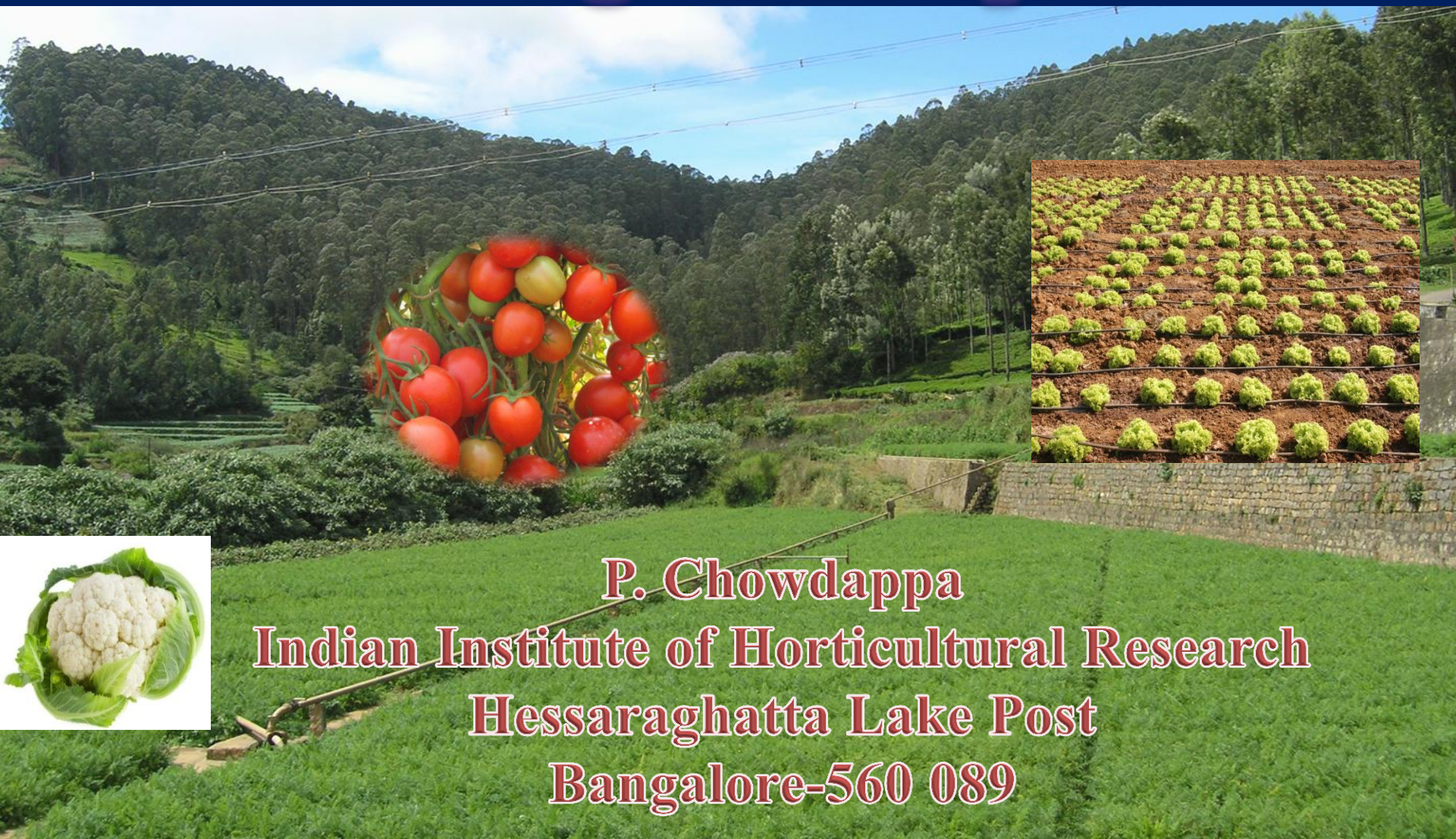




# Integrated Disease Management in Vegetable Crops



**P. Chowdappa**  
**Indian Institute of Horticultural Research**  
**Hessaraghatta Lake Post**  
**Bangalore-560 089**



**BULBOUS**



**COLE CROPS**



**LEGUMINOUS CROPS**



**MALVACEAE**

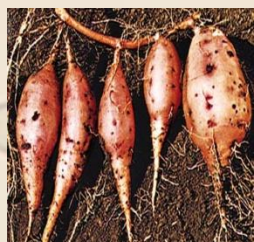


**LEAFY**

**VEGETABLE CROPS**



**CUCURBITS**



**TUBERS**

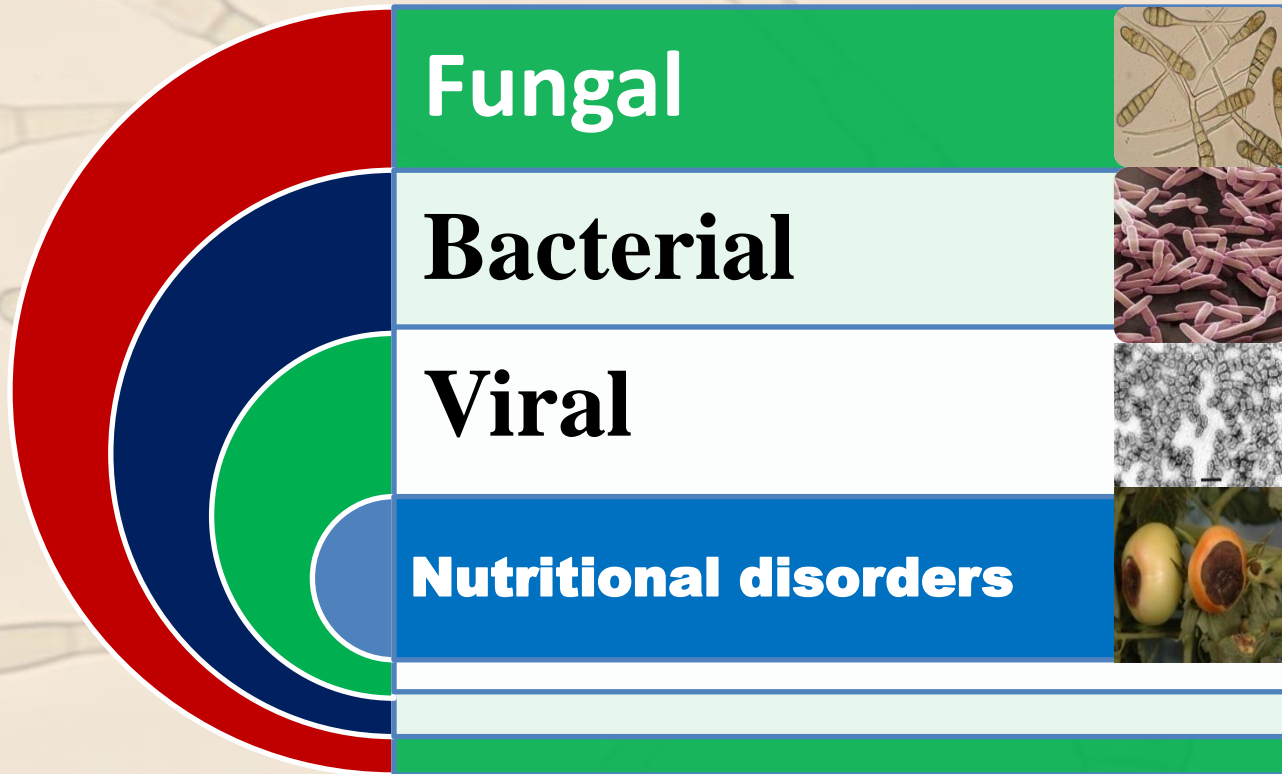


**SOLANACEOUS**



**ROOTS**

# Diseases of Vegetable Crops





**Anthraco**nose



**Alternaria**



**Phytophthora**



**Downy mildews**



**Botrytis**

**Fungal Diseases**



**Powdery mildews**



**Sclerotium**



**Cercospora**



**Rhizoctonia**



**Fusarium wilts**



Potato



Chilli



Brinjal



Onion



Tomato

# Alternaria Diseases



Carrot



Radish



Cabbage



Broccoli

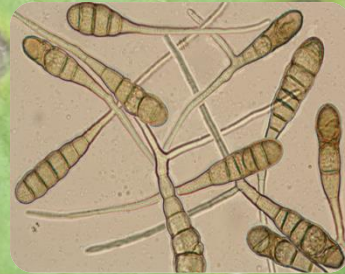


Cauliflower

# *Alternaria* species involved



*A. solani*  
Early blight in  
potato and  
tomato



*A. dauci*  
carrot



*A. brassicicola*  
Cruciferous vegetables



*A. porri*  
purple blotch in onion



*A. brassicae*  
Cruciferous vegetables



*A. alternata*  
Chili, tomato

# Management of Alternaria diseases

- Warm and wet pathogen: June –July
- Use disease free seed and transplants
- Avoid injury to the plant
- Limit leaf wetness by watering through the drip
- Remove or destroy debris after harvest
- Spray chlorothalonil (2g/l) or mancozeb(2g/l) or propineb(2g/l) or copper hydroxide (2g/l) or metiram (2g/l) at fortnight intervals
- Treat the seed with seed pro



Cucurbits



Chilli



Brinjal

Tomato



**Colletotrichum Diseases**

onion

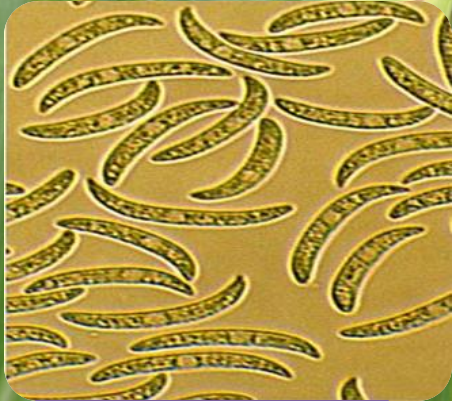




# Colletotrichum



*C. gloeosporioides*



*C. capsici*



*C. acutatum*



*C. boninense*

# ANTHRACNOSE- MANAGEMENT STRATEGIES

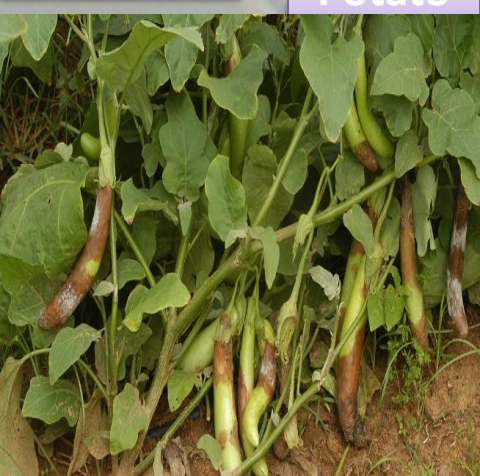
- ◆ Rotation (at least 2 years)
- ◆ Weed control (eliminates alternate hosts)
- ◆ Stake plants
- ◆ Mulches
- ◆ Optimum plant spacing
- ◆ Remove and destroy infected fruit
- ◆ Spray fruits with carbendazim(1g/l) or **benomyl** (1g/l) or carbendazim-mancozeb (2g /l)when first fruit reaches size of a quarter at 15 days interval.



