Course Seminar

On

Impact of abiotic stresses on major fruit crops and how to mitigate it?

By

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HEADS TO BE DISCUSS

- Introduction
- Types of stresses
- Effect of abiotic factors on fruit plants
  - Temperature
  - Water stress
  - Wind stress
  - Salt stress
- Conclusion.

INTROUCTION

What is stress ?

- Stress in biology is any change in environmental conditions that might reduce or adversely change a plant's growth or development.
- Strasser, 1998 defined it as 'a condition caused by factors that tend to alter an equilibrium', 'Stresses' that impact upon seeds can affect plant reproduction and productivity, and hence, agriculture and biodiversity.
- Biotic stress is stress that occurs as a result of damage done to plants by other living organisms. It includes bacteria, fungi, nematodes, viruses and insect- pests.
- The negative impact of environmental factors on plant growth and yield.

Types of stresses

Biotic Stress:

- Biotic stress is stress that occurs as a result of damage done to plants by other living organisms. It includes bacteria, fungi, nematodes, viruses and insect- pests.
- 600 insect and mite pests are present in temperate fruits alone in India (Sharma and Singh, 2006).
- Diseases both in field and storage accounts for 25-30 per cent losses in fruit crops (Rangaswami and Mahadevan, 2002)

Abiotic Stress:

- The negative impact of environmental factors on plant growth and yield.
- Any adverse factor acting on physiological processes/ biochemical activity of the plants is called as abiotic stress.
- 10 million ha under salinization in India (Singh *et al.*, 2006).

Effect of Abiotic Factors on plants

A. Temperature:

1. High Temperature Stress: It results in-

1. Excessive membrane fluidity.
2. Disruption of protein function.
3. Metabolic imbalances.
4. Disruption of normal protein synthesis.
5. Disruption of normal mRNA precursors.

Effect of High Temperature on various stages of crop growth

Vegetative growth	• Bud failure like symptoms in Almond (43^{o}C). • Complete separation of distorted and compressed cells from surrounding tissues takes place by a periderm like layer (Hellali and Kester, 1979).
Flowering	• Abnormal pattern of bud break and development in temperate fruit trees. • In apricot, the warm temperature (15.9^{o}C) 3-5^{o}C higher than the normal results in underdeveloped pistils. Rodrigo and Herrero (2002).
Fruit set and Yield	• Affect the fruit retention during fruit set. • On trifoliate orange rootstocks 30 - 35^{o}C for 48 hrs increased the fruit drop.

Effect of high temperature in various fruits

Spongy tissues and fruit cracking in mango

Sunburn in Apple

Bitter pit in Apple cv. Jonagold

Poor colour development in citrus

Sun scald in pine apple

Mitigation of high temperature stress:

- Use of Reflective Fabric.
- Evaporative Cooling.
- Bagging of Fruit.
- Use of Antitranspirants.

Low Temperature Stress: It results in-

1. **Black heart.**
2. **Collar injury**
3. **Crotch injury.**
4. **Splitting of bark.**

Effect of low temperature in fruits

Pollination & fertilization is highly reduced in almond

Oozing of water from aonla fruits

In banana, below 10^{o}C leads to impedance of inflorescence and malformation of bunches.

In ber, fruits are shriveled, brown and turn black

Drying up of fruits and twigs in citrus

Floral induction in mango

Hardening of fruits in pomegranate

Mitigation of low temperature stress:

- ***Artificial frost protection methods, which modify the microclimate of the plants (e.g. foams, covers and fogging).***
- ***Avoiding freezing through a decrease of the freezing point or an increase in the degree of super cooling.***
- ***Tolerance of extracellular freezing by reducing the amount of ice formed due to an increase of the concentration of solutes in the protoplasm.***
- ***Tolerance of a higher degree of desiccation due to the plasmolysis of the protoplasm or increasing the permeability of the plasma membrane to avoid intracellular freezing.***

B. Water stress:

☞ Condition of soil or atmosphere or both that prevents the plant in obtaining sufficient water for its function. It is of two types:

Drought stress: Drought in meteorological term, it is commonly defined as period without significant rainfall.

Flooding stress: Water supplied excessively to an area. It can also be defined as overflow of water in soil in excess of field capacity.

Effect of drought in various fruit crops

Fruit Growth

- Apple fruit growth continues during the season and therefore, constant water supply is needed.
- Peaches, apricots and plums fruit growth slows during pit hardening but picks up afterwards.
- Studies have shown that peach fruit growth is linearly related to the water stress of the tree.

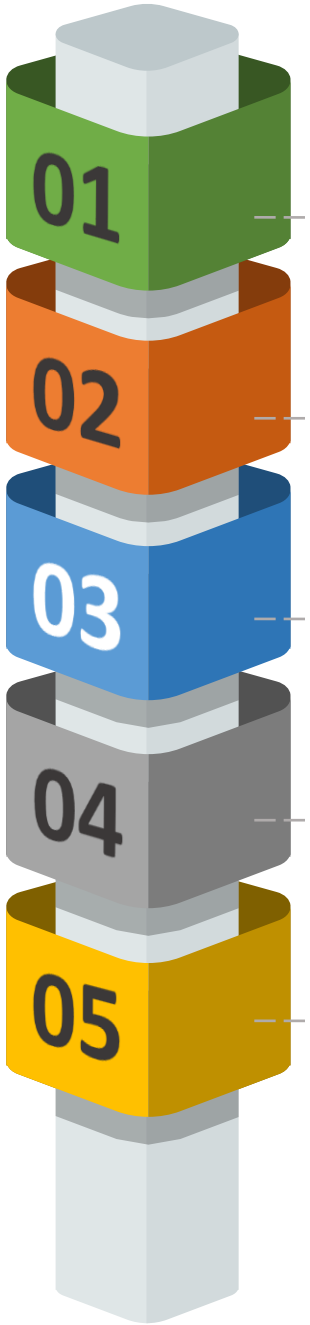
Nutrient levels

- No effect on N and P.
- Increased Mg and Mn.
- Decreased Ca, K and B.
- Reduced leaf size, shoot length and root growth Water deficit in apple.
- Reduced photosynthesis and respiration.

