



RITU MAWAR

ICAR-Central Arid Zone Research Institute, Jodhpur- 342003

AUTHOR



Dr. Ritu Mawar began her research carrier from 1998 at the Central Arid Zone Research Institute Jodhpur, India and worked on management of soil borne plant pathogens particularly *Macrophomina phaseolina*, *Fusarium* and *Ganoderma* by Soil solarization, use of cruciferous residues, composts, prior weakening as a tool and Biological control, etc. Functioned as Women Scientist in a fellowship from Department of Science and Technology, Government of India. In 2012, she was selected as a Senior Scientist (Plant Pathology) at ICAR- Indian Grassland and Fodder research Institute Jhansi.

Currently, working at the Central Arid Zone Research Institute, Jodhpur. During research carrier published more than 65 research papers, chapters in books, popular articles in national and international journals like Annals of applied biology, Crop Protection, Phytopathologia Mediterranea, Phytoparasitica, Australasian Journal of plant pathology and chapters for American Phytopathological society, Springer, etc. Served as a Zonal councilor (central zone) of Indian Phytopathological Society, New Delhi and remained organizing secretary of a National symposium in 2007. Authored 4 books. Delivered several lead lectures in conferences. Visited Thailand, Italy and France to present papers in International conferences. Recipient of 10 best poster paper presentation awards. In 2019, awarded as best women scientist by Indian society of mycology and plant pathology and one patent of a novel bacterium *Bacillus firmus* entitled “Bio formulation of a Bio pesticide and a process for preparing the same” has been granted and one more patent of a “consortium of bio pesticide and bio formulation comprising same” is at the final stage of grant.

INDEX

- ❖ Pearl millet- Downy mildew, Ergot, Smut, Rust
- ❖ Sorghum- Grain molds, Charcoal rot, Downey mildew, Sugary disease, smuts
- ❖ Maize-Banded leaf & sheath blight, Turcium leaf blight , Downy mildew
- ❖ Guar- Dry root rot, Bacterial blight
- ❖ Cowpea- Dry root rot,
- ❖ Moth bean- Yellow mosaic virus
- ❖ Mung bean- Dry root rot, cercospora, virus diseases
- ❖ Ground nut – Early leaf spot, Collar rot
- ❖ Mustard- White rust, stem rot, Downey mildew
- ❖ Sesame- dry root rot & stem rot, Phyllody
- ❖ Cumin- Wilt, Powdery mildew, Blight
- ❖ Coriander- Blight, stem gall, Powdery mildew, stem rot
- ❖ Fenugreek- Powdery mildew, cercospora, Downy mildew
- ❖ Chilli- Damping off, blight, leaf curl, dieback & fruit rot, wilt
- ❖ Onion- Downy mildew, purple blotch
- ❖ Cotton- Black arm, Wilt, Root rot
- ❖ Isabgol- Downey mildew
- ❖ Ber- Powdery mildew
- ❖ Anar- Leaf & fruit spot, Anthracnose, wilt, nematose
- ❖ Anola- Tissue necrosis, Rust, Anthracnose, Fruit rot
- ❖ Date Palm- Graphiola leaf smut
- ❖ Trees- Ganoderma root rot

INDEX...

- ❖ **Polyhouse vegetable diseases**
- ❖ **General eco-friendly disease management technique in agriculture**
- ❖ **Culture Media**
- ❖ **Journals**

PEARL MILLET {*Pennisetum glaucum* (L.)R. BR.}

- ❖ **In India**
- ❖ 9.5 million ha
- ❖ 8.35 million tone
- ❖ 875 kg/ha
- ❖ **In Rajasthan**
- ❖ 4.0 million ha
- ❖ Million tones
- ❖ **Other States**
- ❖ Maharashtra, Gujarat, Haryana, UP, MP, Karnataka, TN



DOWNY MILDEW

- ❖ **Pathogen**
- ❖ *Sclerospora graminicola* (Sacc.) Shroet.
- ❖ Obligate Oomycetes,
- ❖ Grain Yield loss- 20% per annum
- ❖ **Symptoms**
- ❖ **Downy mildew stage**
 - White streaks on lower side of the leaves (20-30 days after planting)
 - Disease plants becomes yellow & remain stunted
- ❖ **Green ear stage**
 - Appears at panicle emergence
 - Green leafy structures are seen instead of grains



EPIDEMIOLOGY

- **Summer fodder crop/Crop stubbles- harbor inoculum**
- **Seedling stage is vulnerable**
- **Secondary spread – Sporangia**
- **Simple interest rate**
- **RH (70-90%), Moderate temp. (25-31°C), good sunshine (> 5 h d⁻¹), moderate rainfall favors**
- **High soil moisture counteract primary infection**



MANAGEMENT

- **Cultural:** Early sowing; Transplanting; Crop rotation, use of clean seeds, Burning infected plant debris, etc.
- **Chemical:** Seed Treatment with Metalaxyl, Apron SD 35 (6 g kg⁻¹ seed) Foliar spray with Ridomil MZ 75 WP. (1 g L⁻¹)
- **Resistance varieties:** HHB 94, HHB 67, HHB 117, ICMH 423, ICTP 8203 Raj 71, Raj 171.

ERGOT

❖ **Pathogen:** *Claviceps fusiformis* Loveless.

Ascomycetes

❖ **Symptoms:**

- Appears as small droplets of pinkish or light color fluid exuding from the spikelets.
- The exudation dries up and in place of honey dew several agglomerated, dark stocky patches may be seen on the ear
- Severely infected ears rarely produce healthy grains.



EPIDEMIOLOGY

❖ **Under General Conditions Disease development is favored by**

- **High relative humidity(80-85%)**
- **Moderate temperature (20-30°C)**
- **Overcast sky, drizzling rain, cool nights**

Longer protogyny periods results in higher disease incidence

❖ **Under Arid Conditions Disease development is favored by**

- **12 mm rainfall**
 - **70% relative humidity**
 - **20°C atmosphere temperature and sun shine for 6 hours**
- from protogyny to early anthesis period**

MANAGEMENT

❖ Cultural

Use of Sclerotium-free seed, eradication of collateral hosts (*Cenchrus ciliaris*, *Penicum antidotale*), early planting

❖ Saline water treatment

Sclerotia mixed with the seeds can be separated by dipping seeds in 10% salt solution

❖ Biological

Spray of biological control agents like *Fusarium sambucinum*, *F. semitectum var. majus* and *cerebella andropogonis*.

❖ Resistance varieties

ICMS 8031, ICMS 8032, ICMS 8034, WC- C75, BJ104.

SMUT

- ❖ **Pathogen:** *Moesziomyces penicillariae*
(Bref.)

Basidiomycetes

Grain yield loss 5-20%

- ❖ **Symptoms:**

- Only some grain in a ear are affected, which are transformed in a egg shape structure
- Infected seeds carries black or dark brown powdery mass
- Healthy ears gets infection from this powdery mass



EPIDEMIOLOGY

- ❖ **High relative humidity(80-95%)**
- ❖ **Moderate temperature (25-35°C) at the flowering stage**
- ❖ **Infection begins from soil & seed-borne inocula**
- ❖ **More severe in genetically uniformed single cross F1 hybrids**

MANAGEMENT

- ❖ **Chemical Control**

Three sprays of Tridemorph (0.1%)or Mancozeb (0.25%)

- ❖ **Resistance varieties**

ICMV 82131, ICMV 82132, ICMA 88006, WC-C75.

RUST

- ❖ **Pathogen:** *Puccinia substriata* Ell. and Barth. var. *indica* Ramachar and Cumm

Basidiomycetes

Grain yield loss Insignificant

- ❖ **Symptoms:**

- Appear on the lower leaf as typical erumpent pustules, which are initially redish brown and turn brown to black
- These pustules contain initially urediniospores and later teliospores
- Symptoms develop mostly on upper surface and on stems
- More pronounced at flowering



EPIDEMIOLOGY

- ❖ **Cooler night temperatures and heavy dew.**
- ❖ **35-40 days old crop is in severe stage.**

MANAGEMENT

- ❖ **Cultural Control**
Use of antibiotics, protective , and Systemic fungicides.
- ❖ **Resistance varieties**
ICML 11, ICML 17, ICML 18, ICML 19, ICML 20 and ICML21

SORGHUM BICOLOR (L) MOENCH

❖ **In India**

Area 10.2 million ha

Production 9 million tones

❖ **States**

Maharashtra, Karnataka Andhra Pradesh and Madhya Pradesh

❖ **Other states**

UP, Rajasthan, Gujarat and Tamil Nadu

❖ **Major Diseases**

Grain molds, Charcoal rot, Downy mildew, Sugary



GRAIN MOLDS

- ❖ **Pathogen:** More than 40 fungi Major are *Fusarium moniliforme* J. Sheld Lisea *Fujikuroi* Sawada , *Curvularia lunata* (Wakker) Boedijn
- ❖ **Symptoms:**
 - Discoloration of grains as black, pink, whitish mold
 - *Fusarium* produces whitish or pinkish fungal growth on the seed whereas *Curvularia* produces dark black discoloration
 - The infection is deep seated with in the grain and heavily molded seed has low viability, low germination percentage



EPIDEMIOLOGY

- ❖ **Rainfall and relative humidity are positively correlated with incidence of molds**
- ❖ **Infection takes place when the crop at maturity coincides with heavy rains leading to grain discoloration**
- ❖ **High humidity creates congenial conditions for the development of molds**

MANAGEMENT

❖ **Cultural Control**

Delayed harvesting increases grain mold incidence so that timely harvest the crop.

❖ **Chemical Control**

Seed treatment with bavistin (2g/kg seed) and biological agents such as *Trichoderma viride*, *T. harzianum*, *Bacillus subtilis*, *Pseudomonas fluorescence*, Combination of Captan 0.2% + Aureofungin (200ppm)

❖ **Resistance varieties**

IS 7173, IS 23773, IS 23783 & IS 34219

CHARCOAL ROT

- ❖ **Pathogen:** *Macrophomina phaseolina* (Tassi) Goid
- ❖ **Symptoms:**
 - The infected plants fall over on the ground
 - Initial symptoms develop on roots and appear as water-soaked lesions. The lesions turn brown or black with age.
 - The fungus continues to invade plant tissue from the crown up and causes similar water soaking and discoloration in the pith, which disintegrates leaving only the vascular strands intact.
 - The most characteristic outward symptom in the field is lodging, premature drying of stalks, root rot and reduction in filling up of grains.



EPIDEMIOLOGY

- ❖ **High soil moisture stress at terminal growth stages coupled with high temperature are conducive for the development of the disease**
- ❖ **The fungus survives during off-season in the form of sclerotia, which remain viable up to 16 months and are released into the soil as plant debris decays.**

MANAGEMENT

❖ **Cultural Control**

Avoid soil moisture stress by mulching

Adjusting dates of sowing- early sowing

Long crop rotation

Reduce Nitrogen

Soil solarization

❖ **Chemical Control**

**Seed treatment with *Trichoderma harzianum* or *T. viride* @
4g/kg seed**

DOWNY MILDEW

- ❖ **Pathogen:** *Peronosclerospora sorghi* (Weston & Uppal)
- ❖ **Symptoms:**
 - Whitish downy growth on the lower surface of leaves, later this spreads over a major portion of leaf blade, which appears yellowish through the upper side
 - As the disease advances chlorotic streaks develop, which turn brown as the interveinal leaf tissues die



EPIDEMIOLOGY

- ❖ **The pathogen is soil, seed and air borne.**
- ❖ **Oospores are thick walled, sexual resting structure of the fungus, which are viable for many years in the soil**
- ❖ **Oospores germinate by a germ tube in response to host root exudates, which infects the sorghum seedling**

MANAGEMENT

❖ **Cultural Control**

Deep ploughing

❖ **Chemical Control**

Seed treatment with Apron XL @ 2g/Kg or Apron 35 1g a.i. /kg and spray of Dithane M 45 @ 0.3 % at 7 days interval beginning from appearance

❖ **Resistance varieties**

SPV-35, 81, 104, 126, CSH-2, 3,4,6 SPH-10, DMS 1B, PVK-3, PVK-10 and MR 750

SUGARY DISEASE

- ❖ **Pathogen:** *Claviceps africana* Frederickson *et. al.*, *Sphacelia sorghi* McRae, *Claviceps sorghi*
- ❖ **Symptoms:**
 - The infected panicles show sweet/ sugary honeydew from the infected florets
 - These droplets are spread to other flowers through ants, some times falls on to the ground through foliage
 - Honey dew like sugary secretion exudes from the infected spikelets



EPIDEMIOLOGY

- ❖ **The pathogen spreads rapidly under cool days, $19\pm 1^{\circ}\text{C}$ temperature, high humidity (75%) and cloudy weather during anthesis period. If dry weather prevails after the honeydew stage, it favors sclerotial development, the honeydew attracts insects and ants, which help in the spread of the disease**
- ❖ **The infection is mainly through air borne conidia, which come to rest in the spike lets**

MANAGEMENT

- ❖ **Cultural Control**

 - Prophylactic spray with crude garlic extract (12%)

- ❖ **Chemical Control**

 - Spraying propaconazole (Tilt) 0.25% on infected spikes

- ❖ **Resistance varieties**

 - CS 3541, IS 3443, IS 3547, IS 14332 and CSH 5, 6 and 9

SMUT

- ❖ **Pathogen:** *Tolyposporium ehrenbergii* (Kuhn) Patouillard
- ❖ **Symptoms:**
 - The infection is seen on few spike lets
 - Spike lets become very long with white papery covering called peridium.
 - The peridium ruptures to release smut spores The fungal sorus is covered by a whitish to dull yellow fairly thick membrane and is cylindrical.
 - Usually the membrane remains intact until broken mechanically releasing the black spore mass. These spores are released into air, which attack healthy grains surrounding



EPIDEMIOLOGY

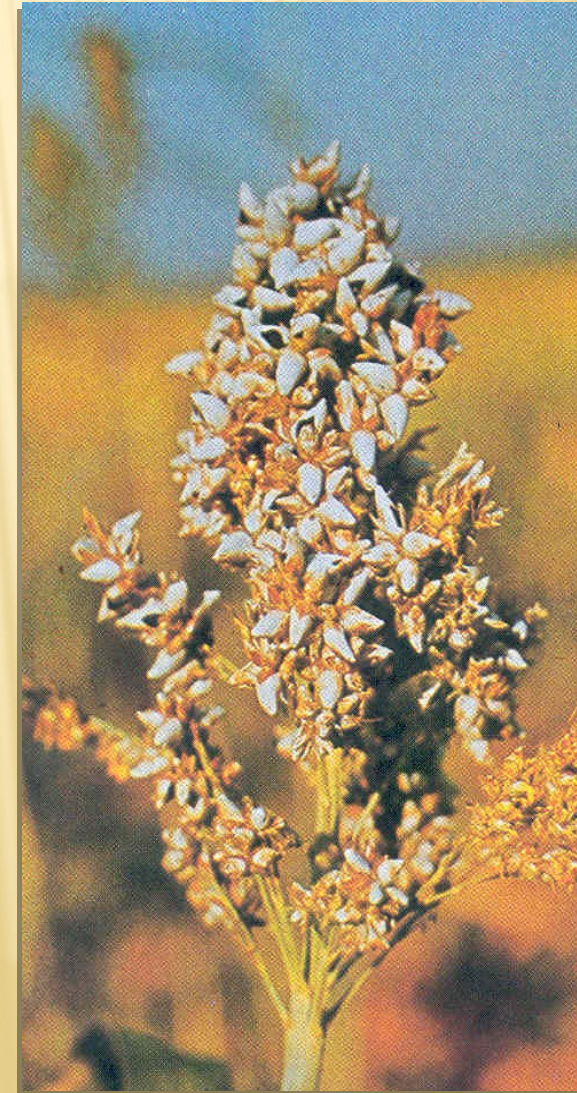
- ❖ **The spores in the soil may germinate to produce clusters of sporidia, which become air borne and cause primary infection. Secondary infection takes place through spores released from the smutted ears in the field.**

MANAGEMENT

- ❖ **Cultural Control**
Pluck and burn infected spikes.
- ❖ **Chemical Control**
Seed dressing with captan or thiram @2.5g/Kg seed.

