaxze + mancozeb 0.2% to 0.4%.

## **DISEASES OF SAPOTA**

<b>Leaf spot</b>	<b>:</b>	<b><i>Phavophleospora indica</i></b>
<b>Sooty mould</b>	<b>:</b>	<b><i>Capnodium spp.</i> (Refer mango)</b>

## **DISEASES OF STRAWPERY**

<b>1. Septoria leaf spot</b>	<b>:</b>	<b><i>Septoria aciculosa</i></b>
<b>2. Leaf and Stem blight</b>	<b>:</b>	<b><i>Mycosphaerella fragariae</i></b>
<b>3. Rust</b>	<b>:</b>	<b><i>Puccinia fragariae</i></b>
<b>4. Botrytis rot</b>	<b>:</b>	<b><i>Botrytis cinerea</i></b>
<b>5. Leaf spot</b>	<b>:</b>	<b><i>Haineria lythri</i></b>

## DISEASES OF POMEGRANATE

Bacterial leaf spot	:	<i>Xanthomonas campestris</i> pv. <i>punicae</i>
Leaf spot	:	<i>Cercospora punicae</i>
	:	<i>Cercospora Iyhracearum</i>
	:	<i>Sphaceloma punicae</i>

1. Bacterical leaf spot	:	<i>Xanthomonas campestris</i> pv. <i>punicae</i>
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### Symptom

Dark coloured irregular spots 2-5 mm in diameter  
The leaves often distorted and malformed  
Premature dropping of leaves. The normal growth of the plant in affected  
Raised spots are seen on the fruits which are irregular .

### Mode of Spread

The bacteria infect through wounds and stomatal openings.

### Survival

Survive in the soil

### Management

(Streptomycin + Tefracycline)  
Agrimycin 100 100 ppm

## DISEASES OF VEGETABLES

### CRUCIFEROUS VEGETABLES

#### Cabbage, Cauliflower.

1. Club root	:	<i>Plosmodiophora brassicae</i>
2. Ring spot	:	<i>Mycosphaerella brassicola</i>
3. Downy mildew	:	<i>Peronospora parasitica</i>
4. Block rot	:	<i>Xanthomonas campestris</i> pv. <i>Campestris</i>
5. Leaf spot	:	<i>Alternaria brassicicola</i> ; <i>A. brassicae</i> .
6. Head rot	:	<i>Sclerotinia sclerotiorum</i>
7. White rust of Crucifers	:	<i>Albugo Candida</i> ( <i>Cystopus candidus</i> )

1. Club root	:	<i>Plasmodiophora brassicae</i>
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### Symptoms

Infected roots enlarge relatively rapidly to form 'clubs' which takes on a variety of shapes (Hyperplasia and hypertrophy)

Wilting of plants during night time. Due to secondary infection the clubs decay.

Gradual and relatively inconspicuous stunting.

The resting spores are hyaline, spherical.

It germinate after a resting period and gives rise to zoospores (amoeboid) and infects the root hairs.

In the host tissue, plasmodium develops.

### **Favourable conditions**

Low lying areas, ill drained soils with a soil temperature of 15-25°C.

Acid soils are highly favourable for the pathogen.

### **Survival**

It persists in the soil and crop refuse.

### **Mode of spread**

Through farming implements.

Surface flood water.

From infected seedlings.

Manure from cattle fed on diseased root crops.

### **Management**

1. Crop rotation
2. Improving drainage facilities
3. Correction of soil by adding lime
4. Crop sanitation
5. Seed treatment with cabendazim 2g/kg
6. Nursery drenching with carbendazim or chlorothalonil 0.1%.
7. Dipping seedlings in 0.8% cabendazim for 20 minutes
8. Spot drenching with carbendazim/chlorothalonil 0.1%.

## **2. Ring spot : *Mycosphaerella brassicola***

### **Symptoms**

The lesions appear on all above ground parts.

Small dark spots which enlarge upto 20mm in diameter.

The brown centres turn gray.

With age on the leaf lesions, small black asexual fruiting bodies appear in great numbers.

Often being arranged in concentric rings.

The concentric ring arrangements sometimes leads to confusion with *Alternaria*.

Tips and branches will be killed and marketability of head gets affected.

The minute black bodies which appear on host lesions are spermogonia.

In the host lesions, Perithecia are formed, later than spermogonia, containing asci.

### **Mode of spread and survival**

Primary infection by air borne conidia and ascospores present in the plant debris

Secondary spread through the conidia.

### **Favourable conditions**

Cool moist weather with some rain is most important for dissemination of the ascospores and penetration.

### **Management**

Removal of infected leaves.

Crop rotation, spraying chlorothalonil 0.1% or Mancozeb 0.1% or copper oxychloride 0.25%.

## **3. Downy mildew : *Peronospora parasitica***

### **Symptoms**

Production of whitefluffy growth on the lower side of the leaves, stem etc.

Under cool moist condition, leaf spot enlarges indefinitely to form yellow areas on the upper side and mildew on lower side.

Severe infection at the seedling stage results in complete death of seedlings.

### **Favourable factors**

Optimum temperature for the conidia is 8 to 10°C

For conidial germination 8 to 12°C and for host penetration 16°C, rapid development 15 to 20°C.

### **Management**

Seed treatment with metalaxyl (Apron 35 S.D.) 6g/kg.

Spraying Metalaxyl + mancozeb combi 4g/litre or Mancozeb 0.25%.

## **4. Block rot : *Xanthomonas campestris* pv. *campestris***

### **Symptoms**

Infection occurs through water pores at the margins of leaves

The affected tissues turn yellow and chlorosis progresses towards the centre of the leaf; usually in V shaped fashion with the base of the V towards the midrib

Vascular bundle discoloration in the main stem and proceeds up and down and soft rot symptoms occur.

### **Mode of Spread**

The bacterium is rod shaped with single polar flagellum  
The chief means of local dissemination are wind blown rain cultivating implements and transplants.  
Widespread distribution is by seed and transplants.

### **Survival**

The organism overwinters in diseased plant refuse or in seed.

### **Favourable condition**

Optimum temperature 26.5 to 30°C and frequent rain

### **Management**

Production of disease free seeds  
Seed bed rotation  
Hot water treatment at 50°C for 30 min.  
Spraying copper oxychloride (0.25%) + Agrimycin 100 at 200 ppm.

## **5. Leaf spot**

*Alternaria brassicicola*; *A. brassicae*

### **Symptoms**

Leaf spots appears as small dark coloured areas which rapidly form circular lesions upto 1 cm indiameter.  
They coalesce to form bigger spots and give blighted appearance.

### **Favourable conditions**

Moist atmosphere is favourable for this disease.  
The pathogen is both internally and externally seed borne

### **Management**

Hot water treatment at 50°C for 20 minutes.  
Seed treatment with Thiram or Captan 4gm/kg of seeds.  
Spraying copper oxychloride 0.25, mancozeb 0.25 or chlorothalonil 0.1%.

## **6. Head rot : *Sclerotinia sclerotiorum***

### **Symptoms**

The collapse of the plant may be the first evidence to the casual observer.

Earlier examination would show the fungus advancing up the main stem from the soil causing soft cortical rot and producing white cottony mycelium and sclerotia.

The sclerotia are large in size and can be seen in the affected area and has no definite dormancy period.

#### Mode of spread and survival

In soil as sclerotia

Primary infection by the ascospores liberated from the apothecium and secondary spread by means of microconidia and through implements and irrigation water.

#### Management

Removal of infected plants and Crop rotation

Spraying copper oxychloride 0.25% or carbendazim 0.1%

### **7. White rust of crucifers : *Albugo Candida* (*Cystopus candidus*)**

#### Symptoms

White creamy pustules on the leaves

The blisters are raised white shiny 1 to 2 mm in diameter

Merging to form larger patches

Young stem and inflorescence are infected and cause deformities

Hypertrophy and hyperplasia and swelling and distortions

The petals and sepals are modified into leaf like structure. Sterility of the ovary.

#### The fungus

Obligate parasite, the mycelium in intercellular and sporangia are produced in chain.

#### Favourable conditions

Optimum 20° C for the germination of sporangia

Moist cool weather and a thin film of water on the leaves.

#### Mode of survival

Survive as oospores in the soil and debris

#### Mode of spread

Primarily by germination of oospore and secondary spread by zoospores.

#### Management

Removal of infected debris  
 Destroy the oospores on surface of seed by 52°C hot water for 20 minutes.  
 Cruciferous weeds has to be removed  
 Spray 0.8% Bordeaux mixture.

## DISEASES OF POTATO

1. Late blight	: <i>Phytophthora infestans</i>
2. Early blight	: <i>Alternaria solani</i>
3. Black scurf and stem canker	: <i>Rhizoctonia solani</i>
4. Dry rots	: <i>Fusarium</i> spp.
5. Bacterial wilt	: <i>Pseudomonas solanacearum</i>
6. Soft rot and black leg	: <i>Erwinia carotovora</i>
7. Common scab	: <i>Streptomyces scabies</i>
8. Leaf roll	: <i>Myzus persicae</i>
9. Purple top roll	: <i>Mycoplasma</i>
10. Severe mosaic	: <i>Myzus persicae</i>
11. Wart	: <i>Synchytrium endobioticum</i>
12. Powdery scab	: <i>Spongospora subterranea</i> .

### 1. Leaf blight : *Phytophthora infestans*

It is the most serious disease.

#### Symptom

It affects leaves, stems and tubers.

Water soaked spots appear on leaves, increase in size, turn purple brown and finally black in 2 or 3 days.

White growth develops on under surface of leaf.

The disease spreads to petioles, rachis and stems.

Stem infection frequently develops at nodes.

Stems break at these point and the plant topples over.

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 centre.

They rot in soil before harvest or during storage.

#### Favourable conditions

Late blight progress rapidly when relative humidity is above 90 per cent and temperature between 10 to 25°C.

In hills, occurrence of the disease generally coincides with the onset of monsoon rains. In plains it appears whenever low temperature prevails in combination with high humidity brought about by rain, dew or irrigation.

1. Night temperature below the dew point for 4 hours or more
2. Night temperature not below 10°C



3. Cloudiness on the next day.
4. Rainfall at least 0.1mm, the following day

#### Mode of survival and spread

It survives in soil and infected tubers.

It spread by sporangia which germinate directly or by producing zoospores depending on temperature.

#### Management

Once the disease appears, it is difficult to control.

Prophylactic sprays of fungicides are, therefore, recommended Mancozeb, chlorothalonil (Daconil) and copper oxychloride can be applied at 7 to 10 days intervals in the hills and 10 to 15 days intervals in plains.

Use a sticker and spreader in spray fluid

Cover under surface of the leaves

Grow resistant varieties such as Kufri jyoti, Kufri badshah Kufri khas igaro.

Avoid infected seed tubers, eliminate self sown plants.

## 2. Early blight : *Alternaria solani*

#### Symptoms

It is prevalent both in hills and plains

The disease appears first on old leaves and subsequently spreads to the top young leaves.

Brown to black necrotic spots angular, oval or circular in shape characterised by concentric rings appear on the affected leaves.

Unlike late blight, these spots are dry and brittle and smaller in size usually not exceeding 1 cm in diameter.

Several spots coalesce and affect the entire leaf.

Sometimes the necrotic tissue drops out leaving shot holes in the leaves.

#### Favourable conditions

It occurs in high intensities in areas where dry warm weather alternates with the intermittent rains.

It is serious in late planted crop in Bihar, Uttar Pradesh and Punjab.

Reduction in plant vigour and senescence increases susceptibility to early blight.

#### Mode of survival and spread

The conidia are windborne.

They survive on debris and also attack tomato.

#### Management

Provide conditions favourable for vigorous growth of the crop.

Fungicides such as mancozeb, chlorothalonil used for late blight, also control this disease.

### **3. Black scurf and stem canker : *Rhizoctonia solani***

#### **Symptoms**

Hard, superficial, dark chocolate brown or black sclerotia can be seen on surface of the tubers.

When an infected tuber is planted emerging shoots are killed, in older plants elongated brown lesions and cankers may develop at base of the stems which may girdle the stems partially or completely causing stem rot or wilting.

#### **Mode of Spread and survival:**

Sclerotia live in soil and cause infection  
The fungus has a wide host range

#### **Favourable conditions:**

Sclerotia can germinate from 8 to 10°C with optimum of 23°C.

#### **Management:**

Treating seed tubers with 1 per cent acetic acid and 0.05 per cent zinc sulphate solution for 15 minutes.

### **4. Dry rots:**

#### **Symptoms:**

Dark patches appear on inner surface.

Skin is sunken and wrinkled with concentric rings.

Tuber becomes dry, hard, shrivelled and light in weight.

When cut it shows internal cavity containing white or coloured mycelium.

The infection generally occurs through bruises and wounds at the time of harvest.

#### **Mode of spread and Survival:**

Contaminated soil adhering to the tubers could also cause the infection.

The symptoms usually develop during storage.

#### **Management:**

Treat seed tubers immediately after harvest with 0.2 per cent mancozeb or 0.5 per cent agalio.

Provide ventilation during storage.

### **5. Bacterial wilt: *Pseudomonas solanacearum***

**Symptoms:**

It occurs in Deccan and Central plateau, Assam, West Bengal Orissa, hills, of Uttar Pradesh and Nilgiris.

The plants wilt at tuber formation stage.

The wilt may be restricted to one branch.

The wilt plants initially recover in the morning or evening but with in the afternoon.

Later they die.

Stems, petioles of the lower leaves and roots become brown; on cutting the infected materials slimy mass of bacteria oozes out.

Such tubers may be easily recognized by adhering soil particles.

When tubers are cut browning of the vascular region can be seen.

When pressed a slimy bacterial ooze emerge.

The tubers may rot at harvest, during storage.

**Mode of survival and spread:**

The tubers carry the bacterium latently.

They serve as initial source of inoculum.

The pathogen is also a soil inhabitant.

It invades the plants through injuries in the underground portion of the plant.

**Management:**

Plant disease free seedtubers, cultivate cereals for 3 years, adopt sanitation measures.

**6. Soft rot and black leg: *Erwinia carotovora*****Symptoms:**

It occurs in two phases, black leg of shoots and soft rot of tubers.

In black Leg phase, black lesions appear at base of stem followed by yellowing, rolling of top leaves and death.

Tubers develop water soaked areas, soft rot and an offensive odour.

Small sunken areas develop on tuber surface.

**Mode of survival and spread:**

Infection takes place through bruises or wounds.

**Favourable conditions:**

High moisture in soil or during storage, harvesting of immature tubers and wetting of tubers predisposes development of soft rot.

**Management:**

Sanitation at harvest and storage, proper drainage, drying of seed tubers, disinfecting propagating material before storage.

## **7. Common scab: *Streptomyces scabies***

Heavy incidence have been reported in some parts of Maharashtra, Punjab, Bihar and western UP.

### **Symptoms**

Tubers show small reddish or brownish spots

Which develop into lesions.

The lesions may be shallow, corky, russetting, pitted or star shaped cracks.

### **Mode of Survival and Spread:**

The bacterium remains viable on the affected tubers.

### **Management:**

Treat seed tubers with organomercurials.

Soil treatment of PCNB at 40kg/ha, crop rotation involving cereals.

Irrigate to field capacity during tuber formation.

## **8. Wart: *Synchytrium endobioticum***

Symptoms:

It is restricted to Darjeeling district of West Bengal. Bhutan and Nepal.

White to brown tumour like outgrowths develop on stems and tubers.

They are loose structures and become black with age and rot.

Mode of survival and spread:

Resting spores survive in soil for 25 to 30 years even in the absence of host crop.

Favourable conditions:

High soil moisture and temperature between 12 to 28°C.

Management:

Ban the movement of potato tubers from infected to non infected areas through quarantine regulations.

Grow immune varieties such as kufri jyoti, kufri jeevan and kufri muthu.

## **9. Powdery scab: *Spongospora subterranea***

Symptoms:

Small light coloured blister like swellings which turn in to dark open pustules 3 to 7 mm diameter appear on tuber surface.

The disease reduces market value of the produce.

Favourable conditions:

The disease is confined to cool and humid soils frequently at elevation above 1500m above m.s.l.

Management:

Rotate with non-solanaceous crops, treat seed tubers with 0.5 per cent agallol for 10 minute dip.

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Management:

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#### **12. Leaf roll: (*Myzus persicae*)**

Symptoms:

It is widely prevalent in plains and plateau region.

Upward rolling of margin of leaves.

Leaves are thick, leathery, brittle and make rattling sound when disturbed.

The infected plants are stunted, produce short stem and few tubers clustered around the stems.

Tubers may develop necrosis.

Management:

Remove the diseased plants.

Spray systemic insecticides to control spread through aphid vectors.

### **13. Purple top roll: *Phytoplasma***

Symptoms:

Chlorosis of younger leaves, followed by rolling starting from base to tip and development of purple colouration.

The diseased plants are stunted, with profuse axillary growth swelling at nodes and formation of aerial tubers.

The diseases is spread by leafhoppers.

Management:

For viral and mycoplasmal diseases use pathogen-free certified seed, spray systemic insecticides to control vectors and inspect the crop three times during the growing season to remove the affected plants along with the tubers formed.

### **14. Severe mosaic**

Symptoms:

Rugosity and twisting of the leaves, necrosis of leaf veins, leaf drop streak.

Plant remain stunted in growth.

Mode of spread and survival:

Infected seed tubers and aphid- *Myzus persicae*

## **DISEASES OF CHILLIES**

<b>1. Damping-off</b>	<b>:</b>	<b><i>Pythium aphanidermatum</i></b>
<b>2. Powdery mildew</b>	<b>:</b>	<b><i>Leveillula taurica</i></b>
<b>3. Fruit rot and Die-back</b>	<b>:</b>	<b><i>Colletotrichum capsici</i></b>
<b>4. Leaf spot</b>	<b>:</b>	<b><i>Cercospora capsici</i></b>
<b>5. Bacterial spot</b>	<b>:</b>	<b><i>Xanthomonas Campestris</i> Pv. <i>vesicatoria</i></b>
<b>6. Mosaic</b>	<b>:</b>	<b><i>Virus</i></b>

## **1. Damping-off: *Pythium aphanidermatum***

Symptoms:

Appearance of water soaked lesions on the collar region. Browning and shrivelling of stem tissues at collar region. As a result of the weakening of tissues at the collar region the seedling collapse and topple over.

The fungus: Produce sporangia, zoospores, and oospores.

Mode of spread and survival:

Spread: Soil-borne-Through irrigation water, implement during cultural operations etc.

Survival: Through oospores present in the soil.

Favourable conditions:

Excessive soil moisture

High humidity

Over crowding of seedling

Management:

See under tomato

## **2. Powdery mildew: *Leveillula taurica***

Symptoms:

White powdery coating on the lower surface mostly but sometimes the powdery coating can also be seen on the upper surface.

Correspondingly on the upper surface yellow patches are seen

Severe infection results in the drying and shedding of affected leaves.

Etiology: Fungus diseases – *Leveillula taurica*  
Oidiopsis type-produce single celled, hyaline conidia.

Mode of spread and Survival:

Spread: Through air-borne conidia

Survival: As dormant mycelium in the infected crop debris.

Favourable conditions:

Same, as for the other powdery mildews.

Management:

Spray Karathane 0.07% or

Wettable sulphur 0.25%

### **3. Fruit rot and Die-back: *Colletotrichum capsici***

Symptoms:

Shedding of flowers due to the infection at pedicel and tips of branches.

Under favourable conditions this infection spreads to stem through the flower stalk and causes die-back of branches.

Fruit infection:

Ripe fruits are more liable for the attack than the green ones.

Brown water soaked patch appears on the skin of the fruit. Severe infection result in the shriveling and drying of fruits. Such fruits become white in colour and lose their pungency. On the surface of the lesions minute black dot like fruiting bodies called 'acervuli' occur.

The affected fruits may fall off subsequently.

Etiology : *Colletotrichum capsici* – Produces hyaline, single celled sickle shaped conidia.

Mode of spread and survival:

Spread: Through infected seeds (Externally seed-borne) and air-borne conidia.

Survival: On the infected fruits.

Optimum temp. 22-25°

Humid weather with rainfall at frequent intervals.

Management:

Collect seeds only from fruits without infection.

Crop debris should be collected and destroyed.

Seed treatment with captan or Thiran 4g/kg

Spraying mancozeb 0.25%

### **5. Bacterial leaf spot: *Xanthomonas campestris pv. vesicatoria***

Symptoms:

Small circular to irregular water soaked areas on the lower surface of the leaves.

The spot bulges and it turns purple with a black centre.

A narrow yellow halo may surround the spots.

The leaves dry and the whole leaf dies.

Sometimes petiole and stems are also infected.

The green fruits are also infected and they turn brown to black

Mode of spread and survival:



The bacterium is seed borne primarily and secondary.  
Spread by rain splash.

Management:

Seeds should be collected from healthy fruits,  
Seed treatment with copper oxychloride 2g/kg seed.  
Spraying Agrimycin 100 at 100 ppm.

#### 6. Mosaic complex

Potato Virus Y, Cucumber Mosaic Virus (CMV) and Tobacco Mosaic Virus (TMV)

Symptoms:

- |       |  |
|-------|--|
| (TMV) | Backward pending of petiole<br>Leaves points towards ground.<br>Necrotic spots are produced on stem. |
| (CMV) | Downward curling along with midrib<br>Leaves are small and later become filiform.                    |
| (PVY) | Vein banding<br>Crinkling of leaves.<br>Leaves are small.  |

Management:

Use healthy seedlings.  
Seeds soaking in 10%  
Trisodium phosphate for 30 minutes.  
Control of insects (Aphids) by spraying monocrotophos or methyl dematon.  
Growing barrier crops like sorghum or maize around chillies to reduces the incidence.

