

NON-PARASITIC CAUSES OF PLANT DISEASES

Aim: To acquaint the students with non-parasitic causes of plant diseases

- Diseases caused by non- parasitic/ abiotic (nonliving) agents are not transmitted from one plant to another. Thus, they are not infectious, and also called non-infectious diseases or simply, disorders.
- Extremes of temperature and water (flooding or drought), deficiency or excess of essential nutrients, presence of toxic chemicals in air, water and soil, transplant shock and mechanical injury are the important causes of abiotic diseases.
- Surprisingly, the symptoms of non-infectious (non-parasitic) diseases resemble those produced by living agents viz., fungi, bacteria, viruses and nematodes. If no signs of these organisms are present, a nonliving agent may be the cause of the disease.
- Meteorological weather reports and plant and soil analyses for mineral elements is the next step to confirm the disease agent.

Temperature Extremes

- Sudden rise and fall in temperature causes injury to plants.
- Harmful effects of chilling, freezing and sunburn are well known.
- The plants may get adapted to their climate and show chill or frost resistance.

Chilling injury: It occurs at temperature close to 0°C. Tropical plants begin to experience cold damage at 5-10°C.

- Symptoms include wilting of the upper portions of stems and leaves, blackening or softening of the plant tissue, surface pitting, necrosis or failure of ripening of fruits.
- This injury is severe in some warm season fruits.

Freezing or Frost injury: It occurs at temperatures below 0°C.

- It is caused by formation of ice. Since water in the intercellular spaces is pure, ice crystals are first formed there, then inside the cells.
- The crystals formed inside the cells damage the cell organelles.

High temperature and dry winds: They cause rapid loss of water.

- Leaf margins turn yellow or brown and leaves fall off prematurely.
- Sun-scald injury occurs when shade loving plants are suddenly exposed to direct sun.
- Sunken brown areas on apples, water-soaked areas on tomatoes are examples of heat injury.
- High temperature also causes water core symptoms in apple.



Frost injury in banana



Water core of apple

Soil Moisture Extremes

Low soil moisture, which occurs during drought, causes accumulation of toxic ions of manganese and boron, which damage tissues and cause stomatal closure.

- This adversely affects the plants. Wilting discoloured foliage, twig and branch 'die back' in the crown, and death of fine roots are the symptoms of water deficiency.

Excess soil moisture or flooding results in diminished oxygen supply in the soil water that kills the root.

- Symptoms of oxygen deficiency, during high moisture are reduced growth, small leaves and thin crowns, twig and branch 'die back' and plant death.

Unfavourable light

Insufficient light causes etiolation, stunted growth, and reduction in flowering.

High light intensity leads to scorching and rolling of leaves and drying of flowers.

Enhanced photoperiod results in abnormal shape, erratic flowering etc.

Lack of Oxygen

- Apart from the asphyxiation of plant roots in waterlogged soils and its adverse effects on the plants as discussed above, lack of oxygen may also result from its failure to diffuse adequately both between and within fruits or the storage organs kept in bulky piles or under poor ventilation.
- In such stress conditions, the cells die of suboxidation and results in storage diseases such as **black heart of potatoes**, in which the cortex of the affected tuber is blackened; and **internal browning in apple**.

Mineral Nutrient Imbalances

- Currently seventeen elements (nickel is the latest addition) are recognized as essential for plant growth. Among them, thirteen are found in soil mineral.

- The essential elements are divided into three categories: **macronutrient** elements, **micronutrient** elements (or trace elements) and **beneficial** elements.
- Carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur are macronutrients.
- The micronutrients (needed less than 100µg per gram in dry tissue) include iron, manganese, zinc, copper (these are metal micronutrients) boron, molybdenum, chlorine and nickel.
- Beneficial elements, although not essential, do provide benefit to the plant.

Mineral deficiencies

- When the soil is deficient in any element, or the element is 'unavailable' due to, for example unsuitable pH, it shows up as typical symptoms in the plant.
- The common symptoms of nutrient deficiencies are: **reduced growth, leaf chlorosis of different patterns, and necrosis**.
- Symptoms are very similar and occasionally indistinguishable for different elements.
- Soil and plant tissue analyses are therefore, necessary for the symptoms. The deficiency may be **acute or chronic**. The former is due to sudden unavailability of the element, while the latter is a continuous insufficient supply.
- Nutrient mobility plays an important role in determining the site of the deficiency symptoms.
- For **highly mobile elements** like nitrogen and potassium, the deficiency symptoms



appear predominantly in older and mature leaves.