GRAIN SMUT

- ❖ **Pathogen:** *Sphacelotheca sorghi* (Link) Clinton
- ❖ **Symptoms:**
 - Apparent only at grain formation stage, at which time smut sori are formed in the place of healthy grains
 - The individual sori are oval or conical in shape and are covered with a peridium, a silvery white thin fungal layer. They are oval to cylindrical, 5-15 mm long and 3-5 mm broad with dirty gray in color



EPIDEMIOLOGY

- ❖ **The disease is seed borne.**
- ❖ **On rupture of sori, spores are released into air, which attack healthy grains surrounding.**

MANAGEMENT

- ❖ **Cultural Control**

Pluck and burn infected spikes.

- ❖ **Chemical Control**

Seed dressing with Captan or Thiram @2.5g/Kg seed or with Sulphur @4g/kg

Maize

Erwinia chrysanthemi pv. *zeae*

Initial symptom is discoloration of the leaf sheath and stalk at a node. As the disease progresses, lesions develop on the leaves and sheath. Disease then develops in the stalk and rapidly spreads up the stalk and into the leaves. As the decay progresses, a foul odor can be detected and the top of the plant can be very easily removed from the rest of the plant. The stalk rots completely and the top collapses. Bacterial stalk rot can affect the plant at any node from the soil surface up to the ear leaves and tassels. Infections that occur high on the plant may impair normal tasseling and affect subsequent pollination. Although it may spread along the plant to infect additional nodes, the bacteria do not usually spread to neighbouring plants unless vectored by an insect. Splitting the stalk reveals internal discoloration and soft slimy rot mostly initiating at the nodes. Because the bacteria usually do not spread from plant to plant, diseased plants are quite often found scattered throughout the field. However, there are reports of plant-to-plant transmission by certain insect vectors.



EPIDEMIOLOGY

Bacterial stalk and top rot is favoured by high temperatures and high relative humidity. It can be a problem in areas of heavy rainfall or where overhead irrigation is used and the water is pumped from a lake, pond, or slow-moving stream.

MANAGEMENT

Genetic Resistance

Hybrid resistance has been reported but because this disease occurs so infrequently, resistance genes are not routinely bred into hybrids and resistance ratings are not usually reported.

Cultural Practices

Management of bacterial stalk and top rot includes fall cultivation to incorporate residue and avoiding excessive irrigation or flooding.

BANDED LEAF AND SHEATH BLIGHT

Thanatephorus sasakii (Shirai) Tu and Kimbrough (St. Imp. *Rhizoctoniz solani* Kühn f. sp. *sasakii* Exner).

Symptoms, disease development and epidemiology:

The pathogen affects all aerial parts of the maize plant except tassel. The disease manifests itself on leaf, leaf sheaths, stalks and ears as leaf blight, stalk lesion or rind spotting and stalk breakage etc.

It was reported that BLSB disease appears at pre-flowering stage on 30 to 40 day-old maize plants, but infection can also occur on young plants which may subsequently result in severe blighting and death of apical region of growing plant. The disease symptoms on leaves as irregularly globular to elongated lesions which appears as water-soaked areas. The affected areas appear bleached, soon they become straw colored and necrotic . The lesions enlarge rapidly resulting in discoloured areas alternating with dark bands, apparent on lower leaves after 7-8 days.



EPIDEMIOLOGY

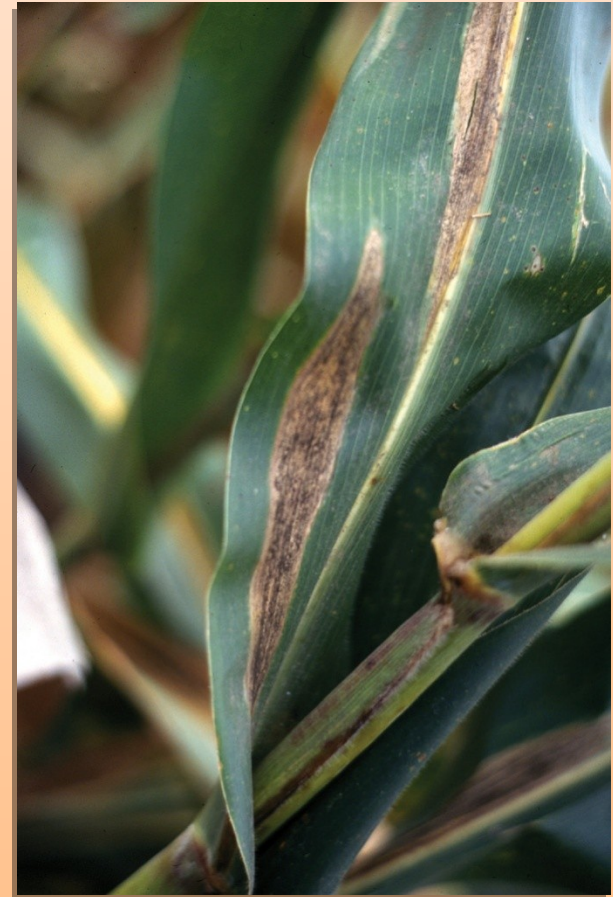
- ❖ **The fungus is capable of infecting maize plants in all the stages of crop growth right from seedling to maturity. *R. solani* survive in the soil and on infected crop debris as sclerotia or mycelium. Sclerotium serves as primary inoculum.**
- ❖ **The fungi spread by irrigation, movement of contaminated soil and infected plant debris. At the onset of growing season, in response to favourable humidity and temperature (15 to 35°C), the fungal growth is attracted to rapidly growing seedlings and water soaked seed coats by chemotropic stimulants released by growing plant cells and decomposing plant residue. Secondary spread of this disease occurs by contact of diseased leaves or sheath with healthy plants.**
- ❖ **High relative humidity (90%), an optimum temperature about 28°C, and rain fall in the first week of infection significantly favours the development and spread of disease.**

MANAGEMENT

- ❖ **Cultural practices like stripping of the second and third leaf sheaths from the ground level at the age of 35-40 days old maize crop is effective in checking further BLSB development. Inter-cropping system of maize with legumes especially with soybean effectively reduced the severity of the pathogen in soil. Selection of a well drained field and planting on raised beds are important cultural aspects to avoid contact of excess water with seeds and faster growth of seedlings**
- ❖ **Propiconazole, 0.1%, and Carbendazim, 0.05%), by applying as foliar sprays, alone or in combinations. Foliar sprays of Carbendazim showed the ineffectiveness against BLSB. Spray Rhizolex at 30 to 40 days stage of the crop @ 10gm/litre of water**
- ❖ **Seed treatment with Pseudomonas fluorescens @ 16gm/ Kg seed.**

TURCICUM LEAF BLIGHT

The fungus affects the crop at young stage. Small yellowish round to oval spots are seen on the leaves. The spots gradually increase in area into bigger elliptical spots and are straw to greyish brown in the centre with dark brown margins. The spots coalesce giving blighted appearance. The surface is covered with olive green velvety masses of conidia and conidiophores.



EPIDEMIOLOGY

Favourable Conditions

- ❖ **Optimum temperature for the germination of conidia is 8 to 27°C provided with free water on the leaf. Infection takes place early in the wet season.**

MANAGEMENT

- ❖ **Spray Mancozeb @2.5-4 gm/litre of water at an interval of 8-10 days**
- ❖ **Grow resistant varieties like M.C.H. -117 or Pusa early hybrid**
- ❖ **Treat the seeds with Captan or Thiram at 4 g/kg.**
- ❖ **Spray Mancozeb 2 kg or captan 1 kg/ha.**

DOWNEY MILDEW

Perenosclerospora maydis

The most characteristic symptom is the development of chlorotic streaks on the leaves. Plants exhibit a stunted and bushy appearance due to shortening of the internodes. White downy growth is seen on the lower surface of leaf. Downy growth also occurs on bracts of green unopened male flowers in the tassel. Small to large leaves are noticed in the tassel. Proliferation of auxillary buds on the stalk of tassel and the cobs is common



EPIDEMIOLOGY

Favourable Conditions

- ❖ Low temperature (21-33°C)
- ❖ High relative humidity (90 per cent) and drizzling.
- ❖ Young plants are highly susceptible.

Management

- ❖ Seed treatment with Apron S.D. @2.5 GM / Kg of seed
- ❖ Spray systemic fungicide Ridomil W.P. @ 1gm/litre of water
- ❖ Grow resistant varieties like Pro- 345, Pusa early hybrid-5, Prakash or NECS -117
- ❖ Deep ploughing.
- ❖ Crop rotation with pulses.
- ❖ Rogue out infected plants.
- ❖ Treat the seeds with metalaxyl at 6g/kg.
- ❖ Spray the crop with Metalaxyl + Mancozeb @ 1kg on 20th day after sowing.
- ❖ Grow resistant varieties and hybrids viz. CO1, COH1 and COH2.

GUAR *CYAMOPSIS TETRAGONOLOBA* (L.) TAUB

❖ **In India**

Area : 4.78 M ha

Production: 2.22 M ton

❖ **Guar gum 110,000 metric tons worth Rs. 814 crores was exported to western countries.**

❖ **Maximum contribution**

Rajasthan (18.18 lakh ha) and Gujarat (2.27 lakh ha)

Rajasthan alone 78.0% area with production of 81.1%

Other states

Haryana and Punjab



DRY ROOT ROT

❖ **Pathogen:** *Macrophomina phaseolina*
(Tassi) Goid

❖ **Symptoms:**

- **Bronzing of leaves on one or more branching followed by dropping of the upper tender parts of the shoot.**
- **Affected plants continue to grow without having clusters or pods, but may break easily in strong winds.**
- **Heavily infected plants rarely produce any grain, and if produced, seeds are also infected.**



EPIDEMIOLOGY

- ❖ **Increases in inoculum and disease development is dependent on moisture stress coupled with temperature stress**
- ❖ **Low native populations of total bacteria and actinomycetes in the soil.**
- ❖ **Clusterbean become predisposed to the fungal infection only after its shoot water potential declined below -1.8 MPa,**
- ❖ **Seedling stage is the most vulnerable**

MANAGEMENT

❖ Cultural Control

- Soil Solarization
- Treated with culture of *Bacillus firmus*, *Aspergillus versicolor*, vesicular arbuscular mycorrhizae i.e. *Glomus mosseae*, *Azotobacter chroococcum*, *Rhizobium sp.*
- Crop Rotation with Pearl millet
- Amendment of soil with pearl millet and weed composts for two consecutive years reduced resident population of *M. phaseolina* by 20-40%

❖ Chemical Control

Seeds treatment with carbendazim or captan @ 2 g/kg or thiram, @ 6 g/kg

❖ Resistance varieties

Genotypes, HG-75 and RCG-1030

BACTERIAL BLIGHT

❖ **Pathogen:** *Xanthomonas campestris*
pv. Cyamopsidis



❖ **Symptoms:**

- Appears as both leaf spots and blight simultaneously.
- The spots resulting from stomatal infection are intra veinal, round, water soaked or oily in appearance.
- The spots may enlarge or coalesce but ultimately result in blight phase. From the leaf, infection advances systematically through petioles into the stem and produces longitudinal streaks that result into blackening and cracking of the stem.

EPIDEMIOLOGY

- ❖ **Spattering rains, High Humidity (80 – 90%), Moderate temperature (27 – 30° C).**
- ❖ **Further spread - Soil moisture stress.**

MANAGEMENT

- ❖ **Chemical Control**
Seed dip for 2 hours in streptocycline , 0.025%
Foliar sprays with streptocycline (100 ppm) at 5th and 7th week after sowing
- ❖ **Resistance varieties**
HG-75

COWPEA (*VIGNA UNGUICULATA* (L.) WALPERS)

❖ **In India**

Area: 6.63lakh ha

Production:3.0 lakh ton



❖ **Maximum contribution**

Rajasthan and Gujarat

DRY ROOT ROT

❖ Pathogen:

Macrophomina phaseolina

(Tassi) Goid



❖ Symptoms:

- Bronzing of leaves on one or more branching followed by dropping of the upper tender parts of the shoot.
- Affected plants continue to grow without having clusters or pods, but may break easily in strong winds.
- Heavily infected plants rarely produce any grain, and if produced, seeds are also infected.

EPIDEMIOLOGY

- ❖ **Increases in inoculum and disease development is dependent on moisture stress coupled with temperature stress**
- ❖ **Low native populations of total bacteria and actinomycetes in the soil.**
- ❖ **Seedling stage is the most vulnerable**

MANAGEMENT

❖ Cultural Control

- Crop Rotation with Pearl millet
- Amendment of soil with pearl millet and weed composts for two consecutive years reduced resident population of *M. phaseolina* by 20-40%
- Soil Solarization
- Treated with culture of *Bacillus firmus*, *Aspergillus versicolor*, vesicular arbuscular mycorrhizae i.e. *Glomus mosseae*, *Azotobacter chroococcum*, *Rhizobium sp.*

❖ Chemical Control

Seeds treatment with carbendazim or captan @ 2 g/kg or thiram, @ 6 g/kg

❖ Resistance varieties

Genotypes HG-75 and RCG-1030

MUNG BEAN (*Vigna radiata*)

India is the largest producer of mung bean where it is third most important pulse crop with an area of approximately 3.43 million hectares (about 15% of the national pulse crop area), production 1.71 million tonnes of grain with productivity of 498 kg/ha.



DRY ROOT ROT

❖ Pathogen:

Macrophomina phaseolina

losses (10-45%)

❖ Symptoms:

- Bronzing of leaves on one or more branching followed by dropping of the upper tender parts of the shoot.
- Affected plants continue to grow without having clusters or pods, but may break easily in strong winds.
- Heavily infected plants rarely produce any grain, and if produced, seeds are also infected.



EPIDEMIOLOGY

- ❖ **Increases in inoculum and disease development is dependent on moisture stress coupled with temperature stress**
- ❖ **Low native populations of total bacteria and actinomycetes in the soil.**
- ❖ **Seedling stage is the most vulnerable**

MANAGEMENT

❖ Cultural Control

- Crop Rotation with Pearl millet
- Amendment of soil with pearl millet and weed composts for two consecutive years reduced resident population of *M. phaseolina* by 20-40%
- Soil Solarization
- Treated with culture of *Bacillus firmus*, *Aspergillus versicolor*, vesicular arbuscular mycorrhizae i.e. *Glomus mosseae*, *Azotobacter chroococcum*, *Rhizobium sp.*

❖ Chemical Control

Seeds treatment with carbendazim or captan @ 2 g/kg or thiram, @ 6 g/kg

❖ Resistance varieties

Genotypes HG-75 and RCG-1030

POWDERY MILDEW- *Erysiphae polygoni*

Symptom:

White, powdery patches appear on leaves and other green parts and later become dull in color. These patches gradually increase in size and become circular, covering the lower surfaces as well. Severely affected parts become shriveled and distorted. In severe infections, foliage turns yellow, causing premature defoliation.



EPIDEMIOLOGY

Maximum temperature varied from 27.2 to 30.3°C, relative humidity from 67 to 90% during the morning and 12 to 38% at noon, and wind velocity from 2.3 to 4.1 km/h.

MANAGEMENT

- ❖ **Spray of wettable sulphur is very effective**
- ❖ **Spray of Dinocap (0.1%) or Tridemorph (0.1) is also equally effective**

CERCOSPORA LEAF SPOT

Pathogen:

Cercospora canescens



❖ **Symptoms:**

Water soaked spots with grayish borders.

The petioles, stem and pods also get affected by the pathogen.

During favorable condition the spots increase in size and at the time of flowering and pod formation leads to defoliation

EPIDEMIOLOGY

- ❖ **Warm wet condition**
- ❖ **Relative humidity 90-100%**
- ❖ **Temperature 20-25°C**

MANAGEMENT

- ❖ **Cultural**

Crop rotation, field sanitation

- ❖ **Chemical Control**

Spray with carbendazim or captan @ 2.5 ml/lit

Or Propiconazole (1ml/lit)

- ❖ **Resistance varieties**

IPM 02-3, SML-32, KESHAVANAND MUNG 2, RMG 492

VIRUS DISEASES

Pathogens:

GBNV is transmitted by *Thrip palmi*

TSV: *Scirtothrips dorsalis*

Symptoms:

Groundnut bud necrosis virus(GBNV) and Tobacco streak virus (TSV) are widely spread in India. They are becoming serious pathogens in many pulses particularly mungbean and urdbean by causing bud necrosis and stem, foliar necrosis. GBNV incidence upto 52% and yield losses upto 92% . Complete yellowing and drying

MANAGEMENT

- ❖ **Grow resistant varieties like I.P.M. 2 or G.M. 4**
- ❖ **Spray Thiomethoate (0.3%) + Malathion (0.05%), imidacloprid @0.1%(10ml/lit)**
- ❖ **In early sown crop less amount of disease is observed.**
- ❖ **Inter cropping or mixed cropping reduces the incidence of disease.**

LEAF CRINKLE DISEASE

Causal agent :Bmov, Comovirus

Symptom: The LCD symptoms appear within 3-4 weeks after sowing, infected plant initially shows curling of leaves and gradually crinkling of leaflets. Petioles of the terminal leaves are shortened and curled.