### DISEASES OF TOMATO

- |                                     |          |  |
|-------------------------------------|----------|--|
| <b>1. Damping off</b>               | <b>:</b> | <b><i>Pythium spp.</i></b>                                   |
| <b>2. Early blight</b>              | <b>:</b> | <b><i>Alternaria solani</i></b>                              |
| <b>3. Late blight</b>               | <b>:</b> | <b><i>Phytophthora infestans,</i></b>                        |
| <b>4. Buck eye rot of tomato</b>    | <b>:</b> | <b><i>Phytophthora nicotianae</i> var. <i>parasitica</i></b> |
| <b>5. Wilt</b>                      | <b>:</b> | <b><i>Fusarium oxysporum</i> f. <i>lycopersici</i></b>       |
| <b>6. Bacterial wilt</b>            | <b>:</b> | <b><i>Pseudomons solanacearum</i> var. <i>abiaticum</i></b>  |
| <b>7. Mosaic</b>                    | <b>:</b> | <b>Tobacco mosaic virus</b>                                  |
| <b>8. Leaf curl</b>                 | <b>:</b> | <b>Tobacco leaf curl virus</b>                               |
| <b>9. Tomato spotted wilt Virus</b> | <b>:</b> | <b><i>Tomato spotted with virus (TSWV)</i></b>               |

- |                      |          |                            |
|----------------------|----------|----------------------------|
| <b>1. Damping of</b> | <b>:</b> | <b><i>Pythium spp.</i></b> |
|----------------------|----------|----------------------------|

Symptoms:

In the nursery seed rot or radicle and plumule rot before coming out resulting in poor germination (p remergence damping off.).

In seedling toppling over after emergence due to infection in roots or collar region infected tissue soft and water soaked, constriction of the stem at base and hence seedling prostrated.

Large patches in of seedlings die.

Mode of spread:

Soil borne zoospores spread through, irrigation water.

Favourable conditions:

Excess soil moisture due to stagnation, high humidity, over crowding of seed rate.

Management:

Use of light soil for nursery, raised seed bed, light but frequent irrigation better drainage, drenching with copper fungicides at 8-10 days interval.

## **2. Early blight: *Alternaria solani***

Symptoms:

Dark brown to black concentric rings of leaf spots, coalesce leaves dry, dark spots and sunken lesions near base of stem stunting and girdling of stem, defoliation and shedding of immature fruits.

Mode of spread:

Seed borne and air borne conidia

Favourable conditions:

June-July sowing, weak and old plants prone to infection high soil moisture and high humidity.

Management:

Spraying copper oxychloride or Zineb 0.25%

## **3. Late blight: *Phytophthora infestans***

Symptoms:

Water soaked lesions with faded green patches in leaves, spread fast to entire leaf and petiole, dead areas appear in leaf tip and margin whitish mildew like growth appear

on leaves, are killed or the dead area become dry, Olivaceous greasy appearing spots on fruits and spots enlarge.

Fruits remain firm; if fruit is cracked a weft of fungus appear resulting in soft rot.

Mode of spread:

Soil borne-spread through spoangia or zoospores dispersed by wind or rainwater.

Favourable conditions:

High humidity and low temperature cloudy weather and rain fall with splashing rains.

Management:

Prophylactic sprays with copper fungicides or dithiocarbomates 0.25% based on weather conditions.

#### **4. Buck eye rot of tomato: *Phytophthora nicotianae* var. *parasitica*.**

Symptoms:

Pale brown spots with concentric rings and fruits, entire fruit may be covered but remain firm unless attacked by secondry organism.

Immature fruits shrink and are mummified.

Mode of spread:

Soil borne-sporangia spread by wind water and others.

Favourable conditions:

Water-logged soil fruits coming in contact with soil, high rainfall.

Management:

Crop rotation, good soil drainage, spray dithiocarbomates, captafol, chlorothalonil etc at regular intervals.

#### **5. Wilt: *Fusarium oxysporum* f.sp. *lycopersici***

Symptoms:

Vein clearing and drooping of petioles, lower leaves yellow in colour few branches are affected, death of plant, cross section of stem near base well shown browning.

Mode of spread:

Soil borne-Survive in crop debris – Produce conidia

Management:

Seed treatment with carbendazim at 2g/kg summer deep ploughing, destruction of left over plants, crop rotation removal of affected plants and spot drenching with carbendazim 01%.

## **6. Bacterial wilt: *Pseudomonas solanacearum***

Symptoms:

Yellowing of foliage, wilting and stunting of plants followed by death, vascular systems turns brown and on culturing bacterial ooze observed.

Mode of spread:

Infection through wounds.

Favourable conditions:

Soil borne-Survives for several years in soil.  
Humid weather, high temperature.

Management:

Crop rotation with cereal crops or cruciferous vegetables to prevent the survival of the pathogen.

## **7. Mosaic: Tobacco mosaic virus**

Symptoms:

The leaves exhibit alternate green and light green patches. In addition there may be leaf disfiguration and puckering of leaves.

In severe cases dark green blisters may be seen.

Mode of spread:

By mechanical contact and seed borne.

## **8. Leaf curl: Tobacco leaf curl virus**

Symptoms:

Crinkling and curling of leaves, plants stunted, reduction in length of internode.

In severe cases leaves reduced in size with puckering of leaves.

On the lower side of leaves there will be thickening of veins with small leaf like outgrowths known as enations.

Mode of spread:

White flies (*Bemisia tabaci*) Seed borne

Management :

Spray Monocrotophos 15, 25, 45, DAS

## 9. Tomato spotted wilt : *Tomato spotted with virus (TSWV)*

Symptoms:

Plants stunted with leaves reduced in size bronzing of veins at early infection in grown up plants necrotic rings on the leaves with necrotic streaks on petioles and stem; concentric rings of mosaic mottling in fruits.

<i>Alternaria</i> leaf spot	Spotted wilt
Necrotic spots with concentric rings	Necrotic rings with a central green portion which later turns necrotic.
Leaf shape not changed but may dry	Leaves curl upwards
No bronzing	Bronzing Characteristic
Plant usually not killed	Plants wilt
No fruit symptoms	Concentric rings on fruits
Air-borne	Thrips transmitted

Mode of spread and Survival:

Thrips *Frankliniella schultzei*, *Scirtothrips dorsalis*.

Adult thrips transmit the disease, only when the larvae acquire the virus from infected plants.

Both the vectors and virus have a wide host range, the disease is easily spread from outside, especially the weeds in and around tomato fields.

After chilli, brinjal, black gram.

Management:

Spray any systemic insecticides till flowering to control insect vectors, Closer spacing, Timely weeding especially in early stages.

Removal of all collateral hosts.

Spraying leaf extracts of sorghum or coconut (1kg-5Lit of water) 70°C 30mts Filter – dilute with 5 Lit of water) 10<sup>th</sup>, 17<sup>th</sup> and 24<sup>th</sup> day.

## DISEASES OF BRINJAL

1. Damping off : *Pythium aphanidermatum* *P. debaryanum* *P. ultimum*
2. Phomopsis blight and Fruit rot : *Phomopsis vexans*

- 3. Bacterial wilt : *Pseudomonas Solanacearum*
- 4. Leaf spots : *Cercospora melongenae*
- 5. Alternaria leaf spot : *Alternaria melongenae*

**1. Damping off: *Pythium aphanidermatum p, debaryanum P.ultimum***

Please see under tomato.

**2. Phomopsis blight and fruit rot: *Phomopsis vexans***

Symptoms:

The pathogens infects from seedlings to harvest.  
 In seedbed it causes damping off.  
 In the leaves coming in contact with light coloured centre.  
 Circular, grey to brown spots with light coloured centre.  
 The affected leaves turn yellow and die.  
 The stem base is affected, the skin peels off and the plant topple down.  
 The fruit is attacked, pale, sunken spots develops on the fruit and it covers entire fruit.  
 The internal portion of fruit rots.  
 The whole fruit in mumified due to dry rot.

The fungus:

The fungus produces septate mycelium.  
 Pycnidia develops on the spots.  
 The conidia are hyaline and septate.  
 Perithecia are produced inculture.  
 Asci are clavate.  
 Asco spores are hyaline.

Favourable conditions:

Temperature from 21°C to 32°C with a optimum 29°C.  
 Wet weather with 26°C favours fruit rot in storage.

Mode of spread and survival:

The fungus in seed borne and also survive in debris.  
 Disseminated through water, tools and insects and through infected seedlings.

Management:

Use of disease free seeds.  
 The seeds should be collected from healthy fruits.  
 Nursery application with mancozeb 0.2%  
 Difolatan 0.2% or captan 0.2% in the main field at intervals of 10 to 15 days.

Debris should be collected and burnt.

**3. Bacterial wilt** : *Pseudomonas solanacearum*  
See under tomato.

**4. Leaf spots** : *Cercospora melongenae*

Symptoms:

Large irregular or circular brown or grey spot on leaves.  
On fruits also spots are produced  
The central portion in grey with pinkish brown margin.

Mode of spread:

Spreads through soil and seed.

Management:

See under phomopsis rot.

**5. Alternaria leaf spot:** *Alternaria melongenae*

Symptoms:

The spots are brown and irregular in shape.  
Concentric rings are present in them.  
Several spots coalesce to form larger necrotic patches.  
Fruits are also affected.  
Large necrotic sunken spots develops on the fruits which turns yellow and drops.

Mode of spread:

Seed and soil borne.

Management:

See under phemopsis rot.

## DISEASES OF PEA

<b>1. Powdery mildew</b>	:	<i>Erysiphe polygoni</i>
<b>2. Rust</b>	:	<i>Uromyces fabae</i> V. <i>pisi</i>
<b>3. Downy mildew</b>	:	<i>Pernospora pisi</i>
<b>4. Seedling blight</b>	:	<i>Pythium</i> sp.
<b>5. Foot rot and blight</b>	:	<i>Aschochyta pinodes</i>
<b>6. Leaf spot</b>	:	<i>Cercospora cruenta</i>
<b>7. Mosaic</b>	:	<i>Virus</i>

## **1. Powdery mildew: *Erysiphe polygoni***

### Symptoms:

On both the surface of the leaves powdery growth can be seen.  
Usually attacks or occurs in late season (after pod formation stage) pods and tendrils are also affected.  
The pods turn black, seeds become wrinkle.

### Mode of spread:

Primarily it is a seed borne and secondary spread through air borne conidia which are produced in chains.

### Survival:

Cleistothecium survive in the soil in debris,

### Favourable conditions:

Dry weather.

### Management:

Removal of debris and destroy.  
Protective spary with Dinocab (Karathane) 0.07 or Calixin (Tridemorph) 0.05%  
Growing renistant varieties – T-10 P-388 T-56, P-185.

## **2. Rust: *Uromyces fabae* V. *pisi***

### Symptoms:

The leaves develop yellow and turn brown  
Large number of brown rusty pustules are seen on the lower surface.  
Later it turns black due to the production of telia.  
In tendrils and in stem also black telial sori develops

### Mode of spread:

Through air borne uredo spores.

### Survival:

It survives in debris.  
Weeds and Lathiras act as a collateral host.  
The telia survive in debris.

### Management:



Debris should be removed and burnt.  
Long rotation  
Avoid growing Lathiras.  
Weed hosts has to be destroyed.  
Seed treatment with captan or thiram 4g/kg.  
Spraying with Tridemorph 0.05% or mancozeb 0.25%

## **5. Foot rot and blight: *Aschochyta pinodes***

### Symptoms:

Small purple spots on the leaves, increases in size, turn brown and become zonate.

Leaves dry and hang down.

Stem infection starts as a browning and blackening of the basal portion.

Similar to those on leaves.

The lesions extends upward and down ward end coalesce.

The spots are also produced on green pods.

The wall of the pod shrinks and seeds are deformed.

### Favourable conditions:

Temperature – 16°C cool weather with abundance of water on the leaves.

Frequent rain.

### Spread:

Primary infection through seeds and secondary spreads through conidia (*pycnidia*) and ascospores (*perithecia*)

### Survival:

Survives in debris and also in seeds.

### Management:

Production of healthy seeds.

Crop rotation.

Burning the debris.

Seed treatment with

Captan or Thiram 4g/kg of seeds

Spraying mancozeb 0.25%

### Minor diseases:

**Cercospora leaf spots** : *Cercospora pisi sativae*

**Anthracnose** : *Colletotrichum pisi*

**Septonia blotch** : *Septoria pisi*

<b>Bacterial blight</b>	:	<b><i>Pseudomonas Syringae</i></b>
<b>Pea mosaic</b>	:	<b><i>Virus</i></b>

### DISEASES OF BEAN

<b>1. Anthracnose</b>	:	<b><i>Colletotrichum lindimuthianum</i> (<i>Glomerella lindimuthianum</i>)</b>
<b>2. Rust</b>	:	<b><i>Uromyces phaseoli</i></b>
<b>3. Powdery mildew</b>	:	<b><i>Erysiphe polygoni</i></b>
<b>4. Leaf spot</b>	:	<b><i>Cercospora cruenta</i></b>
<b>5. Dry root rot</b>	:	<b><i>Macrophomina phaseolina</i></b>
<b>6. Bean common mosaic</b>	:	<b><i>Virus</i></b>
<b>7. Bacterial blight</b>	:	<b><i>Xanthomonas campestris</i> pv. <i>phaseoli</i></b>

**1. Anthracnose:**     *Colletotrichum*                      *lindimuthianum*                      (*Glomerella lindimuthianum*)

Symptoms:

Black spots are seen on leaves, stem and on pods.  
 Black sunken lesions are seen on pods.  
 The central portions of the spots shows pinkish colour under lying seeds in the pods will be discoloured.  
 On the leaves black dots are seen on the lower surface.  
 Dots enlarges and become angular.  
 Infected seeds if it is sown total failure of germination or the seedlings die at an early stage.

Favourable conditions:

High humidity (92%) and 17°C are highly favourable.  
 Disease intensity increases with age of the plant.

Mode of spread:

The pathogen is seed-borne and it spreads from debris also.  
 Primary infection through seeds and secondary by air borne conidia

Mode of survival:

It survives in the seeds and also in the debris.

Management:

Healthy pods should be selected to collect seeds.  
 Deep ploughing to incorporate the debris.  
 Seed treatment with carbendazim 2g/kg  
 Foliar spray with carbendazim 0.1%. 15 days interval.  
 0-2% mancozeb.or

0.1% Chlorothalonil 7-10 days interval starting from 30 DAS

## **2. Rust : *Uromyces phaseoli***

Symptoms:

Reddish brown pustules are seen on the lower surface of the leaves.  
Later it turns black due to formation of Telia.  
The leaves turn yellow and dry or fall off.  
If the infection is 3 percent the loss is about 2.7%  
If it is 79 percent the loss will be 37%

Favourable conditions:

For the production of Uredospores 15° to 20°C  
Teleospores 10° to 15°C  
Long day hours favour.

Mode of spread:

Through repeating spores (uredospores) and due to repeated cultivation

Survival:

The teliospores survive into the debris.

Management:

Destruction of diseased crop debris  
Long rotation.  
Wider spacing.  
Spraying mancozeb 0.25% or Chlorothalonil 0.1% at 7-10 days interval.

## **3. Powdery mildew: *Erysiphe polygoni*** (Refer pea powdery mildew)

## **4. Leaf spot: *Cercospora cruenta***

Symptoms:

Circular to angular brown spots develop on the leaves.  
The centre becomes grey and border is reddish or dark brown.  
Several spots coalesce to form bigger portion.  
The central portion dries and falls off leaving a hole.

Favourable conditions:

Continuous cultivation

Mode of spread:

It also attack cowpea and also wild plants.  
Through air borne conidia.

Mode of survival:

Survives in other crops and also in the debris.

Management:

Spraying mancozeb 0.25%  
Rotahon and Field Sanitation

### **5. Dry root rot: *Macrophomina phaseolina***

Symptoms:

It attacks Seedling and also grown up plants.  
Sunken canker are seen below the cotyledonary node and form black.  
Such seedlings soon die.  
Leaf yellowing.  
Dark lesions on the stem near the base and discolouration of roots and stem.  
The affected tissues shows dry rot and very large number of fruting bodies (Sclerotia or pycnidium) are seen.

Favourable conditions:

Dry weather and high temperature

Mode of survival:

Survives as sclerotia in the soil

Mode of spread:

Primary spread through sclerotia and secondary spread through air borne conidia.

Management:

Long rotation.  
Removal of infected debris.  
Seed treatment with carbendaszim 2g/kg of seeds.  
Trichoderma viride seed application 4g/kg.  
Spot drenching with 0.1% Carbendazim

### **6. Bean common mosaic: *Virus***

Symptoms:

Leaf becomes chlorotic, small in size and stiff.  
Light and dark green areas are formed on the leaves.  
The light green colour are usually along the margins of the leaves.  
Abnormal growth of the tissues causes veins to bend down ward.  
The leaves may look cupped  
Diseased plants produce fewer pods which are small in size.  
Downward curling of the leaves and yellow mosaic is common symptom.

Mode of spread:

Transmission in the field through aphids.  
Myzopersical, *Acyrtosiphum pisum*, *A.gossypii*  
Seed transmission is common and most important source of initial infection in the crop.

Management:

Select seeds from healthy plants.  
Control of insect vectors by spraying systemic insecticides like monocrotophos or methyl demeton.

## **7. Bacterial blight: *Xanthomonas campestris* pv. *phaseoli***

Symptoms:

Red irregular and sunken lesions are formed on the leaves.  
Yellow halo around the spots are common symptom.  
Lesions coalesce to form bigger spots and large area is affected.  
Leaf becomes distorted and finally defoliation occurs.  
Pods are also affected and show small brownish to reddish sunken spots which coalesce.  
On green pods water soaked spots are seen and it turn reddish.  
The seeds in severely affected pods do not develop and shriveled.  
Vascular browning and surface cankers may seen.

Mode of spread and survival:

Primarily through seeds and it survive in the seed for more than two years.  
The bacterium lives in the diseased debris.  
The secondary spread through bacterial ooze that develops on the leaves and rain splashes.

Favourable conditions:

Optimum temperature 26 to 32°C

Management:

Use healthy seeds.  
Seeds should be collected from healthy crops.  
Crop rotation.  
Rogueing of infected plants.  
Infected debris should be destroyed.

### **DISEASES OF BHENDI (OKRA)**

- |                                |          |                                      |
|--------------------------------|----------|--------------------------------------|
| <b>1. Yellow vein mosaic</b>   | <b>:</b> | <b><i>Virus</i></b>                  |
| <b>2. Powdery mildew</b>       | <b>:</b> | <b><i>Erysiphe cichoracearum</i></b> |
| <b>3. Damping off</b>          | <b>:</b> | <b><i>Pythium indicum</i></b>        |
| <b>4. Cercospora leaf spot</b> | <b>:</b> | <b><i>Cercospora abelmoschi</i></b>  |

#### **1. Yellow vein mosaic: *Virus***

Symptoms:

All the veins of leaf turn yellow.  
Leaf gives a yellow net work of veins.  
Later stages entire leaf turn yellow in colour  
Plants stunted and photosynthetic activity is affected.  
Dearly infection Before (35 days) Total loss.  
Subsequent infection-Reduces the size of fruits and malformed.  
Fruits slightly curved.

Mode of spread and survival:

Transimtted by *Bemisia tabaci*  
Survive on weed host croton sparsiflorus

Management:

Vector control by using Nuvan and Dimecron Starting from 7 DAS and repeat every 15 days.  
CO3-Moderately Resistant Parbani Kranthi is renistant

#### **2. Powdery mildew: *Erysiphe cichoracearum***

Symptoms:

Powdery growth can be seen on the upper surface of the leaves.

Mode of spread:

Air borne conidia

Survival:

Survives in the debris.

Management:

Spray wettable sulphur 0.25%  
or Dinocab (Karathane) 0.07%

#### **4. Cercospora leaf spot: *Cercospora abelmoschi***

Symptoms:

The fungus grows as a sooty to dark olivaceous mold on the lower surface of the leaves.

Badly affected leaves roll, wilt and fall down.

Mode of spread:

Through air borne conidia.

Survival:

The conidia and stromata survives on crop refuse

Favourable conditions:

The fungus requires 25 or 29°C for maximum infection.

Management:

Regular spraying with copper oxychloride 0.25%  
or Mancozeb 0.25%  
or Captan 0.1%

### **DISEASES OF CARROT**

- |                                |          |   |
|--------------------------------|----------|---|
| <b>1. Cercospora leaf spot</b> | <b>:</b> | <b><i>Cercospora carotae</i></b>                        |
| <b>2. Alternaria blight</b>    | <b>:</b> | <b><i>Alternaria dauci</i></b>                          |
| <b>3. Bacterial blight</b>     | <b>:</b> | <b><i>Xanthomonas campestris</i> pv. <i>carotae</i></b> |

#### **1. Cercospora leaf spot: *Cercospora carotae***

Symptoms:

Elongated lesions along the edge of leaf lets and causing lateral curling of leaf lets.

The sports are subcircular, grey to brown or black.  
The lamina dies and causing entire leaf to shrivel and turn black.  
Petioles are also affected and girdling of petiole and killing the leaf.

Mode of spread:

Primarily seed borne and secondary spread through conidia

Survival:

The fungus subsists on diseased crop debris as dormant mycelium, conidia and stromata

Favourable conditions:

Optimum 19° to 20°C

Management:

Hot water treatment 50° for 20 minutes

Rotation

Spraying mancozeb 0.25%  
or copper oxychloride 0.25%

## **2. Alternaria blight: *Alternaria dauci***

Symptoms:

Small dark brown to black, irregular spots are formed on the foliage.  
They have a yellow halo and usually first start from the leaf margins.  
Concentric rings are seen on the spots.

