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Heat-Proof Orchards: Strategies to Protect Fruit Crops from Extreme Temperatures

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Climate change has led to an increase in extreme heat events, posing a significant threat to fruit orchards worldwide. Heat stress disrupts critical physiological processes in fruit crops, resulting in reduced yields, lower fruit quality, and substantial economic losses. The impact of high temperatures on fruit trees presents challenges but also opens the door to various heat-proofing strategies. These include selecting heat-resistant varieties, optimizing canopy management, applying mulching techniques, improving irrigation practices and utilizing modern cooling technologies. By integrating these strategies, orchardists can enhance resilience to heat stress and ensure sustainable fruit production in the face of a warming climate.

Keywords: Fruit orchards, Heat stress, Climate resilience, Heat-proofing strategies

Introduction

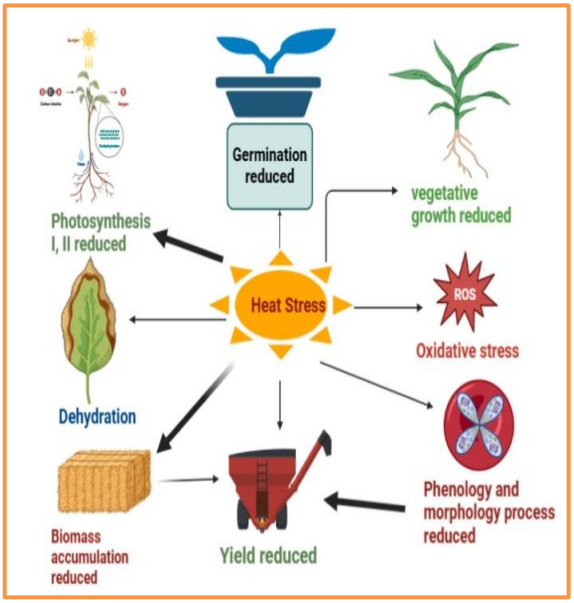
Climate change has significantly altered global weather patterns and extreme heat events are becoming more frequent and intense, particularly during summer months. The increased frequency and intensity of high heat events, posing considerable challenges to fruit growers. Rising temperatures affect fruit crops by interrupting important physiological systems, resulting in lower yields, poor fruit quality and financial losses for producers. Heat stress can jeopardize the survival of entire orchards in areas where temperatures have already reached the maximum limits of crop tolerance.

High temperatures, especially during important growth stages like flowering and fruit development, can cause reduced fruit set, sunburn, and premature fruit drop. Furthermore, heat stress exacerbates water scarcity issues, necessitating effective irrigation measures. As the world climate changes, the implementation of effective heat-proofing techniques becomes critical to preserving the long-term viability of fruit orchards. This research investigates several adaptive approaches, such as cultivar selection, shading tactics, soil moisture management, and advanced cooling technology, to assist reduce the effects of high temperatures on fruit harvests.

The impact of extreme heat on fruit crops

Extreme heat, particularly heatwaves, can be damaging to fruit plants. Temperatures that surpass optimal development thresholds affect physiological functions like photosynthesis, respiration and transpiration. Temperatures above 35°C (95°F) can harm most fruit trees, resulting in lower fruit set, poor fruit quality and crop loss. Apple orchards, for example, exhibit diminished fruit set and poor fruit quality when temperatures rise beyond 30°C (86°F) during blooming and fruit-setting. Similarly, stone fruit crops such as peaches, cherries and plums are extremely heat sensitive, especially during the flowering stage, when high temperatures can result in flower abortion or impaired leaf/fruit development. This is especially important in locations where temperatures are already insufficient for fruit

cultivation. Additionally, prolonged heat stress during the fruit ripening period can lead to sunburn, cracking, and premature fruit drop. Not only does this reduce the quantity and quality of the harvest, but it also affects the financial viability of orchard operations.