Epidemiology

The presence of weed hosts like *Aristolochia bracteata* and *Digera arvensis*. Kharif season crop is highly susceptible. Continuous cropping of other legume crops which also harbor the virus. Environmental factors showed positive interaction in case of maximum and minimum temperature but in case of relative humidity the interaction was negative. With an increase the temperature, the infection rate increased and with increase in relative humidity the infection rate decreased. Maximum disease incidence was developed at maximum temperature of 35- 42°C.

MANAGEMENT

- ❖ To avoid early infection into the crop, planting of disease free seeds.
- ❖ Removed collateral weed hosts around the field and rogue out the diseased plants could reduce the chances of further spread and reduced production of more infected seed.
- ❖ Hot water seed treatment at 52°C for 20-30 min reduced seed borne infection.
- ❖ Cultivation of resistant mungbean entries also decreased diseased incidence.
- ❖ Foliar spray of Thiomethaxam 0.02 per cent at 15 days after showing, decreased whitefly population and incidence of leaf crinkle
- ❖ Neem 2% and akk extract reduced the severity of ULCV infection, nitrogen, phosphorus, potash, zinc, boron and naphthalene acetic acid (NAA) were effectively reducing ULCV infection indifferent varieties of mungbean by the same order from 65 to 58.57%.

YELLOW MOSAIC VIRUS

Pathogen:

Begomovirus species MYMV, MYMIV, DoYMV & HgYMV



Symptoms

Scattered small patches or yellow spots in the leaf lamina, which enlarge to irregular yellow and green patches alternating with each other on matured leaves. Initially small yellow patches or spots appear on green lamina of young leaves. Soon it develops into a characteristic bright yellow mosaic or golden yellow mosaic symptom. Yellow discoloration slowly increases and leaves turn completely yellow. Maturity is delayed in the diseased plants and flower and pod formation are severely reduced. Seeds that develop on severely infected plants are small and immature. In addition to yellow mosaic to the yellow mottle symptoms a necrotic centre develops in the yellow spots in the some varieties. The pods are small and distorted. Early infection causes death of the plant before seed set .

EPIDEMIOLOGY

Incidence and spread of yellow mosaic disease are generally high in summer crops, as compared with rainy or winter season crops. Weed serves as source of primary inoculums. The virus starts spreading with the onset of the monsoon high incidence in areas where the temperature (31 to 35°C) and relative humidity (70%). These conditions favour the disease development and multiplication of the vector *Bemisia tabaci*. It is transmitted by whitefly, *Bemisia tabaci* and grafting under favourable conditions in a circulative, non-propagative manner and by grafting. It is not seed or soil borne or sap transmissible. Weed hosts viz., *Croton sparsiflorus*, *Acalypha indica*, *Eclipta alba* and other legume hosts serve as reservoir for inoculums

MANAGEMENT

- ❖ Avoidance of sources of primary infection
- ❖ Use of resistant varieties, viz., Pant mung 3, PM 5, PM 6, Pusa Vishal, Basanti, ML-267, ML-337, PDM-54, PDM 139, LGG-407, LGG-460, Narendra mung-5, HUM-1, TM-99-37, HUM-16, TARM-1, Pusa-95-31
- ❖ Use of agronomic intervention
- ❖ seed treatment with Imidacloprid-70WS @ 4g/kg seed and two subsequent spray at 21 and 35 days protect the crop up to the pod formation stage. Six foliar spray of the 10 percent aqueous root extract of *Boerhaavia diffusa* and eight spray of leaf extract of *Clerodendrum aculeatum* were found most effective and suppress symptoms severity by 62 to 90 per cent under natural conditions.

MOTH BEAN **(*VIGNA ACONITIFOLIA* (JACQ.) MARECHAL)**

❖ **In India**

Area: 10.8 lakh ha

Production: 2.9 lakh ton



❖ **Maximum contribution**

Rajasthan, Gujarat, Maharashtra, Haryana

YELLOW MOSAIC VIRUS

- ❖ **Pathogen:** *Bemisia tabaci* Gene. (White fly) vector of mosaic virus
- ❖ **Symptoms:**
 - Disease appears as yellow spots scattered over the leaf, which expand rapidly. The leaves show yellow patches alternating with green areas which also turn yellow.
 - Such yellow leaves gradually change to whitish shade and ultimately become necrotic.
 - Reduction in size of leaves, number and size of pods/ plant, seeds/ pod has been observed.



EPIDEMIOLOGY

- ❖ **The virus starts spreading with the onset of monsoon.**

MANAGEMENT

- ❖ **Cultural Control**
Use of resistant varieties and vector management
- ❖ **Chemical Control**
Spraying of methyl demeton, 0.1% , dimethoate, 0.02%, monocrotophos, 0.04% - twice at an interval of 15 days
- ❖ **Resistance varieties**
RMO 40, RMO 257, RMO 225 and RMO 435

GROUND NUT (*ARACHIS HYPOGAEA* L.)

❖ **In India**

Area: 7.6 million ha

Production: 7.8 million tones



❖ **Maximum contribution**

Rajasthan, Gujarat, Maharashtra, Haryana

COLLAR ROT

❖ Pathogen:

Aspergillus niger Van Tieghem

❖ Symptoms:

Disease appears in two phases

- **1. Pre-emergence :** Seeds are covered with sooty black mass of spores . The emerging hypocotyls is rapidly killed by lesions.
- **2. Post emergence :** Circular light brown lesions appear on the cotyledons. The seedling collapse and die due to rotting of the succulent hypocotyls . The affected collar region becomes shredded. Dried branches readily detached from the collar region and blown away by wind



EPIDEMIOLOGY

- ❖ **Maximum seed rot occurs at 15°C and 40°C, whereas appears severely at 31-35°C**

MANAGEMENT

- ❖ **Cultural Control**
 - **Healthy seeds should be sown**
 - **Avoid deep sowing**
 - **Mixed cropping with moth**
 - **Deep tillage, early sowing and crop rotation with wheat and gram**
- ❖ **Bio-agent Control**
 - **Seed treatment with *Trichoderma viride* @4 g/kg seeds**

EARLY LEAF SPOT (TIKKA DISEASE)

❖ **Pathogen:**
Cercospora arachidicola Deighton



❖ **Symptoms:**

- Lesions are sub-circular, varies from 1 to over 10 mm in diameter
- They are dark brown on the upper surface of leaflet where most sporulation occurs and a lighter shade of brown on the lower surface of leaflet.
- The color of the lesion on the lower surface of leaflet is light brown

EPIDEMIOLOGY

- ❖ **Temperatures in the 25° C to 30°C range and high relative humidity (>80%) favor infection and disease development.**

MANAGEMENT

- ❖ **Cultural Control**
 - Crop rotation
 - Intercropping with Bajra (3:1)
 - Foliar application of aqueous neem leaf extract (2-5%)
- ❖ **Chemical Control**
 - Spraying with mancozeb 2 g/l + Carbendazim 1g/l
- ❖ **Resistance varieties**
ICGS 44, M 335, BG 3, ICGS 76, Somnath, CSMG 84-1 M522, IARI 48,52, Makula Red, NRCG 5201

MUSTARD

BRASSICA JUNCEA (L.) CZERN & COSS

❖ **In India**

Area: 6.25million ha

Production: 6.68 million ton

❖ **In Rajasthan**

Area: 39.7%

Production: 50%

❖ **Maximum contribution**

Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and West Bengal



WHITE RUST

❖ **Pathogen:**

Albugo candida

(Pers. Ex. Hook.) O. Kuntze



❖ **Symptoms:**

- **White pustules (sori) of variable size and shapes are formed on leaves, stems, inflorescence and pods**
- **The leaves become thick, fleshy and rolled and when infection is severe, the size of the leaves may be reduced.**
- **The floral parts persist and show hypertrophy or hyperplasia.**

EPIDEMIOLOGY

- ❖ Infections are favored by temperatures between 10 and 15°C and by high atmospheric humidity following rain or heavy dew.

MANAGEMENT

- ❖ **Cultural Control**

Early (September) and timely (October end) sown crops escape staghead infection

Plant extract of garlic and *Acacia nilotica* and isolates of *Trichoderma viride*

- ❖ **Chemical Control**

Three foliar applications of Mancozeb (0.2%), Mancozeb + Metalaxyl (Ridomil MZ 0.05 %) and Ridomil (0.2 %) at 15 days intervals after the appearance of disease

Seed treatment with Metalaxyl (6 g Apron 35 SD/kg seed) followed by three sprays of Dithane M-45

STEM ROT

- ❖ **Pathogen:**

Sclerotinia sclerotiorum (Lib) de Bary

- ❖ **Symptoms:**

- The diseased stem becomes brittle, shreds and often breaks at or slightly above the ground level.
- Numerous black sclerotial bodies are found inside the diseased section of the stem.



EPIDEMIOLOGY

- ❖ **The more common mode of infection occurs when a sclerotium produces one or more germ tube which grows upwards to the soil surface from a depth of 2-3 centimeters.**
- ❖ **Dead or senescent flower parts (petals) are absolutely necessary both for ascospore germination and initial infection. This is one of the main reasons stem rot usually appears at mid-to-late flowering.**

MANAGEMENT

❖ Cultural Control

- Deep summer ploughing

❖ Chemical Control

- Seed treatment with carbendazim @ 1 g kg⁻¹ seed

❖ Resistant varieties

B. juncea (Cutlass, ZYR-6), *B. campestris* (Parkland, Tobin and Candle) and *B. napus* (Westar)

DOWNY MILDEW

❖ Pathogen:

Perenospora parasitica

(Pers. Ex. Fr.) Fr.

❖ Symptoms:

- Occurrence of lesions on leaves surrounded by a conspicuous characteristic white 'downy' growth on abaxial surface.
- The upper surface of affected young and older leaves have ill-defined, irregular, pale, yellow necrotic lesions whereas the lower surface is covered by white grey mycelium.
- On malformed inflorescences sporulation of the downy mildew fungus is predominant in the form of white granular conidia and conidiophores.



EPIDEMIOLOGY

- ❖ **Infections are favored by temperatures between 10 and 15°C and by high atmospheric humidity following rain or heavy dew.**
- ❖ **Further spread of the pathogen is by dissemination of conidia released from conidiophores formed on the cotyledons or hypocotyls.**
- ❖ **A 17°C temperature and 51 mm rainfall results in low infection of downy mildew on mustard in contrast to high infection at 14°C and 152 mm rainfall during the crop season.**

MANAGEMENT

❖ **Cultural Control**

- **Removal, destruction and burning of infected plant debris along with weeds to restrict the source of primary inoculum.**
- **In addition, clean well-drained soils with two years of crop rotation using non-cruciferous crops has been recommended.**
- **Late sown crops have higher incidence of downy mildew than the early (before October), or timely (by middle October) sown crops**

❖ **Chemical Control**

- **Seed treatment with Apron SD 35 (2 g Metalaxyl/kg seed) along with two or three sprays of Mancozeb or with two foliar applications of Ridomil MZ-72 at 30 days intervals.**

SESAME (*Sesamum indicum*)

❖ **In India**

Area: 19.47 lakh ha

Production: 8.66 lakh ton

❖ **Maximum contribution**

**Rajasthan, Maharashtra, West Bengal, AP, Tamil Nadu, MP,
Telangana and Gujarat**



DRY ROOT ROT & STEM ROT

❖ **Pathogen:**

Macrophomina phaseolina

(Tassi) Goid

❖ **Symptoms:**

- **Bronzing of leaves on one or more branching followed by dropping of the upper tender parts of the shoot.**
- **Black dots appear on the infected stem, which are the pycnidia of the fungus. If infected plant is uprooted, black colored roots are observed having sclerotia of the fungus. The roots become brittle.**
- **Heavily infected plants rarely produce any grain, and if produced, seeds are also infected.**



EPIDEMIOLOGY

- ❖ **Increases in inoculum and disease development is dependent on moisture stress coupled with temperature stress.**
- ❖ **Low native populations of total bacteria and actinomycetes in the soil.**
- ❖ **Seedling stage is the most vulnerable.**

MANAGEMENT

❖ Cultural Control

- Crop Rotation with Pearl millet
- Amendment of soil with pearl millet and weed composts for two consecutive years reduced resident population of *M. phaseolina* by 20-40%
- Soil Solarization
- Treated with culture of *Bacillus firmus*, *Aspergillus versicolor*, vesicular arbuscular mycorrhizae i.e. *Glomus mosseae*, *Azotobacter chroococcum*, *Rhizobium sp.*

❖ Chemical Control

- Seeds treatment with carbendazim or captan @ 2 g/kg or thiram, @ 6 g/kg

❖ Resistant varieties

- *EC-770932*, *EC-351832*, *EC-370929*, *ES-379-3-84*, *IS-664-1*, *IS-97*, *IS-100B*

PHYLLODY

❖ Pathogen:

Orosius albicinctus

Symptoms:

- The flowers turn into green leafy structures followed by abundant vegetative growth.
- Infected plant is conspicuous by its stout internodes, abundant abnormal branching, which causes top portion of the branches to bend down



EPIDEMIOLOGY

- ❖ **Phyllody occurs more in early sowing crop as compared to late sowing.**

❖ **Chemical Control** MANAGEMENT

- **Tetracycline HCL and oxytetracycline HCL - concentration of 100, 200, and 300 - sprayed 500 and 750 ppm**

❖ **Resistant Varieties**

RT-46, 103, 125,351 and RT-54

Guj Til-1,2,3, AKT-64, RJS78, RJS147, KMR14, KMR79, Pragati, IC43063 and IC43236 and two wild spp. i.e. Sesamum alatum and Sesamum mulayanum were resistant to phytoplasma

CUMIN (*CUMINUM CYMINUM* L.)

❖ **In India**

Area: 5 lakh hectares

Production: Average yield 0.5 t ha⁻¹ (0.3 – 1 ton ha⁻¹)

❖ **Maximum contribution**

Exclusively cultivated in Arid and semiarid regions of India in Rajasthan and Gujarat States



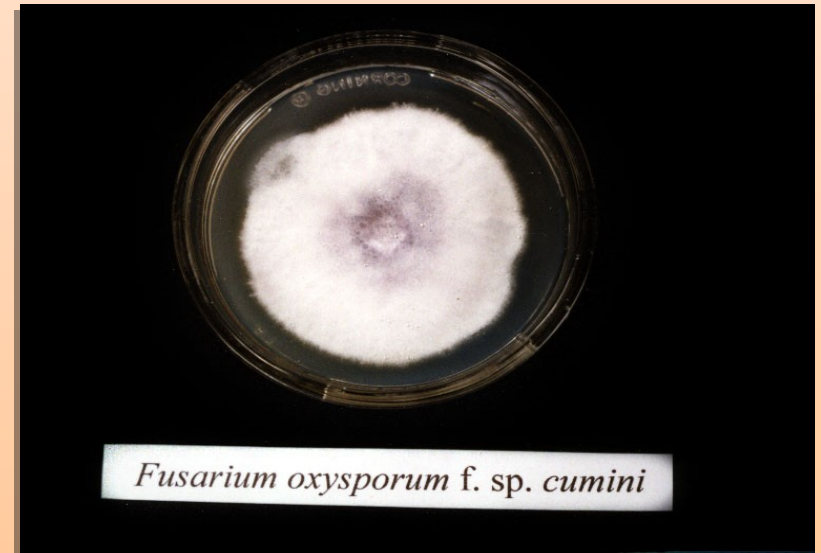
WILT

- ❖ **Pathogen:** *Fusarium oxysporum* f. sp. *cumini*
- ❖ **Symptoms:**
 - The roots of the disease crops bear dark brown markings.
 - In severe stage the tip of the plant and leaf drop down.
 - Such plants can be easily pulled out of the soil.
 - Seeds if formed are thin, small and shriveled.