- Deficiency of **poorly mobile elements**, like calcium, boron and iron show up in younger leaves, opposite of what happens with highly mobile elements.

Bitter pit of apple due to Ca deficiency

Spray injury on pear fruits

- The symptoms of deficiency of **moderately mobile elements** like magnesium and sulphur, are uniformly spread all over the plant.

- The symptoms of mineral deficiencies is recorded in the following table:

Sr.No	Deficient element	Symptoms
1	Nitrogen	Poor growth, chlorosis of leaves, delayed flowering and fruiting
2	Phosphorus	Poor growth, blue/green, but not yellow, colour of leaves, oldest leaves affected first
3	Potassium	Brown scorching and curling of leaf tip, yellowing of leaf veins
4	Calcium	Curling and tip burn of leaves, stunted growth abnormal development of meristmatic tissues, and eventual death of buds and root tips. Also causes bitter pit in apple .
5	Magnesium	Interveinal chlorosis, giving a mottled appearance to leaves, similar to virus infection
6	Sulfur	Chlorotic leaves, petioles and veins distinctly red.
7	Iron	Chlorosis of leaves, young leaves appear bleached, symptoms similar to manganese deficiency
8	Manganese	Chlorotic leaves with green veins
9	Zinc	Younger leaves yellow, pitting on lower leaf surface, leaves and internodes shortened, giving a rosette-like look to plants; guttation increased
10	Copper	Leaves pale and curled; petioles droop down
11	Boron	Drying of growing tip, bushy stunted growth, and internal tissue breakdown.
12	Molybdenum	Chlorosis of leaves; symptoms similar to nitrogen deficiency. Also causes whiptail disease in cauliflower .
13	Chloride	Leaves of abnormal shapes, and with interveinal chlorosis.

- It is toxic to several plants at 2-3 ppm concentration, when the soil pH is 5.5 and above.

Symptoms

- Symptoms of aluminum toxicity are not easily identifiable.
- The foliar symptoms resemble those of phosphorus deficiency, viz., overall stunting, blue/green colour of leaves.

- In some cases, aluminum toxicity appears as an induced calcium deficiency, showing curling, rolling and tip burn of young leaves, and collapse of growing points or petioles.

Injury By Air Pollution (SO₂, F, Cl₂, O₃, PAN, C₂H₄)

- Injury caused by air pollution is often evident on plants before it affects human beings and other animals.
- Air pollutants may be inorganic (sulphur dioxide-SO₂, fluorine-F, chlorine-Cl₂, and ozone-O₃; or organic (peroxy-acetyl nitrate- PAN, and ethylene- C₂H₄).
- The symptoms caused by air pollutants are very similar to those caused by biotic and other abiotic factors, like mineral deficiency and excesses, or the adverse effects of temperature, water and light.
- In general, the visible symptoms are of three types:
 - i) Collapse of leaf tissues, forming necrotic symptoms
 - ii) Yellowing or other colour changes
 - iii) Alterations in growth
 - iv) Premature defoliation
- Damage is severe during warm, still and humid weather, when the atmospheric pressure is high.
- In this condition the pollutants accumulate near the earth's surface, as the warm air above in the atmosphere traps the cooler air near the ground. This is called **air inversion**.
- The plants vary in their response to the pollutants, and are categorized into very sensitive and somewhat resistant plants for each type of pollutant.
- For control and disease management, resistant plants should be grown in SO₂ prone areas, and plant vigor should be maintained.
- In good health, plants resist all types of injury better than weakened plants.
- The damage to plants by air pollutants is given in following Table.

Symptoms caused by air pollutants

Air pollutant	Symptoms
Sulphur dioxide	Marginal and inter-veinal chlorosis, reduced growth and defoliation. Near brick kilns, SO ₂ toxicity is known to cause black tip or tip necrosis of mango in India.
Fluoride	Yellowish mottle to scorching at margins and the tips of broad-leaf plants, tip burns in grasses and conifers
Chloride	Marginal and inter-veinal chlorosis, similar to that caused by sulphur dioxide and chloride.

Ozone	Chlorosis and necrosis, flecking, bronzing and reddening of leaves, stunted growth, reduction in yield more pronounced in dicots (soybean, cotton and peanut) than in monocots (sorghum, corn and wheat)
Organic	
PAN	Collapse and death of leaf tissues, typical leaf glazing, browning or silvering; stunted growth, early senescence and defoliation
Ethylene	Modifies activity of other hormones, affecting normal organ development, shoot and leaf epinasty, accompanied by stunted growth.