**Tomato**



**potato**



**Brinjal**

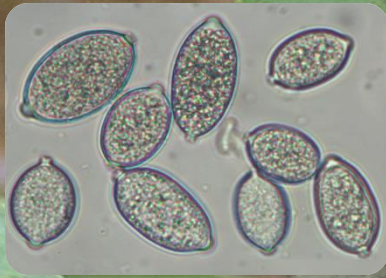


**Chillies**

**Phytophthora Diseases**

**Cucurbits**

# Phytophthora



*P. infestans*



*P. capsici*



*P. nicotianae*



*P. boehmeriae*

# Integrated disease management

- Raising the crop in raised beds with plastic mulch.
- Staking and removal of foliage and fruits up to 30 cm.
- Bordeaux mixture, copper hydroxide or mancozeb or chlorothalonil well before the symptoms appear.
- Pre-packed and tank mixtures of dimethomorph-mancozeb/metiram, cymoxanil,- famoxadone, or fenamidone-mancozeb and iprovalicarb-propineb, at 7- 10 days



# Fungicides for management of Phytophthora blight

- ❖ **Bordeaux mixture** (1%)
- ❖ **Copper hydroxide** (2g/l),
- ❖ **Chlorothalonil** (2g/l),
- ❖ **Mancozeb** (2.5g/l),
- ❖ **Metalaxyl- mancozeb** (2.5g/lit),
- ❖ **Cyamoxinil-mancozeb** (2g/lit)
- ❖ **Dimethomorph-mancozeb /metiram /  
copper hydroxide** (1:2g/lit),
- ❖ **Cymoxanil- famoxadone** (1ml/l),
- ❖ **Fostyl-Al-propineb** (2 : 2g),
- ❖ **Fenamidone-mancozeb** (3g/l)
- ❖ **Iprovalicarb-propineb** (4g/l)
- ❖ **Krexim methyl** (1ml/l)
- ❖ **Metiram-pyroclostrobin** (3g/l)

# Management of late blight of tomato

**BM**

- Continuous sprays with Bordeaux mixture (1%) at seven days interval

**S1**

- Copper hydroxide (0.2%) as protectant followed by Dimethomorph- mancozeb (0.1:0.2%), Famoxadone-Cymoxanil (0.1%), Fenamidone-mancozeb (0.3%), Iprovalicarb-propineb (0.4%), Kresoxim-Methyl (0.1%)

**S2**

- Chlorothalonil (0.2g%) as protectant followed by Famoxadone-Cymoxanil (0.1%), Fenamidone-mancozeb (0.3%), Iprovalicarb-propineb (0.4%), Metriam-pyraclostrobin (0.2%), Cymoxanil+Mancozeb (0.2%)

**S3**

- Mancozeb (0.2%) as protectant followed by Fenamidone-mancozeb (0.3%), Iprovalicarb-propineb (0.4%), Famoxadone-Cymoxanil (0.1%), Metriam-pyraclostrobin (0.2%), Fostyl-Al-propineb (0.2%:0.2%)

**S4**

- *Trichoderma harzianum* (0.5%), Famoxadone-Cymoxanil (0.1%), *Trichoderma harzianum* (0.5%), Fenamidone-mancozeb (0.3%), *Trichoderma harzianum* (0.5%) + Bordeaux mixture at seven days interval.

