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Management of Sunburn Effect in Fruit Crops

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Introduction

- Sunlight is the primary source of energy used in photosynthesis by plants to convert carbon dioxide and water into carbohydrates, which the plant uses to make stems, leaves, roots, and fruits.
- Without this source of energy, life is not possible.
- Besides, sun light up to certain level is very much helpful to improve quality and production, and also reduces incidence of pest and diseases.
- If the intensity of sun light is beyond the optimum, plants suffer from many physiological problems and sun burn is one of them.

What is sunburn?

- It is a physiological disorder- due to excessive exposure of the fruit to sunlight.
- Primarily affects fruit that is exposed to direct sunlight.
- Sunburn can occur in various fruit crops, including mango, banana, apple and citrus fruits.

When occurs?

- Sunburn occurs when the fruit surface temperature (FST) exceeds a threshold, determined for fruits within a range between 39.1 °C (102.4 °F) and 40.8 °C (105.4 °F) (Rabinowitch *et al.*, 1974)
- Sunburn occurs mainly where air temperature and the number of sunny hours are high during the ripening period. Sunburn also occurs when cool or mild weather is abruptly followed by hot, sunny weather.
- Sunburn injury is common on fruits in due to high solar radiation levels and air temperatures, low relative humidity and high elevations.
- Excess absorbed energy is the greatest contributor to cell death and sunburn.
- The incidence and severity of sunburn depends upon climatic factor, cultivars, hormonal, nutritional and soil moisture (Schrader *et al.*, 2003).

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Causes of sun burn

- The main cause is thought to be an increase in reactive oxygen species production which causes oxidative damage due to the incapacity of the fruit to recover from stress.
- This can result in a characteristic morphological and structural phenotype unacceptable to consumers, leading to severe losses in productivity for farmers.

Physiology of sun burning

- Fruits have a great array of mechanisms to mitigate or reduce reactive oxygen species production and the inactivation of photosynthetic apparatus, such as enhanced xanthophyll cycle dependent energy dissipation, accumulation of photoprotective pigments and heat-shock proteins, and the biosynthesis of antioxidants, among others.
- These mechanisms become inefficient when the stress factors altering the fruit surface exceed a certain threshold (of both duration and intensity).

The fruit is influenced by several factors

- Intense sunlight
- Fruit position
- Lack of pigmentation
- Weather conditions
- Sunburn symptoms typically appear as discoloration, browning, or bleaching of the affected fruit surface. The damaged area may become necrotic and develop a dry, papery texture. Severe cases can result in fruit cracking or shriveling.

Spongy tissue or soft nose in mango

Sun burns in fruit crops

- Some modern fruit production techniques can increase the risk of sunburn.
- Rootstock is becoming popular in fruit production and dwarfing rootstocks growing on trellis and using training systems that allows direct sunlight to penetrate throughout the canopy of tree and this can increase fruit yields and improve colour development but can increase the risk of sunburn.

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- Fruit production losses due to sunburn may be 6 to 30 per cent depending on seasons and the type of fruit.
- Estimates of recent losses in susceptible orchards vary from 10 to 40 per cent in Granny Smith apples, 15 to more than 50 per cent in Gala apples, 10 to 25 per cent in Pink Lady apples and 10 to 15 per cent in William's pears.

Prevention and management strategies

- Canopy management
- Irrigation management
- Mulching
- Shade cloth or protective covers
- Fruit thinning
- Application of reflective materials
- Cultivar selection

Canopy management

Plays a vital role in preventing sunburn in fruit crops.

- Pruning: Proper pruning of fruit trees or plants is essential for maintaining an open and well-ventilated canopy.
- Prune to remove excessive branches and foliage, which can create dense canopies that hinder air circulation and increase humidity.
- Thin out the canopy to allow better light penetration and reduce the risk of sunburn.

Training systems

- Implementing appropriate training systems can help optimize canopy structure and distribution of fruiting wood.
- Choose training systems that promote good light exposure to the fruit, such as trellising or espalier systems.
- These systems allow for better sunlight penetration and minimize shading within the canopy.

Canopy density

- Aim for an ideal balance between foliage cover and fruit exposure.
- Dense canopies can create excessive shade, leading to poor fruit coloring and increased susceptibility to sunburn.

