Abiotic stresses in plants for B.Sc. (Hons) course code BOTY 3003 by Dr. Tara Chandra Ram.

What is stress?

Stress can be defined as any environmental condition that prevents the plant from achieving its full genetic potential or significant deviation from optimal condition for life that adversely affect growth development and productivity of plant.

Acclimation and Adaptation

Acclimation is temporary adjustment of plants in the environment in which non permanent change in physiology or morphology of the individual to improve response with exposure to environmental stress.

Epigenetics is a mechanism that alters expression of genes without changing the genetic code. eg. acetylation, methylation etc.

Adaptation is a fixed genetic changes over many generations by selective environmental pressure

Abiotic stresses include water stress, salinity stress, light stress, temperature stress, mineral stress etc.

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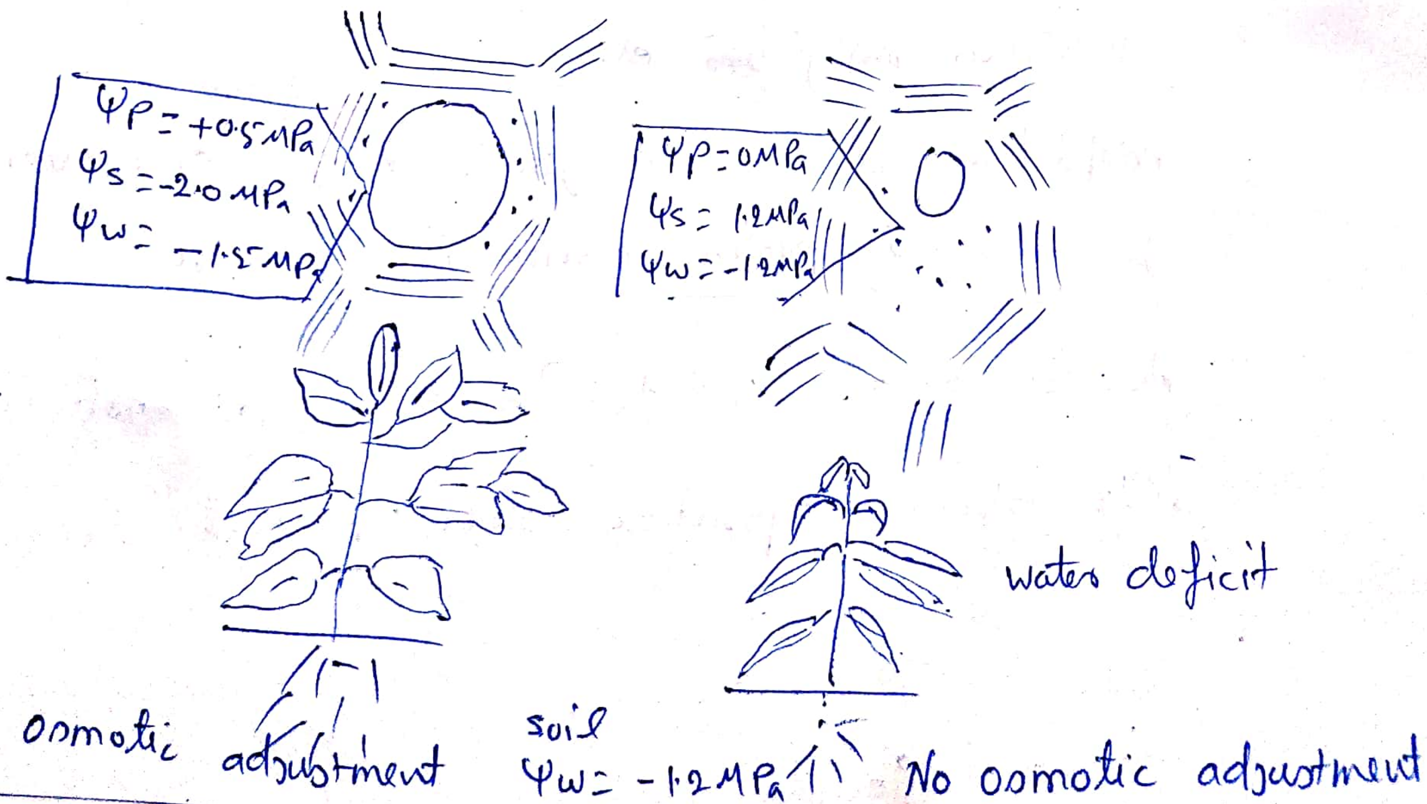
1. Water stress — Water deficits (droughts, low water potentials)
   — Excess water / flood.