**C**

- Control



**Bordeaux mixture**



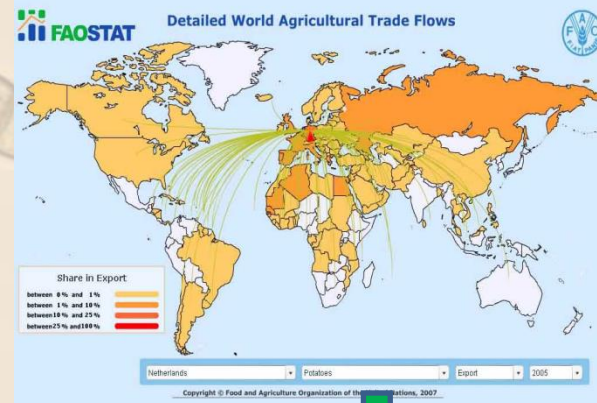
**Control**



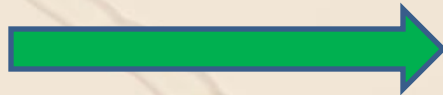
# Integrated Disease management in potato and tomato



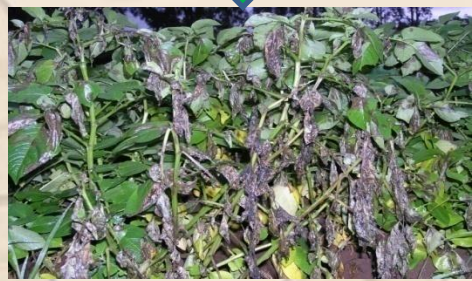
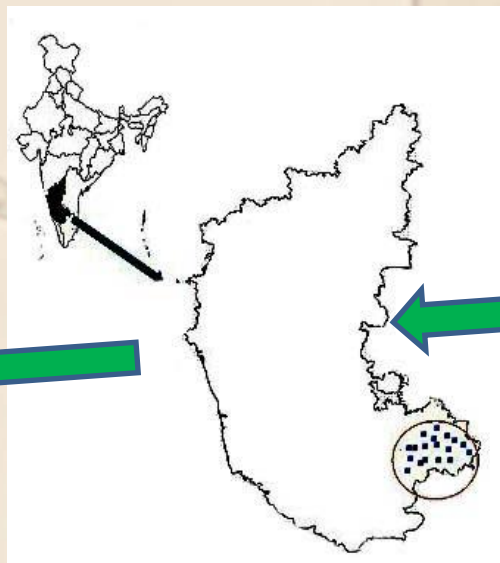
# India needs Bio-security measures



**Invasive alien species remain one of the greatest threats to our biodiversity, and our agricultural productivity.**



**Migration of 13\_A2 clonal lineage of *Phytophthora infestans* from Europe along potato in 2006-07**



**Potato late blight**



**Tomato late blight**

**Impact**

- 1. Reduced area under potato in Hassan from 57,500 to 17,000 ha**
- 2. Huge crop losses**
- 3. Enhanced protection-crop related expenditures**



Chilli



Cucurbits

**Powdery Mildew**



Potato



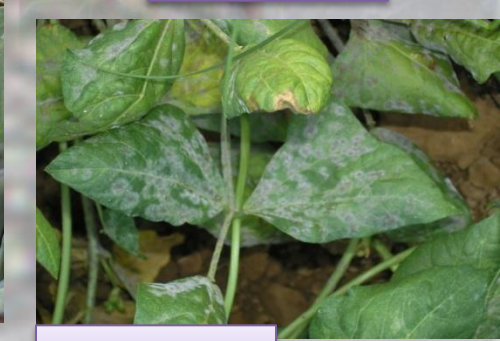
Tomato



Pea

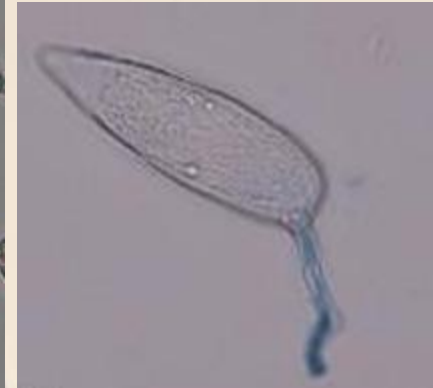
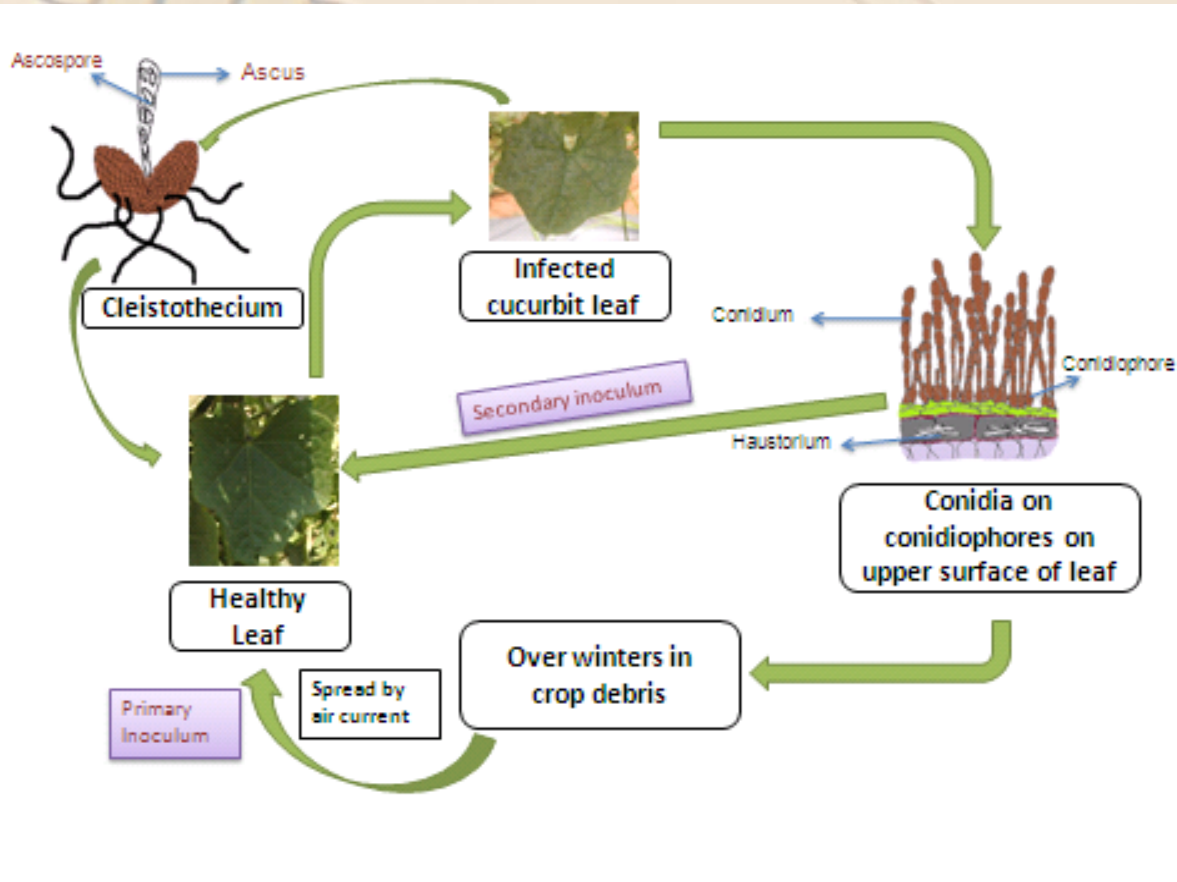