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- Regularly assess the density of the canopy and consider appropriate thinning practices to maintain an optimal balance.

Canopy architecture

- Shape the canopy in a way that maximizes sunlight exposure to the fruit.
- Position branches to create a well-distributed, open canopy that allows sunlight to reach all parts of the plant.
- Avoid excessive overlapping or dense foliage that may block sunlight.

Leaf removal

- In some cases, selective leaf removal can be practiced to expose fruit to more direct sunlight.
- This technique is often used in grapevine cultivation, where leaves on the fruiting zone are removed on the shaded side of the vine.
- However, be cautious not to remove too many leaves as they play a crucial role in photosynthesis and fruit development.

Reflective mulch

- Using reflective mulch materials, such as silver or aluminum coated mulch, can help redirect sunlight towards the fruit and reduce heat buildup.
- Reflective mulches can be applied around the base of the plants to increase light intensity in the lower parts of the canopy.

Shade netting

- Installing shade netting or using shade cloth can provide temporary protection against intense sunlight.
- These materials help diffuse sunlight and reduce its intensity, mitigating the risk of sunburn.
- Choose shade netting with appropriate shading percentage based on the specific crop requirements.
- Remember that the specific canopy management practices may vary depending on the fruit crop and growing conditions.

Irrigation management

- Irrigation management is an important aspect of preventing sunburn in fruit crops.

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- Proper irrigation practices help maintain adequate soil moisture levels and mitigate the risk of sunburn.

Irrigation management strategies

- Consistent watering
- Deep watering
- Timing of irrigation
- Avoid water stress
- Mulching
- Irrigation system selection
- Monitor plant water status
- Remember to consider the specific water requirements of different fruit crops, as they may vary. Factors such as soil type, climate, and stage of fruit development can influence the irrigation needs of each crop.

Mulching

Mulching plays a significant role in managing the risk of sunburn

Soil moisture conservation:

- Mulch acts as a protective layer over the soil, reducing evaporation and conserving soil moisture.
- By maintaining adequate soil moisture levels, mulching helps prevent water stress in fruit crops.
- When plants are well-hydrated, they are better equipped to handle heat stress and are less prone to sunburn.

Temperature regulation:

- Mulch helps regulate soil temperature by insulating the soil from extreme temperature fluctuations.
- During hot weather, mulch acts as a barrier, reducing the amount of heat transferred from the soil to the fruit.
- This can help prevent excessive fruit surface temperatures and minimize the risk of sunburn.

Weed suppression:

- Weeds compete with fruit crops for water, nutrients, and sunlight.

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- By suppressing weed growth, mulch reduces competition and allows fruit crops to receive adequate resources.
- This can lead to healthier plants with a reduced risk of sunburn.

Improved root environment:

- Mulching creates a favorable environment for root development.
- It helps maintain a more stable soil moisture level and temperature, promoting healthy root growth.
- Well-developed root systems enhance the overall vigor and stress tolerance of fruit crops, reducing their susceptibility to sunburn.

Reduced soil erosion:

- Mulch acts as a protective cover over the soil, preventing erosion caused by wind or heavy rain.
- By reducing soil erosion, mulching helps maintain a stable root zone, ensuring the plant's access to water and nutrients.
- Healthy plants are better equipped to withstand environmental stresses, including sunburn.

Fruit cleanliness:

- Mulch can prevent soil splashing onto the lower parts of the fruit during rainfall or irrigation.
- This reduces the risk of soil-borne pathogens adhering to the fruit surface, which can lead to various fruit diseases.
- Healthy, disease-free fruit is less prone to sunburn damage.

Tips for mulching

- Use organic mulch materials such as straw, wood chips, or compost. These materials gradually break down, enriching the soil with organic matter and nutrients.
- Apply a layer of mulch around the base of fruit plants, extending it to cover the root zone but leaving a small gap around the trunk to prevent moisture accumulation.
- Maintain an appropriate mulch depth (typically 2-4 inches) to provide sufficient coverage and insulation without smothering the plants.