EPIDEMIOLOGY

- ❖ Soils are conducive to *Fusarium*
- ❖ Soil-borne Survival
- ❖ Chlamydospores (> 10 years)
- ❖ Heat tolerance(>60°C)
- ❖ Low organic matter
- ❖ Low microbial Population
- ❖ Poor moisture retention capacity of soils
- ❖ Repeated cultivation of susceptible strains



MANAGEMENT

❖ **Cultural Control**

- **Crop Rotation**
- **Less effective due to survival of chlamydospores for more than 10 years.**

Recommended crop sequence :

cumin – wheat – mustard – cumin

- **Soil Solarization**
- **Organic amendments- Incorporation of mustard pod residues (2.5 t ha⁻¹) + mustard oil cake (0.5 t ha⁻¹) with one summer irrigation**

❖ **Bio-control agent Control**

- ***Trichoderma harzianum*- Maru sena 1 as seed treatment and soil application**

❖ **Resistant varieties**

GC 4, RZ 19, RZ 209

POWDERY MILDEW

❖ Pathogen:

Erysiphe polygoni DC

Symptoms:

- Appears as grayish specks on the lower leaves.
- Under favorable condition, these specks enlarge and cover the leaf surface with mycelial growth and conidia of the fungus.
- The seeds if developed will be small, shriveled and lighter than the normal ones
- In severe form, the infected field appear to be dusted with white flour.
- Fruits if formed are light in weight.



EPIDEMIOLOGY

- ❖ **Warm moist conditions.**
- ❖ **Rainfall not necessary, but few light showers in early December may be helpful for initiating early infection.**
- ❖ **Late sown crop is more vulnerable**
- ❖ **Optimum temperature for germination of conidia (20-22 °C) and spread of disease (26.5-35 °C).**

MANAGEMENT

❖ **Cultural Control**

- **Early planting**

❖ **Chemical Control**

- **Application of sulphur dust @ 28 kg /ha at the time flowering.**
- **Second application @ 13.5 kg/ha at the time of seed formation if weather condition are favorable for spread of disease.**
- **Spraying dinocap (0.1%), Carbendazim (0.1%) or Tridemorph (0.1%) checks spread of the disease.**
- **Three sprays of Tridemorph (0.1%) most effective.**

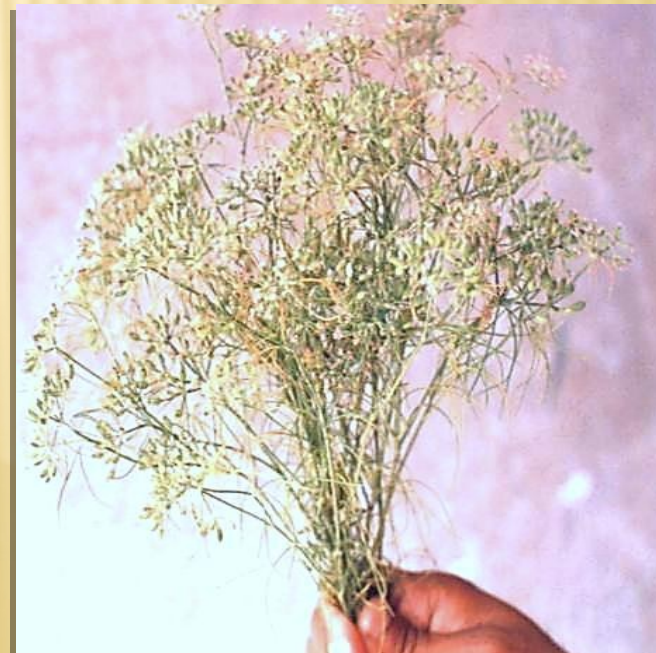
BLIGHT

❖ Pathogen:

Alternaria brunsii

Symptoms:

- Appearance of small, isolated, whitish necrotic areas on the aerial parts especially on tips of young leaves.
- These areas gradually enlarge and coalesce with each others and turn purple; eventually brown and finally black.
- Seeds, if produced are shriveled, dark colored, light weight and usually non-viable.



EPIDEMIOLOGY

- ❖ **Temperature between 23-28° C.**
- ❖ **Under humid and cloudy weather, the disease spreads very fast like a wild fire.**

MANAGEMENT

- ❖ **Chemical Control**
 - **Seed treatment with Aureofungin, Ceresan, Agrosan GN, Captan and Difoltan.**
 - **Four spray of Mancozeb (0.2%).**
 - **Fungicidal spray - Blitox, Vitavax, Captan found effective.**

Resistance varieties

- **GC -1, GC-4**

CORRINDER: *CORIANDRUM SATIVUM*

❖ **In India**

Area:

Production: 433mton

❖ **Maximum contribution**

Rajasthan, Gujarat, Andhra Pradesh, Madhya Pradesh, Tamil Nadu and Karnataka.



BLIGHT

❖ Pathogen:

Fusarium oxysporum f. sp. *corianderi*

Symptoms:

- Drooping of the terminal portions followed by weathering and dry up of the leaves, ultimately resulting in the death
- Partial wilting is also common
- Leaves become pinkish yellow in color



EPIDEMIOLOGY

- ❖ **Maximum development at 24-27°C**
- ❖ **All stages of the crop are vulnerable**
- ❖ **Severity increases with the age**

MANAGEMENT

- ❖ **Cultural Control**
 - **Summer ploughing**
 - **Use of healthy seeds**
 - **Crop rotation for three years**
 - **Early sown crop (early November) escape the disease**
 - **Amending soil with oil cake reduces the disease**
 - **Adjusting soil pH at 8.2 reduces the disease**
- ❖ **Chemical Control**
 - **Seed treatment with carbendazim@1.5 g/kg seed**

POWDERY MILDEW

❖ Pathogen:

Erysiphe polygoni DC

Symptoms:

- Appears as grayish specks on the lower leaves.
- Under favorable condition, these specks enlarge and cover the leaf surface with mycelial growth and conidia of the fungus.
- The seeds if developed will be small, shriveled and lighter than the normal ones
- In severe form, the infected field appear to be dusted with white flour.
- Fruits if formed are light in weight.



EPIDEMIOLOGY

- ❖ **Warm moist conditions.**
- ❖ **Rainfall not necessary, but few light showers in early December may be helpful for initiating early infection.**
- ❖ **Late sown crop is more vulnerable**
- ❖ **Optimum temperature for germination of conidia (20-22°C) and spread of disease (26.5-35°C).**

MANAGEMENT

- ❖ **Cultural Control**
 - **Remove crop stubbles before sowing**
- ❖ **Chemical Control**
 - **Dusting of sulphur @20-25 kg/ha or spray wettable sulphur @ 2 g/l of water or Dinocap @ 1ml/lit. Repeat after 15 days if required.**
- ❖ **Resistant variety**
 - **Cultivars like CS- 52 is moderately resistant**

STEM ROT

❖ **Pathogen:**
Sclerotium sclerotiorum

Symptoms:

- The disease appears mainly around flowering under high soil moisture conditions in patches.
- First water soaked spots are formed on the main stem which turn brown, later the whole stem is girdled.
- The surface gets covered with white fungus hyphae and looks like a cottony growth.
- The plant gradually dries. On splitting the diseased stem black sclerotia are observed.



EPIDEMIOLOGY

- ❖ **Disease is favored by rainy season**

MANAGEMENT

❖ **Cultural Control**

- **Deep ploughing is helpful in burying the sclerotia deep in soil.**
- **Crop rotation is useful in checking the disease as the pathogen is specific to coriander. Paddy after coriander helps in the elimination of the inoculum source.**
- **Adjustment of date of sowing is also useful.**
- **Amendment of soil with oilcakes checks the disease severity.**
- **Either resistant or less susceptible local types may be preferred.**

STEM GALL

- ❖ **Pathogen:**
Protomyces macrosporus Unger
- ❖ **Symptoms:**
 - In the form of small tumour like hypertrophied swellings on the aerial parts
 - Swellings are elongated
 - Galls are soft and fleshy when young later becomes hard and woody
 - Infected plants are stunted
 - Infection becomes systemic in the stem, fruits ,which are larger in size



EPIDEMIOLOGY

- ❖ **High soil moisture and shade with suitable inoculum potential predispose the plants to infection and result in severe incidence of the disease. It is pH 7.4 which attracts maximum infection. The fruits, however, show maximum infection at pH 7.4-8.4.**

MANAGEMENT

- ❖ **Cultural Control**
 - **Removal and destruction of gall bearing plants**
- ❖ **Chemical Control**
 - **Spray of streptomycin(0.1%) or carboxin (0.2%), 30 days after sowing**
 - **Seed treatment with Thiram or captafol(2g/kg seed)**
- ❖ **Resistant variety**
 - **GC88-8, Pant-1, UD-20**

FENUGREEK

TRIGONELLA FOENUM-GRAECUM L.

- **Fenugreek (*Trigonella foenum-graecum* L.) is an annual legume crop cultivated in India, the Mediterranean region, China, parts of Africa, Europe and Australia and, in recent years, in North America. Although traditionally used as a spice crop, fenugreek has important medicinal and nutraceutical properties and is also grown as a forage crop in some countries.**



POWDERY MILDEW

- ❖ **Pathogen:**
Erysiphae polygonii and
Levillula taurica
- ❖ **Symptoms:**
 - White, powdery spots on leaves which expand over time
 - yellow spots may be visible on leaf underside



EPIDEMIOLOGY

- ❖ **Warm moist conditions.**
- ❖ **Rainfall not necessary, but few light showers in early December may be helpful for initiating early infection.**
- ❖ **Late sown crop is more vulnerable.**
- ❖ **Optimum temperature for germination of conidia (20-22° C) and spread of disease (26.5-35° C).**

MANAGEMENT

- ❖ **Cultural Control**
 - **Early sowing results in late appearance of the disease**
- ❖ **Chemical Control**
 - **Spray of wettable sulphur(0.2%), Tridemephon (0.1%), Triazole like fungicides. If needed two more sprays should be given at an interval of 15 days after first spray.**
 - **Crop should be dusted with 300 mesh Sulphur dust @ 25 kg/ha to control this disease.**

Resistant variety

- **GC-39, UM-32, RMt-1**

CERCOSPORA LEAF SPOT

- ❖ **Pathogen:**
Cercospora
- ❖ **Symptoms:**
 - **Circular sunken lesions with chlorotic halos on leaves.**
 - **Necrotic areas on leaves.**
 - **discolored areas on pods**



EPIDEMIOLOGY

- ❖ **Favourable conditions:** Optimum conditions are 25° to 35° C with night temperatures above 16.1° C, and a relative humidity of 90-95%. Infection is greatly reduced or nonexistent at temperatures less than 15° C or during periods of leaf wetness less than 11 hours.
- ❖ **Survival and spread:** Pathogen survives mainly in plant debris as desiccation-resistant pseudostromata, but can also survive as conidia in debris or seeds. When moisture is sufficient, new conidia are formed and spread via rain-splash or wind to new leaves or plants.

MANAGEMENT

❖ **Cultural Control**

- Treated with *Azospirillum* 1.5 kg/ha + *Trichoderma viride* @ 50 g/ha for 12 kg of seeds.

❖ **Chemical Control**

- Spray of Tridemefon 1.0g or mancozeb 2.0 g or cyclobutoni 0.5 g in 1 liter of water , repeat after 10-15 days if required.

DOWNY MILDEW

- ❖ **Pathogen:**
Perenospora trigonellae
- ❖ **Symptoms:**
 - **This disease occurs during February and March. Yellow patches on the upper surface of leaves appear in the infected plants and white cottony mycelium on the lower surface of leaves.**



EPIDEMIOLOGY

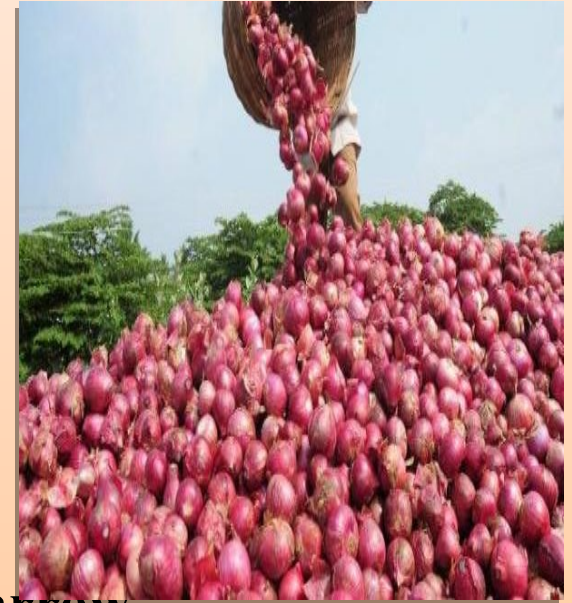
- ❖ **Temperature of 18°C is most favorable**
- ❖ **Leaf wetness period of 12 hrs.**
- ❖ **Low relative humidity**

MANAGEMENT

- ❖ **Cultural Control**
 - **Adopt crop rotation**
 - **Removal of disease stubbles from the field and burying in the soil, Sowing in the mid October**
- ❖ **Chemical Control**
 - **Seed treatment with carbendazim (1.5g) + thiram (1.5 g) for 1 kg of seed, Spray of 20 g solution of Difoltan or any other copper fungicide, Spray tridemefon (1g) or cyclobutonil (0.5g) in 1 lit of water. Repeat after 20 days.**
- **Resistant variety**
 - **A.C.R-1**

ONION (*Allium cepa* L.,)

- ❖ **India is the second largest onion growing country in the world.**
- ❖ **Indian onions are famous for their pungency and are available round the year. Indian onions has two crop cycles, first harvesting starts in November to January and the second harvesting from January to May.**
- ❖ **The onion is a hardy cool-season biennial but usually grown as annual crop. The onion has narrow, hollow leaves and a base which enlarges to form a bulb. The bulb can be white, yellow, or red and require 80 to 150 days to reach harvest.**
- ❖ **The major Onion producing states are Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Rajasthan, Bihar, Andhra Pradesh, Haryana, West Bengal, Uttar Pradesh, Chhattisgarh, Odisha, Tamil Nadu, Jharkhand and Telangana in the country.**



DOWNY MILDEW

❖ **Pathogen:**

Perenospora destructor

❖ **Symptoms:**

- **Downy mildew can infect both onions and garlic. The first evidence of disease is a fine, furry, grayish white to purple growth on the surface of older leaves.**
- **Leaf tissue under the growth becomes pale green, then yellow, and finally collapses. Large, yellowish, circular clumps of infected plants, a few to many feet in diameter, may be the first symptom noticed in the field.**
- **The yellowing patterns often enlarge in the direction of prevailing winds.**



EPIDEMIOLOGY

- ❖ **Downy mildew can develop from an initial infection by airborne spores into an epidemic very quickly if humidity and temperature conditions (1.5 to 7 hours of leaf wetness and 43° to 80°F) are favorable. Spores can travel long distances in moist air, but are quickly killed by dry conditions. Initial sources of disease can be infected bulbs, sets, seeds, and plant debris.**

MANAGEMENT

- ❖ **Cultural Control**
 - **Avoid use of seeds from diseased field**
 - **Drainage in the field should be proper**
 - **Crop rotation and proper weeding**
- **Chemical Control**
 - **Spray mancozeb or Ridomil M.Z @ 2g/lit of water. Repeat after 15 days**

PURPLE BLOTCH

- ❖ **Pathogen:**
Alternaria porri



- ❖ **Symptoms:**
 - It first appears as small, water-soaked lesions that quickly develop white centers. As they age, the lesions turn brown to purple, surrounded by a zone of yellow. Lesions can coalesce, girdle the leaf, and cause tip dieback. Occasionally, bulbs are infected through the neck or wounds on the scales

EPIDEMIOLOGY

- ❖ The disease occurs under favourable conditions of temperature 28-30°C and 80-90% relative humidity.

MANAGEMENT

- ❖ Grow resistant varieties
- ❖ Crop rotation
- ❖ Proper spacing
- ❖ Balanced fertilizer application
- ❖ Spray mancozeb @ 2g/l of water. Repeat after 15 days
- ❖ Remove stubbles from field
- ❖ Summer ploughing

CHILLI or Redpepper (*Capsicum annuum* L.)

➤ **In Rajasthan:**

Area 50 thousand ha

➤ **Production States:**

**Rajasthan, Uttar Pradesh,
Haryana, Madhya Pradesh and
West Bengal**



DAMPING-OFF AND BLIGHT

➤ Pathogen,

Pythium, Phytophthora, Fusarium and Rhizoctonia, etc

➤ Symptoms

It occurs in two stages: (i) pre-emergence, and (ii) post-emergence phase

- ❖ The young seedlings are killed before they reach the surface of the soil. They may be killed even before the hypocotyls has broken the seed coat. The radicle and the plumule, when they come out of the seed, undergo complete rotting.
- ❖ Infected seedlings damp-off any time after they emerge from the soil. the stems become constricted at the base, leaves wilt slightly and finally the plant collapse. The disease often appears in patches both in nurseries and under field conditions.