Okra



Cowpea

# Powdery mildew



*Leveillula taurica*

Life cycle of *P. xanthii* on cucurbits

*Podosphaera xanthii*

# Management of powdery mildews

## **Cultural practices**

**Crop rotation, removal of infected plant debris and alternate hosts, deep ploughing, increasing air movement inside the canopy, reducing nitrogen fertiliser**

## **Chemical management**

**Qo inhibitors** - Azoxystrobin and kresoxim-methyl (1ml/l)

**Triazole** - bitertanol (1g/l), myclobutanil (1g/l), Difenconazole (0.5ml/l), penconazole (0.6ml/l), propiconazole (1ml/l), flusilazole (0.3ml/l) and triadimefon (1g/l)

**Morpholine** - Tridemorph (1ml/l)

**Contact** - Sulphur



# Downy Mildew



Onion



Cucurbits



Cauliflower

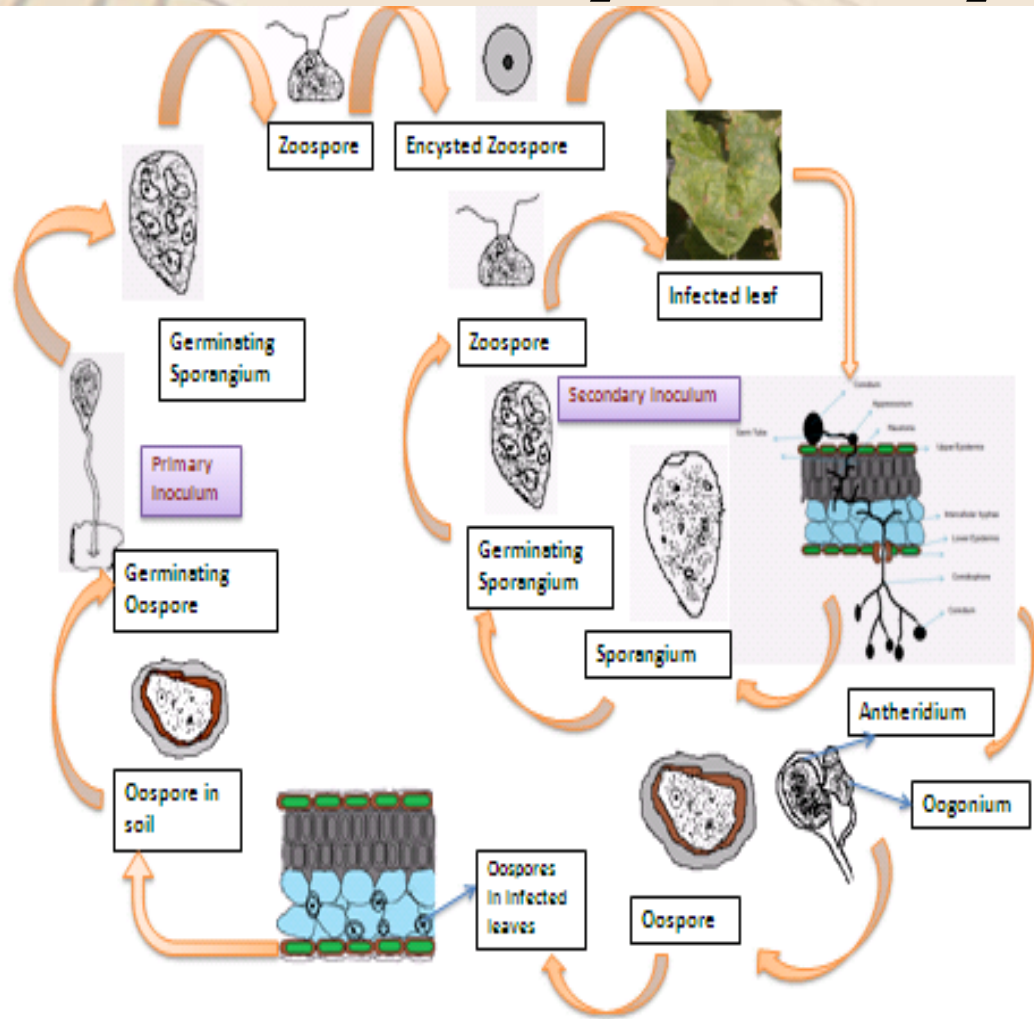


Lettuce



Cabbage

# *Pseudoperonospora cubensis*



**Dichotomously branched sporangiophores with similar age, lemon shaped sporangia, at terminal ends**

# Downy mildew – Management

- Destroy cull piles and weed hosts.
- Plant disease-free tomato transplants
- Chlorothalonil(2g/l)/ mancozeb (2g/l)/ Copper hydroxide(2g/l)
- Bordeaux mixture (1%)
- Metalxyl-mancozeb (2g/lit)
- Dimethomorph (1g/lit)-mancozeb (2.5g/l)
- Fenamidone-mancozeb(3g/lit)
- Metiram-pyroclostrobin(3g/l)
- Famoxadone-cymoxanil(1ml/l)
- Iprovalicarb-propineb (4g/l)
- Krexim –methyl (1ml/l)





Chilli



Tomato



Cucurbits



Cabbage

**Fusarium wilts**



Brinjal



Okra



Onion

# Management of Fusarium wilt



<b>Iprodione + Carbendazim</b>	<b>2g/l</b>
<b>Mancozeb-carbendazim</b>	<b>2g/l</b>