Mode of spread and survival:

Primarily spread through the conidia present on the debris and in the soil.  
The conidia and dormant mycelium, survive in the debris.

Management:

Refer cercospora blight

## **3. Bacterial blight: *Xanthomonas campestris* pv. *carotae*.**

Symptoms:

Small, irregular yellow area appears first in the leaves.  
Turn dark brown and water soaked.  
The centre of the spot become dry and brittle.  
They are surrounded by an irregular halo.



Bacterial exudate may also appear on the leaves, petiole and stem.  
The inflorescence in a seed crop is killed.  
The bacteria are washed down from foliage to soil and infect the fleshy roots.

Mode of spread and survival:

The bacterium survive in the seeds and in debris secondary spreads through rain splashes.

Management:

Seed treatment-hot water 50°C for 15 minutes.  
Crop rotation.

## **DISEASES OF CORIANDER**

### **1. Stem gall: *Protomyces macrosporus***

Symptoms:

Tumour like swellings on leaf veins, leaf stalks, Peduncles stem and on fruits  
It gives swollen, hanging appearance to the leaves.  
The galls rupture and become rough.  
In severe attack the plants may be killed.

Favourable conditions:

High soil moisture, and shade favours ph. 7.4 in more suitable.

Mode of spread:

Primarily through seed and soil.

Mode of survival:

It survives in the soil as resting spores (Chlamydospores) in the seed and in soil.

Management:

Use clean and healthy seeds.  
Field sanitation and crop rotation.  
Diseased crop refuse should not be left in the field.  
Seed treatment with captan or thiram 4g/kg seeds.

## DISEASES OF BEET ROOT

1. Cercospora leaf spot : *Cercospora beticola*  
2. Sclerotium root rot : *Sclerotium rolfsii*

### 1. Cercospora leaf spot: *Cercospora beticola*

#### Symptoms:

The lower leaves near the ground are attacked first.  
The spots are small, circular ashcoloured in the centre with deep violet or reddish-purple borders.  
They coalesce to form bigger and the leaves wrinkle and dry.

#### Mode of spread:

Through seeds and secondary spreads through air borne conidia.

#### Survival:

The pathogen survive in the debris and on seeds.

#### Management:

Deep ploughing of debris.  
Three year rotation.  
The seeds should be disease free  
Seed treatment with Captan or thiram 4g/kg of seeds.  
Foliar spray with mancozeb 0.25% or carbendazim 0.1% at 15 days interval

### 2. Sclerotium root rot: *Sclerotium rolfsii*

#### Symptoms:

The most important sign of the diseases is presence of white strands of fungal mycelium.  
Numerous mustard like sclerotium on the decaying parts are seen yellowing and wilting of plants.  
The fleshy root are found completely or partially decayed.

#### Favourable conditions:

High temperature (above 28°C) and aeration in the field.

#### Mode of survival:

It survives in the soil as saprophyte on crop refuse

Mode of spread:

Spreads from infected debris and through irrigation.

Management:

Destruction of crop refuse

Application of penta chloronitro benzene or Carbendazim 0.1% as soil drench.

Seed treatment with Carbendazim 2g/kg of seeds.

### **DISEASES OF TAIOCA (CASSAVA)**

- |                                |          |                                     |
|--------------------------------|----------|-------------------------------------|
| <b>1. Tapioca mosaic</b>       | <b>:</b> | <b><i>Virus</i></b>                 |
| <b>2. Cercospora leaf spot</b> | <b>:</b> | <b><i>Cercospora henningsii</i></b> |

#### **1. Tapioca mosaic : *Virus***

Symptoms:

Typical mosaic appears on young leaves

Chlorosis is the most pronounced symptom

The chlorotic areas are scattered all over the lamina and leads to distortion of the leaf.

The leaves are reduced in size. Twisted and puckered.

The diseased plant are stunted.

Tuber size will be reduced and it will crack.

Mode of spread:

The virus transmitted by vector *Bemisia tabaci* and through diseased planting sets and secondary spread by vector.

Management:

By planting healthy seed pieces (Sets)

Use of resistant Varieties like CO2.

Selection 2380 and Hybrids 97, 86 and 165 are moderately resistant.

#### **2. Cercospora leaf spot: *Cercospora henningsii***

Symptoms:

Large brown or greyish-brown spots which are spherical or angular.

Borders of the spots are dark brown and the centre is light shade or grey

Older leaves are more readily infected.  
Poor growth and reduction in yield.

Mode of spread and survival;

Since it is long duration crop it can easily spread and survive and reach newly planted crop.  
Debris of diseased foliage and stromata and conidia are air borne.

Favourable conditions:

Humid weather

Management:

Spray 0.2% mancozeb or 0.1% Carbendazim number of sprays depends upon the intensity of the disease.

### **DISEASES OF SWEET POTATO**

- |   |          |  |
|---|----------|--|
| <b>1. Cercospora leaf spot</b>            | <b>:</b> | <b><i>Cercospora ipomoea</i></b>                         |
| <b>2. Black rot</b>                       | <b>:</b> | <b><i>Ceratocystis fimbriata</i></b>                     |
| <b>3. Stem rot or wilt or surface rot</b> | <b>:</b> | <b><i>Fusarium oxysporum</i> f.sp. <i>batatus</i></b>    |
| <b>4. Soft rot rhizopus rot</b>           | <b>:</b> | <b><i>Rhizopus nigrucans</i> or <i>R. stolonifer</i></b> |

**1. Cercospora leaf spot : *Cercospora ipomoea***

**2.**

Symptoms:

Small brown angular spots on leaves.  
Severe case leaves drop from the base produce shot hole symptom.

Spread and survival:

Primary infection through air-borne conidia  
Conidia spread through wind and by rain  
Survive in weed host and debris

Favourable conditions:

32°C – 35°C day temperature with 90-95% relative humidity, Intermittent rain fall.

Management:

Two spraying with zineb 0.2% at 15 days interval

## **2. Black rot: *Ceratocystis fimbriata***

### Symptoms:

- Infect underground parts of the plant
- Small sunken black spots on tuber
- Spots enlarge and cover the whole tuber
- Infected tuber have black lesion
- Tuber give unpleasant taste when cooked

### Spread and Survival:

- Survive in soil debris
- Spread through infected tuber.

### Favourable conditions:

- 23-27°C is optimum for disease development

### Management:

- Use disease free planting material
- Cultivate sweet potato once in 2-3 years
- Dipping tuber in 0.1% Thiabendazole

## **3. Stem rot or wilt or Surface rot: *Fusarium oxysporum* f.sp.*batatus***

### Symptoms:

- Yellowing of the youngest leaves
- Vascular system blackened
- Plant wilt and die
- Blackened ring on the surface of tuber

### Spread and survival;

- Fungus survive in soil as chlamydospore
- Spread through infected tuber and irrigation water.

### Favourable conditions:

- 32-37°C favour this disease

### Management:

- Use healthy seed material
- Adopt crop rotation once in 3 years
- Dipping seed material in 0.17, carbendazim for 20 mts.

## **4. Soft rot or Rhizopus rot: *Rhizopus nigricansor*, *R. stolonifer***

Symptoms:

Broken skin with straw colour oozing  
Tuber decay within 4-5 days  
Fungal growth covers the surface of tuber  
Tissue turn brown  
Emit bad odour

Mode of spread and survival:

Survive in crop refuse for a longer period  
Spread through infected tuber

Favourable conditions:

Optimum temperature 23-28°C  
Decay occur at 15-23°C RH 75-85%

Management:

Avoid wound in tuber at storage  
Dry the tuber 1-2 hours before storage  
Clean storage house washed with 2.5% copper sulphate solution.

## DISEASES OF ONION

- |                         |          |   |
|-------------------------|----------|---|
| <b>1. Purple blotch</b> | <b>:</b> | <b><i>Alternaria porri</i></b>              |
| <b>2. Smut</b>          | <b>:</b> | <b><i>Urocystis cepulae</i></b>             |
| <b>3. Basal rot</b>     | <b>:</b> | <b><i>Fusarium oxysporum f.sp.cepae</i></b> |

**1. Purple blotch: *Alternaria porri***

Symptoms:

Appear as small white lesions on the leaves.  
These lesions further develop towards base of the leaves with an yellow halo.  
Further advancement of the diseases results in the drying and collapse of the leaves.  
The infection then spread to the bulb causing a deep yellow and reddish watery rot.  
The scales become desiccated and dark.  
Bulb development is severely affected.  
*Alternaria porri* produces coloured, septate, (both horizontal and vertical conidia with long beak)

Mode of spread and survival:

Spread through air borne conidia.  
It survive as dormant mycelium in the infected debris.

Favourable conditions:

Optimum temperature 23-27°C; High humidity; Cloudy weather with slight drizzling.

Management:

Spraying mancozeb 0.25%

## **2. Smut: *Urocystis cepulae***

Symptoms:

Appear soon after the seedling emerge from the soil.

Most of the infected seedlings die within 3-5 weeks.

Brown to black blisters appear on the leaves and on rupture of these blisters, black mass of spores are exposed.

Surviving plants remain permanently stunted with short brittle distorted leaves bearing the lesions.

Bulb size is reduced.

Mode of spread and survival:

Through soil-borne teleospores chlamydospores and air borne basidiospores.

As chlamydospores in the soil.

Management:

Crop rotation

Nursery drenching with sulphur (wetttable) 3 g/litre of water.

Seed treatment with sulphur 2 g/kg seeds.

## **3. Basal rot: *Fusarium oxysporum* f. sp. *cepae***

Symptoms:

Wilting and drying of the leaves as the plant approach maturity.

Rotting of roots and presence of whitish mycelial growth on decayed portions of the scale.

Longitudinal section of the infected bulbs shows the semi

Watery of the bulb, which progresses from base upwards

Bulb become soft especially, the basal portion

Mode of spread and survival:

Soil borne-Spread through irrigation water and agricultural operations – survival as chlamydospores.

Favourable conditions:

Optimum temperature 28-32°C (soil temperature). The disease is mostly occurs during maturity period when the soil is exposed to high temperature.

The invasion is facilitated by wounds normally caused by root maggots.

Management:

Spot drenching with carbendazim 0.1% crop rotation.

## **DISEASES OF GARLIC**

### **1. Neck rot and bulb rot**

*Botrytis allii*, *Fusarium oxysporum*

Symptoms

Neck rot is found commonly upon the bulbs at the time of harvest.

Softening of the affected scale tissue.

Dense layer of gray mold appears, at the neck.

The infection progresses most rapidly down the scale which have been originally infected.

Dark sclerotia appears on the older decayed tissue.

In the case of bulb rot caused by *Fusarium* failure of germination and drying of leaves from the tip can be noticed.

Rotting of bulb and production of side shoots produces clump of shoots.

Mode of spread and survival

Both the pathogen survive in the field as well as in storage.

The *Botrytis allii* survive as sclerotia while fusarium survive as chlamydospores in soil and also in bulbs.

Favourable conditions

*Botrytis allii* requires cool, moist weather.

Infection and proliferation decay of bulbs favoured by the temperature between 15 and 20°C.

Fusarial bulb rot is favoured by excess rainfall followed by a dry spell of 10 to 15 days.

The feeding injury by the garlic mite *Rhizoglyphus echinopus* favours bulb rot.

Management

Selection and collection of seed materials from disease free area.

Bulb treatment with Thiram, Captan Vinclozolin 4 g/kg or Carbendazim 2 g/kg.

Spraying vinclozolin 0.1% of carbendazim 0.1%.

## **DISEASES OF CUCURBITS**



1. Powdery mildew : *Erysiphe cichoracearum*
2. Downy mildew : *Pseudoperonospora cubensis*
3. Anthracnose : *Colletotrichum lagenarium*
4. Leaf spot : *Cercospora* sp.

### 1. Powdery mildew : *Erysiphe cichoracearum*

#### Symptoms

White powdery coating on all parts of the plant except fruits.  
 Affected leaves become chlorotic and subsequently drying takes place.  
 Infected shoots also dry off.  
 Affected plants become stunted.  
 Size and quality of the fruit is also affected.  
 Yield will be reduced.

Fungus: produces hyaline single celled conidia in chain Cleistocarps also produced.

#### Mode of spread and survival:

Through air-borne conidia.  
 Through many collateral hosts, also through dormant mycelium and conidia in the infected crop debris.

#### Favourable conditions:

The conidia can germinate even under dry weather and low humidity and hence the spread of the disease is quite rapid

#### Management:

Destroy affected plant parts  
 Spraying Tridemorph at 0.05% (or) Thiophanate methyl 0.05%

### 2. Downy mildew : *Pseudoperonospora cubensis*

#### Symptoms:

Angular yellow patches on the upper surface of the leaves.  
 On the corresponding lower surface, white downy growth of fungus is seen.  
 Severe attack results in drying shedding of leaves.  
 Production of malformed fruits.  
 Stunting and death of plants.

Fungus: Produce sporangia.

#### Mode of spread and survival:

Air-borne sporangia, and through rain splash and irrigation water.

#### Favourable conditions:

Optimum temperature: 15-22°C (Sporangial formation and germination)  
Rain is not essential if heavy dew prevail

Management:

Crop rotation  
Destruction of weed host  
Seed treatment reduce disease severity Mancozeb 0.2% spraying at 10 days interval  
Ridomil M2-72 0.3% at 30 days interval Avoid copper fungicides.

### **3. Anthracnose: *Colletotrichum lagenarium***

All parts of the host are liable to attack.  
The crop presents a scorched appearance under severe attack.  
The disease appears generally late in the season.

Symptoms:

Spots appear on leaves, stem and petiole  
Drying and death of young seedlings.  
On older plants, initially pale green spots appear which later turn to reddish brown with an yellow halo.  
Number of spots coalesce and the leaves dry up subsequently.  
On the affected leaves, minute black dot like fruiting structures viz., acervuli can be seen.  
Stem infection results in the formation of water soaked sunken lesions which later on girdle the stem and cause the death of the shoots.  
Fruit infection, results in cracking of the skin of the fruit.  
Acervuli are formed as, pink mass initially and turn to black on the affected parts of the fruits.

Fungus:

Produce single celled, falcate shaped, hyaline conidia.

Mode of spread and survival:

Through air-borne conidia, water, rain splash  
Through, chlamydospores / Sclerotia formed in the infected tissues.

Favourable conditions:

Optimum temperature 22-27°C

Management:

Seed treatment with Thiram or Captan @ 4g/kg  
Spraying Mancozeb 0.2% at fortnight interval

### **4. Leaf spot: *Cercospora* sp.**

Symptoms:

Small water soaked specks on leaf surface initially  
The lesions turn to grey and dark brown  
Severe infection results in coalition of number of spots and drying of leaves.

Fungus: Produces needle shaped, multicelled, hyaline conidia

Mode of spread and survival:

Through air-borne conidia  
As conidia in infected host tissue, other crop debris and in collateral hosts.

Management:

Spraying Mancozeb 0.2% at fortnight interval.

## **DISEASES OF BLACK PEPPER**

- 1. Quick wilt or Phytophthora foot rot : *Phytophthora capsici***
- 2. Pollu Disease : *Colletotrichum gloeosporioides***

- 1. Quick wilt or Phytophthora foot rot: *Phytophthora capsici***

Symptoms:

A dark patch appears in stem and spread to one foot from base of the plant in case of root rot.  
Stem breaks off at the nodes, leaves turn yellow flaccid and droop the vine dies in 3-4 weeks.  
In leaves dark brown spots appear and enlarge causing a concentric zonation with a grey centre.  
Leaves and spikes are shed.

Mode of spread and survival:

Sporangia are produced in infected leaves of runner shoots and are carried to upper leaves by rain splashed, thereby spreading in a ladder like fashion.  
The inoculum survives in infected debris and soil

Favourable conditions:

The leaf infection is serious in irrigated areca-pepper mixed plantations.  
Collar infection is severe in pure plantations.

Management:

The infected vines and plant parts must be removed and burnt.

Drench with 1% Bordeaux mixture or 2% Copper oxchloride (2 to 3 litres/vine) after opening a shallow basin around the vine.

Spray 1% Bordeaux mixture on the aerial parts of the vines with the onset of the monsoon.

Open the soil and apply 10% Bordeaux pastes on the base of the stem up to 50cm.

Repeat Bordeaux spray and drenching during August-September just before the North east monsoon, and October.

Foliar spray with Metalaxyl (200 ppm) or Al-fosetyl (0.3%) before the onset of the southwest monsoon and in July-August, gave good control.

A third spray can be given during September-October depending upon the severity of the disease.

The systemic action persists for 40-50 days and hence the final should be given before October.

## **2. Pollu Disease: *Colletotrichum gloeosporioides***

Symptoms:

Angular brownish leaf spot with chlorotic halo.

Leaves show concentric zonations.

On berries water soaked, brownish sunken areas appear.

Discoloured berries occur in groups of two to five.

Berries split at the lesion site.

Management:

Spray 1% BM or 0.2% mancozeb

Regulate shade.

A combination spray of (0.1%) Ekalux and (0.2%) mancozeb during September controls both the “Pollu” beetle and disease.

## **NURSERY DISEASES**

1. Leaf rot and blight : *Rhizoctonia solani*

2. Basal wilt : *Sclerotium rolfsii*

Symptoms:

The leaf rot starts as grey spots which enlarge to dark grey irregular patches.

In severe cases, rotting occurs.

*Sclerotium rolfsii* colonises the stem, induces a watery rot and results in death of the cutting.

Favourable conditions:

Heavy shade frequent irrigations, high humidity.

Management:

Fumigate nursery pot mixture

Immediate removal and destruction of the affected cuttings.  
Spray 1% BM 0.2% copper oxychloride or 0.1% carbendazim

## DISEASES OF CARDAMOM

1. Katte disease : *Virus*
2. Capsule rot : *Phytophthora meadii*
3. Clump rot of rhizome : *Pythium vexans* and *Rhizoctinia* sp.
4. Chenthal : *Corynebacterium* sp.
5. Foolkay disease or large cardamom dwarf bush virus:
6. Chirkey disease or mosaic : *Virus*

### 1. Katte diseases: *Virus*

Symptoms:

Spindle shaped chlorotic flecks (2.5mm) appear on the youngest leaves in an infected clump; these flecks progress into light green, discontinuous stripes which run parallel to the vein.

Mosaic symptoms are also frequently mixed.

As the virus is systemic, the disease spreads throughout the clump.

It takes 15-20 days for a young seedling to express the symptoms, 30-45 days for a grown up clump in the active growing period and over 3 months in winter months.

After an year reduction in leaf size and stature of the plant is visible.

The affected clumps produce slender tillers and shorter panicles.

The loss is total when young seedlings are infected 35 and 70% one and two years after infection.

Mode of spread:

It is a non-persistent virus transmitted by the aphid *Pentalonia nigronervosa*, use of infected planting stock.

Management:

In new plantations, only healthy seedlings (raised from seeds) are to be used, locate nurseries away from the “Katte” areas.

For gap fillings avoid clones from diseased gardens.

Infected plants are cut, close to the base, during September-October when there is less vector population.

The pseudostems are not much disturbed, allowed to lie down, dry and decay.

The rhizomes are also to be destroyed.

### 2. Capsule rot: *Phytophthora meadii*

Symptoms:

Leaves, tillers, panicles and capsules are infected.

Water soaked regions appear on the capsule which become dull brown.  
The infected capsules emit a foul smell and snip off from the rachis.  
Tender shoots, decay  
Leaves show water soaked, greenish lesions spread and become necrotic.

Favourable conditions:

High rainfall areas, south west monsoon period August-September high relative humidity and soil moisture.

Mode of spread:

The fungus is soil borne.

Management:

Remove diseased and dead parts.  
Drench soil with 1% Bordeaux mixture (4L) or 0.3% Aliette (1L) per clump 2 to 3 times.  
Fresh mulch of infected clump.  
Provide adequate drainage and remove dampness.

### **3. Clump rot of rhizome rot: *Pythium vexans***

Symptoms:

Yellowing of leaves from the tip.  
Rhizomes decay resulting in death of the clumps

Management:

Provide drainage, drench soil with 1% Bordeaux mixture (or 0.25% Emisan or 0.2% Brassicol 75 WP), apply lime followed by 100g superphosphate per clump before the monsoon.

### **4. Chenthal: *Corynebacterium* sp.**

Symptoms:

Elongated water soaked lesions on the lower surface of the young leaves.  
They turn yellow, then dark brown with a pale yellow halo.  
When the lesions are many, the leaves wither and the pseudostems wilt.  
The panicles dry from tip downwards and the flowers fail to develop

Favourable conditions:

Insufficient shade.

Management:

Provide adequate shade and adopt phytosanitation.

### **5. Foorkey disease or large cardmon dwarf bush virus:**

Symptoms:

Clustering of leaves, acceleration of vegetative growth dwarfing and stunting of plants.

Mode of spread:

Aphid vectors viz., *Pentalonia nigronervosa* and *Micromyzus kalimpongensis*.

Management:

Rogue diseased clumps, plant healthy seedling and spray insecticides to control the aphid vectors.

### **6. Chirkey disease or mosaic: Virus**

Symptoms:

Chlorotic and necrotic streak along the lateral veins of leaves.

Mode of spread:

Aphids viz., *Rhopalosiphum maidis*, *R. padi* and *Sitobion avenae*.

Management:

Some local cultivars viz, Surumpa, Sawney and Kopringer are tolerant use healthy planting material.