EPIDEMIOLOGY

❖ In the presence of high soil moisture, oospores germinate and produce planospores.

MANAGEMENT

- ❖ Seed treatment with *Trichoderma viride* (4 g kg⁻¹ seeds) + *Pseudomonas fluorescens* (5 g kg⁻¹ seeds)
- ❖ Soil solarization
- ❖ Drenching of soil with fungicides like Captan (0.2-0.5%)
- ❖ Seedling may be protected by spraying Bordeaux mixture (1%) or Blitox 50 W (0.3%) or Fytolan (0.3%) from second week of sowing at 10 days interval.

➤ Pathogen,

**Group of Gemini and Bogomo
viruses ChLCVs**

Symptoms

- ❖ Curling of abaxial and adaxial portions of leaves accompanied by puckering, distortion and blistering of inter-veinal areas and shortened internodes.
- ❖ These symptoms are mostly produced on upper leaves giving a typical dwarf and distorted plants with curly leaves.
- ❖ Plants appear dwarf and bushy which assume a witch's broom appearance.



EPIDEMIOLOGY

- ❖ Chilli leaf curl virus can successfully be transmitted by the insect vectors such as white fly (*Bemisia tabaci*) and thrips (*Scirtothrips dorsalis* and *Polyphagotarsanemus latus*).

MANAGEMENT

- ❖ The varieties *viz.*, AVRDC-105 is less affected by leaf curl, Pusa Jwala, Surya Mukhi and Japani Loungi are resistant.
- ❖ Spray of neem based chemicals can be used for eco-friendly control of insect-vectors. Sprays of mineral oil (0.1%) is most effective in reducing the disease incidence.
- ❖ Application of carbofuran 3 G (furan) @ 8-10 g per square meter at the time of sowing seeds in nursery.

➤ PATHOGEN

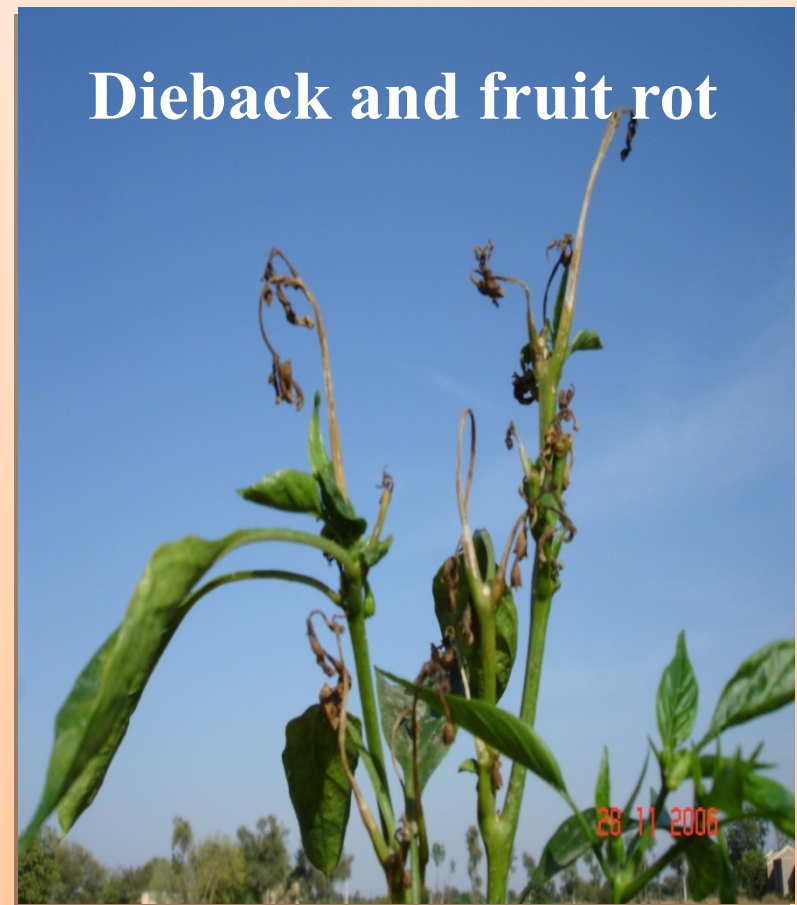
Colletotrichum capsici (Syd.) Butler and Bisby

[perfect stage: *Glomerella cingulata* (Stonem.) Spauld. and Schrenk].

The disease is seed, soil and air-borne.

➤ SYMPTOMS

- ❖ Circular and sunken spots on fruit with black margins and infected fruits drop prematurely
- ❖ The infected plants readily dry up and produce light brown, necrotic lesions at the collar or above ground regions.
- ❖ The fruiting bodies (acervuli) of pathogen develop in large numbers on the upper surface of dead and dried tender branches of diseased plants. The fully-grown plants also get infected with typical dieback symptoms i.e. burning of young branches from the top downwards by producing light dark brown lesions.



Epidemiology

Environmental factors *viz.*, temperature, humidity and rainfall severely affect the incidence and development of dieback and fruit rot.

Management

Varieties *viz.*, Arka Lohit, Jayant, Phule-C-5, X-235 and Jiangshu 3 are resistant to dieback.

Seed treatment with Bavistin (2 g kg⁻¹ seeds), Thiram (3 g kg⁻¹) and Captan (3 g kg⁻¹)

Weeds and other alternate host such as black gram and cowpea should not be allowed to grow in near vicinity of chilli fields

Dipping seedlings in a suspension of *Azospirillum* sp. gave the best control of shoot dieback

BACTERIAL WILT

➤ PATHOGEN,

- ❖ *Ralstonia solanacearum* Smith Yabuuchi et al., (Syn. *Pseudomonas solanacearum* Smith).

➤ SYMPTOMS

- ❖ Leaf drooping and discoloration or one side wilting and stunting, before the plant wilt permanently and dies
- ❖ The vascular tissues of stem and roots turn brown.



EPIDEMIOLOGY

- ❖ High temperature ($>40^{\circ}\text{C}$) coupled with high relative humidity ($>80\%$) favour the disease development

MANAGEMENT

- ❖ Resistant varieties *viz.*, Ujwala, LCA-304, BC-24 and BC-14-2, hybrid-Yuejiao No.1.
- ❖ Sprays of Streptocycline (0.025-0.05%).
- ❖ Light irrigation and crop rotation.

COTTON- *Gossypium herbaceum*

Area : 31.8 m hectares

- ❖ India commands highest share globally (36%) in terms of area under cultivation
- ❖ Global cotton production is estimated at 24,963 mn. Kgs
- ❖ India is the largest producer of cotton accounting for one-fourth of the global cotton production. However, India's yield is much lower than other top cotton growing countries.



WILT

Fusarium oxysporum f.sp. *vasinfectum*

- ❖ Earliest -seedling is the yellowing and browning of the cotyledons.
- ❖ Leaves lose their turgidity first turn yellow and then brown and finally drop off.
- ❖ The tap root stunted and laterals are less abundant.
- ❖ Browning and blackening of vascular tissues.
- ❖ Discolorations of leaves starts from the margins and spread towards midribs.
- ❖ Wilting may be complete or partial.



EPIDEMIOLOGY

- ❖ The disease was more severe forms in heavy soil with soil temperature 20-30 °C during the crop season.
- ❖ Hot and dry periods followed by rains.
- ❖ Heavy black soils with an alkaline reaction
- ❖ Increased doses of nitrogen and phosphatic fertilizers
- ❖ Wounds caused by nematode (*Meloidogyne incognita*) and grubs of Ash weevil (*Mylloceru* *pustulatus*).

MANAGEMENT

- ❖ **Grow *G. hirsutum* in place of *G. arboreaum***
- ❖ **Seed treatment with Carbendazim W.P. @ 2 gm/ Kg of seed**
- ❖ **Soil application with Zinc sulphate@ 25 Kg /ha**
- ❖ **Deep summer ploughing reduces the incidence of the disease**
- ❖ **Application of *Trichoderma harzianum* with organic amendments**
- ❖ **Treat the acid delinted seeds with Carboxin or Carbendazim at 2 g/kg.**
- ❖ **Remove and burn the infected plant debris in the soil after deep summer ploughing during June-July.**
- ❖ **Apply increased doses of potash with a balanced dose of nitrogenous and phosphatic fertilizers.**
- ❖ **Apply heavy doses of farm yard manure or other organic manures. Follow mixed cropping with non-host plants.**
- ❖ **Grow disease resistant varieties of *G. hirsutum* and *G. barbadense* like Varalakshmi, Vijay Pratap, Jayadhar and Verum.**
- ❖ **Spot drench with Carbendazim 1g/litre.**

ROOT ROT –

Macrophomina phaseolina

The pathogen causes three types of symptoms viz., seedling disease, sore-shin and root rot. Germinating seedlings and seedlings of one to two weeks old are attacked by the fungus at the hypocotyls and cause black lesions, girdling of stem and death of the seedling, causing large gaps in the field. In sore-shin stage (4 to 6 weeks old plants), dark reddish-brown cankers are formed on the stems near the soil surface, later turning dark black and plant breaks at the collar region leading to drying of the leaves and subsequently the entire plant.



EPIDEMIOLOGY

- ❖ Dry weather following heavy rains,
- ❖ High soil temperature (35-39°C),
- ❖ Cultivation of favourable hosts like vegetables,
- ❖ Oil seeds and legumes preceding cotton
- ❖ Wounds caused by ash weevil grubs and nematodes.

MANAGEMENT

- ❖ Summer ploughing reduces incidence of disease
- ❖ Timely sowing of the crop (15-30 April)
- ❖ Adopt sound crop rotation
- ❖ Seed treatment with Carbendazim (2gm/ kg seed) or *Trichoderma harzianum* (4gm/kg seed)
- ❖ Cultivation of tolerant varieties like I.G. 8,15, 18 or C.A. -9,10
- ❖ Mixed cropping with moth reduces disease incidence
- ❖ Apply farm yard manure at 10t/ha or neem cake at 150 Kg/ha.
- ❖ Adjust the sowing time, early sowing (First Week of April) or late sowing (Last week of June) so that crop escapes the high soil temperature conditions.
- ❖ Adopt intercropping with sorghum or moth bean (*Phaseolus aconitifolius*) to lower the soil temperature.

BLACK ARM – *Xanthomonas axonopodis* pv *malvacearum*

The bacterium attacks all stages from seed to harvest. Usually five common phases of symptoms are noticed.

Seedlingblight:

Small, water-soaked, circular or irregular lesions develop on the cotyledons, later, the infection spreads to stem through petiole and cause withering and death of seedlings.



Angular leaf spot:

Small, dark green, water soaked areas develop on lower surface of leaves, enlarge gradually and become angular when restricted by veins and veinlets and spots are visible on both the surface of leaves. As the lesions become older, they turn to reddish brown colour and infection spreads to veins and veinlets.

Vein blight or vein necrosis or black vein:

The infection of veins cause blackening of the veins and veinlets, gives a typical 'blighting' appearance. On the lower surface of the leaf, bacterial oozes are formed as crusts or scales. The affected leaves become crinkled and twisted inward and show withering. The infection also spreads from veins to petiole and cause blighting leading to defoliation.

Black arm:

On the stem and fruiting branches, dark brown to black lesions are formed, which may girdle the stem and branches to cause premature drooping off of the leaves, cracking of stem and gummosis, resulting in breaking of the stem and hang typically as dry black twig to give a characteristic "black arm" symptom.

EPIDEMIOLOGY

Optimum soil temperature of 28°C, High atmospheric temperature of 30-40°C, Relative humidity of 85 per cent, early sowing, Delayed thinning,

Poor tillage, late irrigation and Potassium deficiency in soil.

Rain followed by bright sunshine during the months of October and November are highly favourable.

MANAGEMENT

- ❖ **Crop rotation**
- ❖ **Sowing of American cotton between 1-20 May**
- ❖ **Soil application of Potash**
- ❖ **Removal and burn diseased plants**
- ❖ **Weed free cultivation**
- ❖ **Resistant varieties**
- ❖ **Seed treatment with streptomycin (1g/10 lit of water) for 2 hours**
- ❖ **Spray streptomycin or Plantomycin (1g/20 litre of water)**

ISABGOL (*Plantago ovata*)

➤ In India:

Area 2.25 lakh ha

Productivity 625 kg ha

➤ Production States:

**Mainly grown in North Gujarat
and Southern-west Rajasthan**



DOWNY MILDEW

➤ Pathogen,

Peronospora alta Fuckel ,

P.plantaginis Underwood,

Pseudoperonospora

plantaginis

➤ Symptoms



- ❖ Change of leaf color from normal green to pale-yellow or yellow.
- ❖ On lower surface of the affected leaves, sporulation starts within 2-3 days.
- ❖ Plant looks stunted.
- ❖ Leaves of affected plants became necrotic, curled, twisted and the plant started drying, giving a burnt appearance.

EPIDEMIOLOGY

- ❖ **Maximum disease occurred at 15 °C and 100% RH**

MANAGEMENT

- ❖ **Resistant cultivars , DRP-46, DRP-72, FR-169, KLI-7, KLI-13, RI-13, RI-88, RI-89 and RLI-38.**
- ❖ **Cultural: 4 kg/ha at an average plant population of 3.37 lac/ha.**
- ❖ **Chemical: Seed treatment with Apron 35 WS (5 g/kg seeds) followed by three sprays of Ridomil MZ 72 WP (0.1%) or Indofil M-45 (0.2%).**

BER

Ziziphus mauritiana Lam

In India

Area

50,000 ha

Production 526,000 tonnes

Maximum contribution

Rajasthan



Alternaria fruit rot

➤ Pathogen

Alternaria alternata

➤ Symptoms

Disease incidence can be seen in immature as well as young and mature fruits. It starts from pedicel and in bottom portion of fruits. Ripened fruits are nearly free from this rot. Light brown to dark brown spots are produced on ber fruits. Mature fruits rot under severe conditions by brown blotching. Such fruits ultimately fall down resulting huge losses. Some fruits having concentric rings with a number of fungal spores. All the young fruits also fall down in severe case and *ber* plants appear with moderate fruiting.



EPIDEMIOLOGY

The fungus perpetuates as mycelium in infected crop debris. The infection starts from the fruits containing numerous conidia. These conidia are spread by wind, water, rain splash and cause secondary disease. The conidia germinate in the presence of moisture at temperature nearly 25-30°C giving rise to germ tubes, which enter the host tissue.

MANAGEMENT

Cultural control

- ❖ Removal and destruction of infected leaves and twigs from orchard.
- ❖ Keeping the *ber* orchard free from all weeds.
- ❖ Pruning should be done properly in the orchard.

Chemical Control

- ❖ Fungicidal sprays at 15 days interval (mancozeb @ 0.2%) was given to minimize the disease.
- ❖ Mancozeb and copper oxychloride (0.2%) are also useful for retarding the fungal growth.
- ❖ Neem oil significantly reduced severity of fruit rot of *ber* caused by *Alternaria alternata*.
- ❖ For effective disease management, maximum per cent disease control (77.33) was recorded with difenconazole (0.1%) followed by propiconazole @ 0.1% (75.00) whereas Neem oil @ 3.0% (53.45) proved least effective

POWDERY MILDEW

➤ Pathogen

Oidium erysiphoides f. sp. ziziphi



➤ Symptoms

- ❖ Initial symptoms appear on tender or young fruits at pea stage. White specks on any part of immature fruits may occur. In severe incidence, floral parts, whole fruits; pedicel, tender branches and leaves would appear with powdery mass of conidia of the fungus.
- ❖ Both upper and under surface of tender leaves are also affected. The infected areas are slightly raised and rough in appearance causing shrink and defoliation.

EPIDEMIOLOGY

- ❖ **Moderate to severe form under cloudy, humid with moderate temperature coupled with few rainy days. The first week of November is ideal for appearance of powdery mildew under arid conditions.**
- ❖ **Severity of 100% could occur at 21.9°C maximum temperature, 88% morning relative humidity, 59% evening relative humidity and 9.6 hrs sunshine per day.**

MANAGEMENT

- ❖ **Resistant Cultivars viz., Chuhara, Safeda selected, Nazuk, Glory, Sanur-2, ZG-2, ZG-3.**
- ❖ **Spray of Karathane (0.1%) or any sulphur fungicide.**

POMMEGRANATE

Punica granatum L.

