

## Special Article - Drought Tolerance

# Shade Screen and Citriculture

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## Abstract

Sustain citriculture faces various environmental challenges like rising temperature, increase solar radiation, and warm nights during flower bud induction, particularly in arid and semiarid regions. Shading net represents an intermediate solution to maintain the growth and productivity of citrus trees under fluctuation in climate conditions. Shading techniques protect plants from different biotic and abiotic stresses, by modifying the microclimate around the trees. Numerous benefits of shading net include reducing leaves temperature and decreasing light intensity, particularly at midday in the summer season, improving tree vigor, reduce physiological disorder and enhancing fruit quality.

**Keywords:** Arid regions; Citrus; Fruit quality; Rising temperature; Shading net

## Background

There are negative impacts of abiotic stress on citrus trees due to fluctuation in environmental conditions, particularly increasing solar radiation, rising temperature, and warm nights. Usually, citrus trees are grown in the open fields under full sunlight conditions. While rising temperature and increasing solar radiation particularly in arid and semi-arid, represent more challenges facing citrus growers due to their different negative impacts on citrus growth and productivity [14].

There are various environmental factors threatening citrus growers and affecting the sustainability of citriculture, that include higher temperature, excessive solar radiation, reduced rainfall, raised carbon dioxide (CO<sub>2</sub>) levels,...etc. Currently, there is more interest in using shade screens in citrus orchards, particularly, in the arid and semiarid regions such as the Mediterranean area to protect the trees and improve fruit quality [11].

There are negative influences of excess solar radiation and rising temperatures on trees, such as increased water shortage, and diminished light-use efficiency, which causes a reduction in CO<sub>2</sub> assimilation, tree vigor, and crops [7]. Therefore, protecting fruit orchards from the fluctuation of climate conditions is considered a serious challenge for fruit producers worldwide. Shading net is considered a novel technique to reduce the negative impacts of excessive environmental conditions in fruit orchards and enhancement microclimate around the trees. It could use in different ways, closed shading, partial shading, and periodically shading during hot summer [13].

## Temperature Requirement for Citrus

Citrus as a subtropical crop needs moderate temperature above 12.8°C and not exceeding 35°C to grow and produce economic yield. Citrus could grow in different climatic regions except for frozen ones. Currently, both the Mediterranean climate and region are considered the most suitable for achieving the best growth and productivity of citrus.

Currently, the main cultivation area for Citrus is in warm regions

from tropical to arid regions. It could grow in varied temperatures from 10°C to 35°C, while flushes start at 12.8°C and accelerate growth up to 35°C, while, rising temperature more than 35°C inhibit growth until stopped at 45°C, furthermore, the excessive temperature of about 50°C kill new shoots and small fruits [1].

## Some Environmental Challenges for Citrus Growers

Under field conditions, citrus trees are subjected to various abiotic stresses that have negative impacts on the vegetative growth, yield, and fruit characteristics of different fruit orchards in different climatic regions.

The main environmental factor that inhibits the growth and productivity of citrus are considered as follow:

### Rising Temperature

Continuous increase of temperature particularly in extremely hot summer has harmful effects on various crops. In citrus orchards, increased air temperature than 35°C inhibits growth and demolishes chlorophyll, increases fruit abscission, produces poor fruits, and reduces yield [1,6].

### Warm Nights during winter and spring

The chilling requirements of citrus are very low compared to deciduous trees, with flower induction occurring during winter after meeting their chilling requirements during the period (from mid-December to mid-January) approximately.

Warm nights as a symptom of climate change during winter affect negatively on flower induction and fluctuate flowering and fruit set which could reduce tree yield [10].

There are various negative impacts of warm nights particularly during winter on citrus trees as follows:

- Constrain flower induction
- Decrease flowering buds.
- Delay bud-break.
- Alter the flowering stage.



Figure 1: Field image of Lemon trees in South Egypt desert [1].

### Excessive Soil Radiation

Due to fluctuation in climate conditions, there is an increase in solar radiation, which increase evapotranspiration and affect negatively tree vigor (Figure 1), which increase physiological disorder such as fruit sunburn, particularly in some mandarin cultivars, and increase fruit cracking, which affects negatively fruit quality [8].

Therefore, shading net could be an emerging technique to sustain citrus orchards by enhancing vegetative growth, yield, and fruit quality [1].

### Heatwaves

Flowering and fruit set are very sensitive stages in citrus orchards and play the main role in determining tree yield. Therefore, heatwaves during those stages particularly in arid and semiarid regions considered the main threat to citrus [1]. Heatwaves cause a serious problem for citrus growers by minimizing yield and injuring fruit quality. Shading net reduces the negative impacts of heatwaves and improves fruit quality.

### Kinds of net shading

The efficiency of shading materials depends on their ability to protect trees by controlling solar radiation, decreasing the negative effects of rising temperature, improve the microclimate around trees.

There are various materials used in shading fruit orchards as follows:

- Reflective aluminized nets.
- Aluminized-plastic net.
- White shade nets
- Photo-selective nets.

## Why do we Need Shading in Citrus Orchards?

Plants in arid regions are subjected to rising temperatures and high solar radiation, so, it is required more irrigation water to produce economic yield. Therefore, the shading technique represents a great solution to reduce water evaporation, sustain plant productivity, and enhance water use efficiency.

There are positive impacts of shade screens on various parameters of tree vigor and productivity, particularly under arid conditions.

Net shading protects trees from various biotic and abiotic stresses like rising temperature, higher solar radiation, insects, as well as heatwaves [9]. Shading materials scatter high waves of solar radiation, modify the spectrum, and reduce leaf temperature [5].

Furthermore, there are positive impacts of shading on the fruit quality of citrus trees [4].

Shading net reduces transpiration rate in lemon trees and influences stomata conductance [12]. Shade net reduces citrus leaves' temperature than leaves under open field conditions [7].

Shading net reduces transpiration rate in lemon trees and influenced stomatal conductance. Under drying environmental conditions like semi-arid and arid environments, shading net is considered an intermediary solution to improve plant growth under water stress and increase water use efficiency [12].

Shading net redistributes solar radiation more efficiently and reduces its impact by providing an appropriate range of moisture around the plant, which reduces the rate of environmental evaporation.

## Benefits of Shading in Citrus Orchards

Shading net in fruit orchards provides multiple positive effects through modified microclimate around trees, reduced consumption of irrigation water because of reducing evapotranspiration, and increase profitability of citrus growers.

There are various positive effects of shading net on tree vigor, yield, and fruit characters, compared with fruits under open field conditions.

- Decrease leaf temperature.
- Reduce light intensity, particularly in the hot seasons.
- Increase water-use efficiency.
- Increase tree vigor.
- Enhancing fruit quality.

## Conclusion

Under extreme weather conditions and water scarcity in arid regions, shading net could play an important role in modifying environment conditions around the trees, decreasing transpiration, and improving water use efficiency, consequently, enhancing trees' productivity and increasing growers' profitability.

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