Impact of flood on fruit growth

- The roots suffocate.
- The uptake of nutrients also gets adversely affected, because of lack of oxygen in soil
- N, B, Mg, and K are highly soluble in water and go deeper in the soil, below root zone, causing their temporary deficiency.

GENERAL EFFECT OF FLOOD ON FRUIT CROPS



Apple

- Severe injury to the root system.
- stop growing.
- Minerals are not absorbed.
- Leaves turn yellow and remain small.
- Finally roots begin to die as infections of phytopathogen microorganisms occurs.

Cherry

- Fruit cracking.

Pineapple

- Yellowing of the leaves followed by red.
- Reduces the leaf length.

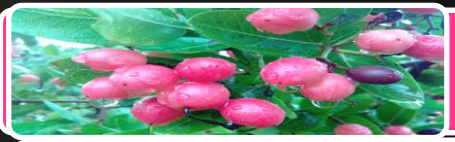
Papaya

- Susceptible to fungal root diseases.
- Killing of waterlogged plants

Mango

- Reduce root dry weight
- Resulting in an increased shoot to root ratio
- Reduced net carbon dioxide assimilation rates.

Mitigation of Water stress:



1. **Use of drought tolerant crop/cultivar.**

2. **Nutritional Management-**

- **Potassium and magnesium during conditions of water deficit enhances the water uptake as well as the water relations in the plant tissues by osmoregulation processes.**
- **Magnesium is component of chlorophyll, its content and uptake is drastically reduced due to the water stress effect.**

3. **Use of Antitranspirants or Materials causing stomatal closure:**

- **Herbicides: like 2, 4-D, Phosphon D and Atrazine.**
- **Fungicides like Phenyl Mercuric Acetate (PMA).**
- **Metabolic inhibitors like Hydroxyl sulfonates, Potassium metabisulphite etc. Growth hormones like ABA, Etheral, TIBA, Succinic acid, Ascorbic acid and Cycocel (CCC).**

4. **Use of Plant Growth Regulators (PGRs)**

- **Spray of Cycocel & Mepiquat chloride.**
- **Cytokinins and Salicylic acid.**
- **Brassinolides increase the photosynthetic activity of the plants.**
- **Ascorbic acid.**

C. Wind stress:

Wind stress is visual stress incurred by wind causes damage to seedlings, breaking branches and even uprooting the whole plants. It helps to covert ground fires to crown fires.

Wind can be detrimental to crop production in many ways:

- Wind stresses plants, reducing their growth, vitality and yield.
- Wind physically damages plants by breaking stems or branches, stripping leaves or tearing flower or fruit from crop plant.
- Wind dries the air around plants, causing them to lose moisture.
- Wind pulls moisture from soil pores on the surface drying soil.
- Wind removes topsoil and organic matter from exposed soil.
- Wind carries salt, especially near coastal areas or on small islands, which draws moisture out of the soil and can harm plant tissue.

Impact of wind stress on fruit growth

Fruit skin cracking and sun burn.

Uprooting, tearing and removal of whole leaf lamina, susceptible to toppling.

Fruit drop.

Increased symptoms of bacterial or fungal diseases.

Crinkled leaves, reduced growth, fruit set, fruit quality, and productivity, susceptible to toppling.

Mitigation of wind stress:

- Shelter belts and wind breaks: Refers to growing trees and tall crops across the direction of prevailing wind to reduce the physiological and mechanical damage to crops.
- Wind breaks reduce the wind velocity and create favorable microclimate.
- Staking: Providing support to the crop plants like Banana.

B. Salt stress:

When salt concentration exceeds threshold value is known as salt stress.

Impact of salt stress on plant growth

- Growth rate and size of plant progressively decreased.
- Plants become stunted.
- Reduction in size of leaves and fruits.
- Decrease in fresh and dry weight of different plant parts.

Impact of salt stress on fruit growth

Scorching of leaf tips and margins, Leaf curling, reduces growth, causes abscission of leaves and death of trees

Leaf length and mass, plant fresh and dry weight, leaf elongation and leaf water potentials decline with increasing the salinity in pineapple.

Saline irrigation water also adversely affect the fruit yield and quality.

Leaf burn and Necrotic symptoms.

Mitigation of Salt Stress

Grow more resistant/ tolerant varieties:

Citrus (*Citrus Spp.*)

- Rangpur Lime, Rough Lemon, Sweet Orange, Sour Orange.

Stone fruit *(Prunus Spp.)*

- Lovell, Shalil

Avacado (*Persea americana*)

- West Indian Mexican

Grape (*Vitis Spp.*)

- Salt Creek, Dogridge, Thompson Seedless.

Berries (*Rubus Spp.*)

- Boysenberry, Indian Summer Raspberry.

Strawberry (*Fragaria Spp.*)

- Lassen, Shasta.

Conclusion

- Short term control of primary stresses are expensive and only moderately effective.
- Long term control involves the understanding of physiological mechanism and using genetic improvement.
- Transgenic technology is the most useful tool to produce resistant plants to various stresses, when the source of resistance is not present in the related genera/species.
- At genetic level gene isolation that impart resistance to different types of stresses in fruits need to be improved.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THANK YOU