## **DISEASES OF GINGER**

- |                            |          |  |
|----------------------------|----------|--|
| <b>1. Rhizome rot</b>      | <b>:</b> | <b><i>Fungal and Bacterial complex</i></b> |
| <b>2. Yellows</b>          | <b>:</b> | <b><i>Fusarium oxysporum</i></b>           |
| <b>3. Ginger leaf spot</b> | <b>:</b> | <b><i>Phyllosticta zingiberi</i></b>       |

### **1. Rhizome rot: *Fungal and Bacterial complex***

Complex disease-*Phthium aphanidermatum*, (soft rot), *Pseudomonas solanacearum*, (bacterial wilt), *Fusarium* sp. (Yellow), nematodes, rhizome maggots of *Mimegrella coeruleifrons* and *Eumerous pulcherrimus*

Symptoms:

Soft rot: Appears in the seedling stage itself if rhizomes are infected and causes damping off.

Plants become pale, leaf tips turn yellow and the infection gradually spreads down the leaf blade and leaf sheath along the margin.

Often the middle portion of the lamina remains green while margins turn yellow.

Yellowing spreads from bottom upwards; leaves droop, plants wither and dry.

Infected plant can be easily pulled out from the soil as the collar region becomes soft, rotten and shows pale, translucent, water soaked patches; Rhizomes get discoloured; soft and form a putrefying mass.

Mode of spread and survival:

Survives in soil and seed rhizomes scales as oospores, and plant debris.

Bacterial wilt: The lowermost leaf shows yellow to bronze coloration of leaf margins, become flaccid, and droop, it spreads upwards.

Water soaked linear streaks are seen in the collar region.

The affected pseudostem comes out with a gentle pull and in advanced stages of infection, they are slimy to touch and milky bacterial ooze exudes when pressed between fingers.

The lesions spread to the rhizomes, infected rhizome is kept under water, a turbid bacterial ooze streams out.

The rotten rhizomes emit a foul smell, become discoloured and turn black.

Mode of spread and Survival:

The pathogen has a wide host range infecting several solanaceous crops.

Favourable conditions:

III-drained soils and damp weather.

Management:

Use healthy seed rhizomes, selected from disease free areas. Treat seed rhizomes with 0.3% Dithane Z-78 or 0.3% Blitox-50 and 200 ppm Streptocycline for 30 min. each and store in sand-lined pits.

Provide adequate aeration with a wooden plank placed as a cover, provided with holes.

Before planting, all plant debris must be destroyed and burnt.

Planting should be done in raised beds with adequate drainage

Rotate with crops not infected by the pathogens.

When symptoms appear drench with 0.3% Dithane M-45 or Cheshunt compound for soft rot and spray 100 ppm Streptocycline or Agrimycin 100 for bacterial wilt.



## **2. Yellow: *Fusarium oxysporum***

Symptoms:

Yellowing of the margins of the lower leaves which gradually spreads to the entire leaf; the affected plant wilts and dries but does not fall down, rhizomes show creamy discoloration of the vascular system and a cortical rot.

Favourable conditions:

Very high humidity (87-95%) and 23-29°C.

Mode of spread and survival:

Infected rhizomes, secondary spread by conidia carried by rain water.

Management:

Crop rotation, seed treatment with organo mercurial fungicide drench soil with 0.3% Dithane M-45 or 0.1% Benlate (or) Bavistin.

## **3. Ginger leaf spot: *Phyllosticta zingiberi***

Symptoms:

Small, oval, elongate spots 1-10 0.5mm; mature spots have a dark brown margin papery white centre and yellow halo spots coalesce and cause extensive discolouration.

Favourable conditions:

Growing without natural shade.

Mode of spread:

Rain splashes

Management:

Spray (0.2%) Dithane Z-78 or 1% Bordeaux mixture or Captafol

## DISEASES OF TURMERIC

1. Turmeric leaf spot : *Colletotrichum capsici*  
2. Turmeric leaf blotch : *Taphrina maculans*

### 1. Turmeric leaf spot: *Colletotrichum capsici*

#### Symptoms

The spots are elliptic to oblong 4.53 cm with grayish white center, brown margin and yellow halo spots coalesce and leaves dry.

#### Favourable conditions

August-September when there is high humidity.

#### Mode of spread and survival

Conidia are disseminated by wind and rain

Also carried over as dormant stromata between the rhizome scales.

#### Management

1% Bordeaux mixture or 0.2% mancozeb in early August before the appearance of the disease.

Select seed rhizomes from healthy areas, avoid excess shade adopt mixed cropping.

### 2. Turmeric leaf blotch : *Taphrina maculans*

#### Symptoms

The leaf spot appear in October-November on both the surfaces of the leaves.

It first appears as apple yellow discolorations turn to dirty yellow and then brown with a chlorotic halo.

The lesions coalesce, forming large necrotic blotches; leaves ultimately dry.

#### Favourable conditions

80% RH and 21-23°C.

#### Mode of spread and survival

Soil debris

#### Management

Spray 1% Bordeaux mixture or 0.2% Copper oxychloride

## DISEASES OF TEA

<b>1. Blister blight</b>	<b>: <i>Exobasidium vexans</i></b>
<b>2. Pink disease</b>	<b>: <i>Pellicularia salmonicolor</i></b>
<b>3. Grey blight</b>	<b>: <i>Pestalotiopsis theae</i></b>
<b>4. Black rot</b>	<b>: <i>Corticium invisum</i>, <i>C. theae</i></b>
<b>5. Red Rust Root disease</b>	<b>: <i>Cephalous parasiticus</i></b>
<b>6. Charcoal stump rot</b>	<b>: <i>Ustulina zonata</i></b>
<b>7. Brown root rot</b>	<b>: <i>Fomes lamoensis</i></b>
<b>8. Black root rot</b>	<b>: <i>Rosellinia arcuata</i></b>
<b>9. Armillaria root rot</b>	<b>: <i>Armillaria mellea</i></b>
<b>10. Red root rot</b>	<b>: <i>Poria hypolateritia</i></b>

### **1. Blister blight: *Exobasidium vexans***

#### Symptoms:

The first visible symptom is an oily, yellowish, translucent spot on the tender leaf and turn deep red shiny blisters

The circular spot gradually enlarges to 3 to 13mm diameter, bulged on the undersurface of the leaf with a concave trough like depression on the upper surface forming a classic blisters lesion.

Leaves become curled and distorted.

It attack the first flush of 2-3 young leaves and kills the young shoots and buds.

Thus the new growth is largely ruined.

Mature leaf is not affected.

If the disease appears in nursery, when stem is less than 15cm height, seedlings are stunted and produce many thin stems instead of a single stalk.

Repeated attacks cause death of seedlings.

Badly affected nurseries will have to be abandoned.

Blister blight produces losses upto to 50%

Protected areas show 57-139% increased yield.

It appears in May.

Succulent leaves and green shoots of newly pruned tea are most susceptible.

It causes severe damage within a few months of pruning

The environment is favourable shortly after commencement of South West monsoon till the close of North-East monsoon.

#### Mode of spread and survival:

The fungus completes its life span in 11-28 days and several generations of spores are produced in a season.

It produces conidia and basidiospores in the same blister.

Spores are airborne.

No resting stage seen in bush.

Abandoned nurseries and badly kept gardens harbour the pathogen.

It first appears in the borders of nearby plantations.

#### Favourable conditions:

Relative humidity plays an important role in the epidemics of blister blight.

If the RH is below 80% for 5 days, the rate of infection decreases.  
 If it was above 83% for 7 to 10 days, the infection was moderate to serious.  
 Temperature above 35°C inhibits the disease,  
 Medium pruned tea is particularly susceptible as it provides vigorous  
 succulent shoots and large tender leaves.  
 Bushes in low, moist and shady localities suffer more.

#### Management:

Copper oxychlorides and oxides are superior to other formulations and are  
 economic.  
 The whole plantations should be covered in the shortest possible time.  
 If there is outbreak after-middle of March, spray regularly at 7-10 days  
 intervals till and 2<sup>nd</sup> week of May.  
 Seedlings should be protected by weekly sprays in nursery.  
 Protective spray soon after plucking keeps down copper residues.  
 Repeated sprays are required.  
 Withhold spray if the RH of 3 day average went below 83%  
 Tolerance limit for made tea for consumption is 150ppm.  
 Two days after spraying with recommended dosage, the residue of copper is  
 already below that limit.  
 There is no copper toxicity on the bushes  
 The fungus does not develop tolerance to copper.  
 Copper stimulates the development of mites.  
 Nickel chloride is used as an eradicant in South India.  
 It does not stimulate mites, and could kill fungus which is already in the leaf  
 tissue.  
 A mixture of 210g copper oxychloride + 210g Nickel chloride per ha sprayed  
 at 5 days intervals from June-September and 11 day intervals in October-  
 November gave economic control.  
 Among organic fungicides, chlorothalonil and dithianon gave protectant and  
 therapeutic effects.  
 Tridemorph (calixin)  
 Dithane M-45, Calixin Baycor and Bayleton and Pyracarbolid (Sicarol)  
 offered good disease control under field conditions Calixin and Sicarol  
 increased yield more than copper.

## 2. Pink disease: *Pellicularia salmonicolor*

#### Symptoms:

First a number of fine silky threads united into a thin film appear on stem.  
 Not found on leaves.  
 Fungus forms pink fructifications over affected stems.  
 Young branches on the outside of the bush lose their leaves and die back.  
 The pink concentrations crack into small fragments at right angles.  
 They are generally confined to lower or more shaded side of branches.  
 Bark killed in patches.  
 When the branch increases in thickness it grows only in areas where bark is  
 not dead.

So branch becomes irregularly swollen,  
Pink tissue become white when old

Mode of spread and survival:

Basidiospores wind borne.  
First appears on borders adjacent to jungles.

Management:

Addition of Potash promotes recovery  
Very difficult to eradicate by removal of affected parts.

### **3. Grey blight: *Pestalotiopsis theae***

Symptoms:

The disease appears as minute brownish spots on older leaves, which soon turn grey.  
The spots are mostly irregular, and several of them may coalesce to form irregular grey patches.  
The spots have fine concentric lines.  
Fructifications of the fungus appears as black dots in older spots on the upper surface.  
The fungus infect plucking points and causes dieback.

Mode of spread and survival:

The conidia are spread by wind.

Favourable conditions:

The incidence is more frequent on weak bushes, especially if potassium is deficient.  
The infection is also predisposed by sunscorch, insect puncture and plucking wounds.

Management:

Copper oxchloride is effective.

### **4. Black rot: *Corticium invisum*, *C. theae***

Symptoms:

Appear in end of May or early June  
Small dark brown irregular spots appear on leaf.

leaf They coalesce produce a dark brown patch which eventually cover the whole

They drop off.

Before the leaf turns black the lower surface assumes a white powdery appearance.

Mode of spread and survival:

Basidiospores carried by workers as clothes.

The disease develops rapidly when temperature is high and air is humid.

At the beginning of rainfall they germinate and produce hyphal which starts fresh infection.

Favourable conditions:

Occur in nursery shaded with *Crotalaria*

Basidiospores germinate only in wet weather or when leaves are covered with dew.

Management:

Prune in December end remove the prunings immediately, burn after drying.

Collect all dead and dried leaves.

Spray a copper fungicide in 3<sup>rd</sup> week of April.

## **5. Red Rust: *Cephalous parasiticus***

Symptoms:

Small translucent water soaking spot appears on leaf.

On the upper surface the spot become purple red, then black with a purple margin.

On the under surface it is purple red becoming grey brown when old.

If it attacks petiole at its junction with stem, leaf falls.

Favourable conditions:

Disease of weak bush – Weakness due to lack of drainage, drainage, shallow soil, hard pan, poor soil, hard plucking, improper, pruning etc.

Too severe pruning of young plants weakening by red spider attack drought logging favour the disease.

Mode of spread and survival:

Sporangia spread by wind or rain

Management:

Rectify soil defects.

Spray Bordeaux mixture or COC immediately after pruning

Badly diseased bushes should be removed.  
Apply N and K.

### **Root diseases:**

#### **Symptoms:**

The serial symptoms of all root diseases are almost the same.  
The leaves turn flaccid, dry and are still attached to the twigs for sometime.  
To identify the root diseases, examination of excavated roots should be carried out.  
There are differences in the colour of the mycelia and the rhizomorphs of the fungi on the root surface, the consistency and colour of the rotten woods, the presence and the absence of the sheath of sand or soil particles on the root surface etc.  
Most root disease fungi produce fructification only in the advanced stage of the disease.  
Only *Poria* and *Ustulina* form fructifications before the bush is completely killed.  
Soil-borne primary root rot diseases are the most stubborn and difficult to treat.  
The infected plants do not shown any aerial symptom but suddenly die after 20-36 months.

### **6. Charcoal stump rot: *Ustulina zonata***

#### **Symptoms:**

It is the most common of the root rots.  
It has many collateral hosts.  
The fungus attacks tea through root contact and infects through root contact and infects through stems too.  
Effused charcoal like adherent fructification at the collar region wads of shining silky mycelium underneath the bark of both stem and root, irregular black lines in the woody tissues.  
If the bark is removed white or brownish white fan shaped patches of mycelium seen on wood.

### **7. Brown root rot: *Fomes lamoensis***

It produces 3-4mm thick dirty encrustation of soil and the mycelial matter at the root surface, tawny-brown cushions of mycelium and deep-brown honey comb-like lines in the wood.  
Fructification are rarely seen.  
This is a faster killer than charcoal stump rot and is more common on sandy soils than clayey; spreads through root contact.

### **8. Black root rot: *Rosellinia arcuata***

The mycelium spreads on the soils surface

Roots upon infection turn blackish on surface mycelium radiates over the wood surface forming a white stat 12mm diameter.  
Faint black lines are seen in the wood tissues.

### 9. Armillaria root rot: *Amillaria mellea*

It produces a longitudinal split at the collar region which gets filled with mycelium.

Furctifications are rare

### 10. Red root rot: *Poria hypolateritia*

It produce rough root exterior and show reddish mycelial strands.

Conidia stages are profuse on the root surface.

In South India, *Symplocos soikata* is an important forest tree host.

#### Management:

Soil fumigation is the best method of control, though expensive.

It is the most suited method to arrest further spread of diseases in young and high yielding mature teas.

The advantage in soil fumigation was that only the dead plant not the apparently healthy suspects was uprooted.

Replanting could be done after 12 weeks as against 24 months of rehabilitation following uprooting of the dead and suspected plants.

Vapam and Metham sodium may be applied into an apparently healthy ring of bushed, 20-25cm away from the collar region of the living plant to avoid phytotoxicity.

They are instilled into drilled holes to a deptch of 20cm at a distance of 30cm.

Dueofume C.P. (methylbromide + ethylene dibromide 1:1) which is supplied in 450g Cans is enough to fumigate 526sq.feet

Isolation trenches, 120cm deep and 45cm wide maybedug.

For brown root disease patches the trench should include one row of apparently healthy bushes, while for red root disease patohes it should include two rows.

Sanitation: Before replanting, the diseased patches should be carefully cleaned by removing old roots bigger than pencil size, after the bushes are pulled.

### DISEASES OF COFFEE

- |                   |   |                               |
|-------------------|---|-------------------------------|
| 1. Leaf rust      | : | <i>Hemiliea vastatrix</i>     |
| 2. Anthracnose    | : | <i>Glomerella cingulata</i>   |
| 3. Brown eye spot | : | <i>Cercospora coffeicola</i>  |
| 4. Black rot      | : | <i>Corticium salmonicolor</i> |
| 5. Sooty mould    | : | <i>Capnodium brasiliense</i>  |

#### 1. Leaf rust: *Hemiliea vastatrix*

#### Symptoms:

Small yellowish, translucent oily spots appear on 12 week old young leaves.



Spots expand into large (10 to 15mm dia) round spots and show a powdery coating of spores on the under surface.

Finally the spots turn bright orange to red with a yellow rusted band.

Leaves are shed when they are 16 weeks old.

In severe attacks leaves are completely defoliated., Berries remain small.

Favourable conditions:

Rainy weather and periods with mist or dew and moderate temperature.

Mode of spread and survival:

One lesion produces 1 ½ lakh uredospores which are spread by rain splash and wind.

Management:

The blossom spray 0.5 percent Bordeaux mixture in February March pre monsoon spary with 0.03% a.i plantvax in May-June

Mid monsoon spary (July-August) and post monsoon spray (September October) with either Bordeaux mixture or plantvax spreaderes and stickers like linseed oil, teepol or casein increased the fungicides efficacy.

## **2. Anthracnose: *Glomerella cigulata***

Symptoms:

Appearance of greyish spots on leaves, twigs and berries

Spots also observed on the internodes of twigs resulting in blackened twigs and begin to die form tip downwards.

Berried fail to mature forming “Kattekai”

Favourable conditions:

Dry period following the monsoon rain

Mode of spread:

Wind-borne conidia

Management:

Provide drainage and apply balanced fertilizer

Spray Bordeaux mixture 1% of Ferbam 0.2%

## **3. Brown eye spot: *Cercospora coffeicola***

Symptoms:

Severe on nursery seedling and young crop

Small circular necrotic spots with a dark brown margin and light brown centre occur on the leaves.

Berries become black with irregular sunken blotch with a purple halo.

Shrink and fall off.

Skin becomes dry and hard making it difficult to pulp.

Made of spread:

The pathogen is seed borne, conidia spread by wind.

Favourable conditions:

Well-nourished, unshaded crop in low altitude

Management:

Maintain adequate shade

Spray Bordeaux mixture 1% or captan, mancozeb, ferbam or ziride (0.2%) or carbendazim (0.05%) from September developing a canopy of shade over the plantation.

#### **4. Black rot: *Corticium salmonicolor***

Symptoms:

Blackening of the affected leaves, twigs and berries.

The under surface of the affected leaves is covered by a thin hyaline spreading web of fungal mycelium.

Leaves and berries become brownish and finally black.

Favourable conditions:

Heavy rains

Mode of spread:

Spread through infected plant debris.

Mycelium, twice in twigs throughout year.

Management:

Remove dead leaves and twigs spray with 1%

Bordeaux mixture during break in monsoon and burn.

Centering and handling of the bushed should be done prior to the onset of S.W. monsoon.

#### **5. Sooty mould: *Capnodium brasiliense***

Symptoms:

Whenever there is heavy attack of aphids and scales sooty mould occurs. The fungus feeds on the secretions of insects but it is not a parasite. It spreads on leaf surface forming a black vein which cuts off light from green leaves. Sooty growth affect photosynthetic activity of the plants.

**Management:**

Control: Aphids and scales with insecticides-Boil maida or jack seed flour with 5 L water, cool, dilute to 20 L and spray. The moldy growth will peel off.

## DISEASES OF RUBBER

1. Secondary leaf fall	:	<i>Phytophthora meadii</i>	
2. Powdery mildew	:	<i>Oidium heveae</i>	
3. Pink disease	:	<i>Corticium Salmonicolor</i>	(or) <i>C. Javanicum</i>
4. White root disease	:	<i>Fomes lignosus</i>	
5. Brown root disease	:	<i>Fomes noxius</i>	
6. Dry root rot Minor disease	:	<i>Ustilina zonata</i>	
7. Bird's eye spot	:	<i>Helminthosporium heveae</i>	
8. Anthracnose	:	<i>Gleomerella cingulata</i>	
9. Stinking disease	:	<i>Sphaerostible repens</i>	
10. Poria root disease	:	<i>Poria sps</i>	

### 1. Secondary leaf fall: *Phytophthora meadii*

Normal leaf occur in December

Secondary leaf fall due to pathogen June-August

#### Symptoms:

Shedding of leaves

Branches show die back symptom

Grey circular spots on leaves

Spots enlarge and become irregular

Petiole exhibit sunken spots

Affected fruits rot

Rotting of bark near tapping cut

Reduction in latex yield

#### Survival:

Survive in infected fruits during dry season

#### Favourable conditions:

Moist climate with intermittent rainfall.

#### Management:

Removal of affected parts and destroyed

Stop tapping during monsoon

Exposed surface should be smeared with tar

Regular shade avoid dense shade

Spraying Bordeaux mixture 1% orzineb 0.2% control effectively

### 2. Powdery mildew: *Oidium heveae*

Symptoms:

White powdery growth on upper surface  
Affected leaves turn purplish black or bluish.

Survival, Favourable conditions, Management – Refer previous chapter

### **3. Pink disease : *Corticium salmonicolor* (or) *C. javanicum***

Symptoms:

Occur in old trees  
Pink encrustation on the affected portion  
Fungus encircle the stem, penetrate bark, and cortical tissues.  
Bark easily split and peeled off  
Tree is killed after rainy season if not recognised early.  
Latex coagulate and become dark is the characteristic feature

Survival and spread:

Survive in affected plant parts.  
Primary infection through wind blown spores.

Favourable conditions:

Moisture is the most essential factor in all root diseases.

Management:

Cut ends should be protected with Bordeaux paste (or)  
Painting tar on the affected portion.

### **4. White root disease: *Fomes lignosus***

Symptoms:

Presence of white rhizo morph in the affected region  
Advance stage root decay  
Leaves turn brown due to root decay.  
Fungus form yellow margin with concentric rings

Spread and survival:

Primary spread through air borne spores.  
Secondary spread through root contact.  
Survival in the infected plant parts

Management:

Removal of affected portion

Cut ends should be poisoned with sodium arsenate.  
Avoid contact of infected roots by making a trench  
Drench the soil with 1% Bordeaux mixture

#### **5. Brown root disease: *Fomes noxius***

##### **Symptoms:**

Affected roots are encrusted with a mass of soil and small stone held by the net work of mycelium.  
Young trees when affected killed entirely

##### **Spread:**

Root contact  
Survival in dead trees

#### **6. Dry root rot : *Ustulina zonata***

##### **Symptoms:**

Affected portion show dry rot  
On outer surface of wood characteristic black lines can be observed.  
Brown discolouration in between lines.  
Seen fructification in the base of the stem when the tree is about to die.