In India

Total area under cultivation

107 thousand ha

Production is around 743 thousands tons

Maximum contribution

Maharashtra-80 thousand ha

and Rajasthan – 18 thousand ha

Popular varieties:

Jalore seedless and Ganesh



BACTERIAL LEAF AND FRUIT SPOT

Xanthomonas axonopodis pv. *Punicae*

Symptoms:

- ❖ Small, translucent water soaked spots appeared on the leaves and became necrotic and finally may turn dark brown.
- ❖ Leaves are distorted and defoliated. Water soaked spots on fruits may turn dark brown.
- ❖ The spots are oily in appearance.



Occurance:

- ❖ Tamil Nadu, Maharashtra and Karnataka as well as in some parts of Gujarat and Rajasthan.

EPIDEMIOLOGY

Disease management

Cultural control

- ❖ Removal of weed hosts and other infected plant parts. Pruning should be done in pomegranate orchard.

Chemical control

- ❖ Spraying of 2g streptomycin in 10lit + copper oxychloride (0.2%) with 3 sprays at fortnightly intervals.

Host resistant

- ❖ Varieties 'Bedanasuri, GKVK-1 and Bhagawa' were moderately resistant to bacterial fruit spot.

ANTHRACNOSE

Colletotricum gloeosporioides

Symptoms:

- ❖ minute, black spots on leaf, which are surrounded by yellow region.
- ❖ Spots enlarges and coalesce to form bigger.
- ❖ Severely infected leaves fall off. In fruits, dark brown spots appear earlier and slowly enlarge in size.
- ❖ In advance stage of infection, few spots coalesce together and big lesions are formed on rind.



Occurance:

- ❖ This disease is also almost prevalent in all the pomegranate growing states of India.

EPIDEMIOLOGY

- ❖ The temperature between 30-35°C with more than 75% relative humidity is favourable conditions for the disease incidence. The disease is severe during August-September.

Disease management practices

- ❖ 1-2 sprays of mancozeb or blitox 50% (0.2%) are required to manage the disease.
- ❖ Sprays of kitazin (iprobenfos) at 0.15-0.20% gave good control of this disease.
- ❖ Spraying of mancozeb + carbendazim were most effective against this disease (Jamadar et al. 2000).

ALTERNARIA LEAF AND FRUIT SPOT

Alternaria alternata

Symptoms:

- ❖ Small reddish brown circular spots appear on the leaves as well as fruits.
- ❖ As the disease advances these spots, coalesce to form larger patches and the fruits start rotting.
- ❖ The fruits get affected which become pale and become unfit for consumption.

Occurrence:

- ❖ This disease is also almost prevalent in all the pomegranate growing states of India.

Disease management strategies

- ❖ All the affected fruits should be collected and destroyed.
- ❖ Spraying of mancozeb (0.25%) effectively controls the disease.



Cercospora leaf spot

Cercospora punicae

Symptoms:

- ❖ Leaf spots are minute, brown with yellow halo.
- ❖ Spots are scattered, circular or irregular and become dark brown with age.
- ❖ Spots on lower side are sunken with clusters of spore bearing structures hence greyish in colour.
- ❖ Minute, circular, black spots appear on sepals of the flower.
- ❖ Fruit spots are black, minute and circular on rind.
- ❖ When grow old, become large, irregularly circular and depressed presenting an ugly look to the fruits.



DISEASE MANAGEMENT

Cultural control

❖ All the affected fruits should be collected and destroyed.

Proper drainage

Chemical control

Two sprays of

❖ Thiophanate-methyl (1g/lit.),

❖ Carbendazim (1g/lit.),

❖ Propiconazole (1 ml/lit.)

were found effective.

DISEASES: DANGER FOR POMEGRANATE

Wilt of pomegranate

Fusarium oxysporum

Symptoms:

- ❖ Affected plants show yellowing of leaves in some twigs or branches, followed by drooping and drying of leaves.
- ❖ The entire tree dies in few months or a year.
- ❖ When affected tree is cut, dark greyish-brown coloration of wood is seen.



Disease management

Cultural control

- ❖ Drainage system should be proper in pomegranate orchard.
- ❖ Orchard must be clean and destroy the dry and infected branches from trees.

Chemical control

- ❖ At initial stage drench Propiconazole (2ml) + Chloropyriphos (4ml) per litre, drench 8-10 lit of solution per tree.
- ❖ Drenching of chemical as per above mentioned, then remove wilted plant along with roots and burn it.
- ❖ Drenching *Trichoderma harzianum* (5ml/ lit).

FRUIT CRACKING

Symptoms:

- ❖ Fruit cracking in pomegranate is a serious physiogenic/ nutritional disorder.
- ❖ It is found at fruit maturity stage. The cracked fruits spoil rapidly and become unfit for human consumption.
- ❖ In severe condition, whole fruit shows splitting. The reduction of marketable yield may be to the extent of 20-30 per cent due to this malady.
- ❖ Cracked fruits are susceptible to storage disease, have shorter storage as well as shelf-life.



FRUIT CRACKING

Causes

- ❖ Cracking occurs mostly due to excessive absorption of moisture by the plant and it is more severe when a period of drought is followed by rains or heavy irrigation.
- ❖ Genetically determined susceptibility of grown species and cultivar.
- ❖ It is due to boron deficiency in young fruits while in developed fruits it may be caused due to extreme variations in day and night temperatures.
- ❖ Temperature plays a very important role in the ratio of fruit cracking. There was a linear increase in cracking with temperature increase from 10 to 40°C. Temperature also affects permeability of the cell walls and bio-chemical processes of the cells etc.

Protective measures

- ❖ Use sufficient FYM and mulch to the basin for maintaining the moisture in the orchard. The water retention capacity of the plants should be increased by the use of organic manures.
- ❖ Grow wind breaks all around the orchard to avoid depletion of moisture from soil.
- ❖ The plants should be irrigated regularly during the entire fruit development stage.
- ❖ Spraying of Boron (50 ppm) and GA (40ppm) on the young fruits minimizes the incidence of fruit cracking.

NEEMITOS (NODES IN ROOTS)

ikS/ksa esa uhehVksl jksx ls ikS/ks dh tM+ksa esa
xkaB ca/kuh 'kq: gksrh gSA xkaBksa dh la[;k c<+us ds
ckn ikS/ks ds rus rd ikuh ugha igq;p ikrkA ,slk gksus ij
igys rks ifÙk;kj fldqMuk 'kq: gksrh gS vkSj ckn esa Qy
cuuk can gks tkrs gSA rhu&pkj lky ckn ikS/kk lw[k tkrk
gSaA blds mipkj ds fy, 50 xzke V^akbdksMjek ds lkFk
isflyksekbll o uhe dh [ky ¼2 fdyksxzke½ feyk dj
ikS/kksa esa Mkyuk pkfg,A

ulZjh mipkj& vukj dh ulZfj;ksa esa 50 xzke V^akbdksMZek
Áfr oxZehVj dh nj ls feyk;saA

tM+ksipkj& ,slh Qlysa fteusa ikS/k rS;kj dj [ksr esa jksi.k
fd;k tkrk gS dh ikS/k dh tM+ksa dks mipkj dj yxkus ls Qly
esa chekjh de vkrh gSA blds fy, 500 xzke V^akbdksMekZ 5
yhVj ikuh esa ?kksy cukdj tM+ksa dks vk/kk ?k.Vk Mqcksdj
jksi.k djuk pkfg,A

jksxksa ds mipkj djrs le; /;ku j[kus okyh ckrsa

xÔs HkjkBZ dk feJ.k ÁR;sd xÔs esa 2 fdyksxzke oehZ
dEiksLV] 2 fdyksxzke uhe dh [kyh] 10 fdyksxzke xkscj dh
[kkn 50 xzke V^akbdksMekZ esa feykdj] vk/kk fdyksxzke
flaxy lqij QkWlQsv rFkk 50 xzke feFkkby iSjkkFk;ku pw.kZ
dks feêh esa feykdj Hkjuk pkfg,A ;fn rkykc dh feêh miyC/k
gks rks mld dqN ek=k xÔs esa Mkyuh pkfg,A xÔksa dks
ekulwu vkus ls igys gh Hkj nsuk pkfg,A ikS/ks yxkus dk
dk;Z tqykbZ&vxlr vFkok Qjojhh&ekpZ esa djuk pkfg,A

AONLA

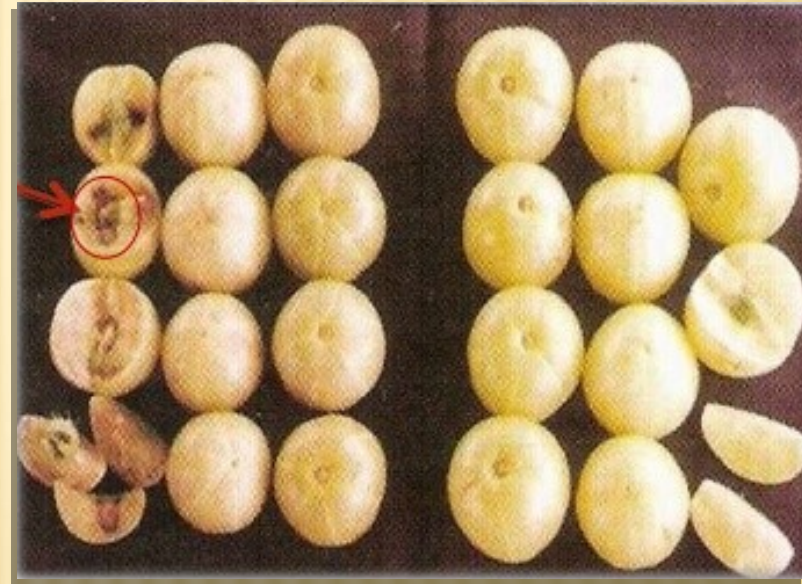
Indian goose berry

**A fruit of medicinal importance,
used for preparing pickels, gem ,
murraba, etc.**



TISSUE NECROSIS- BORON DEFICIENCY

- ❖ **Pathogen:**
Perenospora trigonellae
- ❖ **Symptoms:**
 - Browning of mesocarpic tissue
 - Corky & gummy spots



EPIDEMIOLOGY

MANAGEMENT

❖ **Chemical Control**

- **Soil application of 125 g borox in each tree.**
- **Spray of 6 g borox 3 times in April, July and September.**

Resistant variety

- **Cultivation of “Rajbag” variety**

RUST

- ❖ **Pathogen:**
Ravenilia emblicae
- ❖ **Symptoms:**
 - On fruits as black pustules.
 - Under severe conditions pustules coalesce together and cover a big area
 - Papery covering covers these pustules at initial stage and black spores are exposed when the cover is ruptured
 - On leaves, pinkish brown pustules develop
 - Symptoms on fruits were observed in the month of October. Teleospores of this pathogen causes the fruit and leaf infection



EPIDEMIOLOGY

MANAGEMENT

❖ **Cultural Control**

- It can be managed by integrated approach
- Proper sanitation and clean cultivation
- Collect infected fruits and leaves and destroy at far away place from orchard
- Weed free cultivation

❖ **Chemical Control**

- Spray of copper fungicide @3 g/l, 3-5 times from Aug to Sep at an interval of 10-15 days.
- Three sprays with dithane Z-78 (0.2%) at monthly interval during the months of July to September proves effective against this disease.

FRUIT ROTS

- **Phoma rot - *Phoma emblicae***
- **Alternaria rot - *Alternaria alternata***
- **Cladosporium rot - *Cladosporium tenuissimum***
- **Pestlotia rot - *Pestlotia spp.***
- **Penicillium rot - *Penicillium digitatum*, *P. citrinum*
and *P. isalandicum***
- **Aspergillus rot - *Aspergillus niger***

MANAGEMENT

❖ **Chemical Control**

- **Spray of 2 g captafol or 2g foltaf or 3 g copper oxychloride in one liter of water for 3 times at an interval of 30 days**
- **Dipping in 4% borax, packed in perforated polyethylene bags stored at room temperature or store in 15% salt solution**

Treatment with Topsin-M and Bayleton control Aspergillus rot

ANTHRACNOSE

❖ **Pathogen:**

Colletotrichum gloeosporioides

❖ **Symptoms:**

- This disease appears on leaflets and fruits in August-September.
- Minute, circular, brown to grey spots with yellowish margin in leaflets. Leaves dried up at advance stages.
- In fruits, pin lead like spots appear with dark brown to pink having yellow halo, while on fruits, depressed lesions develop which later turn dark. In severe cases, many spots coalesce with each other to form bigger lesions. The central areas of spots remain grayish raised with dot like fruiting bodies- the acervuli arranged in rings.
- Under severe condition, plenty spots result the fruits become shrivel and rot.



EPIDEMIOLOGY

- ❖ **The fungus perpetuates in infected crop debris and in the soil. Spores are released from last year's diseased tissue. Conidia germinate by germ tube which form appressorium after coming in contact with surface of the host. The infection peg arises from the appressorium and penetrates the host. The spores are carried out by rain splash or wind and cause secondary infection to soft and succulent tissues. The fungus obtains nutrients from plant cells and these cells are killed by leaf lesion. The lesion expands as the fungus spreads.**

MANAGEMENT

- ❖ **Cultural Control**
 - **Discard affected fruits and leaves at initial stage from the orchard. Proper pruning should be done in orchard to improve air circulation within the crown.**
 - Plant trees on a wide spacing and keep the surrounding area clear of vegetation.**
- ❖ **Chemical Control**
 - **Spraying of carbendazim (0.1%) or difolatan (0.2%)**

DATE PALM

Graphiola

leaf spot or

False smut

Symptoms

Appearance of small yellow spots on the upper side of the leaves.

Small black sori (1-3mm) are formed. These are hard in nature.

Matured sori get ruptured and mass of



MANAGEMENT

Removal of infected leaves:

- ❖ **Spray of mancozeb (0.2%) at 15 day interval.**
- ❖ **Four sprays should be done after appearance of the disease**

TREES – ROOT ROT

➤ Pathogen

Ganoderma lucidum , Basidiomycetes, A week parasite

➤ Symptoms

- ❖ Infected trees often shed its leaves
- ❖ Root starts decaying, Die back
- ❖ Large dead branches
- ❖ Sporophores of the fungus appears at the base of the stem
- ❖ Plants are killed within few months or may be in 1-2 years



EPIDEMIOLOGY

- ❖ **Soil moisture stress is the most important factor**
- ❖ **Some injury is essential**
- ❖ **Prior weakening of the host**
 - a soil moisture/ heat stress**
 - b Injury**
 - c Insect attack**
- ❖ **Root to root contact is essential**

MANAGEMENT

Improving soil moisture conditions , Burying plant wastes in trenches around the trees help in soil moisture conservation

Incorporation of onion and cauliflower residues

Annual application of Farm yard manure 50 kg, Green neem leaves 50 kg, Neem cake 5 kg

Soil drenching of 1%, Bordeaux mixture 40 litres

Tridemorph 1 ml is placed in 100 ml water in a polyethylene tube (10”x4”), tied by completely submerging cut end of one active fine root

Post plant solarization

Soil application of phorate (20 g) + *Trichoderma harzianum* (100 g in 10 kg FYM)

VEGETABLE DISEASE IN POLYHOUSE AND THEIR MANAGEMENT

POLY HOUSE



**POLY HOUSE: OUTER
VIEW**

**POLY HOUSE: INNER
VIEW**

FUNGAL DISEASES

- ❖ **LEAF SPOT**
- ❖ **POWDERY MILDEW**
- ❖ **BLIGHTS**
- ❖ **DOWNY MILDEW**
- ❖ **DAMPING OFF (ADRA GALAN)**

LEAF SPOT



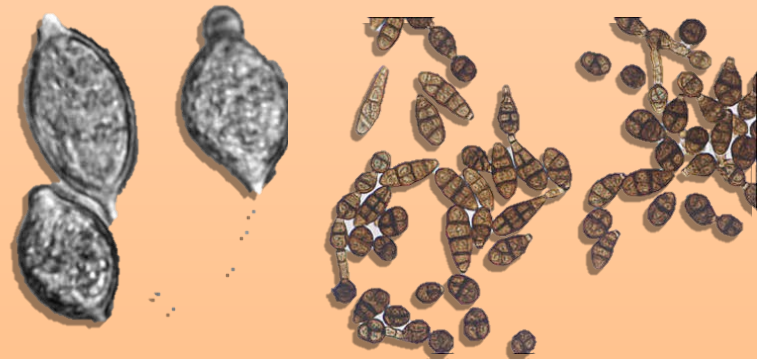
CHARACTERSTICS:

- ❖ Spot of leaf
- ❖ Leaf fall in juvenile stage
- ❖ Immature mortality



PATHOGEN:

- ❖ *Alternaria*, *Cercospora*,
Phytophthora, *Sepataria*
Etc.



