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Physiological Responses of Fruit Plants due to High Temperature Stress

(*Shivani)
Department of Horticulture, CCS Haryana Agricultural University, Hisar-125004, Haryana
*Corresponding Author's email: shivanigadai81@gmail.com

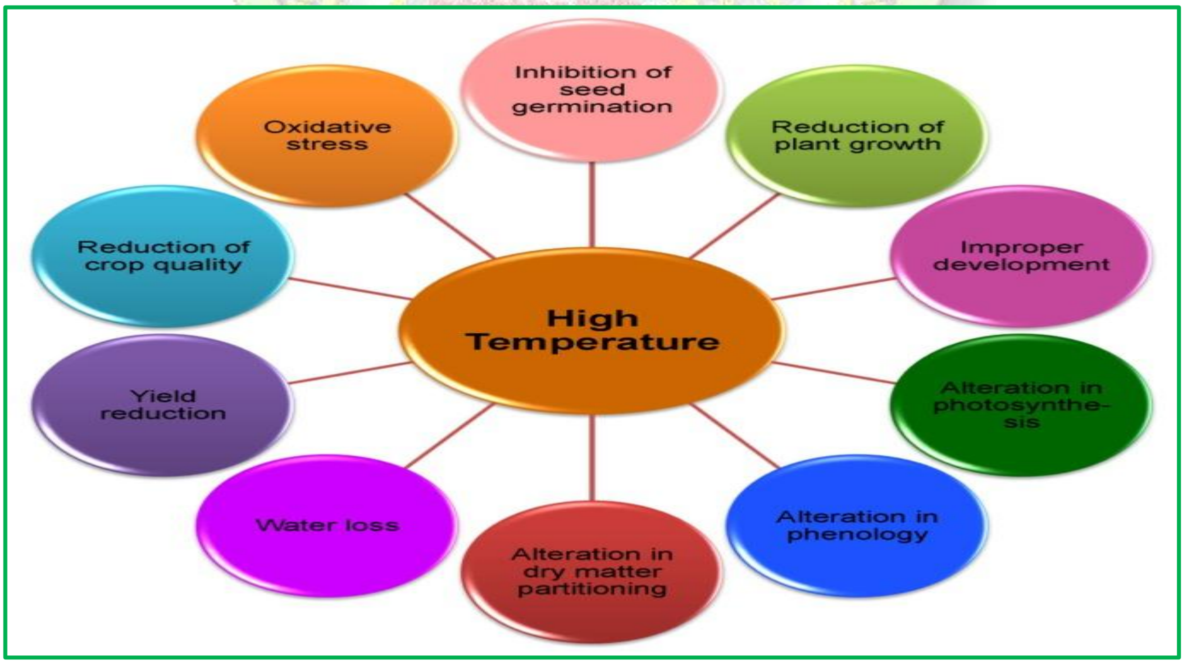
Any variation from the ideal state of any factor necessary for its growth will cause an abnormal alteration in physiological processes, which will cause tension in the plant's body. This condition is known as plant stress.

- When this condition prevails for some time stress causes injury with or without producing visible symptoms, which can be referred to as a strain.
- Injury occurs as a result of aberrant metabolism and may be expressed as a reduction in growth, yield, and death of the plant or plant part.
- Both biotic (disease, herbivores) and abiotic (physical and chemical) factors can contribute to stress.

- **Temperature Stress cause by:**
- High temperature injury
- Chilling injury and Freezing injury

Definition

- **High-temperature stress:** High temperature stress is defined as an increase in temperature beyond a critical threshold for a period of time sufficient to cause irreversible damage to plant growth and development. Numerous biochemical processes are involved in the growth and development of plants and each of these processes is to some extent temperature-sensitive.



Physiological responses of fruit plants to high temperature stress

- **High temperature limits to optimal plant performance:** Temperature changes can be significant for plants on a daily or seasonal basis. Therefore, it makes sense that plants would have developed mechanisms to allow for the maintenance of cellular activity throughout a range of temperature conditions. The real upper temperature limitations for survival between 40°C and 55°C for temperate plant species, depending on the time of exposure affect plant distribution and the amount of land that may be used for agriculture. Depending on the degree, length, and timing of the stress during the developmental process the plants exhibit varying sensitivity to high temperatures.
- **Heat sensitivity of photosynthesis:** It is generally known that heat stress reduces the amount of photosynthetic activity and that photosynthesis. One of the physiological processes in plants that are most sensitive to heat is photosynthesis. High temperatures have a more significant impact on C3 plants than C4 plants in terms of their ability to photosynthesize. Photosynthesis can be significantly impacted by extremely high temperatures (>40°C).
- **Water relations:** Plant water status is the most crucial factor under changing ambient temperature. Reduced water supply is typically linked to high temperature stress. In general the increased transpiration during the daytime causes a water deficit in plants which cause a drop in water potential and the disruption of numerous physiological processes.
- **Hormonal changes:** Under heat stress, there are changes to hormonal homeostasis, stability, content, biosynthesis, and compartmentalization. Increased ABA levels are a result of high temperature stress. In the field where heat and drought challenges frequently coexist the ABA induction is a key element of thermotolerance. Its play an important role in the metabolic processes necessary for survival under heat-induced desiccation stress. It has been demonstrated that kiwifruit treated with propylene ripens more quickly at temperatures up to 35°C due to an increase in ethylene production. However, temperatures above 35°C prevent ripening by inhibiting ethylene production even though respiration continues until tissue disintegration.
- **Accumulation of compatible osmolytes:** Heat stress causes changes in the level of several physiological parameters including lipid peroxidation, H_2O_2 production and proline accumulation. Heat stress is also known to induce oxidative stress caused by the accumulation of superoxides (O^{2-}), hydrogen peroxide (H^2O^2) and hydroxyl radicals (OH^-), which are commonly known as reactive oxygen species (ROS). For example, the generation and reactions of activated oxygen species (AOS) including singlet oxygen, superoxide radical (O^{2-}), hydrogen peroxide (H) and hydroxyl radical (OH^-) are symptoms of cellular injury due to high temperature.
- **Cell membrane thermostability:** AOS alter the functionalities of membranes by causing the autocatalytic peroxidation of membrane lipids and pigments, which results in the loss of semi-permeability. The chloroplast and mitochondrion regularly create superoxide radical, and microbodies also make some of it in small amounts.

