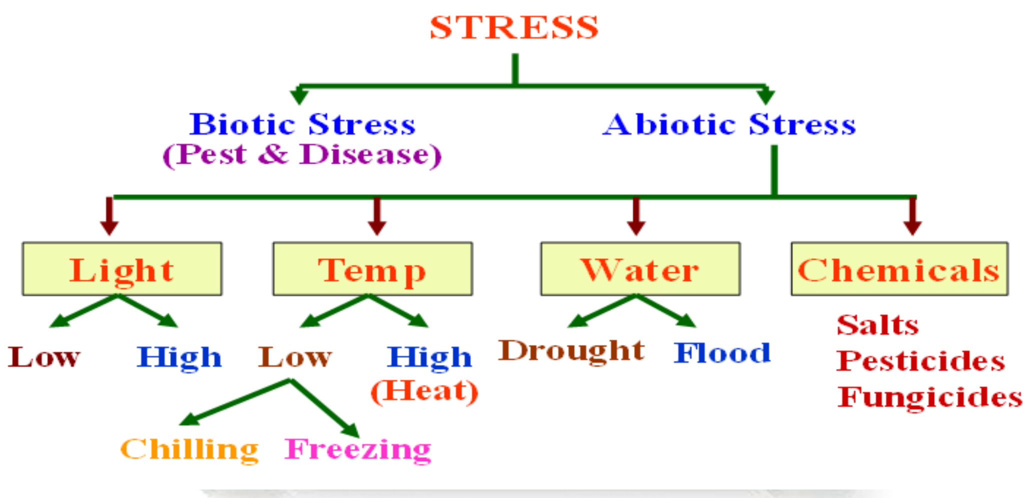
Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 05 (SEP-OCT, 2024)
Available online at http://www.agriarticles.com

Stress Physiology in Plants

(*Soundharya N, Harish R and Hariharaa Sudhan S)
J.K.K. Munirajah College of Agricultural Science, T. N. Palayam, Gobi, Erode-638506
*Corresponding Author's email: n.soundh@gmail.com

Plant stress refers to any external factor that impacts a plant's development, production, and overall life processes. Environmental changes can disrupt a plant's homeostasis, causing biological stress. This stress occurs when a plant experiences a rapid shift from normal environmental conditions, leading to an imbalance. Strain, resulting from such stress, involves physical or chemical alterations that push the plant system away from its normal state. These environmental stresses can significantly reduce agricultural productivity and hinder the introduction of new species for cultivation. Prolonged or severe stress can inhibit essential processes like flowering, germination, and reproduction, potentially leading to plant death. Plants that are unable to withstand these stresses are termed susceptible, while those that manage to escape or endure are known as stress escapists, such as desert or ephemeral plants.

Two main types of stress are Biotic Stress and Abiotic Stress



Biotic Stress: Biologic stress, as defined by us, is an external biological stress that disrupts the growth of plants and impacts nearly every plant group as well as individual cells, tissues, molecules, organelles, entire plants, and even entire plant residents. The most significant environmental stress is communication between the plant and other living things, which can cause partial damage that the plant can recover from or complete damage that can lead to the plant's death.

Abiotic Stress: Abiotic stress include conditions such as drought or water logging, extremes in temperature, metal toxicity, and excessive salt in the soil, excessive or insufficient light, and nutritional deficiencies in the soil. Abiotic stress have the potential to hinder plant growth over an extended period of time. Every plant has the capacity to complete its life cycles and reach the maturity stage when conditions are normal. The various physiological, biochemical, and metabolic functions of plants are altered, and plant growth is impacted by any abiotic stress or modification in a normal biological factor present in the environment. Plants exhibit a variety of antioxidant defense mechanisms in response to these extreme stress.

Major Types of Abiotic Stress

1. Drought or water stress
2. Salt stress
3. Temperature stress
4. Light stress
5. Heavy metal stress

Drought or water stress: Water is the main component of life forms containing 80-90% of the inner mass of non-woody plants, and the major intermediate for conveying various nutrients and metabolites by which plants complete their different processes of development. The availability of excessive (flooding) or inadequate (drought) supply of water is called the water stress.

Changes in plant growth

- Under prolonged drought, plants will dehydrate and die.
- Reduce the plant-cell's water potential.
- Affects translocation indirectly by altering the source to sink relationships for assimilates.
- Changes in structure of macromolecules by dehydration of water.
- Rate of cell expansion is inhibited due to loss in turgor pressure.
- Reduction of water of mesophyll cells inhibits photosynthesis.
- Decrease in turgor causes stomatal closure.