Shade cloth or protective covers (Bagging)

Here's how shade cloth and protective covers can help:

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- Sunlight reduction
- Temperature moderation
- UV radiation reduction
- Protection from extreme weather
- Adjustable light transmission
- Pest control

Points to be ponder

- Choose shade cloth or protective covers with appropriate shading percentages that align with the sunlight requirements of your fruit crop.
- The optimal shading percentage may vary depending on the specific crop and local climate.
- Install the shade cloth or covers in a way that allows for adequate airflow and prevents heat buildup. Proper ventilation is crucial for preventing excessive humidity and maintaining optimal plant health.
- Regularly monitor the microclimate under the shade cloth or protective covers to ensure it remains favorable for fruit growth.
- The specific installation requirements and durability of the shade cloth or covers to ensure they can withstand environmental conditions and remain effective throughout the growing season

Advantages of Fruit Bagging

- Environment-friendly technology.
- Reduces the residues of pesticides, improves eating quality of fruit.
- Integral part of organic fruit production.
- The paper bags are recyclable and biodegradable.
- Protects the fruit from cracking and sunburn.
- Significantly improves the appearance of the fruit, which facilitates in obtaining a good market price.
- Eliminates fruit fly infestations, restricts bird damages and reduces diseases infection.

Different types of bag

1. White paper bag (WPB)

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2. Newspaper bag (NPB)
3. Yellow paper Bag (YPB)
4. Transparent polythene
5. Blue polythene
6. Red polythene
7. Black polythene
8. Jute bag
9. Dried banana leaves
10. Cellophane paper
11. Transparent polypropylene micro-perforated bag

Fruit thinning

- By reducing fruit density, fruit thinning helps improve airflow, light penetration, and overall canopy management, thereby reducing the likelihood of sunburn.
- Enhanced airflow:
  - Thinning excess fruit allows for better air circulation within the canopy.
  - Improved airflow reduces humidity levels, decreases the risk of fungal diseases, and helps maintain a healthier fruiting environment.
  - Adequate airflow also prevents the accumulation of heat around the fruit, reducing the chances of sunburn.

Increased light penetration:

- Thinning fruits helps ensure better light penetration throughout the canopy.
- Direct exposure to sunlight is important for proper fruit development and coloration.
- When fruits are overcrowded, shading occurs, which can lead to insufficient sunlight reaching the individual fruit.
- By thinning, more light can reach the remaining fruits, promoting even ripening and reducing the risk of sunburn.

Balanced fruit growth:

- Fruit thinning promotes more balanced growth and distribution of resources among the remaining fruits.
- When there are too many fruits on a plant, they compete for limited resources such as water and nutrients.

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- Thinning helps alleviate this competition, ensuring that the remaining fruits receive sufficient resources for optimal growth and development.
- Healthy, well-nourished fruits are less prone to stress and sunburn.

Larger fruit size:

- Thinning allows the plant to redirect its energy and resources to a reduced number of fruits.
- With fewer fruits to support, the plant can allocate more resources to each individual fruit, resulting in larger fruit size and better fruit quality.
- Larger fruits generally have a lower risk of sunburn due to their increased surface area, which allows for better heat dissipation.

Guidelines for fruit thinning

- Thinning should be done when the fruits are still small and immature.
- Remove excess fruits evenly throughout the canopy, aiming for a balanced distribution. This ensures that the remaining fruits have ample space and access to light.
- Use appropriate tools or techniques for thinning, such as hand-pruning or using thinning shears. Take care not to damage the remaining fruits or the plant during the thinning process.
- Adjust irrigation and fertilization practices after thinning to align with the reduced fruit load and prevent overfeeding the remaining fruits.

Application of Antitranspirant

- The application of reflective materials can be an effective method to reduce the risk of sunburn in fruit crops.
- Reflective materials help redirect sunlight away from the fruit or reflect excess heat, minimizing the potential for sunburn damage.

Factors of Antitranspirant

Heat reduction:

- Reflective materials, such as reflective films or coatings, can help reduce the buildup of heat around the fruit.
- These materials reflect a portion of the sunlight and prevent it from being absorbed by the fruit.
- By reducing heat accumulation, the risk of sunburn decreases.

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Light diffusion:

- Reflective materials can also help diffuse sunlight, spreading it more evenly throughout the canopy.
- This helps prevent hotspots and provides a more uniform light environment for the fruit.
- Uniform light distribution supports balanced fruit development and reduces the likelihood of sunburn on specific areas of the fruit surface.