##### **Spread:**

Through winds

##### **Management:**

Removal of infected roots.  
Cut end protected with copper sulphate

## DISEASES OF ARECANUT

1. Mahali disease	:	<i>Phytophthora arecae</i>
2. Foot rot (or) Anabe roga	:	<i>Ganoderma lucidum</i>
3. Die-back (or) button shedding	:	<i>Colletotrichum sporioidies</i>
4. Yellow disease	:	<i>Not traced</i>
5. Bud rot	:	<i>Phytophthora arecae</i>
6. Stem bleeding	:	<i>Thielaviopsis paradoxa</i>
7. Yellow leaf spot	:	<i>Curvularia sp</i>
8. Collar rot	:	<i>Fusarium sp</i>
9. Bacterial leaf stripe	:	<i>Xanthomoncas sp</i>

- 1. Mahali disease: (or) Koleroga (Kota-rotling roga disease *Phytophthora arecae*)**  
Common in heavy rainfall area

### Symptoms:

Rotting and excessive shedding of immature nuts  
Water soaked lesion on nuts  
Lesion covering entire nuts  
Fruit stalk & inflorescence rachis are also affected  
Affected nuts show vacuole inside

### Survival and spread:

Survive in affected nuts  
Rain play major role in spread

### Favourable conditions:

Low temperature and high humidity favour the growth

### Management:

Spray 1% Bordeaux mixture with Adhesive or vegetative oil

## **2. Foot rot or Anabe roga: *Ganoderma lucidum***

### Symptoms:

Yellowish discolouration of leaves from the outer whorl  
In advance stage whole leaf become yellow  
Development of inflorescence and nut is arrested.  
Oozing from the base of the stem  
Bracket appears at the base of the trunk  
On cutting open central tissue emit a bad smell due to the invasion of fungus  
in conducting vessels.

### Survival and spread:

Fungus survive in soil

Spread through air, Irrigation water and root contact

Favourable conditions:

Fungus grow well in PH 3-9 and soil moisture 40-80%

Management:

- Collect and burn dead stumps roots and fungal fruiting bodies.
- Improve drainage facility
- Avoid close spacing
- Maintain good sanitation
- Digging deep trenches to avoid root contact from diseased to healthy.
- Drench 1% Bordeaux mixture at frequent interval.

### **3. Die-back (or) button shedding: *Colletotrichum sporioides***

Symptoms:

- Brownish patches on the inflorescence
- Spread from tip to downwards known as die back.
- In advance stage conidial mass occur on the infected patches
- Button shedding occur

Survival and spread:

- Survival in infected plant parts
- Spread through rain water and air
- Spraying 0.1% Carbendazim

Favourable conditions:

Disease present through out the year more during February-May

Management:

- Removal of affected plant parts
- Spraying carbendazim 0.1%

### **4. Yellow leaf disease:**

A complex disease

Symptoms:

Yellowing of leaves and shedding of matured and immature nuts.



Brown necrotic streaks run parallel to lamina in unfolded leaves.  
In advanced stage leaves size reduced stiff and closely bunched  
Root tips turn dark and rot.

Management:

Basal treatment with blue copper  
Application of neem cake  
application of farm yard manure  
Regular manuring practice with NPD + lime + zinc increased the yield

### **5. Bud rot: *Phytophthora arecae***

Symptoms:

Discolouration of spindle from yellow to brown rotting of young leaves  
Infection spreads inside and rotting of growing point occur  
Spindle can be drawn with a gentle pull  
Bad odour come out due to invasion of secondary pathogen

Management:

Remove the infected portion  
Apply Bordeaux paste

### **6. Stem bleeding: *Thielaviopsis paradoxa***

Symptoms:

Small discolouration near the basal portion of the stem  
Later spots coalesce and cracks develop on the stem  
Size of crown get reduced.  
Dark brown ooze from cracks

Management:

Improve drainage facility  
Application of Bordeaux paste on the basal portion

### **7. Yellow leaf spot: *Curvularia* sp**

Symptoms:

Yellow specks on the leaves  
Spots coalesce form larger lesion surrounded by yellow halo Finally seedling die.

Management:

Spraying zineb 0.2% or 1% Bordeaux mixture

### 9. Bacterial leaf stripe: *Xanthomonas* sp

Symptoms:

Water soaked lesion on the leaf tip

Usually lesion are straight or wavy, lesion contain creamy white or yellowish ooze.

Entire crown may be killed particularly in seedlings.

Management:

Any Antibacterial antibiotic as prophylactic and curative treatments

## DISEASES OF BETELVINE

1. Foot rot and leaf rot: *Phytophthora parasitica* var *piperina*
2. Sclerotial foot rot and wilt : *Sclerotium rolfsii*
3. Powdery mildew : *Oidium piperis*
4. Bacterial leaf spot (or) Stem rot: *betilicola*

### 1. Foot rot and leaf rot: *Phytophthora parasitica* var. *piperina*

The pathogen is found to occur during winter months (Sep. to Feb) and attacks root, stem and leaves.

Symptoms:

In leaf symptom, a circular black (or) brown spot appears on leaf and it develops a wet-rot covering major portions of the leaf.

Usually the initial symptoms appear on the matured leaves near the soil and the rot extends to the petiole and stem.

Affected leaves fall off prematurely.

At the initial stages of infection, finer young root in foot region gets rotted and soft tissues of old roots and internodal portions of the vines also rot leaving only the sticky fibrous portions which emits a fishy odour.

Under severe conditions, plants droop down and it leads to death of the plant.

Etiology:

Mycelium	-	hyaline, non septate
Sporangia	-	lemon shaped, hyaline, thin walled
Zoospores	-	Reniform, biflagellate
Oospores	-	Dark brown, thick walled

Mode of spread:

The fungus is mainly soil-borne and is also carried through irrigation water and through collateral host.

The secondary spread is through sporangia produced on the leaves

#### Survival:

Survives in the soil and crop debris as oospores and chlamydospores.

#### Favourable conditions:

Favourable period - September to February

Low temperature (23°C and below) and high relative humidity favour the spread.

#### Management:

Collection, removal and destruction of infected plants and plant parts.

Frequency of irrigation should be reduced during cold weather period.

Clean cultivation and alternate cropping

Soil drenching with 0.5% Bordeaux mixture at monthly intervals @ 500 ml/hill

Application of neem cake or neem cake urea @ 150 kg N/ha/year near the root zone.

## 2. Sclerotial foot rot and wilt: *Sclerotium rolfsii*

The disease is found to occur during summer months i.e., May to July

#### Symptoms:

The vine is susceptible to all stages of its growth and the infection usually appears at the collar region.

Whitish cottony mass of fungal mycelial growth is seen on the stem resulting in rotting of the tissues at the point of attack.

The affected plants show drooping of leaves they dry up ultimately

Round light to deep brown mustard seed like sclerotia are formed around the infected portion and the soil around the vine.

#### Etiology:

Mycelium - Profusely branching, white to grayish in colour

Sclerotia - Spherical, smooth, black and shiny

#### Mode of spread:

The fungus is mainly soil borne and it multiplies in the soil where there is copious supply of organic matter and moisture.

It also spreads through irrigation water

Survival:

The fungus survives in the soil as well as in the infected debris as sclerotia.

Management:

Application of soil amendments check the disease spread  
The affected portions should be removed and destroyed.  
Soil drenching with Carbendazim or PCNB (0.1%)

## **2. Powdery mildew: *Oidium piperis***

Symptoms:

The disease occurs on the tender shoots and leaves and affects the crop at all stages of its growth.  
Correspondingly the upper leaf surface shows yellowish irregular patches  
The affected leaves get shrivelled, deformed and shed from the vines.

Etiology

Hyphae	-	branched, hyaline, septate
Conidiophore	-	short, club shaped, non septate produce chains of
conidia		
Conidia	-	Single celled, hyaline, elliptical and smooth

Mode of spread:

The fungus is mainly air-borne  
The spores of the fungus also carried through irrigation water

Survival:

It survives in crop debris in the soil

Favourable conditions:

Dry humid weather favours the development (May to July)

Management:

Affected leaves should be removed and burnt  
Sulphur dusting @ 25 kg/ha or spraying wettable sulphur 0.2% at monthly interval helps to reduce the incidence.

## **4. Bacterial leaf spot (or) Stem rot: *betilicola***

Symptoms appears on leaves and stem of betelvine during wet weather.

Symptoms:

The disease starts as minute, small brown water soaked spots on leaves surrounded by yellow halo which later increase in size and become necrotic and are confined to the interveinal space giving angular in shape.

The leaves lose their lustre, turn yellow and fall off.

The severity of infection is denoted by the appearance of stem infection.

Initially small elongated black specks appear on lower nodes and internodes of the vine.

These specks elongate along the length of vine.

In some cases the blackening may spread beyond the node of the adjacent internode.

#### Etiology:

Bacterium is rod-shaped, gram negative, non spore forming with single polar flagellum.

#### Mode of spread:

The infected leaves and stems serve as a source of inoculum.

The bacterium enters through the injuries and stomata.

It also spreads through irrigation water when splash irrigation is given.

#### Favourable conditions:

Cloudy weather with high humidity coupled with intermittent rains favour the disease development.

More than two years old crop is more vulnerable.

#### Management:

Affected leaves should be removed and destroyed.

Infected vines should be removed and burnt.

Spraying Bordeaux mixture 0.25% + 0.05% streptocycline should be done after harvesting the leaves.

### DISEASES OF ROSE

- |                          |          |                                      |
|--------------------------|----------|--------------------------------------|
| <b>1. Powdery mildew</b> | <b>:</b> | <b><i>Sphaerotheca pannosa</i></b>   |
| <b>2. Die back</b>       | <b>:</b> | <b><i>Diplodia rosarum</i></b>       |
| <b>3. Black spot</b>     | <b>:</b> | <b><i>Diplocarpon rosae</i></b>      |
| <b>4. Rust</b>           | <b>:</b> | <b><i>Phragmidium mucronatum</i></b> |

#### **1. Powdery mildew: *Sphaerotheca pannosa***

##### Symptoms:

At first raised blister like areas occur on the leaves and soon become covered with a greyish white, powdery fungus growth.

Leaves become curled and distorted.

White patches of fungus growth of leaves buds and young shoots covering the entire terminal portion.  
Buds fail to open properly.

Mode spread and Survival:

Fungus overwinters as mycelium in dormant buds and shoots conidia are wind borne.

Management:

Spray wettable sulphur 0.3 or Karathane 0.07% or carbendazim 0.1% or  
Dusting with sulphur at 20kg/ha (phaltan 0.3% + carbendazim 0.025%)

## **2. Die back: *Diplodia rosarum***

Symptoms:

The pruned surface of the twig dries tip-downwards  
Twigs become black in colour  
The disease passes from the branch twig to the main stem and from there to the root, killing the whole plant.  
Stem and the roots show browning of the internal tissues.

Mode spread and Survival:

The fungus persists in dead twigs and the stalks of the withered blooms

Management:

Prune affected shoots  
Pruned ends should be immediately coated with a paint made up of 4 parts of copper carbonate, 4 parts of red lead and 5 parts of linseed oil with traces of BHC to ward off the digger wasp.

## **3. Rust: *Phragmidium mucronatum***

Symptoms

At first raised blister like areas occur on the leaves and soon become covered with a greyish white, powdery fungus growth.  
Leaves become curled and distorted.  
White patches of fungus growth of leaves buds and young shoots covering the entire terminal portion.  
Buds fail to open properly.

Mode of spread and survival

Fungus overwinters as mycelium in dormant buds and shoots conidia are wind borne.

## Management

Spray wettable sulphur 0.3, or Karathane 0.07% or carbendazim 0.1% or Dusting with sulphur at 20 kg/ha (phaltan 0.3% + carbendazim 0.025%).

### **4.Black spot : *Diplocarpon roase***

## Symptoms

Circular black spots with a very irregular fibrillose border on the leaves, leaf buds, stem flowers of rose bushes.

Blackened blistered appearance dotted with pustules on the stem.

## Favourable conditions

Winter frosts

## Management

Spray 0.2% captan at fortnightly intervals, collect fallen leaves and destroy.

## **DISEASES OF CROSSANDRA**

### **Wilt : *Fusarium solani***

## Symptoms

The disease occurs from one month after transplanting.

Yellowing of leaves initially and pink discolouration in later stages.

Drooping of leaves and wilting of plants.

## Favourable conditions

Incidence more in the presence of root lesion nematode, *Pratylenchus delatrei*.

## Mode of survival and spread

Chlamydomonas survive in soil spread by irrigation water.

## Management

Soil application of phorate at 1 g/plant.

Soil drenching with 0.1% carbendazim or 0.25% copper oxychloride on 30th day in soil and repeat 3-4 weeks interval if necessary.

## DISEASES OF CHRYSANTHEMUM

1. Bacterial blight : *Erwinia chrysanthemi*
2. Rust : *Puccinia chrysanthemi*
3. Leaf spot : *Alternaria, Cercospora, Phyllosticta Chrysanthemi*
4. Powdery mildew : *Oidium chrysanthemi*

### 1. Bacterial blight : *Erwinia chrysanthemi*

#### Symptoms

Rotting in upper part of stem  
Occasionally marginal leaf scorch  
Wilting and collapse of plant

#### Survival

Infected plants, soil, weed host.

#### Spread

Rain drops

#### Favourable conditions

High humid weather

#### Management

Select disease free cuttings  
Cutting dipped in Antibiotic solution for 4 hour

### 2. Rust : *Puccinia chrysanthemi*

#### Symptoms

Yellowish green spots on upper surface of leaves lower surface brown powdery pustules.  
Advanced stage drying up of leaves.

#### Survival

Infected plant debris, weed host

#### Spread

Air borne uredospores



## Management

0.2% wettable sulphur, 0.1% Tridemorph.

### **3. Leaf spot : *Alternaria*, *Cercospora*, *Phyllosticta Chrysanthemi***

#### Symptoms

Leaf drying is a common symptom in all Leaf spot pathogens.

#### Management

Destroying the infected leaves

Avoid wetting leaves while watering

Weekly application of mancozeb or zineb 0.2%

### **5. Powdery mildew : *Oidium chrysanthemi***

#### Symptoms

Whitish, ash grey powdery growth on upper surface.

Discoloured corresponding lower surface.

#### Spread

Air borne conidia

#### Favourable conditions

Dry weather

#### Management

Wettable sulphur 0.2%

Karathane 0.07%.

## **DISEASES OF JASMINE**

- |                               |   |
|-------------------------------|---|
| <b>1. Leaf spot</b>           | <b>: <i>Cercospora jasminicola</i>, <i>Alternaria alternata</i></b> |
| <b>2. Wilt</b>                | <b>: <i>Fusarium solani</i>, <i>Sclerotium rolfsii</i></b>          |
| <b>3. Rust</b>                | <b>: <i>Uromyces habsonii</i></b>                                   |
| <b>4. Bacterial leaf spot</b> | <b>: <i>Xanthomonas jasmini</i></b>                                 |
| <b>5. Phyllody</b>            | <b>: <i>Phytoplasma</i></b>   |

### **1. Leaf spot : *Cercospora jasminicola*, *Alternaria alternata***

#### Symptoms

Small minute greyish spot with dark brown margin.

In advanced stage produce shot hole symptom.

#### Symptoms

*Alternaria alternata*

Spots starts from the tip of leaves and proceed towards petiole irregular brown lesion seperated from healthy tissue with dark coloured bands.

Produce shot hole symptom.

Spread

Air borne conidia

Survival

Infected plant debris.

Favourable condition

Temperature 21-23°C

Relative humidity 80%

Management

Spraying mancozeb or zinb 0.2%.

**2. Wilt : *Fusarium solani*, *Sclerotium rolfsii***

Symptoms

*Fusarium* :    Wilting of top leaf  
                      Yellowing of bottom leaves  
                      Black discolouration on root  
                      Death of the plant  
                      Occur in patches.

*Sclerotium* :    In addition to above symptom white mycelia growth and sclerotia on the root surface.

Spread and Survival

Soil borne chlamydospores and sclerotia respectively.

Management

Soil drenching 1% Bordeaux mixture or 0.1% Carbendazim.

**3. Rust : *Uromyces hobsonii***

Symptoms

Occur July-August  
Orange coloured pustules on both surface of the leaves but more in lower surface.  
Cause yellowing and falling of leaves.  
Stems and branches are also affected  
Splitting of barks and subsequent death of the branches occur.

## Spread and Survival

Air borne conidia  
Infected plant debris and weed host

## Management

Sulphur dust 20-25 kg/ha  
Tridemorph 0.1%

### **4. Bacterial leaf spot : *Xanthomonas jasminii***

#### Symptoms

Water soaked lesion on upper surface of leaves lesion.  
Enlarge in size and yellowish green colour  
Spots are confined and eruptive in nature.  
Severe case defoliation occur.

#### Management

Removal of affected leaves  
Spraying Antilrecterial antiliotic.

### **5. Phyllody : *Phytoplasma***

#### Symptoms

Affected plants are bushy  
Leaves are small, malformed and closely arranged.  
Fragrant flowers are converted into green leaf like structure.

#### Transmitted by

Grafting and by whitefly  
*Dialeurodes kirkaldii*

#### Management

Vector control with any systemic insecticide  
Cuttings should be from disease free plants  
Spraying tetracycline reduce disease severity.

## DISEASES OF MARIGOLD

1. Leaf spot : *Septaria tagietcola*
2. Wilt and stem rot : *Phytophthora cryptogea*
3. Bacterial blight : *Xanthomonas tagetis*
4. Mosaic : *Virus*

### 1. Leaf spot : *Septoria tageticola*

#### Symptoms

Oval to irregular, smoky grey to black spots  
Minute black fruiting bodies on the leaflets  
Infection start from lower leaves and progresses upwards.

#### Spread

Air borne conidia

#### Survival

Infected plant debris

#### Management

Spraying 0.25% copper oxychloride or dithiocarbamates.

### 2. Wilt and stem rot : *Phytophthora cryptogea*

#### Symptoms

Stem become brown  
Shrivel near soil line  
Causing root decay  
Foliage wilts and the whole plant dies.

#### Spread

Primary infection through zoospores

#### Survival

Survive as oospore

#### Management

Removal of infected plants  
Drenching 1% Bordeaux mixture (or) 0.2%. COC.

### 3. Bacterial blight : *Xanthomonas tagetis*

## Symptoms

Minute light green water soaked lesions on the old leaf.  
Heavy infections cause severe drying and defoliation.

## Management

Removal of affected plant parts  
Spraying any Antibacterial antibiotic

### 4. Mosaic : *Virus*

## Symptoms

Mosaic mottling at early stage  
Leaf lamina distorted  
Plants remain stunted and produce poorly developed flowers

**Vector :** *Aphis craccivora*, *Aphis gossypii*, *Myzus persicae*

## Management

Removal of affected plants.  
Control vector by spraying any systemic insecticides.

## DISEASES OF DAHLIA Spp.

- |                        |   |   |
|------------------------|---|---|
| 1. Wilt                | : | <i>Verticillium albo-atrum</i><br><i>Fusarium sp.</i> |
| 2. Powdery mildew      | : | <i>Erysiphe cichoracearum</i>                         |
| 3. Leaf spot (or) smut | : | <i>Entyloma dahliae</i>                               |
| 4. Mosaic              | : | <i>Virus</i>  |

- |         |   |   |
|---------|---|---|
| 1. Wilt | : | <i>Verticillium albo-atrum</i><br><i>Fusarium sp.</i> |
|---------|---|---|

## Symptoms

Drooping of leaves  
Reddish brown or black discolouration of conductive vessels

## Management

Use healthy tuber  
Pull out and destroy infected plants  
Treat the tuber with 0.1% Carbendazim before planting  
Drench 0.1% Carbendazim after planting.

## **2. Powder mildew : *Erysiphe cichoracearum***

### **Symptoms**

Occur during September and October  
Lower leaves covered with white ash grey mold  
Leaves distorted and fall

### **Management**

Spraying 0.2% wettable sulphur or 0.07% Karathane.

## **3. Leaf spot or Smut : *Entyloma dahliae***

### **Symptoms**

Yellowish green flecks on lower leaves.  
Spots become circular or angular.  
Necrotic centre produce shot hole symptom  
Leaves shrivel and die  
Petioles may also affected.

### **Spread**

Spread through irrigation water

### **Survival**

Survive as chlamydospores in soil and leaf debris

### **Favourable conditions**

Deficiency of lime  
High humidity  
Late planting

### **Management**

Spraying 1% Bordeaux mixture or zineb or copper oxychloride 0.2%.

## **4. Mosaic : *Virus***

Dahlia mosaic virus and cucumber mosaic virus are the causal agents.

### **Symptoms**

Leaves become mosaic and mottling produce vein clearing symptom also

Leaves are dwarfed

**Vector**

Aphids : *Myzus persicae*, *Aphis gossypii*, *Aphis fabae*

**Management**

Disease free tuber

Rogueing of infected plants

## POST HARVEST DISEASES OF FRUITS AND VEGETABLES

### DISEASES OF FRUITS

#### MANGO

##### 1. Stem end rot or

Stalk end rot : *Botrytis theobromae*

2. Anthracnose : *Colletotrichum gloeosporioides*

3. Aspergillus rot : *Aspergillus niger*

4. Rhizopus rot : *Rhizopus* spp

1. Stem end rot or Stalk end rot : *Botrytis theobromae*

##### Symptoms

Light brown spots near pedicel.