Chilli



Tomato



Cauliflower



Cucurbits



Potato

## Rhizoctonia Diseases



Brinjal



Okra



Radish



Cabbage



Web blight in cowpea

# Management of Rhizoctonia root rot

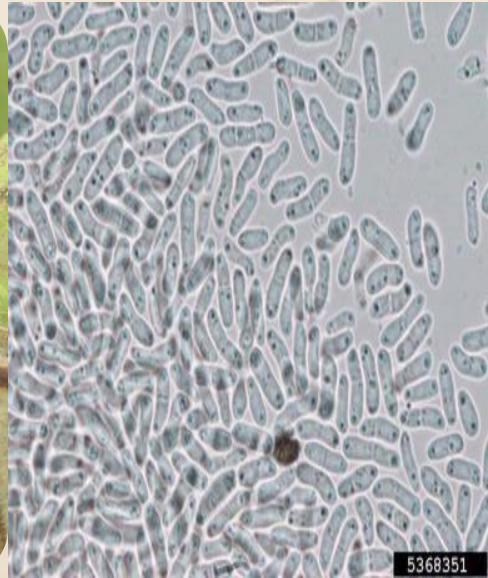


- |                                |              |
|--------------------------------|--------------|
| <b>Iprodione + carbendazim</b> | <b>2g/l</b>  |
| <b>Mancozeb-carbendazim</b>    | <b>2g/l</b>  |
| <b>Pencycuron</b>              | <b>1ml/l</b> |

# Gummy stem blight in cucurbits



**Water melon**  
**Musk melon**  
**Bottle gourd**



***Didymella bryoniae***

**Metiram-pyroclostrobin(3g/l)**

# Stemphylium leaf blight of onion



**Purple blotch**



**Stemphylium leaf blight**



**Anthracnose**

# Rust and smut



**Rust on beans**

**Triazole-** bitertanol (1g/l), myclobutanil (1g/l), propiconazole (1ml/l), and triadimefon (1g/l), Bordeaux mixture (1%), chlorothalolnil (2g/l)



**Smut on onion**



भारत  
अनुसंधान  
ICAR



Chilli



Tomato



Onion



Carrot

## Sclerotium Diseases



Cabbage



Lettuce



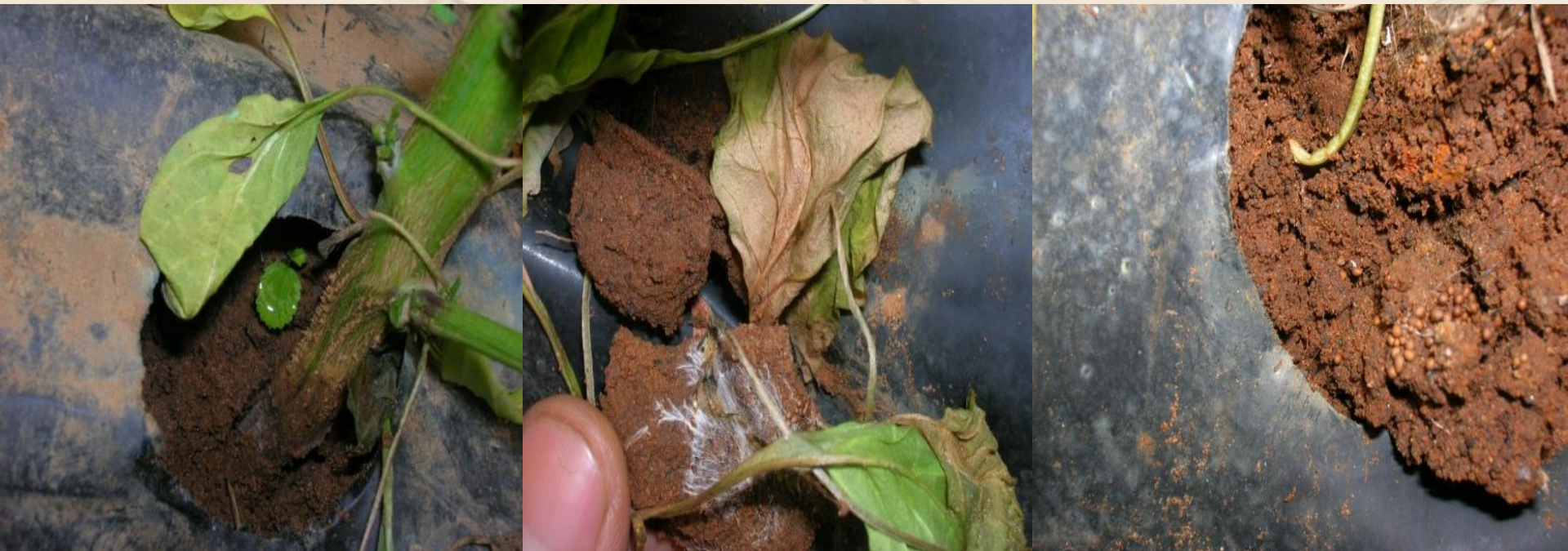
Potato



Carrot



# Management of Sclerotium rot



**Iprodione + carbendazim**  
**Mancozeb-carbendazim**

**2g/l**  
**2g/l**



**Chilli**



**Palak**



**Bottle Gourd**

## **Cercospora Diseases**



**Coccinia**



**Field bean**



**Brinjal**

# Management of cercospora diseases



Copper hydroxide	2g/l
Iprodione + Carbendazim	2g/l
Mancozeb-carbendazim	2g/l



Cucurbits



Tomato

## Botrytis Diseases



Cabbage



Beet root



**Wilt**  
(*Ralstonia solanacearum*)

**Canker**  
*Clavibacter michiganensis*  
pv.  
*michiganensis*

**Leaf and fruit spot**  
(*Xanthomonas campestris* pv.  
*Vesicatoria*)

**Speck**  
*Pseudomonas syringae* pv.  
*tomato*

# Bacterial diseases

# Management of bacterial diseases

- **Crop rotation with maize-sorghum-ragi or maize-onion or garlic and rice**
- **Seed treatment with seed pro 10g/kg seeds before sowing.**
- **Seedling root dip with seed pro 10g/l and planting in green manure (Sannhemp) amended soil**
- **Foliar application/root drenching with Copper hydroxide (2g/l)**



**Tomato big bud**



**Tomato TOSPO**



**Okra yellow vein**



**Water melon bud necrosis**



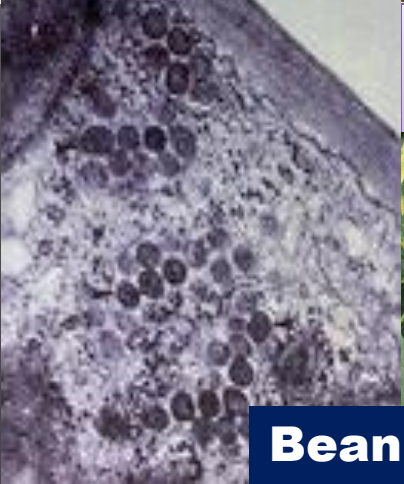
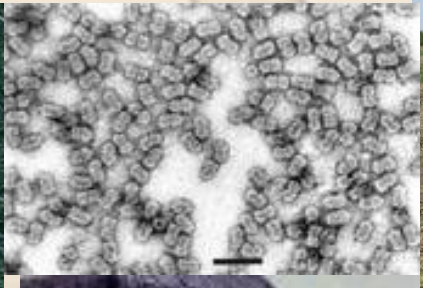
**Chilli leaf curl**