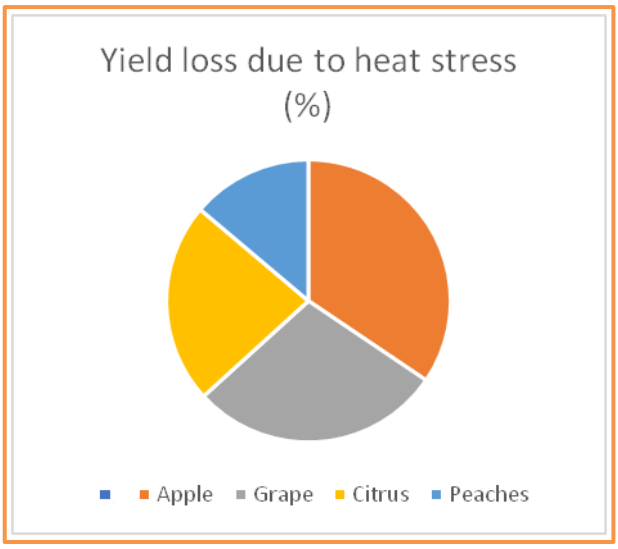
Why Extreme Heat Hurts Fruit Crops: Fruit trees are sensitive to temperature changes. When temperatures rise above the normal range for a particular fruit crop, it can disrupt their growth and development. High heat can:

- **Reduce fruit set**: Extreme heat during flowering can prevent flowers from setting into fruit.
- **Cause sunburn**: Direct sunlight on fruit can lead to sunburn, causing unsightly blemishes or even fruit loss.
- **Reduce fruit quality**: High temperatures can cause fruits to ripen too quickly, leading to poor taste, smaller size, or premature fruit drop.
- **Cause water stress**: Heat increases evaporation, causing soil moisture to decrease faster and stressing the plant's ability to take up water.

(Sher, Alam *et al.* 2024)

For small farmers, these impacts can be devastating, especially when crops like apples, peaches, or grapes are their primary source of income.

Heat stress and the economics of fruit production



The economic impact of heat stress on fruit crops is significant. According to the Intergovernmental Panel on Climate Change (IPCC), extreme weather events may cause a 10-20% drop in worldwide agricultural productivity by 2050. Fruit orchards are especially vulnerable since their production cycles are sensitive to seasonal temperature changes. According to research undertaken by the University of California's Agriculture and Natural Resources division, heat stress can impair output by up to 30-50% in certain fruit crops such as cherries, apples and grapes. This decrease in productivity concerns not only food security but also the livelihoods of orchard farmers. The economic consequences of these losses can be severe, especially for smallholder farmers who depend on these crops for their income.

Heat-proofing strategies: mitigating the impact of extreme temperatures

To protect fruit crops from the harmful effects of heat, numerous measures can be used to preserve orchards from excessive temperatures. These solutions range from crop management approaches to technological treatments that can reduce heat stress and increase resistance.

Choosing the Best Heat-Resistant Varieties Based on Agro-Climatic Zones: Selecting heat-tolerant varieties is essential for sustaining fruit production in different agro-climatic zones. In tropical and subtropical regions, mangoes (Kesar, Langra), citrus (Valencia orange), and bananas (Dwarf Cavendish) exhibit strong heat resilience. Temperate zone crops like

apples (Anna, Dorsett Golden), cherries (Bing, Lapins), and grapes (Thompson Seedless) require heat adaptation strategies such as shade management and heat-tolerant rootstocks. In arid and semi-arid regions, olives (Arbequina), pomegranates, and date palms thrive due to their natural drought resistance. Efficient irrigation methods like drip irrigation further enhance heat resilience across all zones. By selecting the right varieties, farmers can significantly reduce the risks of heat stress. It's important to consult with local agricultural extension services to identify the best varieties for specific regions.

