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Impact of Water Deficit on Tomato Fruit Growth and Quality depends on the fruit developmental stage

Ripoll Julie^{1,2}, Urban Laurent², Brunel Béatrice¹, L'Hôtel Jean-Claude.¹ and Bertin Nadia¹

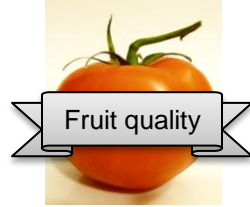
1. Plantes et Systèmes de Culture Horticoles (UR1115) - INRA PACA, France

2. Laboratoire de Physiologie des Fruits et Légumes (EA4279) - Université d'Avignon et des Pays du Vaucluse, France

E-mail: laurent.urban@univ-avignon.fr

www.ihc2014.org

Introduction & Objectives



- **Climate change** has a significant and increasing impact on water resources. **Controlled water deficit (WD)** may be a good alternative to current practices, to increase water use efficiency of horticultural crops, like **tomato** which is the second vegetable eaten up in the world.
- WD is known to **improve fruit quality** but at the price of a **reduction of yield** (Barbagallo *et al.*, 2013). A **better understanding and quantification of the plant and fruit responses to WD** could help finding **compromises between fruit quality and yield under water deficit** (Ripoll *et al.*, 2014).
- **Fruit development includes 3 main phases: cell division, cell expansion and ripening.** Few studies investigated the effect of WD applied at specific stage of tomato development, and they mainly concerned the ripening stage (Veit-Köhler *et al.*, 1999).
- In this experimental approach, a moderate water deficit was applied during the three fruit development stages of two contrasted tomato (*S. lycopersicum cerasiforme* L.) genotypes, with the objective of reducing water consumption and preserving yield.

Materials and Methods

- **Genotypes:** **Plovdiv XXIVa** and **LA1420** were selected for their contrasted sensitivity to WD; plants of Plovdiv are more sensitive than LA1420 (unpub. Data)
- **WD:** 5 days before the targeted fruit development stages, we **reduced water supply by 60 %** (Fig. 1). WD was monitored by measurements of soil humidity using a WCM Control (Fig.2, Grodan©)
- **Fruit measurements on mature fruits:**
 - **Water potential** was measured using a WP4C (Fig.3, Decagon©) on cut slices of fruits
 - **Fruit dry matter** content was measured after 3 weeks of drying in an oven at 70°C
 - **Fruit size and weight** were measured directly after harvest; all trusses were pruned when 6 fruits were set
 - **Total sugar content** was measured by HPLC according to the method of Gomez *et al.* (2002).
- **Statistical analysis on R 3.1:**
 - Parametric data (total sugar content and dry matter) were analyzed by **two-way anova** followed by multiple comparison of means (Tukey test; lsmeans package)
 - Non parametric data analysis was performed using the **Kruskal-Wallis test** followed by multiple comparison of means (H test; pgirmness package)

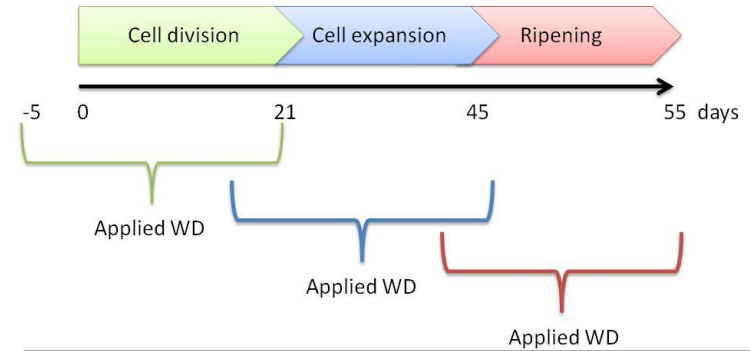


Fig 1: The applied WD during the fruit development stages of tomato, on different trusses for each treatment

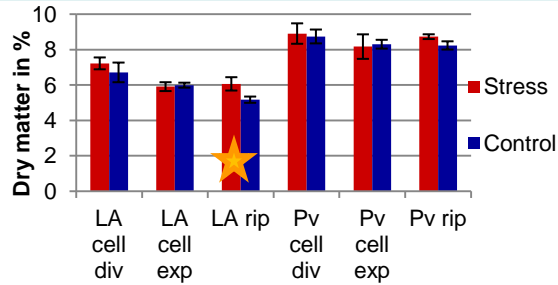
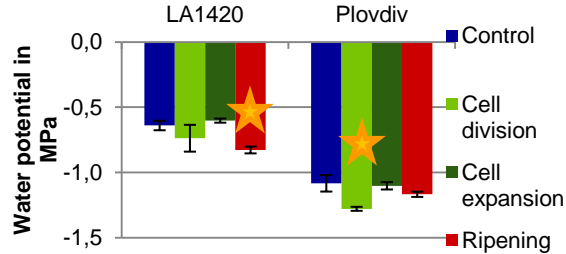