**Chilli Mottle chlorotic**



**Chilli TOSPO**



**Viral Diseases**



**Bean yellow mosaic**

# Management of Viruses - Nursery Stage

- Soaking of seed in Trisodium citrate solution ( 3-5g per liter) for 15 to 20 min and drying
- Growing of nursery under Nylon net cover (60-80) mesh
- Soil Application Furadon @ 1.0 Kg ai / ha at the time of sowing seeds in the nursery bed
- Prior to transplantation the seedlings should be sprayed with Dimethoate @ 2.0 ml per liter or Monocrotophos @ 1.5ml per liter or Acephate 1.5 g/liter.
- Seedling dip in 0.5 ml/L Imidacloprid

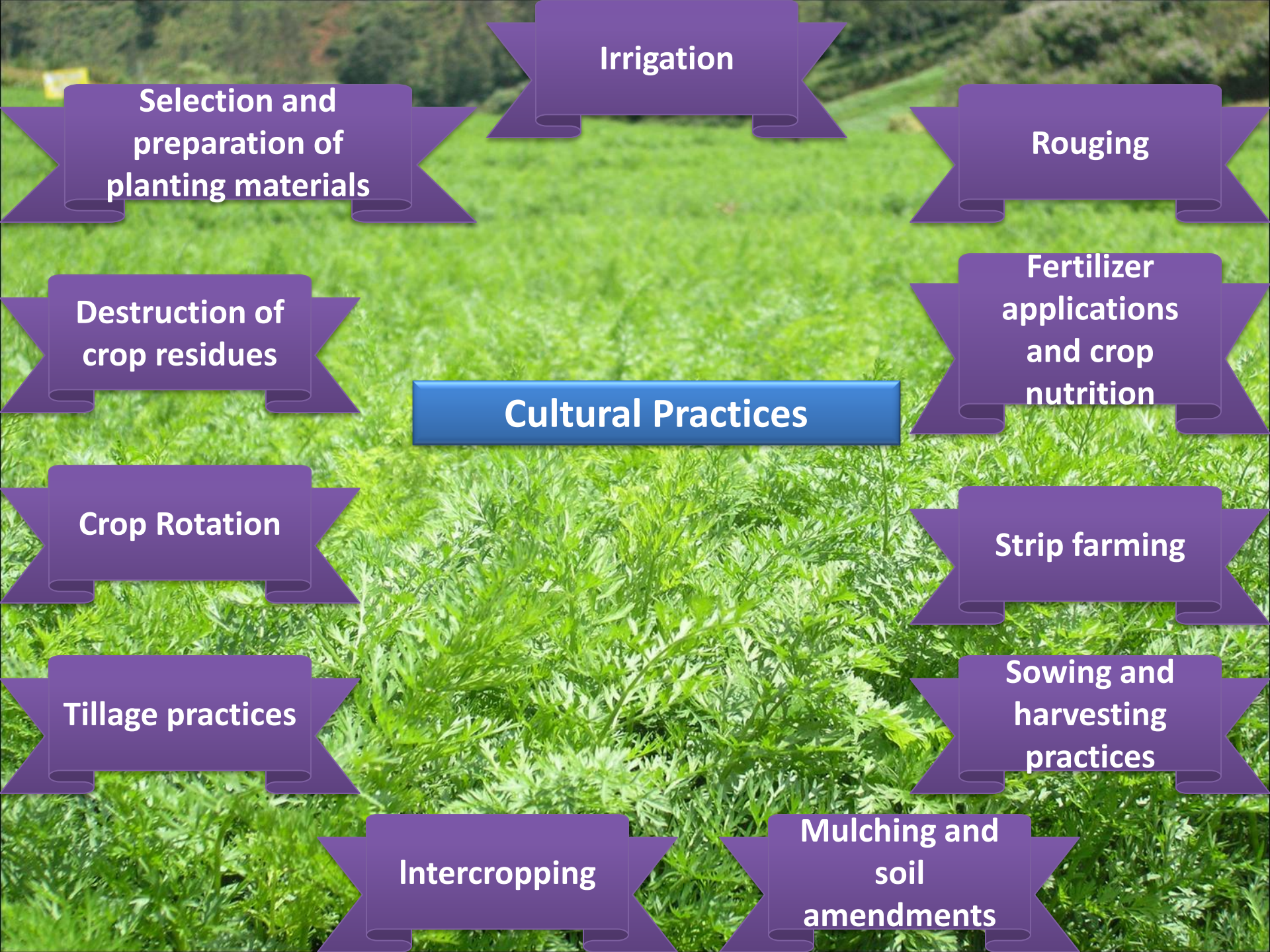




# Integrated Management of viruses –Main field

- **Sowing of border crops like Maize, Bajra / Jowar 15 days before the transplanting of Chilli**
- **Removal of early infected plants from the field**
- **Spraying of Acephate @ 1.5g per liter (or) Hostothion @ 1.0 ml per liter (or) Imidacloprid @ 0.5ml per liter (or) Regent @ 1.0 ml/liter at 7 to 10 days interval, 15 days after transplanting until fruit formation**
- **Spraying of Neem seed Kernel extract 2% + sticker 10 days interval 15 days after transplanting until fruit formation**
- **Mulching with silver or black polythene color mulch sheet**





**Cultural Practices**

**Selection and preparation of planting materials**

**Irrigation**

**Rouging**

**Fertilizer applications and crop nutrition**

**Strip farming**

**Sowing and harvesting practices**

**Mulching and soil amendments**

**Intercropping**

**Tillage practices**

**Crop Rotation**

**Destruction of crop residues**

**Protectants**  
**broad-spectrum**  
**No resistance**  
**Mancozeb, copper based**

**Specific type**  
**fungicides**  
**single-site toxicant**  
**Resistance**  
**Benomyl, metalaxyl**

**Fungicides in disease  
management**

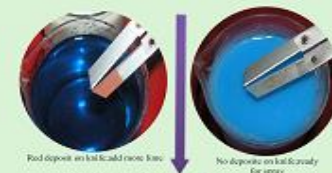
**Fungicide mixtures**  
**Carbendazim-mancozeb**

**Fungicide resistance**  
**management**  
**Metalaxyl-mancozeb**

# Bordeaux Mixture



Add lime solution to Copper sulphate solution slowly with constant stirring using wooden stick.



To check neutrality of bordeaux mixture Dip well polished knife in bordeaux mixture solution for few minutes.



Bordeaux mixture(1%)  
Ready for spray

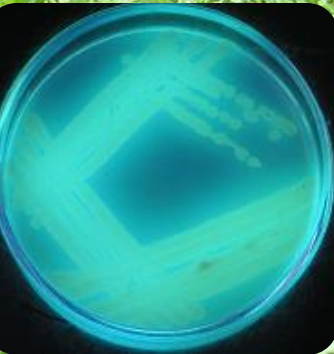
Fig.2 Preparation of Bordeaux mixture



*Trichoderma* spp.



*Bacillus* spp.



*Pseudomonas* spp.



