

## Phytopathology

### Methods of control of plant diseases

**Physical Methods:** It aims at direct eradication or reduction of inoculum of plant diseases.

❖ **Heat treatment:** The scientific principle involved in heat therapy is that the pathogen present in seed material is selectively inactivated or eliminated at temperatures that are non lethal to the host tissues.

- **Soil sterilisation:** Hot air is also passed through pipelines to sterilize the soils in the nursery areas.
- **Hot Water Treatment of Seeds and other Parts:** It is used to kill the pathogens which infect or may be present inside seed coat, bulb scales etc. or which may be present in external surfaces or wounds.
- **Hot air treatment of storage organs:** Treatment with warm air removes the moisture from their surfaces and hastens healing of wounds thus preventing their infection.
- **Soil Solarization:** Soil solarization is generally used for controlling soil-borne pathogens like *Pythium*, *Verticillium*, *Rhizoctonia*, *Fusarium* etc. and nematodes in small areas like nurseries.

❖ **Refrigeration:** The low temperature at or slightly above the freezing point checks the growth and activities of all such pathogens that cause a variety of post harvest diseases of vegetables and fruits. Therefore most perishable fruits and vegetables should be transported and stored in refrigerated vehicles and stores.

❖ **Radiation:** Electromagnetic radiations such as ultraviolet (UV) light, X rays and  $\gamma$  rays as well as particulate radiations have been studied in relation to management of post harvest diseases of horticultural crops.

**Chemical methods:** It aims at direct protection of plants from the pathogen or eradicate or reduce the amount of pathogen inoculum. Chemicals are used to treat seeds, soil, propagated plant materials other than seeds and standing crops. Fungicides mean a chemical, which are able to kill the fungi. However all the fungicides do not kill the fungi, they may check the growth of fungi temporarily or they may check the germination of fungal spores. Therefore they can be classified as i) Protectants and ii) Therapeutants

❖ **Protectants** are those fungicides, which are used to protect the plants from the attack of pathogens. They should be applied before infection e.g. Zineb, Maneb, Sulfur etc.

❖ **Therapeutants** are those chemicals which are capable of eradicating the pathogen even after causing the infection e.g. Vitavax, Hinosan, antibiotics etc.

Based on mode of action they can also be classified as :

- 1) **Contact fungicides** - These act by direct contact with the pathogenic fungus before or after the infection.
- 2) **Residual fungicides** - These are sprayed on the host plant before the pathogen infection, as they form a protective covering over the surface of the host plant even before infection.
- 3) **Systemic fungicides:** Most systemic compounds are absorbed by the roots and transported acropetally to the xylem and from there transported upwards to aerial parts. They are usually not transported downwards through the phloem tissue. A systemic fungicide can eradicate

established infection and protect the new parts of the host plant as they are produced and it would not be subject to loss by weathering.

Action of systemic fungicide:

- Causes in activation of enzymes and toxins of pathogens.
- Exhibits selective accumulation of the fungicide in the fungal pathogen due to greater permeability of the fungus cell wall.
- Causes damage to the membrane of fungal hyphae and inhibits its growth.
- Causes inhibition of action of fungal enzymes leading to their destruction.

### **Formulation of fungicides**

- Water dispersible or wettable powders
- Dusts
- Suspension or slurries

Fungicides are generally applied as sprays or dust on standing crops. For seed borne pathogens, fungicides are applied to seeds before they are sown or bagged and stored.

*#Table of various chemical compounds used for plant disease control is provided in another document.*

### **Biological methods:**

The use of microbial antagonists to suppress plant disease pathogens.

**1. Direct mechanism:** Direct lysis or killing of pathogen by biocontrol agent.

#### **Antibiosis or Antibiotic mediated suppression:**

Antibiotics are microbial toxins that can, at low concentrations, poison or kill other microorganisms.

#### **Parasitism**

- Direct utilization of pathogens as source nutrients.
- Mycoparasitism refers to association in which a parasitic fungus (hyperparasite) live as a parasite to another fungus (hypoparasite).
- Also known as Hyperparasitism, when hyperparasites (biocontrol fungi) utilize hypoparasites (pathogenic fungi) as source of nutrients.
- Hyperparasites produce parasitizing hyphae to acquire host nutrients.
- May also requires cell wall degrading enzymes.

**2. Indirect mechanism:** Exclusion of plant pathogen as a result of the presence, activity or products of biocontrol agent.

#### **Competition**

- It is an indirect mechanism
- Exclusion of pathogens by biological control agents via competition for space or nutrients.
- Production of substances (such as siderophore) for nutrient acquisition.
- Deprive pathogens of nutrients.

#### **Induced systemic resistance (ISR):**

- Also known as systemic acquired resistance (SAR), resistance in plants to varieties of pathogens induced by the presence or products of biocontrol agent.
- Plants infected with one pathogen become more resistant to subsequent infection by another pathogen.

Suggested Reading :

Sharma P.D. (2011). Plant Pathology. Meerut, U.P.: Rastogi Publication.

## TYPES OF CHEMICAL COMPOUNDS USED FOR PLANT DISEASE CONTROL

### A. Inorganic chemicals

- i) Copper compounds
- ii) Inorganic sulphur
- iii) Carbonate compounds
- iv) Phosphate and phosphonate compounds

#### Copper compounds

- The Bordeaux mixture (copper sulphate + calcium hydroxide), named after the region of Bordeaux of France, where it was developed against the downy mildew of grapes.
- It is still a widely used fungicide to control many diseases like bacterial leaf spot, blights, anthracnose, downy mildews and cankers throughout the world.
- Phytotoxicity of Bordeaux mixture can be reduced by increasing the ratio of hydrated lime to the copper sulphate.
- Copper oxychloride (Brand names: Blitox 50, Blue copper, Fytolan, etc.) is used to control diseases caused by oomycetes and cankers of fruit trees.

