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Role of Abiotic Factors in Plant Disease

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Abstract: *Physiological disorders are often caused by the lack or excess of something that supports life or by the presence of something that interferes with life. They can influence plant physiology at any stages of life. Different plants react differently with the same agent and the extent of reaction varies from a simple action to serious manifestations leading to death also.*

Abiotic factors are referred to as non-living factors such as environmental factors, air pollution, mineral nutrients, temperature, water, etc. Various abiotic factors depend on plant physiology. Some disease symptoms like heat killing, leaf burn, physiological wilting, leaf roll disease, blossom end etc. are manifestations of abiotic effect. It is found that when temperature compensation point is crossed, the photosynthesis process cannot replace the carbon dioxide as a substrate for respiration. As a result, carbohydrate reservation is declined and fruits & vegetables lose their sweetness in taste. Another important abiotic factor is low temperature which causes chilling injury in plants. Again, deficiency of calcium which causes "Bitter Pit" in plants is also an example of abiotic (mineral deficiency) effect. The mechanical damage in plants like girdling from root, airflow is also classified under abiotic factor. For the treatment and curing of abiotic plant disease(s), it is necessary to know the etiology and main cause of the disease(s) first. Some specific fertilizers, chemicals, pesticides, fungicides with sufficient quantity may cure and improve the plant diseases caused by abiotic factors.

Keywords: *Plant disease1, Abiotic factors2, Oedema3, Blossom end4, Physiological wilting5.*

1. INTRODUCTION

Where the live present, there must be present disease. What is the actual meaning of the term 'Disease'? (Disease = prefix dis + ease) The term 'Ease' means peace, natural rest or natural comfort. But when that natural comfort dis balanced by any cause(s) (biotic or abiotic) is called disease. When it occurs in plant is called plant disease and also study about plant disease(s) and study about their improvement is called plant pathology.

Mainly plants are affected by two factors 1.biotic & 2.abiotic. The biotic factors are referred to living organism(s) such as bacteria, virus, fungi, nematode etc. And abiotic factors are referred to non-living things such as temperature, water, minerals, wind flow, polluted air etc. Abiotic affect the productivity of agricultural crops as well as the microbial activity in soil. Extreme conditions such as prolonged drought, intense rains flooding, high temperature, frost and low temperature, which are expected to intensify in the future due to climate changes, will significantly affect plants and soil microorganisms. Plant physiological disorder also an abiotic factor, range from suitable symptoms not visibly apparent to severely stunted and malformed growth. In some cases, the effect can be severe enough to limit the effective use of controlled environment facilities for research and commercial production of some species. Any kind of foreign chemical applied in the wrong dosage or at the wrong time is capable of doing physical damage.

2. TYPES OF ABIOTIC FACTORS

2.1. Mineral Nutrients

2.2. Air pollution

2.3. Water

2.4. Temperature

2.5. Light

2.1. Effects of Mineral Nutrients in Plant

Mineral nutrients are one of the abiotic factors, have an important role in plant life. Mineral nutrients are mainly two types about their importance and quantity. These are macro elements and micro elements. Besides these they are classified according to biochemical function.

MINERALS	FUNCTIONS	EFFECT OF DEFICENCY
GROUP 1.	**(NUTRIENTS THAT ARE PART OF CARBON COMPOUNDS)**	
N.	Function as constituent of amino acids, amides, proteins, nucleotides, coenzymes, hexoamines, etc.	Chlorosis disease, stunted growth.
S.	It is the main component of cysteine, cysteine, methionine, and proteins. Constituent of lipoic acids, coenzyme A, thymine, pyrophosphate, glutathione, biotin, adenosine-5'- phosphate, and 3-phosphoadenosine	Curling of leaves, chlorosis is noted first in younger leaves, stems become hard and woody. Juicy content of Citrus is reduced.
GROUP 2.	**(NUTRIENTS THAT ARE IMPORTANT IN ENERGY STORAGE OR STRUCTURAL INTEGRITY)**	
P.	Component of sugar phosphates', nucleic acids, nucleotides, coenzymes, phosphor lipids, phythic acid etc. Has a key role in reactions that involve ATP.	Leaves are dark green. It promotes leaf fall and delays flowering.
Si.	Contributes to cell wall mechanical properties, including rigidity and elasticity.	Damage cell wall formation.
B.	It helps to involved in cell elongation and nucleic acid metabolism.	Failure of root tip formation. **'Heart rot'**, 'stem rot' diseases, causes disintegration of internal tissues.
GROUP 3.	**(NUTRIENTS THAT REMAIN IN IONIC FORM)**	
K.	It required as a cofactor for more than 40 enzymes. Principal cation in establishing cell turgor and maintaining cell electro neutrality.	Stalks are turned into very weak, dark necrotic lesions.
Ca.	Constitute of middle lamella of cell walls. Act as a second messenger in metabolic regulation.	Deficiency symptoms are more noticed in young tissues. It causes degeneration of young fruits near the blossom in tomatoes i.e. "blossom end".
Mg.	Constitute the chlorophyll molecule.	Leaf tips and margin turned upward. Reduced growth, wilting, necrotic spots etc.
Cl.	Required for the photosynthetic reactions involved in O_2 evolution.	Causes disorganization of thylakoid membrane. "March spot" of pea.
Mn.	Involved with other cation-activated enzymes and photosynthetic O_2 evolution.	Decrease evolves of PEP enzymes.
Na.	Involved with the regeneration of phosphoenolpyruvate in C_4 and CAM plants.	
GROUP 4.	**(NUTRIENTS THAT ARE INVOLVED IN REDOX REACTION)**	
Fe.	It constituent of cytochromes and non-heme iron proteins involved in photosynthesis, N_2 fixation, and respiration.	Leaf turned into yellow in color, chlorosis noticed in young leaves.
Zn.	Constituent of alcohol dehydrogenase, glutamic dehydrogenase, carbonic anhydrase, etc.	Causes stunted growth, decrease of seed formation.
Cu.	It acts as an activator of several enzymes such as lactase, oxidase, and phosphoenoloxidase. Synthesis ascorbic acid.	Leaves are discolored, leaves may be lost, wilted whole plant body.