*Pichia pastoris*



# Mechanism of Biocontrol Agents



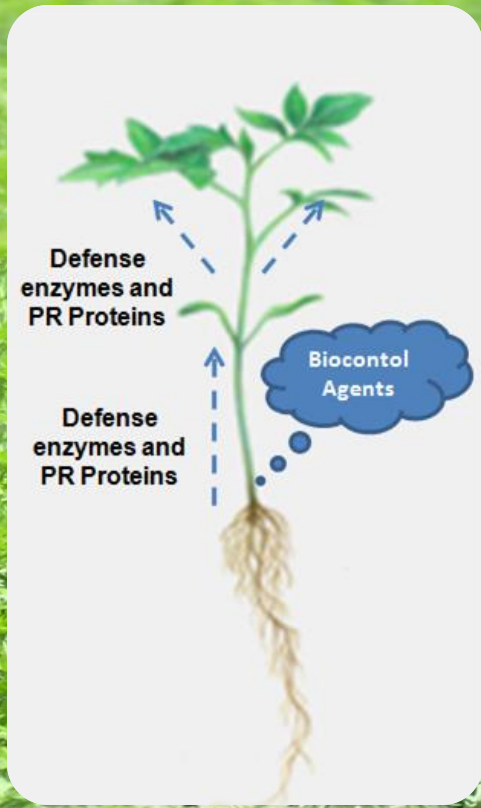
**Mycoparasitism**



**Competition**



**Antibiosis**



**Induction of Systemic Resistance**



**Plant Growth Promotion**

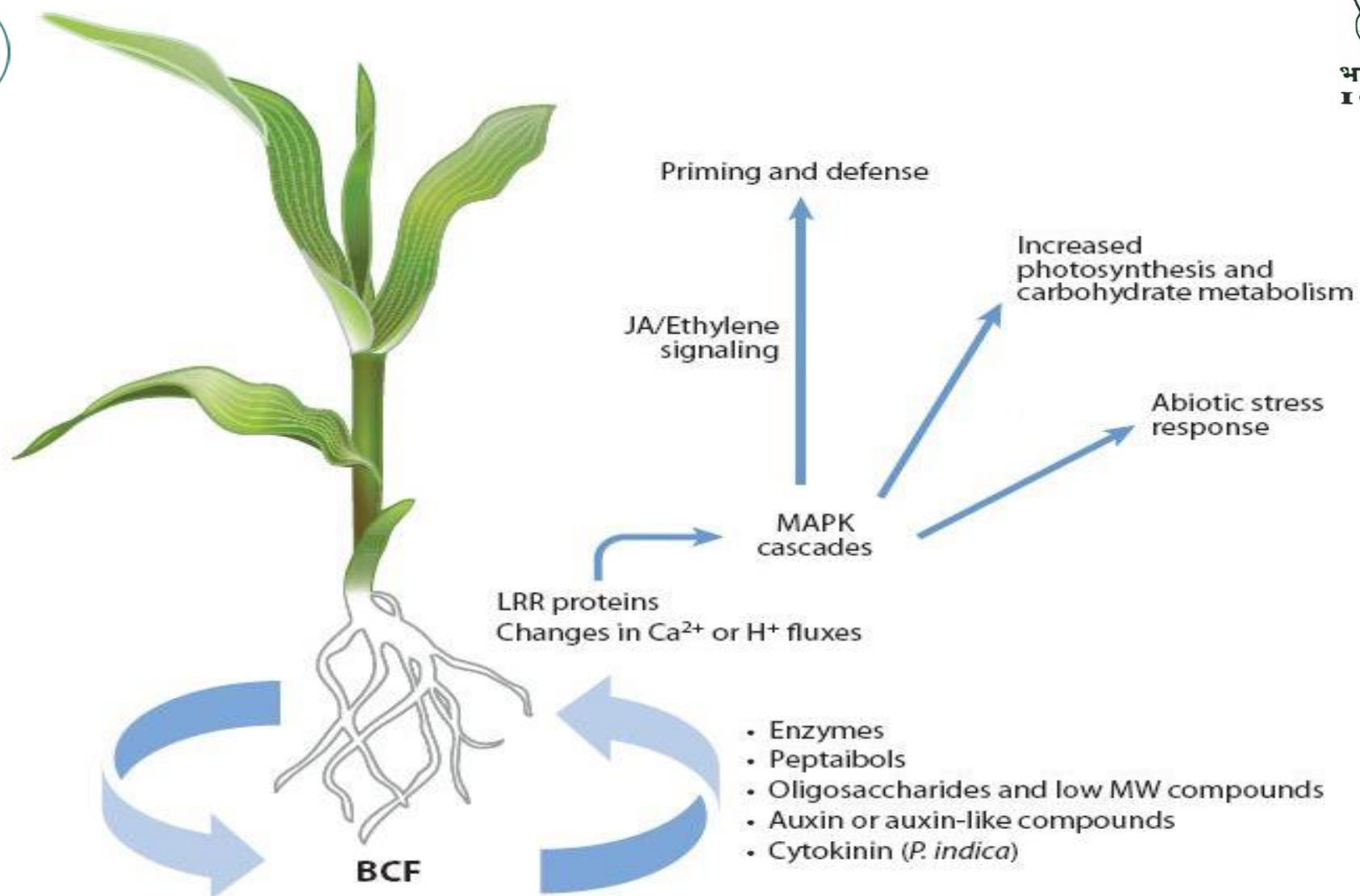


Diagram of the overall effects of *Trichoderma* strains, and of other root-colonizing plant symbiotic microbes on plants and plant productivity. A somewhat similar diagram has been published previously (Shoresh *et al.*, 2010). LRR, leucine-rich-repeat; MAPK, mitogen-activated protein kinase; MW, molecular weight; *P. indica*, *Piriformaspora indica*.



## Biocontrol Products Available in Market



Product name	Biocontrol organism	Disease	Company
Ballad	<i>Bacillus pumilus</i>	Several (foliar)	AgraQuest
Bio-Save	<i>Pseudomonas syringie</i>	Post-harvest	Jet Harvest Solutions
Contans	<i>Coniothyrium minitans</i>	White mold	Sylvan Bioproducts
Kodiak	<i>Bacillus subtilis</i>	Several (soil-borne)	Gustafson, LLC
Mycostop	<i>Streptomyces griseoviridis</i>	Several (soil-borne)	Ag-Bio, Inc.
Plant-Shield	<i>Trichoderma</i> spp.	Root diseases	BioWorks, Inc.
Rootshield	<i>Trichoderma</i> spp.	Pythium, Rhizoctonia, Phytophthora	BioWorks, Inc.
Serenade	<i>Bacillus subtilis</i>	Several (foliar)	AgraQuest
SoilGard	<i>Gliocladium virens</i>	Damping off	Certis USA, LLC
Sonata	<i>Bacillus pumilus</i>	Several (foliar)	AgraQuest
T22-HC	<i>Trichoderma harzianum</i>	Pythium, Rhizoctonia, Fusarium	BioWorks, Inc.
T22-Planter Box	<i>Trichoderma harzianum</i>	Pythium, Rhizoctonia, Fusarium	BioWorks, Inc.
Yield Shield	<i>Bacillus pumillus</i>	Several (soil-borne)	Gustafson, LLC





Tomato



Chilli



Cauliflower



Brinjal

Seed pro  
a microbial growth promoter

Indian Institute of Horticultural Research,  
Hesaraghatta Lake Post, Bangalore-560 089

Product Development Under  
AG-COCCSA  
An Outreach Program  
Addressing Climate Resilient and  
Sustainable Agriculture

Includes: Cauliflower, Tomato, Potato, Brinjal, Chilli, Okra, Bottle Gourd, Bitter Gourd, Beans, Soya Bean, Cabbage, Carrot, Ridge Gourd.