Fruit	Yield loss due to heat stress (%)
Apple	30
Grape	25
Citrus	20
Peaches	12

Shade and Canopy Management: One of the most effective ways to protect fruit crops from excessive heat is by providing shade. This can be achieved through several ways by which farmers can create shade for their orchards:

- **Shade Nets**: Shade nets are an affordable and effective solution to protect fruit trees from intense heat. They reduce sunlight by 30% to 50%, lowering temperatures by 5 to 10°C. These nets are often available in local markets and are relatively easy to install. They can be placed over the orchard or on individual rows, depending on the layout.
- **Tree Pruning**: Regular pruning of trees to maintain a balanced canopy can help reduce heat stress. Pruning allows more air to circulate around the trees, which can help cool down the orchard and reduce humidity. It also encourages better sunlight penetration, leading to more even fruit ripening.
- **Intercropping**: Growing tall crops like sunflowers, corn, or beans between fruit trees can provide additional shade and help reduce heat stress for fruit crops. These plants also improve soil health and increase biodiversity in the orchard.

Mulching and Soil Moisture Management: Mulching is another valuable strategy for protecting fruit crops from heat stress. Applying organic mulches like straw or wood chips around the base of trees helps retain soil moisture, reducing evaporation during hot periods. It also regulates soil temperature, preventing it from becoming too hot or too cold, which can affect root growth and nutrient uptake. It offers several benefits:

- **Maintains Soil Moisture**: Mulch helps reduce the rate at which water evaporates from the soil. During hot periods, this helps keep the roots of the trees hydrated, which is crucial for their overall health and productivity.
- **Regulates Soil Temperature**: Mulch acts as an insulating layer that keeps the soil cooler during hot weather and warmer during cooler periods, helping stabilize the environment around the tree roots.
- **Reduces Weeds**: Weeds compete with fruit trees for water and nutrients. Mulch helps suppress weed growth, ensuring that trees have more resources to cope with heat.

Selective Breeding and Heat-Tolerant Varieties: One long-term solution to heat stress is to develop heat-tolerant fruit cultivars. Researchers are increasingly interested in creating crops that can survive in warmer regions. For example, developing drought-resistant apple types or heat-tolerant grapevines can help orchards remain productive in the face of rising temperatures. Several breeding projects have successfully generated high-temperature-tolerant peaches, plums, and citrus fruits. These types are not only more heat-tolerant, but they also have higher disease resistance, which is useful for regulating orchard health throughout the warmer months.

Judicious & efficient Watering: Water is the most critical resource during periods of extreme heat. Small farmers must ensure that their orchards are adequately watered to withstand high temperatures. Here are some simple, effective irrigation techniques:

- **Drip Irrigation**: it is efficient and conserves water by sending it directly to the tree's base. This strategy reduces water waste through evaporation and guarantees that the roots receive the moisture they require during hot weather.
- **Watering Early or Late in the Day**: Watering during the hottest part of the day may cause evaporation before the trees can absorb it. Watering in the early morning or late evening ensures that the water reaches the roots without being lost due to heat.
- **Deep Watering**: promotes deep root growth and allows trees to absorb moisture from lower soil layers, especially during heatwaves.

Low-cost Cooling Systems: Investing in automated cooling systems, such as evaporative or misting systems, can help combat high heat, especially during the fruit ripening season. By spreading fine mist over the orchard, these devices can lower the ambient temperature by several degrees, creating a more suitable environment for fruit growth.

- **Evaporative Cooling**: Sprinkling water in the orchard in the early morning or late evening might provide a cooling effect. The water evaporates and cools the surrounding air, providing some comfort during heatwaves. However, it is important to employ this technique carefully to avoid water waste and ensure that the soil does not get too saturated.
- **Misting**: modest-scale farmers can install low-cost misting systems, either manually or with modest pumps, to lightly spritz water over their orchards. This helps to cool the air and reduces the impact of excessive heat on fruit crops. Misting is most effective during the hottest parts of the day, especially in areas with little humidity.

While these systems can be costly to install and maintain, they are increasingly being used in high-value crops like grapes and citrus to ensure consistent fruit quality and higher market prices. Misting systems can reduce fruit damage caused by sunburn and increase overall yields by improving fruit ripening under extreme heat conditions.