Water related stresses could affect plants if the environment contain insufficient water to meet basic needs. Drought, hypersaline conditions, low temperature and transient loss of turgor lead to water deficit.

Tolerance to drought and salinity in plants

What is osmotic adjustment?

- A biochemical mechanism that helps plants acclimate to dry and saline conditions.
- Many drought-tolerant plants can regulate their solute water potential (Ψ_s) to compensate for transient or extended periods of water stress by making osmotic adjustments, which result in a net increase in the number of solutes particles present in the plant cell.



Osmotic adjustment occurs when the concentration of solutes within a plant cell increases to maintain a positive turgor pressure within the cell. The cell actively accumulates solutes and as a result the solute potential (Ψs) drops, promoting the flow of water into the cell.

Osmolytes or compatible solutes or osmoprotectants —
Osmoprotectants or compatible solutes are small molecules that acts as osmolytes and help organisms survive extreme osmotic stress. examples includes glycine betaine, proline betaine, alanine betaine mannitol, sorbitol, sucrose, trehalose etc.

2. Salinity stress -
Salinity stress caused due to high accumulation of calcium, Magnesium as well as sodium and anions such as sulphate, Nitrate, carbonate and bicarbonate, chloride etc.

Based on the responses to high concentration of salts plants can be divided into two groups.

1. Halophytes 2. Glycophytes.

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Halophytes are native to saline soils and complete their life cycle in salt concentration

Glycophyte- salt sensitive plants (plant grown is inhibited by saline soil.

What is light stress?

Exposure of plants to irradiances far above the light saturation point of photosynthesis known as high light stress

- Strong light presents the leaf with more photochemical energy than can be utilized for photosynthesis.
- Extremely high light destroys photosynthetic pigments and thylakoid structure is called photodamage.

Temperature stresses:

Each plants have its unique set of temperature requirement for growth and development. There are two types of limits of temperature upper and lower limit.

1- High temperature
2- Low temperature

- Effects of high temperature on the plants are known as heat stress.
- The typical responses to heat stress is a decrease in the synthesis of normal proteins,

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accompanied by an accelerated transcription and translation of new proteins known as heat shock proteins (HSPs). Heat shock proteins may arise in leaves, when transpiration is insufficient and when stomata are partially or fully closed and irradience is high. Heat shock proteins may also arise in germinating seedlings when soil is warmed by the sun

Classes of HSPs

Protein Class	Size (KDa)	Location
HSP 100	100-114	cytoplasm
HSP 90	80-94	cytoplasm, ER
HSP 70	69-71	ER, cytoplasm, Mitochondria
HSP 60	10-60	chloroplast, Mitochondria

Low temperature stress

Chilling stress - when plants are exposed to a low temperature above 0°c.

Freezing stress - when plants are exposed to a low temperature below 0°c.

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Membrane Properties changes in response to Chilling injury

In chilling sensitive plants, the lipids in the bilayer have a high percentage of saturated fatty acid chains, and membranes with this composition tend to solidify into a semy-crystaline state at a temperature well above 0°c. keep in mind that saturated fatty acids that have no double bonds and lipid containing trans - monounsaturated fatty acids solidify at higher temperature than do membranes composed of lipids than unsaturated fatty acids

Membrane lipids from chilling resistant plants often have a greater properties of unsaturated fatty acids than those from chilling sensitive plants and during acclimation to cool temperature the activity of desaturase enzymes increases and the proportion of unsaturated lipids rises. this modification lowers the temperature at which membrane lipids begin a gradual phase change from fluid to semi-crystaline and allows membrane to remain fluid

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at lower temperature. thus desaturation of fatty acids provides some protection against damage from chilling.

Thank you.