#### Inorganic sulphur

- Elemental sulphur is known as the oldest fungicide.
- It is used as a dust, wettable powder, paste or liquid formulation.
- It primarily controls powdery mildews, certain rusts, leaf blights and fruit rots.
- These are available in different trade names like Sulfex, Wettasul, Cosavet etc.

#### Carbonate compounds

- Sodium bicarbonate, as well as bicarbonate salts of ammonium, potassium and lithium are used as fungicides.
- These compounds plus 1 per cent superfine oil are inhibitory and fungicidal to the powdery mildew fungi on roses, grey mould and southern blight fungus.

#### Phosphate and phosphonate compounds

- Spraying cucurbits or grapevines with either of monopotassium or dipotassium phosphate gives satisfactory control of powdery mildew diseases of these two hosts.

### B. Organic Chemicals

- i) Organic sulphur compounds or dithiocarbamates
- ii) Quinones

- iii) Aromatic compounds
- iv) Heterocyclic nitrogenous compounds

### **Organic sulphur compounds or dithiocarbamates**

- Organic sulphur compounds form the most versatile and widely used group of modern fungicides.
- This group includes thiram, ziram, ferbam, nabam, maneb, mancozeb and zineb.
- They are the derivatives of dithiocarbamic acid which are toxic to fungi due to isothiocyanate radicals and inactivate the sulphhydryl (SH) group in amino acids and enzymes within the fungus cells.

### **Quinones**

- Quinones occur naturally in many plants and are used as fungicides.
- Only two quinone compounds chloranil and dichlone are used.

### **Aromatic compounds**

- Many unrelated compounds that have benzene ring in centre are toxic to microorganisms, and several of them have been used as fungicide.
- Penta-chloro-nitro benzene (PCNB) sold as Brassicol is a long lasting soil fungicide which controls various soil borne diseases of vegetables and ornamentals and is applied as dip or furrow treatment.
- Another fungicide dichloran (DCNA) sold as Botran is widely used against diseases caused by Botrytis, Sclerotinia and Rhizopus.
- Chlorothalonil available as Bravo, Daconil and many other brand names is excellent broad-spectrum fungicide and is used against many leaf spots, blights, downy mildews, rusts, anthracnose, scab and fruit rots of fruits and vegetables.
- Biphenyl is used against various diseases caused by Penicillium, Diplodia, Botrytis and Phomopsis in case of citrus.

### **Heterocyclic nitrogenous compounds**

- This group includes important fungicides, like captan, captafol and folpet.
- Captan is excellent fungicide for control of leaf spots, blights and rots of many fruits and vegetables and is used as seed treatment and foliar spray.

### **Systemic Fungicides**

#### **Acylalanines**

- Most important fungicide in this group is metalaxyl which is effective against oomycetes, like Pythium, Phytophthora and downy mildews.

#### **Benzimidazoles**

- They include some of the systemic fungicides like benomyl, carbendazim, thiabendazole and thiophanate methyl.
- Benomyl (which is sold as Benlate) and carbendazim (sold as brand names, like Bavistin, etc.) control various types of diseases like leaf spots, blights, rots,

scab and seed borne diseases; but are not effective against oomycetes and dark colour spore forming fungi including *Alternaria* spp.

- They are effective against powdery mildews on many crops, apple scab and brown rot of stone fruits.
- Thiophanate methyl sold as Topsin M, is a broad-spectrum fungicide is also used against powdery mildew of various crops.

### **Oxanthiins**

- They were the first to be discovered as having systemic fungicide activity.
- Carboxin is sold as Vitavax used against damping-off disease caused by *Rhizoctonia* and various smuts of grain crops.
- Oxycarboxin- marketed as Plantvax is effective against wheat rusts.

### **Organophosphates**

- They include primarily fosetyl-Al, sold as Aliette which is very effective against many foliar, root and stem diseases caused by oomycetes such as *Pythium*, *Phytophthora*, and downy mildews in a variety of crops.
- Fosetyl-Al has been reported to stimulate defence reactions and the synthesis of phytoalexins against oomycetes.

### **Pyrimidines**

- They include dimethirimol (Milcurb), ethirimol (Milstem) and bupirimate (Nimrod), all of which are effective against powdery mildew of various crops.
- Fenarimol (Rubigan) and Nuarimol (Trimidal) are effective against powdery mildew and also other scab, leaf spot, rust and smut diseases.

### **Triazoles**

- Triazoles (-conazoles or imidazoles) include several excellent systemic fungicides such as triadimefon, bitertanol, difenoconazole, propiconazole, myclobutanil, cyprconazole and tebuconazole, etc.
- They show long protective and curative activity against broad-spectrum of foliar, root and seedling diseases like leaf spot, blights, powdery mildew and rusts causing fungi.
- They can be applied as foliar as well as seed and soil treatments.

### **Strobilurins**

- These are the latest fungicides, also known as QoI fungicides.
- The most important strobilurin fungicides are azoxystrobin, trifloxystrobin and kresoxim methyl.
- These strobilurins can be used for controlling the diseases of grapevines, pome and stone fruits, cucurbits, sugar beet and rice.