Crop Monitoring and Climate Adaptation Models: Technological advancements have enabled real-time monitoring of orchard conditions. Temperature sensors, soil moisture sensors, and weather forecasting technologies let farmers make data-driven irrigation and pest management decisions. Farmers can use climate adaptation models to predict heat stress and schedule interventions appropriately, lowering the risk of crop failure and yield loss. Climate-smart farming practices are becoming increasingly popular. Farmers that adopt such tactics can make informed judgments based on accurate weather forecasts and local climate predictions, allowing them to prepare their orchards ahead of excessive heat occurrences.

The Road Ahead: Building Resilient Orchards

As global temperatures rise, orchardists must adopt new ways and technologies to combat heat stress. Traditional farming practices, including as canopy management and mulching, will be combined with modern technologies, such as automated cooling systems and data-driven climate adaption tools, to ensure that orchards remain resilient in the face of high temperatures. In the coming decades, the use of heat-tolerant fruit varieties and climate-smart methods will become increasingly important. These measures, together with continued research and innovation, will assist orchardists in protecting their crops, ensuring food security, and preserving the economic sustainability of fruit production in a warming world.

Conclusion

As climate change worsens, the frequency and severity of high heat events become a serious threat to fruit orchards globally. Rising temperatures impair important physiological processes in fruit trees, resulting in decreased fruit set, poorer yields, and compromised fruit quality. The economic impact of heat stress is especially severe for smallholder farmers, whose livelihoods rely on stable and productive orchards. To address these difficulties, orchardists must take a multifaceted approach that includes both classic and current heat-proofing methods. Selecting heat-tolerant types, employing efficient irrigation procedures, using shading strategies, and mulching are all important factors in minimizing the effects of high temperatures. Furthermore, developing technologies such as climate-smart monitoring

systems, evaporative cooling, and precision agriculture tools offer novel approaches to improving orchard resilience.

References

1. Bhattacharjee, Panchaal & Warang, Omkar. 2022. Impact of Climate Change on fruit crops: A review. *Current World Environment, 17(2), 319*
2. Haider, Saqlain, Raza, A., Iqbal, J., Shaukat Muzaffar and Mahmood, Tariq. 2022. Analyzing the regulatory role of heat shock transcription factors in plant heat stress tolerance: A brief appraisal. *Molecular Biology Reports, 49(6), 5771-5785*
3. Hannam, K. and MacDonald, J. .2023. Tools for climate resilience in tree fruit II: a calcium carbonate-based foliar spray showed potential for protecting fruit quality during an unprecedented heat event. *Canadian Journal of Plant Science*, 103(2)
4. Hasan, M.M., and Shanmugam, V. 2020. Impact of Heat Stress on Crop Yields and Economics Losse. *Environmental Research Letters*, 15(3)
5. Fiore, A., Lardo, E., Montanaro, G., Laterza, D., Loiudice, C., Berloco, T., Dichio, B. and Xiloyannis, C. .2018. Mitigation of global warming impact of fresh fruit production through climate smart management. *Journal of Cleaner Production*,172: 3634-3643
6. Moriondo, M., et al. 2011. Impact of climate change on the yield of major crops in the mediterranean region. *Climate Research*, 44(3), 147- 165
7. Nath, V., Kumar, G., Pandey, S.D., Pandey, S. 2019. Impact of climate change on tropical fruit production systems and its mitigation strategies. In: Climate change & agriculture in India: Impact and adaptation. *Cham: Spinger*; 129-146
8. Sher, Alam *et al.* 2024. Heat stress effects on legumes: Challenges, management strategies and future insights. *Plant Stress.* Vol. 13.
9. Sundarrajan, R., Rajangam, J., Saraswathy, S., Gnanasekaran, M., Rajesh, S., Anitha, T., Muthuramalingam, S. and Sankar, C. .2025. A comprehensive review on impact of climatic change on adaptability and mitigation in fruit crop. *Plant Science Today*, 12(1), 2348-1900