Fig1. *Biochemical functions of mineral nutrients and their effects of deficiency.*

2.2. Effect of Air Pollution

Air pollution refers to the release into the atmosphere of materials in concentrations that are harmful to man, other animals and plants. Major sources of air pollution are fossil fuels and industries.

Air pollution is another abiotic source for plant disease. We are all known that without CO_2 the photosynthesis could not occurred but when the limit of CO_2 concentration break there are occurred various types of disorder in plant life. The relatively closed environment of growth chambers facilitates CO_2 enrichment studies with plants, and several commercial growth chamber manufacturers will provide CO_2 control capabilities upon request. Provided the CO_2 is clean of contaminants such as ethylene (Morison and Giffod, 1984), enrichment is generally beneficial for growth and provides maximum benefit between 0.1 and 0.2kPa. Yet with certain species enrichment above 0.1kPa can be injurious. The symptoms of leaf rolling or deformation and chlorosis or chlorotic, mottling of leaves are caused by air pollution. In cucumber, the chlorosis can be accompanied by abscission of older leaves i.e. overall growth can be depressed by excessive CO_2 concentrations. Recent studies have also shown that high CO_2 can increase endogenous ethylene production in some plants, which may contribute to the injurious effects from high CO_2 levels.

2.3. Effects of Water

Water has most important role in whole plant life. It act as human blood in plant life , it is the media of cell to cell contact and also bears mineral nutrients to all the body i.e. transporter substance. But sometimes that water give stress in plant physiological function by various processes i.e. called abiotic water stress.

2.3.1. Various Types of Abiotic Stress by Water

Drought Stress: Any water content of a tissue or cell that is below the highest water content exhibited at the most hydrate state that is termed as drought stress or water deficit. It occurred when the water concentration increased by soil minerals then hydrolyses the water from plant cell. As result plant growth damaged, also noticed physiological wilting.

Physiological Responses	**Biochemical Responses**	**Molecular Responses**
a. Loss of turgor and osmotic adjustment **b.** Decrease in stomatal conductance to CO_2. **c.** Decline the net photosynthesis **d.** Reduced growth rate.	a. Decreased efficiency of Rubisco. b. Accumulation of stress metabolites like Glutathione, Polyamines, and α-tocopherol. c. Decrease in photochemical efficiency.	**a.** It gives response gene expression. **b.** Increased expression in ABA biosynthetic genes. **c.** Synthesis of specific proteins like dehydrins.

Fig2. *Effect of Drought Stress*

Salinity Stress also caused by water: Water-deficit stress can be defined as a situation in which plant water potential and turgor are reduced enough to interface with normal functions. Water stress is considered to be a moderate loss of water, which leads to stomatal closure and limitation of gas exchange. Desiccation is a much more extensive loss of water that can potentially lead to gross disruption of metabolism and cell structure and eventually to the cessation of enzyme catalyzing reactions. Water stress is characterized by reduction of water content, turgor, total water potential, wilting, closure of stomata, and decrease in cell enlargement and growth. Severe water stress may result in arrest of photosynthesis, disturbance of metabolism, and finally death.