Plant Responses to Drought Stress for Prevention: Primary responses of plants to drought stress generally support the plant to relive for a while. The main aspects of plant responses to water involve the maintenance of homeostasis by ionic balance and osmotic adjustment. Reduced leaf area, stomatal conductance and highly developed root system. Abscisic acid, a plant hormone which is produced mostly in stress condition, also known as stress hormone. Accumulation of ABA under drought conditions helps the plant to survive from dehydration and provide tolerance.

Salt Stress: Salt stress can be defined as the accumulation of excess content of salt in the soil which cause inhibition of plant growth and sometime also leads to plant death. It is one of the major abiotic factors which decrease the crop yield in the arid region. Salinity leads to a number of inhibitory effects on the plant like limiting the crop productivity, seed germination, and crop yield. Affects plant adversely in two ways: High solute content in rooting medium creates water stress by decreasing osmotic potential and direct toxic effect of higher concentration of ions.

Different plants response differently to the salt stress based on their salt tolerance ability. So, based on the tolerance ability, plants generally classified into two categories:

1. Halophytes
2. Glycophytes

Halophytes: These are not usually affected at higher salinity. Known for their ability to grow comfortably in saline soil with high salt concentration.

Glycophytes: The plant which cannot grow in the presence of high concentration of salts. But manage to grow in saline soil by adopting some mechanisms as

- Accumulation of sugars in leaves
- Compartmentalization (checked from reaching to photosynthetic parts).

Mechanism of Tolerance

- Presence of salt excreting glands that reduce the concentration of salt in the plant

e.g. Frankenia, Spartina.
• Development of small leaves, water storage hairs, and aerenchyma.
• Succulence that may lead to dilution of intracellular salt such as occurs in Salicorma sp.

Avoidance: A state of avoiding excessive salt from the parts of the plant where they are detrimental through-
• Salt exclusion
• Salt excretion
• Salt Dilution.

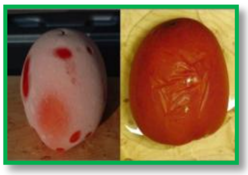
Temperature Stress: Temperature stress is one of the severe environment factor which affect plant development, by showing low germination rate, growth retardation, reduced photosynthesis, and often die.

It is divided into three main parts:
1. Chilling Injury
2. Freezing Injury
3. Heat Stress or High-Temperature Stress

Chilling Injury: The injury which causes due to low but above zero-degree centigrade temperature is called chilling injury.

• Temperature 0˚C to 15˚C causes chilling stress.
• Less than 0˚C will cause freezing stress.

Freezing Injury: Freezing injury occurs at a temperature below the freezing point of water (below 0◦C) and primarily the liquid phase in the cell wall freezes.



- At 0˚C there is a phase transition in water from liquid to solid. Development of ice crystals in the cell walls and intercellular places.
- Damage occurs when ice crystals grow and puncture into the cytoplasm.

High Temperature Stress or Heat Stress: High temperature (HT) or Heat stress is also a main abiotic stress that affects the development of plant, their different processes, and their overall production. Almost every physiological and biochemical processes are sensitive to high temperature. Different plants have different ability to respond to the high temperature.

• Normal temperature ranges from 0˚C to 4˚C.
• Stress temperature is above 40◦C.

Light Stress: Light stress is also a stress factor that damages plants and its development very badly. Light is one of the most important components for photosynthesis as an energy source and a main environmental factor for plant growth and development. But the changed light quality and quantity can also be harmful to plant processes and lead to photo-destruction and photo-inhibition. Due to changed light intensity either low or high, plants unable to protect them by being stabilized and loss their normal metabolic functions.
• When light intensity is low below the compensation point, carbohydrate level in plants declines by using it as a substrate first for respiration and then for the other purpose.
• In high-intensity, light photosynthesis performance of plants, is depends upon the relationship between photo-inhibition of photosynthesis and the damaged chlorophyll ratio.

Conclusion

Stress physiology in plants examines how environmental factors, such as drought, salinity, and extreme temperatures, affect plant health and development. It explores how plants perceive and respond to stress, including physiological and biochemical adaptations that help them survive and maintain growth. Understanding these responses is vital for improving crop resilience and optimizing agricultural practices in changing environmental conditions.

References

1. Loon LC (1985). "Pathogenesis-related proteins". *Plant Molecular Biology*. **4** (2–3): 111–116.
2. Lutz, Diana (2012). Key part of plants rapid response system revealed.
3. Matthews B. "The Hypersensitive Response". *Agricultural Research Service: Plant Science Institute*. The United States Department of Agriculture. Archived from the original on 2007-02-22. Retrieved 2007-01-12.