LEAF SPOT

DISEASE MANAGEMENT:

- ❖ **0.3% Mancozeb**
treatment of bulbs before sowing
- ❖ **0.25% Mancozeb**
treatment on diseased plant
- ❖ **0.2% Dithane Z-78 or Phytolan**



POWDERY MILDEW



CHARACTERISTICS:

- ❖ Common vegetable disease
- ❖ White powder on Leaf, Stem, Fruits etc.
- ❖ Diseased plant shrinks.

PATHOGEN:

- ❖ *Erysiphe cichoracearum* in solanaceae vegs.



POWDERY MILDEW



DISEASE MANAGEMENT:

- ❖ Sulphur Powder
25Kg/hectare
- ❖ Sulphur Solution
25Kg/hectare
- ❖ Spray Karathane 2ml/lit
(Repeat Spray on 15 days gap)



ALTERNARIA BLIGHT



CHARACTERSTICS:

- ❖ Dark spots on leaf and stem
- ❖ Black fungal spots on fruit
- ❖ Diseased plants start decay

PATHOGEN:

- ❖ Various *Alternaria spp.*



ALTERNARIA BLIGHT



DISEASE MANAGEMENT:

- ❖ **Copper fungicide 2g/l**
- ❖ **Mancozeb (Dithene M-45) 2g/l or 2kg/hactare**



DAMPING OFF (ADRA GALAN)



CHARACTERISTICS:

- ❖ Germinating plantlets fall
- ❖ Weak stem at base
- ❖ Immature plantlets mortality

PATHOGEN:

- ❖ *Fusarium*, *Macrophomina phaseoli*, *Phytophthora spp.*

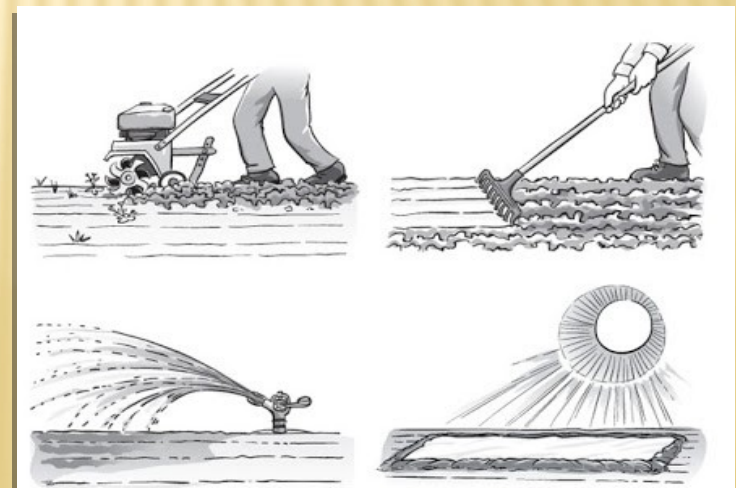


DAMPING OFF (ADRA GALAN)



DISEASE MANAGEMENT:

- ❖ Drenching Land treatment with 1% chloropicrin/dazomet before sowing
- ❖ Fumigate Farmland 48hrs with metam sodium fumes by covered with polythene to wet
- ❖ Farm should keep 2-3 days open before sowing to avoid best germination
- ❖ After 20.. As per monte meet proposal Formalin drenching is restricted to use in developed country but in India this processing is common.



DAMPING OFF (ADRA GALAN)



DISEASE MANAGEMENT:

- ❖ Dip Roots and seeds/ bulbs in 0.2% carbendazim for five minutes
- ❖ Thiram treatment 3g/kg seed



BACTERIAL DISEASES

- ❖ **BACTERIAL LEAF SPOT OF TOMATO**
- ❖ **SOFT ROT OR BROWN ROT**
- ❖ **BACTERIAL BLIGHT OF GUAR**
- ❖ **KOTHIYA LEAF IN CUCUMBER**
- ❖ **BACTERIAL MURJHAN OF CUCURBITS**

BACTERIAL LEAF SPOT OF TOMATO

CHARACTERISTICS:

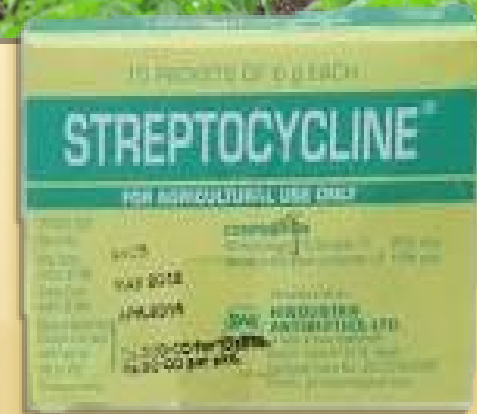
- ❖ Oily Spots on Leaf
- ❖ Spots become Embossed Black
- ❖ Fruits become rotten on ripening.



BACTERIAL LEAF SPOT OF TOMATO

DISEASE MANAGEMENT:

- ❖ **Spray Streptocyclin
200mg/ltr, repeat on 15
days interval till fruiting**



SOFT ROT OR BROWN ROT OF POTATO

CHARACTERISTICS:

- ❖ Plant become Pale Green-Yellow
- ❖ Black streak on Stem
- ❖ Leaves shows wilting
- ❖ Potato Bulb rotten with brown spots

PATHOGEN:

- ❖ *Bacteria*



KALA SADAN OF CAULIFLOWER



CHARACTERISTICS:

- ❖ Mostly appear in Nursery Plantlets
- ❖ Start from the Outer edge of leaf
- ❖ 'V' Shape Yellow spots
- ❖ Leaf veins become black

PATHOGEN:

- ❖ *Xanthomonas campestris*



KALA SADAN OF CAULIFLOWER

DISEASE MANAGEMENT:

- ❖ Seed treatment with 250mg/ltr Streptocyclin aqueous solution
- ❖ Seed soak in Bavistin 1g/ltr for 2 hours, dry before sowing
- ❖ Roots of plantlets can be treat with Streptocyclin or Bavistin in to procure disease



BACTERIAL BLIGHT OF GUAR



CHARACTERISTICS:

- ❖ Disease appear in very early stage of germination as it vectored with seeds
- ❖ Rainy season with wild wind cause Infection in Healthy plants too
- ❖ Leaf shows Aqueous Spot which turned Brown and cover whole plant soon

PATHOGEN:

- ❖ *Xanthomonas spp.*



BACTERIAL BLIGHT OF GUAR



DISEASE MANAGEMENT:

- ❖ Spray Antibiotic 250ppm solution.
- ❖ Use Healthy and Treated Seeds.
- ❖ Seed treatment with 250ppm solution of antibiotic.



KOTHIYA PATTI IN CUCUMBER



CHARACTERISTICS:

- ❖ Common disease of Cucumber
- ❖ Leaf shows angular brown spots
- ❖ Leaf fall and fruit shows brown rotten area
- ❖ Disease vectored via contact seed and water

PATHOGEN:

- ❖ *Pseudomonas lacrimans*



KOTHIYA PATTI IN CUCUMBER



DISEASE MANAGEMENT:

- ❖ Soak seed in 250ppm solution of streptomycin
- ❖ Air dry seed for 2-4 hours before sowing to avoid disease
- ❖ Diseased plant can be treated with Streptomycin 250ppm



BACTERIAL MURJHAN OF MELONS



CHARACTERISTICS:

- ❖ Yellowing of few leaves in start turned into complete wilted yellow plant
- ❖ Cuts on infected Stem secretes sticky substance
- ❖ Bacteria vectored via Cucumber beetle pest

PATHOGEN:

- ❖ *Arvinia tricephalis*



BACTERIAL MURJHAN OF MELONS



DISEASE MANAGEMENT:

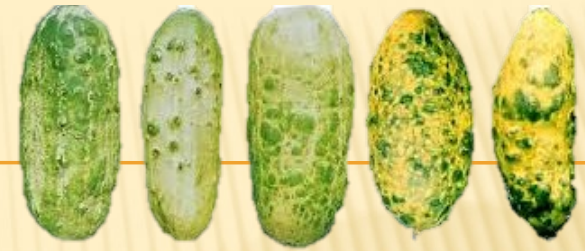
- ❖ Use powder of Malathion on Diseased plant
- ❖ Spray Aqueous solution of Methyl Parathion to cure from disease



VIRAL DISEASES

- ❖ **CUCUMBER MOSAIC VIRUS**
- ❖ **YELLOW VEIN MOSAIC VIRUS**
- ❖ **MIRCH, TOMATO, BENGAN MOSAIC VIRUS**

CUCURBITACEOUS MOSAIC VIRUS



CHARACTERISTICS:

- ❖ Virus vector via Aphids
- ❖ Length and Width of Diseased plant reduced
- ❖ Fruits of diseased plant become misshaped and faded color

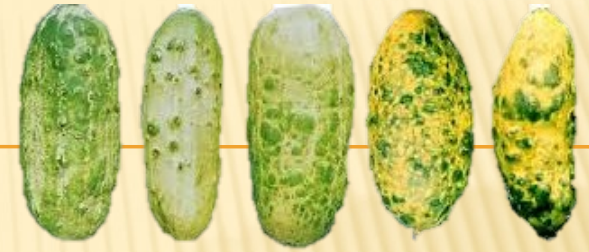
PATHOGEN:

- ❖ *Cucumber Mosaic Virus (CMV)*
- ❖ *Watermelon Mosaic Virus (WMV)*



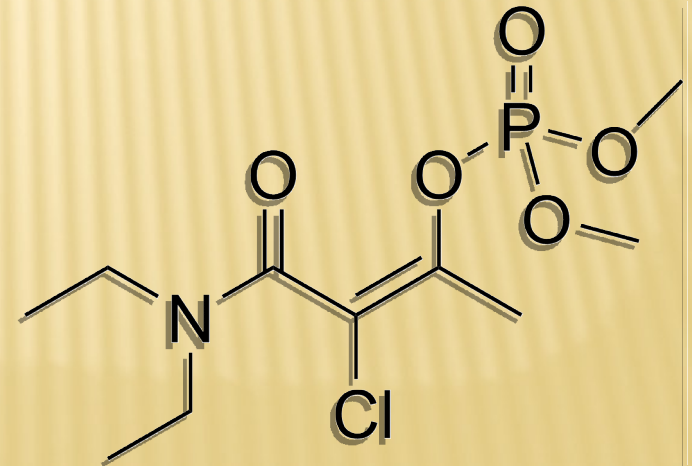
1576638

CUCURBITACEOUS MOSAIC VIRUS



DISEASE MANAGEMENT:

- ❖ Destroy Diseased plant
- ❖ Use virus resistant seed variety
- ❖ Control Aphids by spray of 150ml/hactare Phosphamidon with duration of 10-15 days



YELLOW VEIN MOSAIC VIRUS



CHARACTERISTICS:

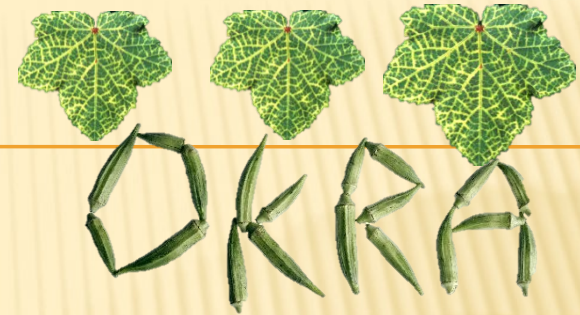
- ❖ Yellow spots on leaves of diseased plant
- ❖ Plant stops to Photosynthesis
- ❖ Plant growth become restricted

PATHOGEN:

- ❖ *Yellow Vein Mosaic Virus*



YELLOW VEIN MOSAIC VIRUS



DISEASE MANAGEMENT:

- ❖ Spray Internal pesticide i.e. Dimethoate on 15 days interval till fruiting
- ❖ After Fruiting Spray Malathion and Endosulphon
- ❖ Use Resistant Variety of *Abelmoschus spp.*



MOSAIC VIRUS OF CHILLI TOMATO AND BRINJAL



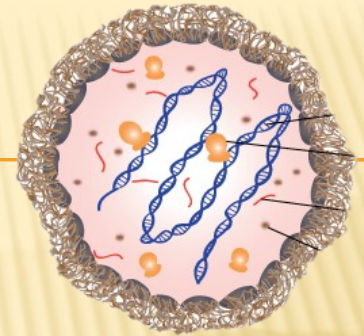
CHARACTERISTICS:

- ❖ Germinating plantlets fall
- ❖ Weak stem at base
- ❖ Immature plantlets mortality



MYCOPLASMA DISEASES

LITTLE LEAF DISEASE



CHARACTERISTICS:

- ❖ Reduction in size of leaves
- ❖ Shortened petioles
- ❖ Excessive growth of branches
- ❖ general stunting of plants
- ❖ Conversion of floral parts into leafy structures
- ❖ Plants become bushy
- ❖ Fruiting is rare
- ❖ Vector of little leaf of brinjal

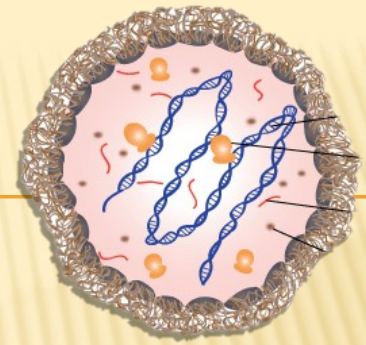
PATHOGEN:

- ❖ *Mycoplasma*
- ❖ *Vector:* (Brown leaf hopper)
Cestius phycitis



MYCOPLASMA DISEASES

LITTLE LEAF DISEASE



DISEASE MANAGEMENT:

- ❖ Remove infected plants and destroy them
- ❖ Before transplantation dip the seedlings in 0.2% carbofuran 50 STD solution (control insect vectors)
- ❖ Spray with methyl parathion 0.5% or dimethoate 0.3%



Sustainable Management Techniques

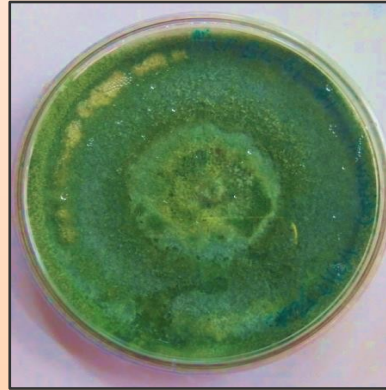
GENERAL ECOFRIENDLY DISEASE MANAGEMENT TECHNIQUE IN AGRICULTURE

- ❖ Select Approved Disease resistant, Hybrid and Genetically Modified Varieties of seeds
- ❖ Use of bio control agents
- ❖ Control all vector pest Efficiently
 - ✓ Neem Oil, NSKE, Garlic Extract,
 - ✓ Insect traps i.e. Light trap, Pheromone trap, Sticky Trap etc.