Sr No.	Name of Fruit Crops/Cultivars	Effect of High Temperature
1	Apple	Sunburn
2	Apple cv. Jonagold	Bitterpit
3	Citrus	Poor colour development
4	Avacado	Reduced fruit set
5	Cherry	Accelerated pollen tube growth
6	Mango	Spongy tissues and fruit cracking
7	Pineapple	Sun Scald

MANAGEMENT PRACTICES TO ALLEVIATE HEAT STRESS

- **Selection of Fruit Crops:** It is best to select perennial fruit species that can withstand the high temperatures that are anticipated to occur in that region. The deep root systems, leaf shedding, water binding mechanisms, the presence of thorns, leaf orientation, vertical and rolling of leaves, and a well-formed canopy are examples of heat and drought tolerance mechanisms. Fruit crops such as Indian fig, ber, pomegranate, aonla, fig, ker, tamarind, bordi (Ziziphus species), karonda, lasora, and bordi can be chosen to grow in hot climates.
- **Selection of Cultivars:** The drought and heat tolerance cultivar in fruit crop viz. Ruby (Pomegranate), Arka Sahan (Annona), Deanna and Banana-cultivars belonging to BB genome shown to be drought tolerant viz. Karpuravali and Kanthali.
- **Rootstock:** The use of adaptable rootstock genotypes is one method for enhancing fruit trees resilience to heat stress and water shortage circumstances. The initial consequences of dry conditions would be reduced with the adoption of heat and drought-tolerant rootstocks.With more knowledge of the benefits of employing rootstocks to combat the negative impacts of heat and drought rootstock use for agriculture has expanded.
- **Canopy Management:** The selection of cultivars, irrigation techniques, fertilizer management techniques and pruning and training techniques can all affect how much fruit is shaded by leaves. Any procedure that lowers canopy cover such as foliar diseases, wilting brought on by insufficient irrigation, excessive or late pruning, excessive summer pruning, and leaf stripping increases sunburn. The development of adequate leaf cover in the canopy to shade the fruit is the first step in preventing sunburn in fruits. The fruits that are exposed to the sun the most in the afternoon will be the ones that are most likely to get sunburned.
- **Irrigation:** To prevent heat stress and sunburn the irrigation should be administered soon before or during heat waves. By using irrigation to meet the demand for evapotranspiration the heat stress is mostly reduced. Reduced tissue temperature and a smaller water vapour pressure deficit can also be achieved by using overhead watering, sprinkling, and misting.
- **Nutrient Management:** One effective way to reduce heat stress is proper plant nutrition. Under moderate heat stress, the split application of N and K fertilisers enhances plant development. To relieve heat exhaustion, a foliar spray of 2% DAP and 1% KCl (MOP) is also utilised. To prevent leaf scorching during the spray, there should be enough moisture in the soil. Foliar spray of 0.5% zinc sulphate + 0.3 % boric acid + 0.5 % + Ferrous sulphate + 1% urea.
- **Mulching:** Mulches also aid in regulating transpiration, keeping the canopy cool. Utilizing low density, organic, reflective mulches like straw will help conserve moisture while reducing surface radiation through heat dissipation and reflection. By lowering emitted heat and total incoming radiation the shading cloth is used to provide partial shading.
- **Anti-Transpiration:** Anti-transpiration chemicals are used to minimize the evapo-transpiration rate. Application of foliar spray of 3% Kaoline can reduce heat stress by reducing evapotranspiration.
- **Growth Regulators:** The spray of exogenous PGR spraying can be used to help plants develop a tolerance to stress. Under heat stress, salicylic acid therapy can keep grape leaves photosynthetic levels greater. Spraying 100 ppm salicylic acid on stressed crops will boost stem reserve use and the harvest index.
- **Fruit Bagging:** Large percentages of exposed fruits at risk of sunburn can be protected by using shade cloth (10-30% shade).

- **Fruit Suppressants/ Film Spray:** A film spray can lessen or even completely prevent sunburn. The Screen Duo and Purshade are kaolin clay-based products that leave a white particle film on the fruit. Additionally there are films like Raynox that shield produce from sunburn without leaving a white film behind.
- **Bark Painting:** The bark of exposed trunks and branches can be coated with a reflective white coating to prevent high temperature damage to the cambium in the trunk.

Conclusion

High temperatures are a damaging environmental factor that have an impact on a variety of crop mechanisms, affecting crop growth and yield. Since high temperatures have a direct impact on yield, they are a serious concern that must be taken into account in a situation where high yield is required to end world hunger, meet demand for food and ensure food security.

It is necessary to research new ways to withstand or improve high-temperature tolerance. By using climate-smart practises, stress tolerant varieties, management practices, genetic modified crops, high-throughput phenotyping techniques and disclosing the traits that are tolerant can protect, safeguard and defend tomorrow. It is also crucial to implement or adhere to improved agricultural practises across the globe.