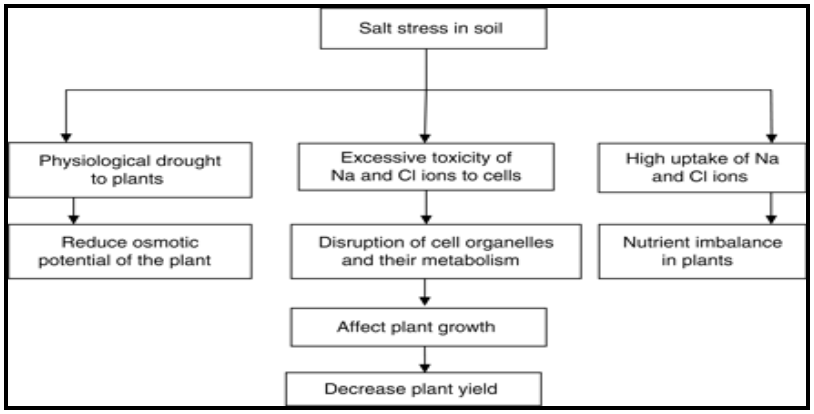

Fig3. *Effects of salt stress on plants*

2.4. Effect of Temperature

We are all known that temperature had an important role in plant physiological function such as seed germination, enzyme activity, bud dormancy, growth of plant parts etc. The temperature at which the amount of CO_2 fixed by photosynthesis equals the amount of CO_2 released by respiration in a given time is called temperature compensation point.

ACTION OF TEMPERATURE	EFFECTS OF TEMPERATURE
A. HIGH TEMPERATURE	1. Water deficit i.e. high amount of water loss by evaporation as result plants are dry off as result rate of photosynthesis decrease. 2. When temperature compensation point cross inhibited the respiration and photosynthesis. 3. At high temperature leaf burn disease may be noticed. 4. Each plant(s) had a capacity to tolerate thermal effect but when it crossed, plants died which is known as "heat killing temperature". 5. When temperature reached on 60-70 ^{0}C enzyme activity failed or destroyed.
B. LOW OR CHILLING TEMPERATURE	1. Cell membrane properties damaged. 2. Inhibit protein synthesis. 3. Ice crystal formation and protoplast dehydration kill cells. 4. When temperature reached very low temperature then the enzyme activity stopped. 5. Some bacteria that are live on leaf surfaces increase "frost damage".

Fig3. *Action of temperature*

PLANT	HEAT-KILLING TEMPERATURE (C^0)	TIME OF EXPOSURE
Nicotiana rustica (wild obacco)	49-51	10 min
Cucurbita pepo (squash)	49-51	10 min
Zea mays (corn)	49-51	10 min
Brassica napusa (rape)	49-51	10 min
Potato leaves	42.5	1 hour
Red pine pollen	70	1 hour
Medicago seeds (alfalfa)	120	30 min

Fig4. *Heat killing temperature of some plants*

2.5. Effects of Light

Light is an abiotic factors has an important role from seed germination to whole life as various activity. But sometimes it gives stress to plant for effects of low light or high light at a time.

2.5.1. Physiological Effects by Low Light

I. Increase in cotyledonary leaf area.
II. Increase in leaf area expansion.
III. Increase in shedding of fruiting parts.
IV. Decrease in biomass production
V. Decrease in specific leaf weight. (SLW)

2.5.2. Physiological Effects by High Light

1. UV light increase with the gain of sunlight that causes photo synthesis decrease because PSI and PSII wave length crossed.
2. Also noticed solar injury.

3. PLANT DISEASES CAUSED BY ABIOTIC FACTORS AT A GLANCE

DISEASES NAME	CAUSE OR FACTORS	SYMPTOMS
Browning of Leaf Tissue	Frost Injury	Leaves are turned into brown in color.
Damaged or Cracked Fruit	Frost Injury	Fruits are small in size, cracked the outer wall of fruit.
Scorch Injury	Hot Climate	Rate of transpiration occurred abnormally. Water transport system damaged.
Bitter Pit of Apple	Calcium problem	Black points spots noticed on fruit.

		Fruit hard in nature.
Blossom End Rot of tomato	Calcium problem	Burn dry spot on tomato.
Oedema	UV radiation	Gall like protrusions on leaves and callus like growth on stems, petioles, and midveins. Abnormal cell growth.
Leaf Pleating	Increase Humidity level.	Curling leaf tip, abnormal needle leaf of pine.
Sunburn	High Temperature	Burning spot on leaf .

4. CONCLUSION

Disease(s) occurred by more or less continuous irritation of the plant tissues by a primary causal agent. Extreme abiotic factors such as prolonged drought, intense rains flooding, high temperatures, frost and low temperatures, which are expected to intensify in the future due to climate changes, will significantly affect plants. At present time the use of various types of heavy metalized fertilizers, herbicides, fungicides, and insecticides caused soil pollution and also water pollution that cause plant disease. So, it would be needed self-control to use of that chemical in cultivation field. It is very important to know the particular dose and about disease before apply the fertilizer(s).

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