BIO - CONTROL AGENTS IN USE



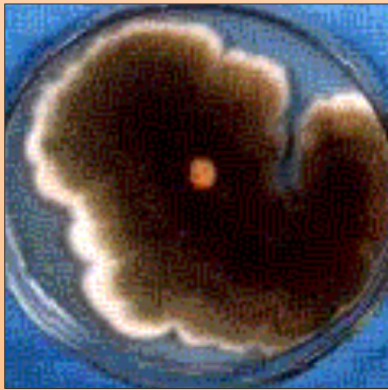
Trichoderma harzianum



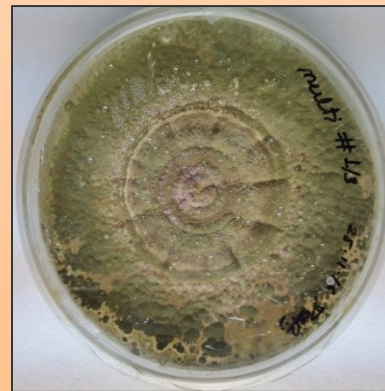
T. longibrachium



T. viride



Aspergillus versicolor



A. nidulans



Bacillus firmus

CHARACTERISTICS

TRICHODERMA HARZIANUM

- ❖ **BROAD SPECTRUM BCA**
- ❖ Heat Tolerance $> 40^{\circ}\text{C}$
- ❖ Check growth of *Fusarium* and *Macrophomina phaseolina*
- ❖ Compatibility with *Bacillus firmus*
- ❖ Plant growth promoting



CHARACTERISTICS

BACILLUS FIRMUS

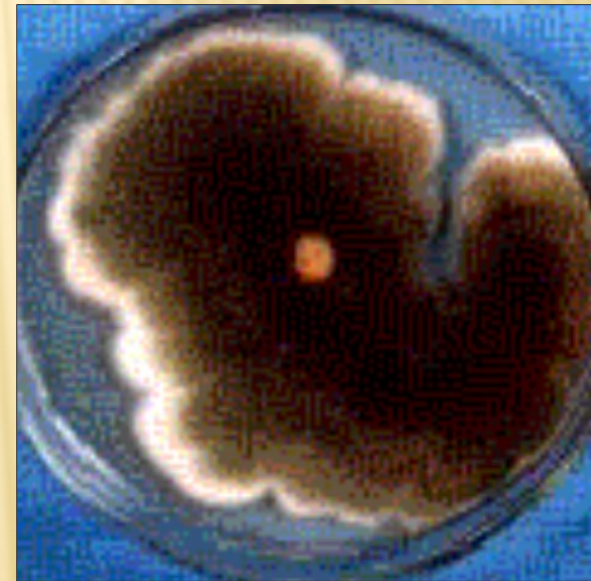
- ❖ **FIRST RECORD IN WORLD**
 - ❖ Thermal sensitivity 45°C
 - ❖ Specific to *M. phaseolina*
 - ❖ Phosphate solubilizing bacterium
 - ❖ Compatibility with *T. harzianum*
 - ❖ Increase nodulation
 - ❖ Plant growth promoting bacterium
- Potential to colonize roots



CHARACTERISTICS

ASPERGILLUS VERSICOLOR

- ❖ **HEAT TOLERANCE.**
- ❖ Survival at low soil moisture
- ❖ Check growth of *Fusarium* and *Macrophomina phaseolina*.
- ❖ More effective than *T. harzianum* in arid regions
- ❖ Root colonization helped in promoting crop growth .
- ❖ Produces antibiotic mycoversilin and releases volatiles (hydrocarbons, alcohols and sulphur containing compounds).



MARU SENA : Bio-Control Defense Line for Crop



केन्द्रीय मरु अनुसंधान संस्थान, जोधपुर
कृषि तकनीकी सूचना केन्द्र (ATIC)

मरु सेना 1

मिश्र फफूंद :- यह दलहनी व तिलहनी फसलों के जड़ गलन व उखटा रोगों की रोकथाम के लिये पश्चिमी राजस्थान की भूमि से ही निकाली गई, मिश्र फफूंद ट्राईकोडर्मा हारजियेनम है।

इसके द्वारा बीजोपचार से पौधों का अंकुरण व फैलाव उत्तम होता है व पौधों में भूमि जनित रोगों का प्रकोप कम होता है, जिससे फसलों की पैदावार अधिक होती है।

मूल्य रु.

आइ सी ए आर - केन्द्रीय शुष्क क्षेत्र अनुसंधान संस्थान, जोधपुर
कृषि तकनीकी सूचना केन्द्र (एटिक)

मिश्रित मरुसेना

मिश्र जीवाणु फफूंद
यह दलहनी व तिलहनी फसलों के जड़गलन, आन्तगलन व सूखा जड़गलन रोगों के रोकथाम के लिए पश्चिमी राजस्थान की भूमि से ही निकाली गयी एक मिश्र फफूंद ट्राइकोडर्मा हरजियेनम व मिश्र जीवाणु बैसिलस फाल्सस है।
इसके द्वारा बीजोपचार से पौधों का अंकुरण व फैलाव उत्तम होता है व पौधों में भूमि जनित रोगों का प्रकोप कम होता है, जिससे पौधों की पैदावार अधिक होती है।

ऋतु मावर
वरिष्ठ वैज्ञानिक

निदेशक
आइ सी ए आर - केन्द्रीय शुष्क क्षेत्र अनुसंधान संस्थान
जोधपुर - 342 003

केन्द्रीय मरु अनुसंधान संस्थान, जोधपुर
कृषि तकनीकी सूचना केन्द्र

मरु सेना 3

जीवाणु - यह मूंग, चवला, ग्वार, मोठ आदि दलहनी फसलों के जड़ गलन रोग (ड्राई रूट रोट) के रोकथाम के लिये पश्चिमी राजस्थान की भूमि से निकाला हुआ जीवाणु है।

इसके द्वारा बीजोपचार से पौधों का अंकुरण व फैलाव उत्तम होता है व जड़ गलन रोग का प्रकोप कम होता है, जिससे दलहनी फसलों की पैदावार अधिक होती है।

निदेशक
केन्द्रीय मरु अनुसंधान संस्थान
जोधपुर - 342003

SEED TREATMENT

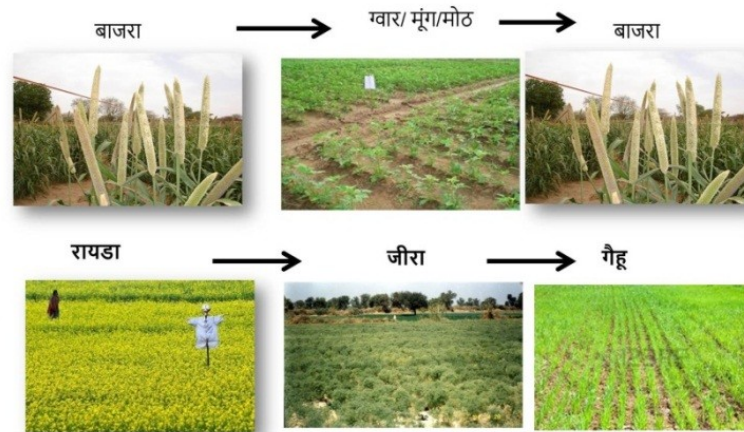
SEED COATING BY BIOCONTROL AGENTS

- ❖ Select Best Variety Seed
- ❖ Apply 4-6g Maru Sena-1 and Mix with 1000g seeds (Use water if required)
- ❖ Mix well the seed
- ❖ Air dry the Seed for 4-5 hours
- ❖ Sow treated seeds
- ❖ Enjoy best Germination and Highest Yield



Crop Rotation

सही फसल चक्र अपनाए



- ❖ Soil borne plant pathogens, which can attack plants of one or a few species or even families can be often eliminated from the soil by planting for 3-4 years. A sound crop rotation of legumes and cereals is advocated for many crops.
- ❖ Downy mildew of pearl millet- pearl millet- legume rotation
- ❖ Wilt of cumin- Wheat- mustard-cumin

Soil Solarization

- ❖ Soil solarization is a technique used primarily for the disinfestation of soil. In this method, a transparent polyethylene sheet (50 μ) is mulched on moist soil during period of high ambient temperature for atleast 20-30 days depending on availability of heat.
- ❖ **Concept: To increase soil temperature in the ranges found to be lethal for resting structures of soil-borne pathogens.**



Inter cropping

- ❖ **Intercropping is done for getting maximum livelihood security in order to enrich fields with nitrogen through legumes. Intercropping also derives moisture from different depths**
- ❖ Intercropping sunflower with groundnut in 6:2 ratio reduces incidence of Alternaria blight on sunflower.
- ❖ Intercropping pearl millet or sorghum with groundnut (1;3) is useful in reducing Tikka disease of groundnut
- ❖ Groundnut intercropped with mothbean reduces collar rot in groundnut

Mixed cropping

- ❖ **Mixed cropping is traditional way of cultivating different rain-fed crops varying in root habits and maturity. This mixture is sown after the onset of monsoon to avert vagaries of rains. It also reduces the economic losses from diseases.**
- ❖ **In addition to increased availability of nitrogen from legumes, more efficient use of solar radiation and better use of soil moisture.**

CULTURE MEDIA

M. phaseolina on Chloroneb-Mercury-Rose Bengal-Agar Medium (CMRA)

- ❖ Rice- 10 g / l
- ❖ Chloroneb- 480 mg
- ❖ Mercuric chloride –8 mg
- ❖ Rose bengal- 112 mg
- ❖ Streptomycin sulphate- 40 mg
- ❖ Potasium Penicillin (Pentid 400)- 60 mg
- ❖ Agar- 20g
- ❖ Distilled water- 1000 ml

Note: Dye and Antibiotic added after autoclave (60°C)

CULTURE MEDIA

Fusarium on PCNB Medium

- ❖ Difco Peptone- 15 g
- ❖ KH₂PO₄ - 2 g
- ❖ MgSO₄ - 500 mg
- ❖ PCNB- 664 mg
- ❖ Oxgall- 500 mg
- ❖ Streptomycin sulphate – 100 mg
- ❖ Chlorotetracycline hydrochloride - 50 mg
- ❖ Agar- 20 g
- ❖ Distilled water- 1000 ml

Note: Dye and Antibiotic added after autoclave (60°C)

CULTURE MEDIA

Total Fungi on Martin Rose Bengal Agar Medium

- ❖ **Dextrose- 10 g**
- ❖ **Peptone- 5 g**
- ❖ **KH₂PO₄- 1 g**
- ❖ **MgSO₄- 500 mg**
- ❖ **Rose bengal - 35 mg**
- ❖ **Streptoimycin sulphate- 30 mg**
- ❖ **Agar- 15 g**
- ❖ **Distilled water- 1000 ml**

Note: Dye and Antibiotic added after autoclave (60°C)

CULTURE MEDIA

Total Actinomycetes on Ken-knight's Agar medium

- ❖ **Glucose- 1 g**
- ❖ **KH₂PO₄-100 mg**
- ❖ **NaNO₃-100 mg**
- ❖ **KCl - 100 mg**
- ❖ **MgSO₄- 100 mg**
- ❖ **Agar - 15 g**
- ❖ **Distilled water- 1000 ml**

Note: Dye added after autoclave (60°C)

CULTURE MEDIA

Total Bacteria on Thoronton Agar medium

- ❖ Mannitol - 1 g
- ❖ Asparagine - 1.5 g
- ❖ K_2HPO_4 - 1 g
- ❖ KNO_3 - 500 mg
- ❖ $MgSO_4$ - 200 mg
- ❖ $CaCl_2$ - 100 mg
- ❖ $NaCl$ - 100 mg
- ❖ $FeCl_3$ - 2 mg
- ❖ Agar- 15 g
- ❖ Distilled water- 1000 ml

Note: Dye added after autoclave (60°C)

CULTURE MEDIA

Antagonistic actinomycetes on Czapeck's Dox Agar Medium

- ❖ Sucrose- 30 g
- ❖ NaNO_3 - 2 g
- ❖ K_2HPO_4 - 1 g
- ❖ MgSO_4 - 0.5 g
- ❖ KCl - 0.5 g
- ❖ FeSO_4 -0.01g
- ❖ Pectin- 2 g
- ❖ Agar- 15 g
- ❖ Distilled water- 1000 ml

CULTURE MEDIA

Armstrong's Fusarium medium

- ❖ Sucrose or glucose – 20g
- ❖ $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ – 0.4
- ❖ KCl – 1.6g
- ❖ KH_2PO_4 – 1.1g
- ❖ $\text{Ca}(\text{NO}_3)_2$ – 5.9g
- ❖ FeCl_3 – 0.2ppm
- ❖ MnSO_4 – 0.2ppm
- ❖ ZnSO_4 – 0.2ppm
- ❖ Distilled water – 1000ml

Richard's broth media for fungal growth

- ❖ Sucrose – 50g
- ❖ KNO_3 – 10g
- ❖ KH_2PO_4 – 5g
- ❖ MgSO_4 – 2.5g
- ❖ FeCl_3 – 0.02g
- ❖ Distilled water- 1000ml

CULTURE MEDIA

Selective medium for *Trichoderma spp.* (especially for *T. hamatum*)

- ❖ Glucose – 3g
- ❖ NH₄NO₃ – 1g
- ❖ K₂HPO₄ – 0.9g
- ❖ MgSO₄.7H₂O – 0.2g
- ❖ KCl – 0.15g
- ❖ FeSO₄.7H₂O – 20mg
- ❖ MnSO₄.H₂O – 20mg
- ❖ ZnSO₄.7H₂O – 20mg
- ❖ Rose-bengal – 30mg
- ❖ Agar - 20g

Note: After autoclaving add 50mg Chloramphenicol, 50mg Streptomycin, 10mg Metalaxyl (25.1%) and 0.1 g of PCNB (75%)

CULTURE MEDIA

Adapted Selective Medium for *Tricoderma* *spp.*

- ❖ MgSO₄.7H₂O – 0.2 g
- ❖ K₂HPO₄
- ❖ KCL
- ❖ NH₄ NO₃- 3.0g
- ❖ Chloromphenicol- 0.25
- ❖ Rose Bengal* – 0.15g
- ❖ Captan* 0.2g
- ❖ Water 1L

**Note: After autoclaving add
Antibiotic**

Nutrient agar medium

- ❖ Beef extract – 3.0g
- ❖ Bacto-peptone- 5.0g
- ❖ Glucose – 5.0g
- ❖ Nacl – 5.0g
- ❖ Agar – 15g
- ❖ Water - 1000 ml
- ❖ pH- 7.0 – 7.2

**Note: After autoclaving add
Antibiotic**

CULTURE MEDIA

SabourD Dextrose Agar with Yeast (SDAY)

- ❖ Peptone – 10.0 g
- ❖ Dextrose - 40.0g
- ❖ Yeast extract - 5.0g
- ❖ Agar - 15.0 g
- ❖ Water 1000 ml

**Note: After autoclaving add
Antibiotic**

SabourD Maltose Agar with Yeast (SMAY)

- ❖ Peptone – 10.0g
- ❖ Dextrose – 40.0g
- ❖ Yeast extract – 5.0g
- ❖ Agar – 15.0 g
- ❖ Water - 1000 ml

**Note: After autoclaving add
Antibiotic**

Potato dextrose / Jaggery medium

- ❖ Potato – 200g ;
- ❖ Dextrose / Jaggery – 20g
- ❖ Water – 1000 ml

Reputed Journals their address

**Plant Disease/ Phytopathology
The American Phytopathological Society
3340 Pilot Knob Road
St. Paul, Minnesota
MN 55121, USA**



Reputed Journals their address

**Indian Phytopathology
Division of Plant Pathology
IARI, New Delhi 110012**

**Journal of Mycology and Plant Pathology
Department of Plant Pathology
Rajasthan College of Agriculture (MPUAT) Udaipur**

Reputed Journals their address

Crop Protection

Elsevier Science Ltd.

**The Boulevard Longford Lane, Kidlington, Oxford
OX15 1GB, UK**

Plant Pathology

**Anna Rivers, Blackwell Scientific Publications Ltd.,
osney mead, Oxford OX2 OEL, UK**

Reputed Journals their address

Phytopathology

The American Phytopathological Society

3340 Pilot Knob Road

St. Paul, MN 55121, USA

<http://apsjournals>, apsnet.org

The American Phytopathological Society

3340 Pilot Knob Road

St. Paul, MN 55121, USA

<http://apsjournals>, apsnet.org

Reputed Journals their address

Phytopathologia Mediterranea
MPU, Dipartimento Biotecnologic Agraric –
Patologia Vegetale, University, Firenze, Italy
email : [**laura.mugnai@unifi.it**](mailto:laura.mugnai@unifi.it)

Phytoparasitica
P.O.B. 2385
Rehovot, 76123
Israel

Reputed Journals their address

Plant and Soil

Kluwer Academic Publishers

Editorial Office , P.O. Box 990

3300 AZ Dordrecht, The Netherlands

<http://www.wkap.nl//>

European Journal of Plant Pathology

Kluwer Academic Publishers, P.O. Box 322

3300 AH Dordrecht

The Netherlands

<http://www.wkap.nl//>

Reputed Journals their address

Journal of Plant Pathology
Folia Microbiologica
Videnska 1083
14Z 20 Prague CZECH REPUBLIC
Email: folia@biomed.cas.cz

Scientia Horticulturae 3
Acta Horticulturae, ISHS
Secretariat of ISHS
K. Mercierlaan, 92
3001 Leuven, Belgium
Ishs@agr.kuleuven.ac.be

Reputed Journals their address

Soil Biology and Biochemistry (3.5)

Editor

Department of Microbiology

Annals of Applied Biology (3.0)

Association of Applied Biologists

National vegetable Research Station

Wellesbourne, Warwickshire CV35 9EF UK



THANK YOU

**Miles to go before I
sleep...**