Physiology and productivity of Tango mandarin in response to sustained water limitation and synthetic mulching

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Introduction

Water limitation is one of the serious concerns of worldwide citrus production areas, including California. In the present research, we attempted to study the effect of the sustained water limitation on citrus trees' physiology and productivity and the possibility of using synthetic ground mulching to alleviate its impact.

Objectives

The goal was to identify the physiological and morphological responses of citrus trees to long-term water limitation and test the effect of synthetic mulching on this response.

Materials and Methods

A field trial was conducted to test the effect of long-term water limitation on the physiology and productivity of citrus trees and the effect of some ground mulching materials on tree response to water stress. The study was started in 2019 using ten-year-old Tango mandarin trees grafted on Carrizo rootstock located at Lindcove Research and Extension Center, Exeter, CA. Trees were exposed to a limited irrigation schedule reducing the water to 50%. Full irrigated trees received 4-acre foot water per acre and trees irrigated with a limited irrigation schedule received 2-acre foot water per acre of land. Two different mulching materials were used, white woven and metalized polyethylene mulch. Mulching was applied close to the trunk and 6 feet from each side of the tree (Figure 1). To be able to install the mulching deep root irrigation system was used in these treatments.

No mulch **Metalized mulch** **Woven white mulch**

Figure 1. Different mulching materials were applied on Tango mandarin.

Results

Sustained water limitation resulted in a reduction of the tango mandarin tree yield, however, this effect was significant in the third year of treatments (Figure 2A). Average fruit weight was reduced starting from the first season; however, the reduction was more significant as well during the third season (Figure 2B). The number of fruits per tree was reduced by the third season only and both mulching improved it (Figure 2C).

Results

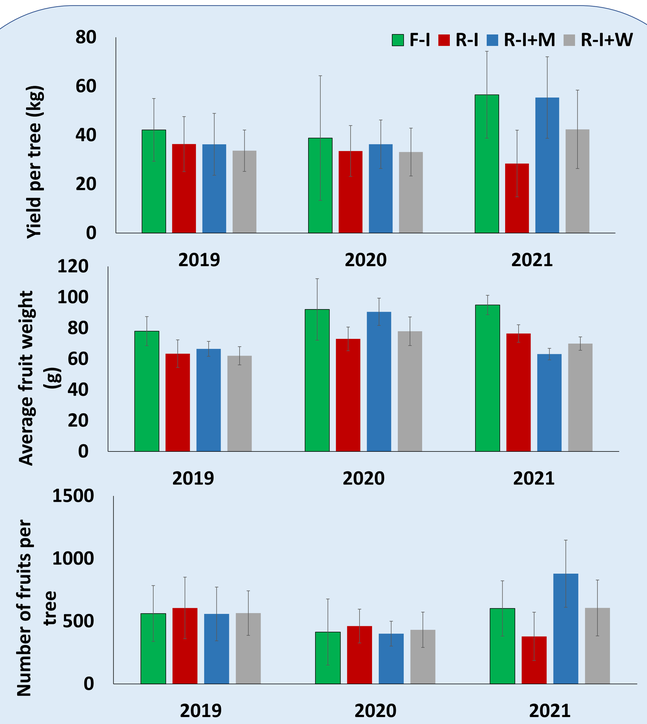
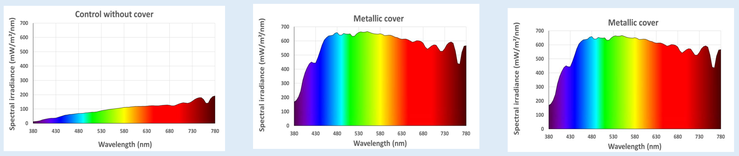


Figure 2. Yield (A), fruit weight (B), and fruit number (C) of Tango mandarin in response to water limitation, F-I (full irrigation), R-I (reduced irrigation), R-I+M (reduced irrigation plus metalized mulch) and R-I+W (reduced irrigation plus white mulch).

Light reflection from the ground data showed that mulching altered the light spectrum surrounding the trees (Figure 3). That could affect tree physiology and improves fruit set resulting in a higher number of fruits per tree.



No mulch **Metalized mulch** **Woven white mulch**

Figure 3. White and metalized mulch improves the light spectrum surrounding the tango mandarin trees. Light spectrum reflection was measured using MAVOSPEC Base Spectrometer.

Water limitation resulted in a higher leaf transpiration rate and mulching reduced that effect significantly (Figure 3). Tree size was also reduced by the water limitation, however, non of the mulching material alleviate that effect (Figure 4).

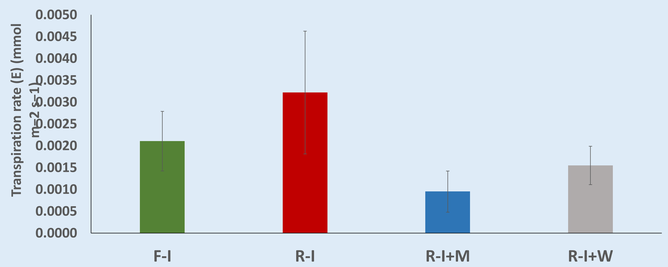


Figure 3. Tango mandarin leaf transpiration rate in response to water limitation and mulching during 2020/2021 season.