Application of Antitranspirant

UV radiation reflection:

- Some reflective materials have the ability to reflect ultraviolet (UV) radiation, which can contribute to sunburn development.
- By reflecting UV rays, these materials provide an additional layer of protection against sunburn damage in fruits with thin or light-colored skins.

Increased light intensity in shaded areas:

- Reflective materials can redirect sunlight towards shaded or less exposed areas of the fruit.
- This can be particularly useful in dense canopies or when there is limited direct sunlight reaching certain parts of the fruit.
- By increasing the light intensity in these areas, reflective materials promote more uniform fruit development and reduce the risk of sunburn.

Cultivar selection for managing the sunburn effect in fruit crops

- Cultivar selection plays a significant role in managing the risk of sunburn in fruit crops.
- Choosing cultivars that are naturally more tolerant to sunburn can help minimize sunburn damage.
  - **Skin thickness and color:** Fruits with thicker and darker-colored skins generally have better natural protection against sunburn.
  - **Epidermal characteristics:** Consider cultivars that have specialized epidermal features, such as a waxy cuticle or dense trichomes (hairs) on the fruit surface.

Cultivar selection for managing the sunburn effect in fruit crops

- ✓ **Canopy density and leaf coverage:** Some cultivars naturally have a more compact growth habit or denser foliage, which can provide better shade and protection to the fruit.

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- ✓ **Adaptation to local conditions:** Choose cultivars that are well-adapted to your specific growing region and its climatic conditions.
- ✓ **Disease resistance**: Sunburn can weaken the fruit's natural defense mechanisms, making it more susceptible to diseases. Consider cultivars that have good disease resistance to minimize the chances of opportunistic pathogens taking hold on sunburn-damaged fruit.

Cultivar selection for managing the sunburn effect in fruit crops

- ✓ **Quality attributes:** While focusing on sunburn resistance, it's important to consider other important fruit quality attributes as well. Look for cultivars that meet your desired taste, texture, size, and other market or culinary requirements.
- ✓ It's worth noting that while cultivar selection can help mitigate sunburn risk, it should be complemented by other management practices, such as canopy management, irrigation, and shading techniques, to provide comprehensive sunburn protection for your fruit crops.

NAU Research

- ➢ Use of SA at 2000 ppm increase the hermaphrodite flower to male ratio, more no. fruits per plant, no. of fruit per tree, TSS, acidity, reducing sugar and last increase the yield of the **mango cultivar Kesar**. (Ngullie*et al*., 2014).
- ➢ The **guava** fruitsbagged with brown paper bag showed the highest carotenoid content (4.07µg/g) and varieties (3.90µg/g) were also affected significantly by the same. They also found the highest pulp color (7.33) and taste score (7.47) when fruits of Kesar variety were bagged in brown paper. (Singh *et al.,* 2017).
- ➢ In **guava** the maximum fruit weight (134.79 and 137.13 kg), fruit length (6.07and 6.22 cm), fruit diameter (6.43 and 6.53 cm), TSS (11.83 and 12.07 ^{o}brix), reducing sugars (6.48 and 6.61 %) and total sugars (8.32 and 8.56 %) at egg stage of fruit bagging with red non-woven bag in guava cv. Lalit. (Sushravya*et al.*, 2022).

Management strategies in fruit crops

- ➢ Use fruit varieties that are more tolerant of sunburn
- ➢ Schedule irrigations to avoid tree water stress
- ➢ Train fruit trees to develop an appropriate canopy
- ➢ Avoid excessive summer pruning and leaf stripping

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- Cover cropping
- Improve air movement through the fruit block
- Over-tree sprinkler cooling systems
- Aerial evaporative cooling
- Hydro-cooling
- Surface evaporative cooling
- Shade netting (Fruit bagging, Particle film, Suppressants, Kaolin based product, Kaolin based product, Talc-based products, Sunscreen)
- Chemical protectants (Ascorbic acid, Ascorbic acid, Anti-transpirant)

Future thrust

In the future, research and development efforts in sunburn management in fruit crops could focus on the following areas:

- Understanding underlying mechanisms
- Genetic improvement
- Advanced protective materials
- Precision agriculture technologies
- Climate adaptation
- Sustainable practices
- Economic assessment
- Collaboration between researchers, growers, and industry stakeholders is crucial to address the future challenges associated with sunburn management in fruit crops.

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