Spot enlarge form brownish black patches

Under favourable conditions pycnidia form on the skin

2. Anthracnose : *Collectotrichum gloeosporioides*

##### Symptoms

Black round, irregular sunken spots on the skin.

Extend to whole surface during ripening.

Produce acervuli.

3. Aspergillus rot : *Aspergillus niger*

##### Symptoms

Occur during mechanical injury.

Sunken rotting areas on fruits

Advanced stage conidial head seen.

4. Rhizopus rot : *Rhizopus* spp

##### Symptoms

Soft watery rot with strands of mycelium

Crack develop with slight pressure.

##### Management

Regular pre harvest spray schedule mancozeb 0.25%

Hot water treatment 50-55°C for 15 minutes

Dipping fruits in suitable fungicide as post harvest treatment.

#### BANANA

1. Anthracnose : *Gloeosporium masarum*

2. Black-Tip : *Botrytis cinerea*

3. Crown rot : *Ceratocystis paradoxa*

1. Anthracnose : *Gloeosporium musarum*

##### Symptoms

Light brown depressed lesion

Coalesce and cover the whole fruit

Severe case pink spore masses on fruit

2. Botryodiplodia rot – Black tip –Finger tip rot – Black rot

*Botrytis cinerea*

##### Symptoms

Downward rotting of bunch

Dropping of fingers

Extensive finger rot is a common symptom from the tip to main stalkend.

Dark brown skin, wrinkled with pycnidia

Rotting of pulps.

3. Crown rot or Pine apple disease : *Ceratocystis paradoxa*



## Symptoms

Main stalk decay rapidly  
Tissue become blackened  
Emit pineapple odour

## Management

Reduce inoculum level orchard sanitation, removal of flower erect, tipping or removal of floral remnants.  
Harvest at correct stage.  
Careful handling during storage.  
Post harvest spray with mancozeb 0.2% or carbendazim 0.1% before storage.  
Store at 12-13°C varie to variety to variety below this temperature cause chilling injury.

## CITRUS

1. **Blue mould** : *Penicillium italicum*
  2. **Green mould** : *Penicillium digitatum*
  3. **Brown rot** : *Phytophthora* spp
  4. **Stem end rot** : *Phomopsis citri*
  5. **Anthraxnose** : *Colletotrichum gloeosporioides*
1. **Blue mould**, 2. **Green mould** : *Pencillium* spp.

## Symptoms

Soft watery spot  
Initially white mycelial growth  
Later develop blue or green mold.  
Spore masses are powdery or velvety.  
Fruits shrink and mummified.  
In case green mold when fruits are wrapped the wrappers stick to the fruit.  
This will not happen in Blue mold.

3. **Brown rot** : *Phytophthora* spp

## Symptoms

Fruits near ground level mostly affected.  
Dull white or brown colour discolouration  
Affected rind is leathery and gradually soften  
Fungus restricted to rind due to acidic.  
Emit aromatic odour

4. **Stem end rot** : *Phosmopsis citri*

## Symptoms

Leathery rind  
Softening of the pulp  
Disease start from stem end or from side  
Affected rind turn brown or black colour  
Immature fruits are more susceptible.

5. **Anthraxnose** : *Collectotrichum gloeosporioides*

## Symptoms

Red spots on the skin  
Subsequently rotting occur due to latent infection.

## Management

Good Sanitation  
Pruning branches 3 feet above ground level.  
Pre harvest treatment with copper fungicide

Hot water treatment for 2-4 min at 115-120°F, 36 hour after picking (or)  
Soaking in warm solution (43°C) or soak in Borax or sodium carbonate solution.

Wrapping fruits paper impregnated with fungicidal solution.

## **GRAPES**

**Grey mould rot** : *Botrytis cinerea*

### **Symptoms**

Skin condensed from flesh and gets separated  
Skin become brown  
Flesh becomes soft and watery  
Decay and foul smell noticed.

### **Management**

Fumigate the basket with sodium sulphide  
Transport in refrigerator van (4°C)  
Store the fruit at 0°C.

## **PAPAYA**

**1. Rhizopus rot** : *Rhizopus stolonifer*

**2. Anthracnose** : *Colletotrichum* spp

**3. Botryodiplodia**

**fruit rot** : *Botryodiplodia theobromae*

**1. Rhizopus rot** : *Rhizopus stolonifer*

### **Symptoms**

Irregular, water soaked lesion  
Gradually enlarge and get covered  
White and dark brown fungal growth  
Finally fruit collapse.

**2. Anthracnose** : *Colletotrichum* spp

### **Symptoms**

Brown superficial discolouration on the skin later develop into circular slightly sunken area.  
Lesion coalesce and white mycelial growth appear  
Salmon pink spore masses on the fruit.

**3. Botryod : plodia fruit rot** : *Botryodiplodia theobromae*

### **Symptoms**

Initially produce water soaked spots  
Black and have a rough surface later  
Eruptive, confluent arrangement of pycnidia.

### **Management**

Orchard sanitation  
Preharvest spray with 0.2% mancozeb or Bordeaux mixture 1%.  
Storing fruit at 10°C.  
Hot water treatment at 49°C for 20 minutes.

## **GUAVA**

**1. Phoma rot** : *Phoma psidi*

**2. Botryodiplodia rot** : *Botryodiplodia* spp

**3. Phytophthora rot** : *Phytophthora parasitica*

**1. Phoma rot** : *Phoma psidi*

### **Symptoms**

Brown coloured spots of fruits  
Centre of the spot gradually depressed

Water soaked lesion around the margin  
 Pycnidia develop in the centre of the spot.  
 Creamy colour ooze from the infected portion.

**2. Botryodiplodia rot** : *Botrydiploidia* sp

**Symptoms**

Brown discolouration at the stem end.  
 Gradually proceeds downwards with wavy margin.  
 Advanced stage pycnidia produced on injection region.

**3. Phytophthora rot** : *Phytophthora parasitica*

**Symptoms**

Dark brown circular spots on fruits  
 Spots extend and cover whole surface.  
 Infected fruits are shed prematurely.  
 Do not show superficial mycelial growth except in humid atmosphere.

**Management**

Orchard sanitation  
 Preharvest spraying with mancozeb 0.2%  
 Arrest tea mosquito bug infestation.  
 Careful handling.  
 Storage at 15°C.

**APPLE**

- 1. Soft rot or blue mould** : *Penicillium expansum*
- 2. Bitter rot** : *Glomerella cingulata*
- 3. Grey mould** : *Botrytis cinerea*
- 4. Phytophthora rot** : *Phytophthora cactorum*

**1. Soft rot or blue mould** : *Penicillium expansum*

**Symptoms**

Rotted area light in colour.  
 Soft and watery texture.  
 Rotted area advances, does not sunken.  
 Grey-blue cushion fruiting bodies on the diseased skin.

**2. Bitter rot** : *Glomerella cingulata*

**Symptoms**

Faint, light brown discolouration beneath the skin.  
 Discolouration increase and extends in a cone shaped mannure  
 Rough, circular lesion becomes depressed.  
 Tiny, raised black dot appear beneath the cuticle.  
 They give rise to acervuli which break cuticle.  
 Entire fruit becomes rotted.  
 Rotted fruit drop and mummified.

**3. Grey mould** : *Botryis cinerea*

**Symptoms**

Translucent watery light brown to dark brown spots.  
 Spread by contact.

**4. Phytophthora rot** : *Phytophthora cactorum*

**Symptoms**

Irregular outlined rotted surface.  
 Flesh turn pale to brown  
 Affected portion may become spongy and water soaked.

## Management

Orchard sanitation, pre harvest spraying with Benomyl 500 ppm or 0.25% COC precaution in picking, grading and packing.

Discard injured fruits.

Adopt proper cold storage 0°C-1.6°C.

Fruit should be wrapped with wrapper treated with double boiled linseed oil

Post harvest dipping in 500 ppm aureofungin for 20 minutes or benomyl 1000 ppm.

## VEGETABLES

1. Alternaria rot : *Alternaria tenuis*
2. Phoma rot : *Phoma desituctiva*
3. Phytophthora rot : *Phytophthora infestans*
4. Bacterial soft rot : *Erwinia carotovora*

1. Alternaria rot : *Alternaria tenuis*

### Symptoms

Brown to black lesion with definite margin.

Lesion slightly sunken in advanced stage.

Mould growth on the lesion.

2. Phoma rot : *Phoma destructive*

### Symptoms

Slightly sunken brown spots at the edge of stem scar.

Spots extends and become circular.

In the center of the spot brown to black pycnidia form.

3. Phytophthora rot : *Phytophthora infestans*

### Symptom

Affected area less firm, water soaked.

White fungal growth in advanced stage.

4. Bacterial soft rot : *Erwinia carotovora*

### Symptoms

Depressed water soaked spots

Spots enlarge become soft and watery.

Emit foul odour

### Favourable conditions.

High moisture

High temperature

Vegetables harvest with wounds

Latent infection

Chilling injury.

## Management

Good agronomical practice

Good sanitation

Careful handling of vegetables

Harvest at correct stage

Preharvest spraying with 0.25% Mancozeb before 10 days of harvest.

## MUSHROOM

Mushroom is a fleshy fruiting body of some fungi arising from a group of mycelium buried in substratum. Most of the mushrooms belong to the Sub- Division: Basidiomycotina and a few belong to Ascomycotina. In general, the fungi are put under a separate Kingdom: protist and are divided further as follows:

In Basidiomycotina, three types of mycelia viz., primary, secondary and tertiary, are noticed. The primary mycelium is monokaryotic and is formed by germination of Basidio-spores. These are of different mating types and give rise to secondary mycelium by somato-gamy or fusion of two basidiospores or spermatization of two female sex organs. The secondary mycelium forms major portion of the somatic phase and later produces tertiary mycelia, which give rise to fruiting body- basidiocarp (Mushroom).

Mushrooms and toadstools are included under Agaricals. Their fruiting bodies are like umbrella, found in every country from snowy mountains to sandy deserts on all types of soils, pastures, forests, wastelands and cultivable lands. Naturally they appear in all seasons, chiefly during rainy season, as the conditions favour the development of fruiting bodies from the buried mycelia. The edible fruiting bodies are called mushroom and poisonous ones are called as toadstools. The word “toadstool” in fact, is a distortion of the German word ”Toadestuhl”, which means “ death chair”. Moreover, the name of the “mycology” was given to the “study of mushrooms” (Mykes = mushroom). In addition, some fungi belong to Ascomycotina (Class: Discomycetes, Order: Pezizales and Family: Morchellaceae) also produce fleshy fruiting bodies which are used as food. They are commonly called as Morels and Truffles. Species of Morchella and Tuber are such edible fungi under this sub division. In Tuber, the cup-shaped fruiting body is infolded and resembles like potato and hence called Tuber. In Morels, the cup is infolded and convoluted like a sponge, hence called as Sponge mushroom.

It is reported that there are about 50,000 known species of fungi and about 10000 are considered as edible ones. Of which, about one hundred and eighty mushrooms can be tried for artificial cultivation and seventy are widely accepted as food. The cultivation techniques were perfected for about twenty mushrooms and about dozen of them have been recommended for commercial cultivation. However, only six mushrooms are widely preferred for large-scale cultivation. They are

- 1) Paddy straw mushroom - Volvariella spp.
- 2) Oyster mushroom - Pleurotus spp.
- 3) Button mushroom - Agaricus spp.
- 4) Milky mushroom - Calocybe spp.
- 5) Shiitake mushroom - Lentinus spp.
- 6) Jew's ear mushroom - Auricularia sp.

### Morphology of Mushroom

The mycelium of the fungus is present in the substratum and produce fruiting bodies when the conditions are conducive. The fruit bodies begin as tiny knob of tissue arising from the under ground mycelium. It grows into a button, which later enlarges to form a well-developed fruiting body. The fruiting body of the mushroom consists of a stem( Stipe), which supports as expanded, umbrella-shaped cap(Pileus).

On the under side of the umbrella are the gills or lamellae, which in the young stage are enclosed by a membrane that extends from the margin of the pileus to stipe. This membrane is known as Partial veil and usually tears around the margin of the pileus as the latter expands but remains attached to the stipe where it forms a ring (Annulus). In some mushrooms, the young buttons are covered by a membrane called Universal veil or General veil. When the cap expands, the veil is torn and the remnants at the base form Volva and some of the fragments remain attached to the pileus surface.

## EDIBLE AND POISONOUS MUSHROOMS

Natural mushroom flora contains both edible and poisonous types and so far no well perfected technique available to distinguish edible ones from poisonous ones. Some of the criteria suggested by mycologist for general classification is given below

Character	Edible mushroom	Poisonous mushroom
COLOUR	White or Grey	Ornamental
SCALES	Absent	Present
SMELL	Pleasant smell	Unpleasant smell
COOKING :		
Using silver spoon	No change in the color of spoon	Color of spoon changes to black
Cooking with onion	No color change in onion	Color of onion changes to black
Presence of Latex	Absent	Present
Presence of tough volva	Absent	Present

The above said characters may not fully correct to identify the edible/ poisonous mushrooms as some of the edible mushrooms are also brightly coloured with some ornamentations, scales and pleasant odour. Similarly, some of the white coloured ones are also poisonous, without scales and having pleasant smell. Some of the edible mushroom also has a prominent volva. Hence, only the experienced mycologist who involves in the mushroom work can easily differentiate the poisonous and edible ones.

## IMPORTANCE OF MUSHROOM CULTIVATION

### 1) Highly Nutritious food

Mushroom is considered to be as a complete and safest food and suitable for all age groups, child to aged people. It is one of the good sources of Protein, which contains less of carbohydrate and fat. The most population in India suffers due to protein- malnutrition, as sufficient requirement of proteinaceous supplement is not available in daily diet. The protein consumption in India is far below the International level and the various developmental programmes were aimed to increase the Pulse grain production, which are the main sources of protein. In recent years, the importance of mushroom as a good source of protein is much felt and lot of emphasis is being given for popularization of cultivation as a commercial venture to augment the protein supply.

The mushrooms contain as high as 30 per cent protein by dry weight, contain less of fat and carbohydrate. So this is a very good food for the people who suffer from hypertension and diabetics. Because of its high fibre content, it is a very good diet for people who suffer from constipation and peptic ulcers. In addition, all mushrooms contain almost all-essential amino acids like leucine, isoleucine, valine, tryptophan, lysine, threonine, phenylalanine and methionine. These are also considered as a good source for several vitamins like thiamine, riboflavin and niacin, and essential minerals like calcium, phosphorus, iron, sodium and potassium. In addition, active principles are also extracted from poisonous mushrooms to cure several diseases in medical science.

#### Nutritive value of mushrooms (Fresh weight basis)

Protein	-	2.90 %	Fibre	-	1.10 %
Fat	-	0.37 %	Ash	-	1.10 %
Carbohydrate	-	5.36 %	Calories	-	33.90 / Kg

#### Comparative statement on Protein content of mushroom with other food items

Mushroom	-	2.9 %
Peas	-	2.6
Cabbage	-	1.5
Carrot	-	1.1
Cauliflower	-	2.7
Potatoes	-	2.1
Apple	-	0.3
Banana	-	1.1
Rice	-	0.7
Wheat	-	1.3
Soybean	-	3.9
Milk	-	2.5

## 2) Recycling of farm residues

Mushroom cultivation is much useful in recycling of organic waste like paddy straw and other farm residues for better utilization as substrates for growing mushrooms. The spent waste of the substrates is used as very good manure enriched with the nutrients. In addition, the mushroom spawn can be successfully used for decomposing coir pith as an enriched manure. The straw substrate after harvesting mushroom can be better utilized as a nutritive cattle feed.

## 3) Additional income

Mushroom culture is one of the important components of Integrated Farming System and farmer/ farmwomen can get additional income from the mushroom culture by utilizing the lean seasons/ leisure hours to increase his economic status.

## 4) Solves unemployment Problems

The mushroom culture serves as a low investment venture for the Unemployed graduates. Mushroom cultivation can be started with a very minimum capital investment and it does not need any sophisticated equipment/ techniques. So it is a very profitable venture for the persons interested in self-employment.

## 5) New food products development

The mushroom cultivation encourages the development of new food products and gives chances of employment for the people involved in the new industries/ commercial units. The some of the new food products developed using the mushroom are canned mushrooms, Mushroom soup powder, papads, noodles and pickles etc.

## 6) Increases foreign revenues

The potential for export of new food products of mushroom is really felt by the mushroom growers and a large quantities of button mushroom is exported to foreign countries like U.S.A. and other European countries to get foreign exchanges. In addition, great demands for the mushroom pickles and mushroom papads are noticed in other countries.

## 7) Used as medicines

Because of very low fat content, it is very good food for hypertension patients. It also serves as a very safe food for Diabetic people because of its low carbohydrate content. In addition it cures peptic ulcers and constipation because of the more fibre content in the mushrooms. The continuous uptake of *L.edodes*, *F.velutipes* and *A.bisporus* critically reduces the blood cholesterol level.



Several alkaloids and extracts obtained from the mushrooms act as medicines for curing several ailments. Anti tumour principles are reported to present in *Agaricus bisporus*, *Lentinus edodes*, *Pleurotus ostreatus* and *Flamulina velutipes*. The alkaloids from *Agaricus campestris* also act as anti bacterial compounds, some of the extracts like 'Lentinan' and 'rentinan' from *L. edodes* cures cancer and it also reported that the continuous use of this mushroom is very effective in reducing the HIV population to recover from AIDS syndrome. It is also used as a liver protectant.

## **PREPARATION OF BASE SPAWN**

Base spawn / Nucleus culture:

Tissue culture technique is used to bring the edible mushroom to pure culture so that the mushroom fungus can further be used to prepare spawn, which is an essential material for mushroom cultivation. This nucleus culture is grown on Potato Dextrose Agar medium in test tubes. A small tissue from a well-grown mushroom is aseptically transferred to agar medium in a test tube in a culture room. The test tubes are incubated under room temperature for 10 days for full white growth of fungal culture. This is further used for preparation of Mother spawn.

Procedure:

- i) Select well grown, disease free oyster mushroom early in the morning and keep it on a clean paper for 2-3 hr. to get certain amount of moisture present in the mushroom to get evaporated.
- ii) Clean the culture room/ laminar flow chamber with antiseptic solution.
- iii) Keep the sterilized PDA slants, razor blades, forceps etc. inside the chamber and put on the UV light.
- iv) After 20 minutes put off the UV light and start working after 5 minutes.
- v) Sterilize all the instruments to be used by exposing to Bunsen burner.
- vi) Take in the mushroom and split open the mushroom longitudinally into two halves.
- vii) Using a new, sterilized blade cut a small piece of tissue from the centre of the split mushroom at the junction of pileus and stipe.
- viii) Remove the cotton plug of the agar slant and the tissue is aseptically placed inside the slant by using a sterilized forceps and close it immediately.
- xi) After transferring tissues from the mushroom, the tube are arranged in a wire basket and kept in a clean room at room temperature for the growth of the fungus.
- xii) Observe the tube at periodical intervals and remove the contaminated ones. The tubes will be ready for further use within another ten days. The base spawn is used for preparation of mother spawns.

Precautions to be observed:

Wash the hands with antiseptic lotion before start working inside the chamber. If possible, it is better to use hand gloves while operation.

It is better that the maximum of two persons may work inside the room at a time. Avoid unnecessary talking while working inside the room.

While separating the tissue from the centre of the mushroom it should not touch the bottom or sides of the mushroom.

## **PREPARATION OF MOTHER SPAWN**

Mother spawn:

Mother spawn is nothing but the mushroom fungus grown on a grain based medium. Among the several substrate materials tested by TNAU, Coimbatore, sorghum grains are the best substrate for excellent growth of the fungus. Well-filled, disease- free sorghum grains are used as substrate for growing the spawn materials. The various steps involving in preparation of mother spawn are listed below here under.

- i) Wash the sorghum grains in water thoroughly to remove chaffy and damaged grains.
- ii) Cook the grains in an autoclave / vessel for 30 minutes just to soften them.
- iii) Take out the cooked grains and spread evenly over a Hessian cloth on a platform to remove the excess water.
- iv) Mix Calcium carbonate ( $\text{CaCO}_3$ ) thoroughly with the cooked, dried grains @ 20 g / Kg .
- v) Fill the grains in polypropylene bags up to 3/4th height (approximately 300-330 g / bag), insert a PVC ring , bold the edges of the bag down and plug the mouth tightly with non-absorbent cotton wool.
- vi) Cover the cotton plug with a piece of waste paper and tie tightly around the neck with a jute thread.
- vii) Arrange the bags inside an autoclave and sterilize under 20-lbs. pressure for 2 hours.
- viii) Take out the bags after cooling and keep them inside the culture room and put on the UV light.
- ix) After 20 minutes put off the UV light and start working in the culture room. Cut the fungal culture into two equal halves using a inoculation needle and transfer one half portion to a bag. Similarly, transfer another half portion of the culture to an another bag.
- x) Incubate the inoculated bags in a clean room under room temperature for 10 days

for further use to prepare bed spawn.

Note: The purpose of mixing Calcium carbonate is i) to remove the excess moisture present in the cooked grains, ii) to neutralize the pH of the grains and iii) to avoid caking of grains after sterilization.

Precaution to be observed:

Avoid over cooking of sorghum grains, as over cooking lead to splitting of grains.

Don't dry the cooked grains on the floor. Always dry over hessian cloth spread on a raised platform

Use only recommended dose of  $\text{CaCO}_3$  for mixing with the cooked grains. Mixing over dose reduces the fungal growth in the inoculated bags.

### **PREPARATION OF BED SPAWN**

Bed spawn:

The method of preparation of bed spawn was same as that of mother spawn. The cooking, filling and sterilization were similar to that of mother spawn. After sterilization, the bags are taken for inoculation.