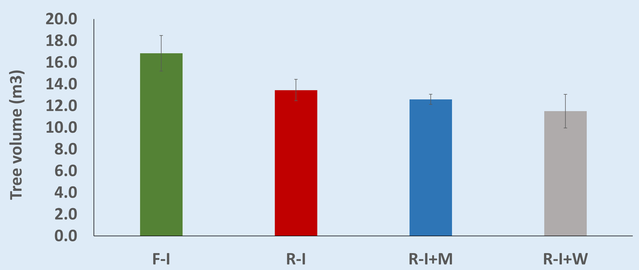


Figure 4. Tango mandarin tree size in response to water limitation and mulching during 2020/2021 season.

Various plant hormones synthesize in response to drought stress and manage processes related to drought tolerance mechanisms, the results showed that the limited supply of water triggers the accumulation of various hormones (Fig.5).

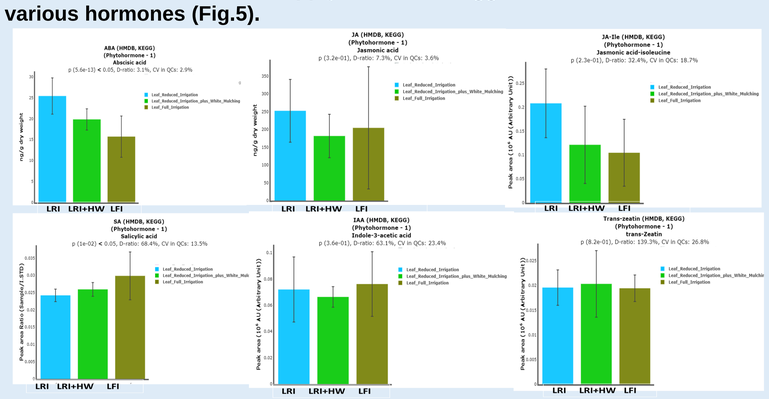


Figure 5. Response of phytohormones to water limitation and mulching

A limited supply of water initiates the biosynthesis of different types of protective secondary metabolites (SMs). SMs provide multi-stress tolerance, including abiotic and biotic stresses. The results show an increase in SMs accumulation under stress in leaves and fruits (Fig.6 & 7).

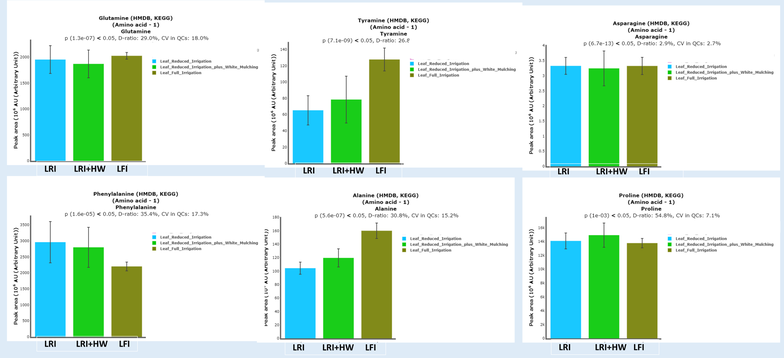


Figure 6. Response of secondary metabolites to water limitation and mulching

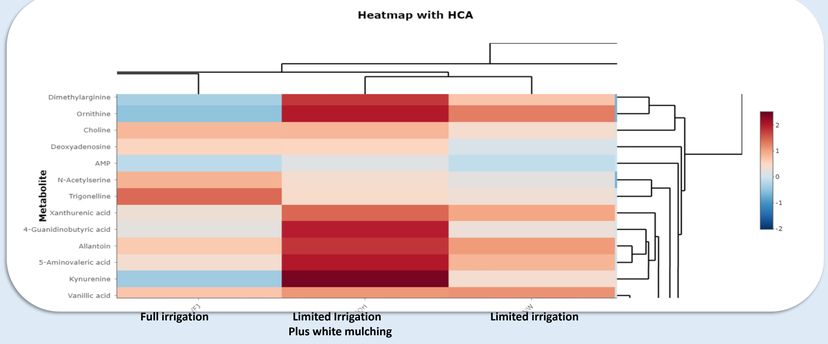


Figure 7. Leaf primary metabolites in response to water limitation and mulching

Conclusion

- **Water limitation reduced tang tree volume, however, the synthetic mulcting did not increase it.**
- **Mulching was able to reduce the increase of leaf transpiration and temperature case by water limitation.**
- **Water limitation reduced the yield and number of fruits per tree, however, the effect was more obvious during the third year of the study.**
- **Mulching was able to alleviate the negative effect of the water limitation on the number of fruit per tree and yield.**
- **Metabolomic data showed that water limitation impacted several components of the antioxidant system and mulching was able to alter this impact.**
- **We identified a number of metabolites that could be tested in the field to alleviate the water stress in tango, however, more studies are in need to translate this data into field recommendations.**