Fig 2: WCM Control device in 4L pot with compost



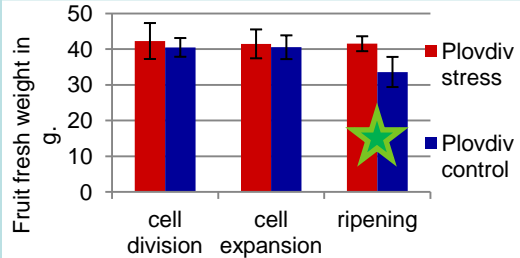
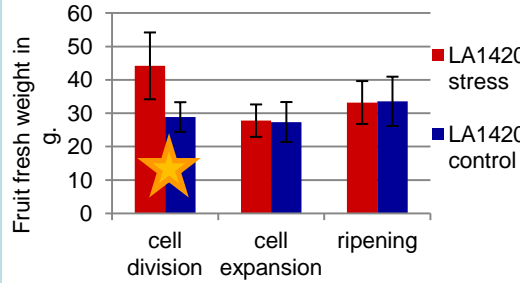
Fig.3: WP4C device with cut slices of mature fruits

Results



Fruit water potential was lower under WD at the ripening stage in LA 1420 and at the cell division stage in Plovdiv

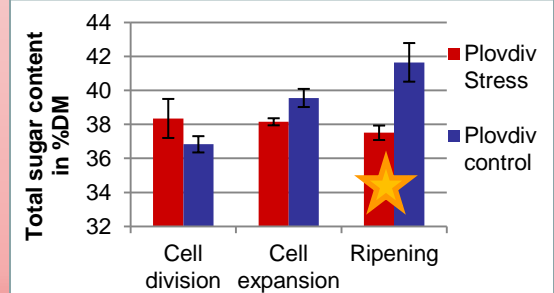
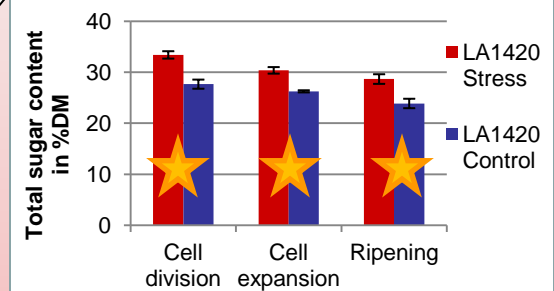
WD significantly increased the fruit dry matter content of LA1420 when applied during ripening.



LA1420 was most sensitive to WD during fruit cell division with an increase in fresh weight, whereas Plovdiv was most sensitive during ripening with a decrease of fresh weight.

Similar results were observed for fruit size when the stress was applied during cell division for LA1420.

Yellow stars correspond to significant differences at $p < 0.05$
Green stars correspond to significant differences at $p < 0.1$



Total sugar content on a dry matter (DM) basis of LA1420 fruits was improved at all stages. Total sugar content was diminished in Plovdiv when WD was applied during ripening.

Similar differences among treatments were observed when sugar content was expressed on a fresh weight basis.

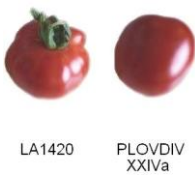
Conclusion

- The different WD treatments permitted to **save 20% of water** when compared to the control.
- **Considering water potential, Plovdiv** was more affected during **cell division** and **LA1420** was more affected during **ripening**.
- Fruit **total sugar content was improved for LA1420 for all treatments**. For **Plovdiv** when the stress occurred during ripening we observed a **decrease in total sugar content**.
- As a conclusion, the response to WD applied during different fruit development stages is **genotype dependant**.
- WD could be applied at a given period of development to improve fruit quality without reducing fruit size as exemplified by LA1420



LA1420	1	2	3
Water potential	-	-	↘
Dry matter	-	-	↗
Fresh weight	↗	-	-
Fruit size (not shown)	↗	-	-
Total sugar	↗	↗	↗
Plovdiv	1	2	3
Water potential	↘	-	-
Dry matter	-	-	-
Fresh weight	-	-	↘
Fruit size (not shown)	-	-	-
Total sugar	-	-	↘

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