Procedure:

- i) The sterilized bags are placed inside the culture room and put on the UV light.
- ii) After 20 minute put off the UV light and take in the well-grown mother spawn.
- iii) Transfer spawn from the mother spawn to sterilized bags @ 10 g per bag.
- iv) After inoculation the spawn bags are kept in a clean room for fungal growth. (This is first generation of bed spawn)
- v) Use the bed spawn after 10 days of inoculation for bed preparation.
- vi) Sub culture the first generation bed spawn as mother spawn to produce one more generation, which is second generation bed spawn.

Precautions to be observed:

Avoid over cooking of sorghum grains, as over cooking lead to splitting of grains.

Don't dry the cooked grains on the floor. Always dry over hessian cloth spread on a raised platform

Use only recommended dose of CaCo<sub>3</sub> for mixing with the cooked grains. Mixing over dose reduces the fungal growth in the inoculated bags.

Avoid further sub culturing of the second generation bed spawns. This leads to lose of virulence of the spawn lead to reduced yield and repeated sub culturing lead to complete lose of virulence wherein the fungal growth may be noted in the beds but no buttoning is completely arrested.

### **OYSTER MUSHROOM- Preparation of substrates and sterilization**

*Pleurotus* spp. can be grown indoors and any well-ventilated room would be suitable. A thatched shed with false roofing is an ideal room for successful cultivation of this mushroom, as the required temperature pf 20-25° and relative humidity of 80-85 % cab easily be maintained.

Preparation of substrate:

In the cultivation of oyster mushroom, most cellulosic farm waste is used as substrate. These include paddy straw, corncobs, bagasse, banana leaves, leaf litters of various kinds, waste paper, cotton waste etc., Among them, paddy straw is found to be the best substrate giving more bio efficiency. Paddy straw is chopped into bits of size 2-3” for easy handling and operation.

Sterilization of substrate:

There are three methods with which the chopped straw can be sterilized. Any one method can be adopted based on the facilities available.

Hot water treatment/ Boiling method:

- i) Soak the chopped paddy straw in cold water for 4 hr in a G.I. Drum..
- ii) Drain the water and add fresh water and cover the drum with gunny sac.
- iii) Boil the contents over the flame for one hr.
- iv) After boiling, take out the straw and drain the excess water by keeping then in wire baskets.
- v) Spread the straw as thin layer on a hessian cloth, spread on a raised platform.
- vi) Shade dry the straw to get 60-65 % moisture capacity.

2. Steaming:

- i) Soak the chopped paddy straw in cold water for 4 hr in a G.I. Drum..
- ii) Drain the water and take straw out and fill it in big wire baskets.
- iii) Keep the wire baskets in an autoclave and put on the autoclave and allow it to steam for 1 hr.

iv) After steaming, take out the straw and drain the excess water by keeping then in wire baskets.

v) Spread the straw as thin layer on a hessian cloth, spread on a raised platform.

vi) Shade dry the straw to get 60-65 % moisture capacity.

### 3. Chemical method:

i) Take 100 litre of clean cold water in a 200-litre G.I. drum and mix 10 g of carbendazim and 120 ml. of formalin.

ii) Weigh 10 kg of dry straw and soak in the solution and cover it air tight with a thick polythene sheet.

iii) Soak the straw in the chemical solution for 16 hr. .

iv) After soaking, take out the straw and drain the excess chemical solution by keeping then in wire baskets.

v) Spread the straw as thin layer on a hessian cloth, spread on a raised platform.

vi) Shade dry the straw to get 60-65 % moisture capacity.

### Precautions to be observed:

i) The straw should not be dried on a floor.

ii) The hessian cloth should be disinfected Dettol or any disinfectant before use.

iii) In the case of chemical treatment, the doses of the chemical should not exceed the recommended level.

iv) The 60 % moisture content in the straw can be judged by taking a handful of straw and squeeze it tightly. The water should not drip out and the palm can feel the wetness of the straw.

### OYSTER MUSHROOM – BED preparation

The cultivation of oyster mushroom is usually carried out in transparent polythene covers. The size of the cover should be 60 x 30 cm, with a thickness of 80 gauge.

#### Procedure:

i) Wash hands thoroughly with antiseptic lotion.

ii) Take the polythene cover and tie the bottom end with a thread and turn it inwards.

iii) Mix the dried straw thoroughly to get a uniform moisture level in all areas.

iv) Take out a well-grown bed spawn, squeeze thoroughly and divide into two halves.

(Two beds are prepared from the single spawn bag)

v) Fill the straw to a height of 3" in the bottom of polythene bag, take a handful of spawn and sprinkle over the straw layer, concentrating more on the edges.

vi) Fill the second layer of the straw to a height of 5" and spawn it as above.

vii) Repeat this process to get five straw layers with spawns.

viii) Gently press the bed and tie it tightly with a thread.

ix) Put 6 ventilation holes randomly for ventilation as well as to remove excess moisture present inside the bed.

x) Arrange the beds in side the thatched shed, (Spawn running room) following Rack system or Hanging system.

xi) Maintain the temperature of 22-25° C and relative humidity of 85-90 % inside the shed.

xii) Observe the beds daily for contamination, if any. The contaminated beds should be removed and destroyed.

xiii) Similarly, observe regularly for the infestation of insect pests viz., flies, beetles, mites etc., If noticed, the pesticide like Malathion should be sprayed in side the shed @ 1 ml per litre of water.

xiv) The fully spawn run beds can be shifted to cropping room for initiation of buttons.

Precautions to be observed:

i) Keep the spawn running room dark so that spawn running will be faster.

ii) Periodically place Rat-baiting to kill rats as they are attracted by the spawn.

iii) Periodically sprinkle water on sand layer to maintain the required conditions.

iv) Never spray any insecticides on the mushroom beds.

### OYSTER MUSHROOM - CROPPING, harvesting and packing

The fully spawn run beds should be transferred to cropping room in the thatched shed, where the diffused light and good ventilation are necessary for the button development.

There are different methods to handle the spawn run bed to initiate button development. They are

1. Open bed method, wherein the polythene cover is completely removed and allowed for cropping.

2. Closed bed method, wherein the polythene cover is intact and buttons will come out through the holes made of pierce through the cover.
3. Half cover open method, wherein the one half of the polythene cover is removed for cropping and second half after first harvest.
4. Stripe method, wherein the polythene cover as longitudinal strips of 5-cm breadth at 4-5 places in the bed.
5. Tear method, wherein the polythene cover is teared longitudinally at several places.
6. Round opening method, wherein the round shaped openings of 5 cm diameter are made at random.

However, among all the methods of opening of beds, complete removal of the polythene cover is found to give more yields than others. The steps followed in full opening of bed are described below:

Procedure:

- i) Use a new blade and cut the polythene covers and remove fully.
- ii) Allow the bed to dry for a day, as freshly opened beds contain more moisture.
- iii) Spray water on the beds from second day of opening using an atomizer.  
( Based on the condition, two to three sprays are necessary daily and never allow beds to dry completely))
- iv) Observe the beds regularly and bed, if any, showing contamination should be removed.  
(Two to three days after opening pinheads of mushroom button develop which will be ready for harvest with in another 4 days)
- v) Harvest the entire bunch of mushroom gently in the early hours of morning.
- vi) Remove the straw bits adheres to the mushroom and cut off the bottom portion of the stalk.
- vii) Pack neatly in a polythene cover @ 200 g per bag and put a few ventilation holes.
- viii) Keep them in an icebox and send to sales unit immediately.  
( The freshly harvested and packed mushrooms can be kept in a refrigerator, if mushroom to be sold next day)
- xi) After harvest, scrap out the mushroom bed with a new comb to remove dried and rotten buds of mushroom.
- xii) Spray the beds daily, based on the conditions of the beds two to three sprays may be needed.  
( Second harvest can be done 7-10 days after the first harvest)
- xiii) After second harvest, scrap out the outer layers as above and spray water regularly.  
(Third harvest can be had after a week or ten days).
- xiv) Dispose the beds after third harvest as it is uneconomical to keep the beds further.

Precautions to be observed:



- i) Always maintain the optimum temperature of 23-25° C and relative humidity of 80-85% inside the shed.
- ii) Never pour water on the beds, which leads to complete rotting of young developing buds.
- iii) Spray water on the beds only after harvesting the mushroom.
- iv) Always harvest the mushroom in the morning and pack them immediately.
- v) If the closed bed system or other partial opening methods is followed, it is better to wet the sand layer frequently to maintain the temperature and relative humidity)

## POST HARVEST PROCESSING

Mushrooms are best consumed as fresh. However, in actual practice this is may not be possible. The storage at high temperature results in browning. Mushrooms have a high rate of respiration and hence proper attention should be given for storage. Some of the commonly adopted methods are described hereunder:

### 1) Refrigeration/ Instant packing:

Freshly harvested mushrooms are packed in 25 gauge polythene bags with 2-4 pinholes. Immediately after packing they are stored at 5° C in a refrigerator. This process extends the storage life for 3-5 days. This process helps in reducing the respiratory rate and minimizing the water loss. In addition, it reduces browning of mushroom and off flavour development.

### 2) Freeze-drying:

The mushrooms are sliced and immersed in 0.05 per cent sodium meta bisulphite and 2 per cent common salt solution for 30 minutes. They then blanched in boiling water for 2 minutes, followed by cooling. This then frozen for one minute at -12 ° C and store at -20 ° C. This process extends the storage life for 3-4 months.

### 3) Dehydration:

This treatment involves three steps viz., Pretreatment, drying and storage.

#### a) Pre treatment:

- i) Clean the mushroom and blanch it in boiling water for 2 minutes and immerse it in cold water for 2 minutes.
- ii) Dip the mushroom in water containing 0.2 per cent potassium meta bisulphite and 1 per cent citric acid and use for drying.

#### b) Drying:

- i) Sun drying: The pre treated mushroom is dried in open sunlight till it reaches 1/10th weight of the fresh product. After drying, it can be stored for

3 months, however colour may turn to brown and appearance of the final product is not good.

ii) Drying in flow drier: Dry the pre treated mushroom at 60° C with heated air for 6-8 hr. This process lead to bring the final moisture level to 3-5%.

iii) Vacuum drying: Dry the pre treated mushroom at 40° C under vacuum condition instantly. This process yield a very good quality mushrooms but cost of processing is heavy.

#### 4. Canning:

Canning is adopted on a very large scale, especially for preservation of button mushrooms. For canning purpose, the mushrooms should be harvested at an early stage. The mushrooms of uniform size are selected and stalks are cut before processing.

##### Procedure:

- i) Wash the mushroom in clean water to remove dirt and other foreign materials.
  - ii) Dip the mushroom in boiling water for 2 minutes, take it out and dip in cold water for 2 minutes.
  - iii) Fill the mushrooms in the specially made cans upto  $\frac{3}{4}$  capacity.  
(Approximately 220-g mushrooms are filled in 1-lb cans)
  - iv) Add salt solution consisting of 2 per cent common salt, 2 per cent sugar and 0.3 per cent citric acid just to fill up to the brim. ( Before adding, the salt solution should be boiled and filtered through muslin cloth)  
(Approximately 125 ml. solution is needed for 1 lb can).
  - v) Place the lid on the can and keep the cans in boiling water or steam till the temperature in the centre of the cans reaches 80-85° C.
  - vi) Seal the can on a seamer to get a air tight seam.
  - vii) Sterilize the cans in an autoclave at 10 lb. pressure for 20-25 minutes.
  - viii) Keep the cans immediately after sterilization in a clean cool water for cooling.
  - ix) Wipe the cans with a dry cloth and store in a cool dry place.
- This process extends the storage life up to 12 months.

## **MILKY MUSHROOM**

### **MILKY MUSHROOM – BED PREPARATION**

The cultivation of milky mushroom is usually carried out in transparent polythene covers. The size of the cover should be 60 x 30 cm, with a thickness of 80 gauge.

Procedure:

- i) Wash hands thoroughly with antiseptic lotion.
- ii) Take the polythene cover and tie the bottom end with a thread and turn it inwards.
- iii) Mix the dried straw thoroughly to get a uniform moisture level in all areas.
- iv) Take out well-grown bed spawn, squeeze thoroughly and divide into two halves.

(Two beds are prepared from the single spawn bag)

- v) Fill the straw to a height of 3" in the bottom of polythene bag, take a handful of spawn and sprinkle over the straw layer, concentrating more on the edges.
- vi) Fill the second layer of the straw to a height of 5" and spawn it as above.
- vii) Repeat this process to get five straw layers with spawns.
- viii) Gently press the bed and tie it tightly with a thread.
- ix) Put 6 ventilation holes randomly for ventilation as well as to remove excess moisture present inside the bed.
- x) Arrange the beds in side the thatched shed, (Spawn running room) following Rack system of hanging system.
- xi) Maintain the temperature of 22-25° C and relative humidity of 85-90 % inside the shed.
- xii) Observe the beds daily for contamination, if any. The contaminated beds should be removed and destroyed.
- xiii) Similarly, observe regularly for the infestation of insect pests viz., flies, beetles, mites etc., If noticed, the pesticide like Malathion should be sprayed in side the shed @ 1 ml per litre of water.
- xiv) The fully spawn run beds can be shifted to blue coloured tent after casing for initiation of buttons.

Precautions to be observed:

- i) Keep the spawn running room dark so that spawn running will be faster.
- ii) Periodically place Rat-baiting to kill rats as they are attracted by the spawn.
- iii) Periodically sprinkle water on sand layer to maintain the required conditions.
- iv) Never spray any insecticides on the mushroom beds.

## MIKLY MUSHROOM- CASING AND CROPPING

In the case of milky mushroom, an extra process called casing has to be done to induce button formation. After casing operation the beds should be arranged inside the Blue polythene covered pit tent for the growth of the mushroom. The fungus requires an optimum temperature of 30-35° C and relative humidity of 80-85 per cent for the better growth and production of sporocarp. In addition, the fungus needs a light intensity of 2500- 3000-lux for production of buttons, and the cased beds should be kept inside the blue tent.

### Casing:

Casing nothing but application of thin layer of sterilized soil on the surface of mushroom bed to induce buttons formation. For casing, garden land soil rich in calcium is preferable. Instead of that soil and river sand, mixed in equal proportion can also be used. Sometimes the soil is mixed with Calcium carbonate @ 100 g/ kg and used as a casing medium. The soil used for casing process should be free of stones and stubble and has to be sterilized before casing. The soil is taken in a mud pot or a vessel and steamed in an autoclave or pressure for 45 minutes. (Soil can also be mixed with a little quantity of water and sterilized for this purpose). The soil is used for casing after cooling.

### Procedure:

- i) Take the fully spawn run bed and cut horizontally into two equal halves.
- ii) Compact the beds as much as possible by pressing firmly with hand.
- iii) Apply casing soil to a height of 1 cm and press it gently.
- iv) Spray the water sufficiently to wet the cased soil.
- v) Place the beds inside the blue tent.
- vi) Observe the beds daily and spray water, if necessary, to keep the beds wet.
- vii) Watch for any contamination and insect pests. If noticed take necessary steps.  
( Ten after casing the small pin head buttons develop and with in another 7 days mushrooms are ready for harvest)
- viii) Harvest the mushroom, clean it and pack it in a polythene bag for sales.
- xi) Stir the top of the bed after first harvest and spray water regularly.  
(Second harvest can be obtained in another 10 days)
- xii) Disturb the topsoil after second harvest and spray water as regular.  
(Third harvest can be done after 10 days and for commercial cultivation a maximum of three harvests is recommended).

The mushroom yield of 350 –400 g can be obtained from 250 g dry weight of the straw, providing all optimum conditions inside the mushroom shed.

## PADDY STRAW MUSHROOM - SPAWN PREPARATION

### Mother spawn:

Mother spawn is nothing but the mushroom fungus grown on a substrate medium. In this case instead of sorghum grains chopped paddy straw as such are used for spawn preparation. The various steps involving in preparation of mother spawn are listed below here under.

- i) Cut the paddy straw into small bits and soak it in cold water for 30 minutes.
- ii) Take out the straw and spread evenly over a Hessian cloth on a platform and dry for 30 minutes.
- iii) Fill the straw in polypropylene bags up to 3/4th height, mix 10 g of horse gram powder, insert a PVC ring, bold the edges of the bag down and plug the mouth tightly with non-absorbent cotton wool.
- vi) Cover the cotton plug with a piece of waste paper and tie tightly around the neck with a jute thread.
- vii) Arrange the bags inside an autoclave and sterilize under 20-lbs. pressure for 1 hour.
- viii) Take out the bags after cooling and keep them inside the culture room and put on the UV light.
- ix) After 20 minutes put off the UV light and start working in the culture room. Cut the fungal culture into two equal halves using an inoculation needle and transfer one half portion to a bag. Similarly, transfer another half portion of the culture to another bag.
- x) Incubate the inoculated bags in a clean room under room temperature for 10 days for further use to prepare bed spawn.

Note: The purpose of mixing Calcium carbonate is i) to remove the excess moisture present in the cooked grains, ii) to neutralize the pH of the grains and iii) to avoid caking of grains after sterilization.

### Bed spawn:

The method of preparation of bed spawn was same as that of mother spawn. The cooking, filling and sterilization were similar to that of mother spawn. After sterilization, the bags are taken for inoculation.

#### Procedure:

- i) The sterilized bags are placed inside the culture room and put on the UV light.
- ii) After 20 minute put off the UV light and take in the well-grown mother spawn.

- iii) Transfer a little quantity of mother spawn from into the sterilized bags.
- iv) After inoculation the spawn bags are kept in a clean room for fungal growth. (This is first generation of bed spawn)
- v) Use the bed spawn after 10 days of inoculation for bed preparation.
- vi) Sub culture the first generation bed spawn as mother spawn to produce one more generation, which is second generation bed spawn.

Precautions to be observed:

Avoid over over soaking of paddy straw.

Don't dry the straw on the floor. Always dry over hessian cloth spread on a raised platform

Avoid further sub culturing of the second-generation bed spawns. This leads to lose of virulence of the spawn lead to reduced yield and repeated sub culturing lead to complete lose of virulence wherein the fungal growth may be noted in the beds but no buttoning is completely arrested.

## PADDY STRAW MUSHROOM - BED PREPARATION AND CROPPING

The cultivation of paddy straw mushroom can be done in a thatched house and also under the shade of a tree. Fresh , disease free paddy straw is the ideal substrate . Ten –fifteen kg paddy straw is necessary for preparing one bed. In recent years, it is cultivated inside plastic film houses to maintain the temperature of around 25 -35 ° C and relative humidity of 75-80 %.

Paddy Straw bundle method

Procedure:

- i) Prepare a raised platform of about 1 m in length and 0.75 m in breadth with a deal wood flanks and keep it over a support by arranging bricks on all four corners.
- ii) The paddy straw is bundled into to weigh about 8 kg each.
- iii) Soak the straw bundles in water for 12-18 hr.
- iv) Then bundles are taken out and drain the excess water
- v) Place the bundles over the platform with their butt end on one side.
- vi) Build the second layer by placing the butt end towards the other direction.  
(These 8 bundles make one layer of bed)
- vii) Place the a small quantity of spawn 8-12 cm inside the margin at an interval of 10-15 cm all along the periphery.
- viii) Apply a spoonful of coarsely powdered dhal powder before placing spawn.
- ix) Place the straw bundles at right angles to the previous layer in criss-cross fashion to make the third layer.

- x) Place the straw bundles with opposite butt ends to make fourth layer.
- xi) Spawn this layer as stated above.
- xii) Place another layer of straw bundles over this and do not apply spawn.
- xiii) Pressure the bed to make it as compact as possible and cover it with a transparent polythene sheet.
- xiv) Keep the beds undisturbed for for a few days.

Note: Usually the bed will have the necessary humidity, if the straw bundles are properly soaked. If moisture is found to be less, it may be watered using a rose can. On the other hand, if the moisture is found to be excess, polythene cover is to be partly to regulate the moisture. The success of cultivation depends upon the temperature and moisture in the bed. The optimum temperature of 30- 35 ° C is necessary for developing buttons.

The mushrooms start appearing from all sides in 6-10 days as tiny buttons, which can be harvested in another 4- 5 days. The harvesting is to be done at the button stage itself, since the opened sporocarp will be more fibrous. Usually, 1-2 kg of mushroom can be harvested from 10 kg substrate.

Paddy straw twist method:

Instead of bundled straw, twisted paddy straw can also be used for cultivation

Procedure:

- i) Make the straw into twists of about 5-8 m long and 5-10 cm diameter.
- ii) Immerse the twists in water for 12 hr.
- iii) Take out the straw and drain the excess water.
- iv. Place the place them lengthwise over a platform on a zigzag manner.
- v) Place a second over this in an opposite direction.  
(This forms the first layer of the bed)
- vi) Sprinkle the coarsely powdered dhal and place small bits of spawn all along the periphery as above.
- vii) Build another layer as described above and spawn the layer.
- viii) Build up 4-5 layers and spawn as usual.
- xi) Compact the bed by pressing and cover it with a polythene sheet.

## **BUTTON MUSHROOM - COMPOST PREPARATION**

The substrate for cultivation is specially prepared compost. The mushroom houses should have the facilities for temperature control and pasteurization. Buildings are constructed of wood or hollow cement bricks or double walls. The shed is partitioned into small compartments and provided with trays. Environmental conditions like temperature, relative humidity and ventilation are controlled inside the shed by installing suitable equipment.