Papaya



Cabbage



Rice



Wheat



**Demonstration on Ginger at Kasargod**



**Cotton**

Seed pro  
the microbial growth promoter

Indian Institute of Horticultural Research,  
Hesaraghatta Lake, Post, Bangalore-560 089



**Demonstration on Potato at Hassan**



**Amaranthus**



**Cabbage at IIHR**



A Product Developed Under  
ALCOCEA  
An Outreach Programme  
Alternaria, Colletotrichum and Cercospora  
Diseases

## eed pro

a microbial growth promoter



- ➔ Brinjal
- ➔ Beans
- ➔ Bitter gourd
- ➔ Bottle gourd
- ➔ Cabbage
- ➔ Chilli
- ➔ Carrot
- ➔ Cauliflower
- ➔ Pumpkin
- ➔ Ridge gourd
- ➔ Tomato
- ➔ Potato
- ➔ Soya bean
- ➔ Paddy
- ➔ Wheat
- ➔ Cotton
- ➔ Ground nut
- ➔ Cow pea
- ➔ Green gram
- ➔ Pigeon Pea
- ➔ Papaya

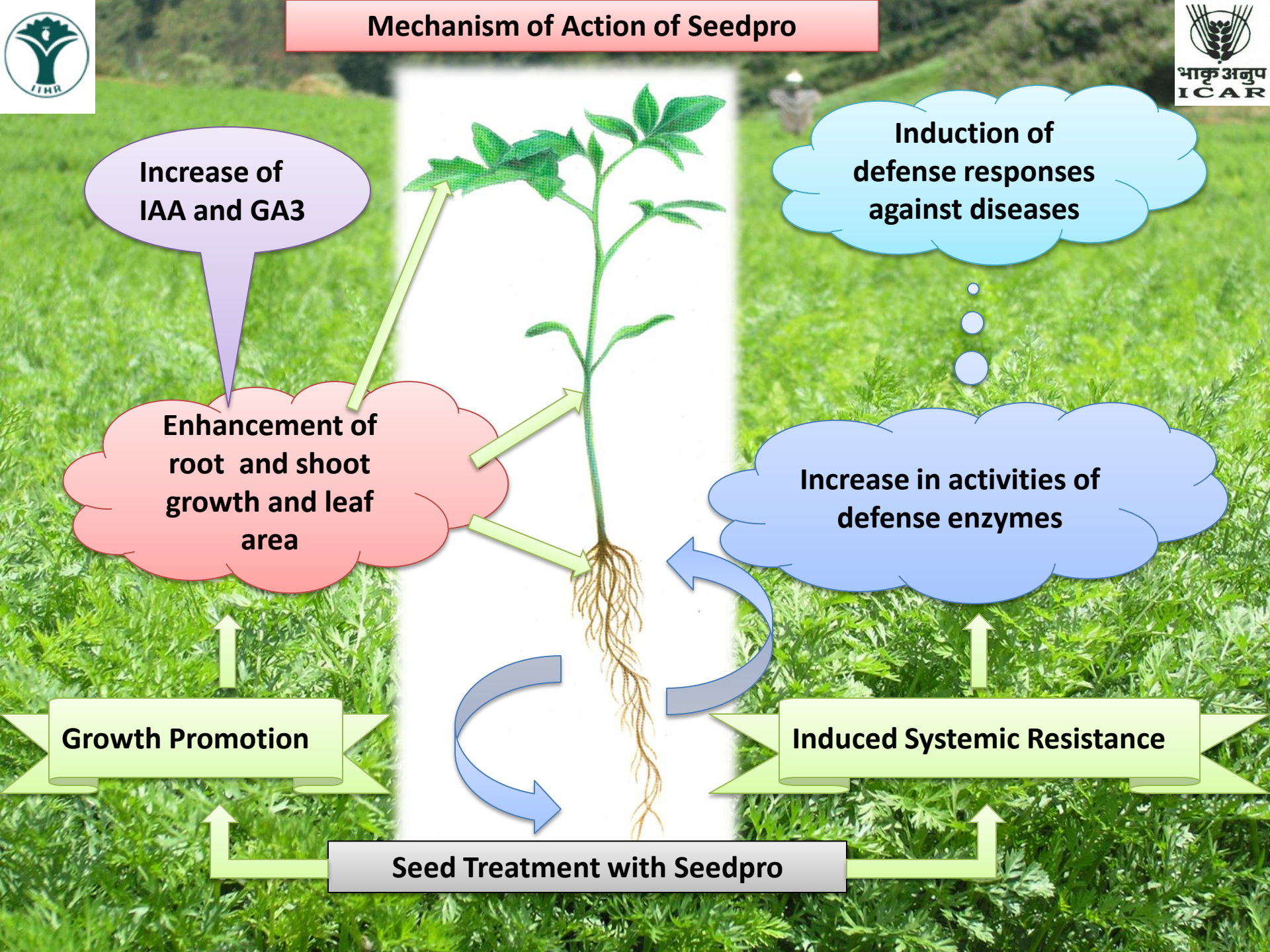
Indian Institute of Horticultural Research,  
Hesaraghatta Lake Post, Bangalore-560 089

Hesaraghatta Lake Post, Bangalore-560 089

Indian Institute of Horticultural Research



# Mechanism of Action of Seedpro





# Commercialization



**Seedpro**  
...A microbial plant growth promotor

Product developed under  
ALCOCERA  
An Out Reach Programme on  
*Alternaria, Colletotrichum and Cercospora*  
Diseases

Indian Institute of Horticultural Research  
Hesaraghatta Lake Post  
Bangalore-560089



**ISO**  
9001 & 14001  
Certified Company

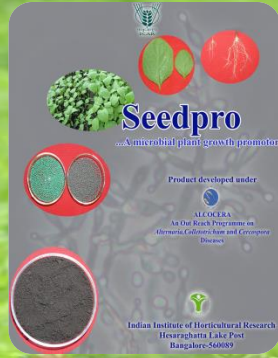
**multiplex**

**CHIRAYU**  
GERMINATION ENHANCER & GROWTH PROMOTER

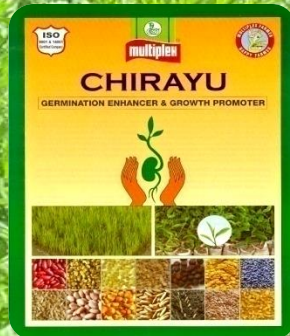
**MULTIPLY FARMER**  
HAPPY FARMER

Grid of agricultural products including various grains, pulses, and vegetables.





## Farmers interaction



# Nutritional disorders

## **BLOSSOM END ROT in tomato**



A close-up photograph of a field of purple chrysanthemum flowers. The flowers are in various stages of bloom, with some showing bright yellow centers. The petals are a vibrant purple, and the background is filled with more flowers and green foliage, creating a dense and colorful scene.

**THANK YOU**