Compost is the substrate in which the mushroom mycelium grows and on which it produces fruiting bodies. It is the product of a fermentation process brought out by a

number of mesophilic and thermophilic microorganisms that decompose plant residues and other organic and inorganic matters. The quality of compost influences the yield of mushroom. Compost prepared out of horse manure and wheat straw is ideal one. Since these materials are not easily available, many substitutes are suggested and are in use. There are two methods of composting, Long method and short method. The distinction is based on the time taken for composting and the long method needs three to four weeks, while the short method requires only 12 –15 days, since the composting process is hastened by pasteurization. In the long method of composting, pasteurization is avoided, which will make the compost poor in quality and often gives variable yields.

#### Long method :

The composting is done on a cement floor. It can be done in the open or under a roof, but sides are to keep open.

#### Natural compost:

This compost is traditionally prepared by using horse manure and the barn waste consisting of straw bedding of wheat or barley. These are taken in the proportion of 4:3 and to this mixture, generally 100 kg of chicken manure and 5 kg of urea are added per tonne of substrate. The manure is kept as heap of about one metre height and is regularly examined and turned down repeatedly when it emits ammonia smell. This is to be done for every three – four days. Finally every tonne 25-kg of gypsum is added.

#### Artificial compost:

Many formulae are available and ingredients to be used vary according to the locality and availability of materials. A widely used formulae in India is given below:

Wheat straw (chopped to 8-2- cm)	: 250 g
Wheat bran	: 25 kg
Ammonium sulphate or Calcium ammonium nitrate	: 4 kg
Urea	: 3 kg
Gypsum	: 20 kg

Chopped wheat straw is spread over the floor and water is sprinkled thoroughly to wet the straw. Mix all the ingredients except gypsum. Finally the mixture stacked to a height of one metre and compacted using wooden boards. This mixture is turned periodically on 5th, 10th, 14th, 18th, 22nd and 26th day. The gypsum is added in two equal splits on the 14th day and 18th day. It is advisable to add nematicides like nemagon on the 22nd day @ 40-50 ml per tonne of substrate. In mushroom houses where insect pests are also a problem, 10-15 ml of Malathion is also added during the final turning and sufficient quantity of water is also added on the heap.

#### 2. Short method:

The short-term compost involves two phases of operation, Outdoors composting and Steam pasteurization.



The commonly used formula is give below:

Chopped wheat straw	: 100 kg
Chicken manure	: 400 kg
Barley	: 72 kg
Urea	: 14.5 kg
Gypsum	: 30 kg

Phase: I.

Outdoor composting:

Barley and chicken manure are added to wheat straw and stacked after adding sufficient water to completely wet the same. The stack can be 3.3 x 2.5 x 1 m size. Turnings are given on the 2, 4, 6 and 8th days. The pH to be adjusted to 8.5 and the compost filled into trays for pasteurization.

Phase: II

Steam pasteurization

Steam or dry heat is introduced to establish an aerobic fermentation and the temperature maintained between 52 -60° C inside the compost. Usually it is done in a room well insulated where the trays are properly kept and after this all ventilators are closed and steam is introduced to raise the temperature to 52-54° C for 2 or 4 days. After that the temperature of compost is further raised to 58-62° C for four hr and afterwards fresh air is introduced and steam supply cut off.

## BUTTON MUSHROOM – SPAWNING

a) Tray system of cultivation:

The compost when ready, is taken in trays leaving about 5 cm from the top. There are different methods of spawning and are indicated below:

1. Single layer spawning:

The grain spawn is scattered uniformly all over the compost surface in a tray which is then covered with a thin layer of compost. 200 g of spawn for 1 m<sup>2</sup> beds.

2. Double layer spawning:

The trays are half filled and spawn is scattered . Then the tray is filled completely compost and spawn is applied as above and covered with a thin layer of spawn.

3. Thorough spawning/ mixed spawning:

The required quantity of spawn is mixed with the compost and filled in trays or polybags

#### 4. Spot spawning

The compost is filled in trays and holes of 2.5 to 5 cm deep are made with fingers about 8-12 cm apart in rows. About 5g of spawn is introduced into the cavities and covered with a thin layer of compost.

After spawning the beds should be covered with sterilized newspapers and water is sprinkled over the papers to maintain the moisture in the compost. The temperature should be around  $25 \pm 2^\circ \text{C}$  with RH of 90 per cent. The spawn running will be completed in 15 days and it is ready for casing.

#### b) Bag system of cultivation:

In this method polythene covers of size: 35"x24" with 150 gauge thickness are used. The spawn is mixed with the compost @ 500- 750 g/ 100 kg compost. Then mixed compost is filled in polythene bags @ 15-20 kg / bag. Finally, the beds are covered with newspaper.

### BUTTON MUSHROOM- CASING AND CROPPING

Casing is nothing but application of a thin layer of soil so as to induce buttoning. There are different materials used for casing and some of the commonly used ones are given below:

#### Casing materials:

1. Spent compost: sand: lime 4:1:1
2. Spent compost: FYM : clay loam 2:1:1
3. FYM: Clay Loam soils 1:1
4. Loam Soil: sand 1:1

Casing soil should have 80% water holding capacity, with a pH of 6-7 – 8.2 (Best: 7.7). In addition it should have high porosity to get good aerobic condition

#### Treatment of casing materials:

The casing materials are to be sterilized before application. Chemical treatment and Pasteurization are the two important methods followed .

#### Chemical treatment:

Prepare Formalin 2% solution by mixing 2 lit in 40 lit of water. Heap the case material and drench formalin @ 10 lit / M3 and cover it with polythene sheets for 3 days. After 3 days disturb the casing soil to remove excess formaldehyde and used for casing. It has to be done 15 days before casing.

#### Pasteurization:

Fill the casing soil in trays and steam at 65 – 70 ° C for 4 hours.

Procedure for casing:

- i) Remove newspaper and apply casing soil to a thickness of 3-4 cm and gently press it.
  - ii) Keep the temperature around 24 and relative humidity of 100 for one week.
  - iii) Reduce the temperature to 15-18 and relative humidity to 85-90 after one week.
- ( Pinheads appear 12- 15 days after casing and cropping continues for 6-8 weeks. Mushroom ready for harvest in another 10 days and appear at weekly intervals).

Normally 4 kg of mushroom can be harvested from 20 kg compost in Polybag method. In the case of tray system, the yield varies from 6-8 kg/ Sq. m.

Mushrooms can be harvested by gently twisting the fully-grown mushroom to avoid disturbance to young buttons. The following are the different stages of mushroom and the button stage is the correct stage of harvest and stages yield poor quality mushroom.

Stages of harvest:

Buttons: Mushroom with closed membrane. Size- diameter of button will be 3-6 cm with a stem length of 2 cm.

Cups: Membrane just opened with a stem length of 2.5 cm.

Opens/ flats: Fully opened mushroom, which is “T”, shaped with a stalk. The cap diameter may be 6-7cm with a stalk length of 2.5 to 3 cm.

The harvested mushrooms are cleaned to remove dirt and soil particles adhering and packed in polythene bags and send for sales.

## OTHER CULTIVABLE MUSHROOMS

### 1) Shiitake mushroom:

*Lentinus edodes* (*Lentinellus edodes*) is called as shiitake mushroom in Japan, where it is extensively cultivated. It has been in cultivation in Japan and China from very olden days dating back to more than 2000 years. This is a lignicolous fungus, which may grow up on wood logs. It is normally grown using logs from some important tree species

like shii, chestnut and oak. Logs of oak (*Quercus serrata* and *Q. acutissima*) are very commonly used. However, in recent years cultivation of this mushroom on artificially prepared substrates is being tried in several countries. Generally substrates prepared by mixing sawdust, bran etc., are known to support the growth.

Plastic bag method:

In Taiwan, a new substrate base has been prepared for successful cultivation of this mushroom under artificial conditions. The substrate used in the new process is a mixture of saw dust of a broad leaved tree (90 %), rice bran (10 %) and calcium carbonate (0.2 %) with 65 % moisture. The moistened mixture is placed in plastic bags (16.5 x 33.5 cm) and sterilized at 121° C for 1 hr. After 2-3 months of incubation, the plastic bags are opened for fruiting under 16-22 ° C and Relative Humidity of 90-95 %.

## 2. Wood ear or Jew's ear mushroom:

The fruiting bodies look like the human ear and hence they are called as wood ear and Jew's ear mushroom. The important species are *Auricularia auricula* (= *A. auricula* – *judae*) and *A. polytricha*

This is one of the earliest known edible mushrooms in China and has been in cultivation for nearly 2000 years. At present it is extensively cultivated in Taiwan. Commonly the logs of trees like *Morus australis*, *Rhus verniciflura*, *Magnolia obovata*, *Acacia confusa*, *Ficus retusa*, *F. stipulosa*, *Pongamia pinnata*, *Gardonia jasminodes* and *Bombax ceiba* etc., are used for cultivation. However, in recent years Polybag technique has been developed in Taiwan. Small huts are constructed using bamboo and straw for cultivation.

Poly bag method:

Saw dust is mixed thoroughly with 20 % bran and a little of calcium carbonate to adjust the pH. This mixture is taken in a polybag of special quality of about 15-20 cm length and 10-20 cm in diameter and sterilized at 90-100 ° C for 90 minutes. After cooling they are inoculated and incubated in the mushroom house at 25 -28° C. After spawn run, both the ends of bag are cut open and arranged in bamboo frames for buttoning. The yield per bag ranges from 50-500 g.

## 3. Winter mushroom:

The sporospores of mushroom normally appear in winter and hence the name. *Flammulina velutipes* is the mushroom collected wildy from forest areas and consumed in ancient Japan. At present, it is cultivated mainly in Japan and Taiwan. Cultivation was started on wood logs as in other wood destroying mushrooms. However, in recent years they are cultivated using saw dust- bran mixture.

Procedure:

Sawdust and bran are well mixed at 4:1 ratio and filled in Polypropylene bottles and capped. They are sterilized at 100° C for 1 hr. After cooling, the bottles were inoculated with spawn and incubated for spawn run. Optimum temperature for spawn run is 22-26° C and for fruiting body formation is 10-12° C. After spawn run the caps are removed and bottles are incubated in dark at a temperature of 10 -12° C and relative humidity of 80-85 %. In another 10-15 days primordia are formed and at that time the temperature has to be lowered to 3-5° C. The mushrooms are harvested when the stipe length is 13-14 cm and bundled. The yield may be 150-250 g per bottle. It takes about 50-60 days from initial fruiting to cropping. The same bottle can be used for a second crop, which may about 100-150 g/ bottle.

#### 4. Garden giant mushroom:

This mushroom, *Stropharia rugosannulata*, was first cultivated in Germany. The mushroom has a very wide sporocarp, usually upto 40 cm in diameter. The colour of the mushroom is yellow of brown with a red tint. Usually straw is used as substrate.

##### Procedure:

Fresh straw is cut into small pieces and soaked in water for 48 hr. The wet straw is piled on the ground at a height of about 25 cm, in one sq. m. area. Spawn is inoculated at 500 g per pile. Small pieces of spawn are placed to a depth of 5-8 cm and it is slightly pressed down. Spawn run is usually good at 20-30° C. The beds are kept covered with sacks or sheets of newspapers and compressed with weighted boards. When the surface growth appears, the cover is removed and a thin layer of moist humid soil is spread over the bed. In another 30-40 days time first harvest can be done, and it will continue for about 2- 3 months. An average yield of 600 g/ kg of dry straw will be obtained.

#### 5. Nameko mushroom:

*Pholiota nameko* is commonly called as nameko mushroom, which is widely cultivated in Japan. Under natural conditions , the mushroom grows on the woods of many trees. The wild species of *Quercus* is the most common substrate. The pileus of the mushroom is yellowish brown and is covered by a gelatinous mucilage and hence the name in Japan.

##### Procedure:

The sawdust from the selected trees is stored for about a year and then mixed with bran and wetted properly. The mixture is filled in special type of polypropylene bottles and steam sterilized. After cooling the bottles are inoculated with spawn and it takes nearly two months to get the mushroom.

#### 6. Silver ear mushroom:

This mushroom, *Tremella fuciformis*, is also called as white jelly fungus, grows naturally on dead tree trunks in China. The fruit bodies have a number of lobes on which

the hymenium is found. The margin of the pileus is lobed and curved. They occur in clusters of about 10 cm in width. They vary in colour from transparent to opaque, white to grey. The old technique of cultivation was very primitive wherein the infected wood logs are collected and stacked along with the suitable logs for natural infection and fruiting. In recent years, special type of logs is inoculated with spawn prepared in sawdust – bran mixture. The logs of trees like *Rhus succdanea*, *Fagus* spp. *Eugenia jambosa* and *Mangifera indica* are used. Small holes made in the wood logs at regular intervals and are spawned, closed and covered with plastic sheets. The mushrooms can be harvested after two months after spawning and harvesting can be continued for about 7 more months.

## PEST AND DISEASE PROBLEMS IN MUSHROOM CULTIVATION

### Insect pests:

Many insect pests attack the mushrooms. Small larvae of flies, beetles, springtails are very commonly noticed, in addition to mites and nematodes. Absolute cleanliness is a must to prevent the infestation of the insect pests in mushroom sheds.

#### a) Flies:

i) Phorid fly: *Megaselia halterata* and *M. tamilnadolensis*

ii) Sciarid fly *Lycoriella mali*

Phorid	Sciarid	
Life cycle	20- 38 days	20 – 33 days
Size	small	Bigger than phorid
Antenna	3 segmented	16 segmented
Egg laying	15- 150 eggs individually	15 150 eggs in masses.
Larva	5mm	6-7 mm
Pupa	Dark brown and larva not visible	Light yellow and larva visible.

#### Damage:

The larvae feed on the mycelium and show rotting patches in the beds. Young buds are also eaten by the larvae. They also tunnel into grown up mushroom and cause rotting of the mushrooms. The flies spread the disease from one bed to others.

#### Favorable conditions

Temperature of 16-24 is highly favorable and moisture contents of 70 % and above show more incidences. More severe in button mushroom cultivation, when compared to oyster and milky mushrooms.

b) Beetles:

Black beetle: *Sacphisoma nigrofaceatum*

Brown beetle : *S. pictummotschulsky* – golden lines seen on the body of the insect.

Both feed on young buds and grown up mushrooms by scrapping the tissues. They mainly transmit the bacterial blotch disease from one bed to other.

c) Spring tails / Columboles:

Tiny insects with stout antennae feed on the mycelium and buds. *Lepidocyrtus cyaneus* and *Isotoma simplex*.

d) Nematodes:

Nematode infestation is more severe in button mushrooms. The following two nematodes are very commonly noticed: *Ditylenchus mycelophagus* and *Aphelenchoides compositicola*.

e) Mites:

In addition to insect pests, two mites are very severely feed on the mushroom spawn as well as on mushroom buttons. They are

i) Tarsonemid mite- *Tarsonemus myceliophagus* and *T. floriculus* feed on mycelium and transmit the diseases.

ii) Tryoglyphid mite- *Tyrophagus lintneri*, and *T. longior*

Integrated Pest Management:

Bed moisture content should be around 60- 65%

Fix insect proof nets in the windows.

In button mushroom , newspaper should be treated with 0.1 % formalin

Fix white insect trap to attract the flies.

Spray malathion @ 1 ml./ lit. or dichlorvas 0.5 ml/lit. in the floor and sides to kill the flies and beetles, never spray on the mushroom beds and buttons.

Weeds, moulds and Diseases:

a) Weeds:

i) Ink Cap:

*Coprinus comatus* is a common weed on mushroom beds. It is favoured by high moisture content of the beds, more compaction of beds and poor ventilation with more of ammonia in side the cropping room.

It produces dark blue to violet coloured buds with a long white thin stalk , with opens in a few days and disintegrate as black mass of tissues, covering the entire bed , thus arresting the growth of spawn, development of young buds. The entire bed becomes black in color show rotting of the spawn.

Management:

Avoid using damaged and old straw for bed preparation.

Remove and destroy the infected beds immediately

Avoid preparing beds with more than 70 per cent moisture

Avoid chemical method of sterilization as this process lead to more weed growth.

b) Green moulds:

Mainly *Trichoderma viride* is severe both in beds and on mushroom buds. In addition, *Penicillium* and *Aspergillus* spp. may also cause mouldy growth on the beds. The infection lead to development of green color patches in the beds , which spreads quickly and entire bed is covered fully with green growth, which completely arrests the spawn running. This is due to improper sterilization of straw and bed preparation with more moisture.

Management:

Avoid using damaged and old straw for bed preparation.

Remove and destroy the infected beds immediately

Avoid preparing beds with more than 70 per cent moisture

c) Fungal diseases

In addition to the above fungal diseases, some other diseases in the mushroom beds are

i) Dry bubble- *Verticillium malthousei* and *V. psalliotae*

ii) Truffle- *Pseudobalsamia microspora*

iii) Mildew/ Cobweb- *Dactylium dendroides*

d) Bacterial blotch/ bacterial pit / brown blotch:



This disease is caused by a bacterium, *Pseudomonas tolaasi*. It produces pale-yellow spots on the surface of the pileus, which later turn brown. Pits are often found just below surface. This disease also cause considerable damage in storage and transit. The incidence is more when the mushrooms are watered heavily in the early bud stage. Because of very high humidity film of water always present on the surface of buttons leading to browning and rotting, emitting a fowl smell. Possibly the tryoglyphid mite mites carry the pathogen from one bed to other. In addition, the water splash from the infected bed also carries the bacterial inoculum.

**Management:**

- Keep the population of tryoglyphid mite under control

- Avoid pouring excess water to the beds.

- Remove the infected beds periodically to avoid further spread.

- Spray water mixed with bleaching powder @ 2 g / 10 litres of water.

**e) Viral diseases:**

Complex viruses cause a disease variously called the Brown disease/ watering stipe/ X- disease/ die back disease. It is difficult to diagnose the disease on the basis of symptoms- drumstick like mushroom and premature opening of veils- because similar symptoms can also be caused by certain environmental and cultural conditions. Even the virus infection may be symptomless. Reduction in yields of mushroom is perhaps the most reliable symptom. The other symptom commonly associated with the infected crop is the slow and depressed growth of the mycelium isolated from infected mushroom. Transmission of virus is through mushroom spores and spawn. In addition, phorid larvae and tarsonemid mites are also act as vectors for this complex disease.

## **MEDICINAL VALUES OF MUSHROOMS**

Mushrooms are rich in vitamins including folic acid and vitamins B<sub>12</sub>, low calorie protein, high K-Na ratio and less fat which are essential for diabetes, hypertension and atherosclerosis. Mushrooms are used as medicines and tonics traditionally in China, Japan and Korea. One of the Chinese medical theories says that Shiitake mushroom consumption was recommended for long life and good health and it was said that Shiitake preserved health, improved stamina and blood circulation and cured colds. Several alkaloids and extracts obtained from the mushrooms act as medicines for curing several ailments.

Both edible and poisonous mushrooms are known for their medicinal properties and poisonous mushrooms widely use in China as medicines, which include *Amanita muscaria*, *A. phalloides*, *Boletus edulis*, *Clitocybe illudens*, *Lameteromyces japonicus* and *Psilocybe mexicana*. Edible mushrooms like *Agaricus campestris*, *Flammulina velutipes*, *Lentinus edodes*, *Grifola frondosa*, *Ganoderma* spp. *Volvariella volvacea* and *Pleurotus passackarinus*, which are only few to mention. Researchers are concentrated mostly on *Ganoderma* spp., *Lentinus edodes* and *Grifola frondosa*.

Anti tumour principles are reported to present in *Agaricus bisporus*, *L. edodes*, *Pleurotus ostreatus* and *F. velutipes*. The alkaloids from *Agaricus campestris* also act as a anti bacterial compounds, some of the extracts like 'Lentinan' and 'rentinan' from *L. edodes* cures cancer and it also reported that the continuous use of this mushroom is very effective in reducing the HIV population to recover from AIDS syndrome. It is also used as a liver protectant. Because of very low fat content, it is very good food for hypertension patients. It also serves as a very safe food for Diabetic people because of its low carbohydrate content. In addition it cures peptic ulcers and constipation because of the more fibre content in the mushrooms. The continuous uptake of *L.edodes*, *F.velutipes* and *A.bisporus* critically reduces the blood cholesterol level.

#### Active Principles:

These are substances in mushroom that are responsible for the pharmaceutical properties. Nucleosidic nebularine in *A. bisporus*, Mucoproteins in *Boletus edulis*, Illudins in *C. lludens*, Flammulin in *F.velutipes* and Psilocin in *Psilocybe mexicana* are found to be active principles in the respective mushrooms. In *Ganoderma* spp., polysaccharides, triterpenes, Ling zhi-8 protein and organic germanium are regarded as active principles. Similarly, a polysaccharide- lentinan, ds RNA, peptidomannan, nucleic acid derivatives and lentinan sulphate in *L. edodes* are active principles for curing many human disorders.

Mostly mushroom are considered being immunomodulatory and they do not act directly on disease causing organisms. The medicinal activities of some mushroom are given below:

1. *A. bisporus* : Stimulate digestion and cure hypertension
2. *Auricularia polytricha* : Health strengthener and helps in good blood circulation.
3. *Auricularia minor* : Good for piles and helps in good blood circulation
4. *Boletus edulis* : Causes muscle and joints relaxation
5. *Clitocybe illudin* : has anti-tumour action
6. *Flammulina velutipes* : acts directly on tumour cells
7. *Ganoderma lucidum* : has rejuvenating effect
8. *Grifola frondosa* : Health strengthener, resists diseases, control blood pressure, controls diabetes and constipation, kills AIDS virus and have stronger anti-cancer effect than *L. edodes* and *Ganoderma* spp.
9. *Lentinus edodes* : health strengthener, resists diseases, anti-HIV, anti-

