Impact of water deficit on tomato fruit quality and growth depends on the developmental stage

Julie Ripoll, Laurent Urban, Béatrice Brunel, Jean-Claude L'Hôtel, Nadia Bertin

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

Ripoll Julie[1,2], Urban Laurent[2], Brunel Béatrice[1], L'Hôtel Jean-Claude.[1] and Bertin Nadia[1]

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
Horticulture–sustaining lives, livelihoods and landscapes
29th International Horticultural Congress 2014

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©)

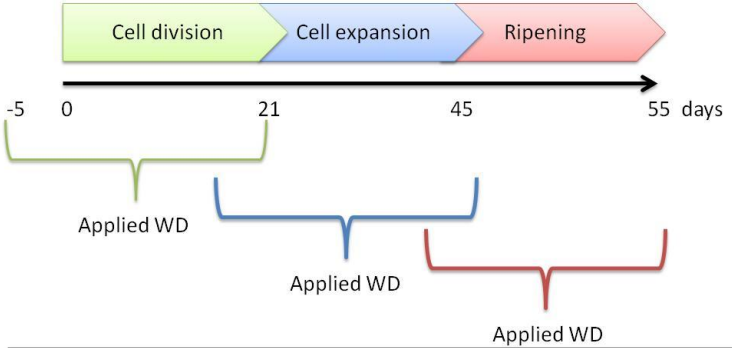


Fig 1: The applied WD during the fruit development stages of tomato, on different trusses for each treatment

- **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)

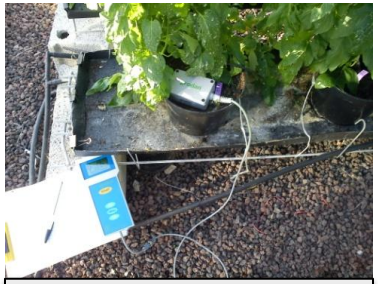
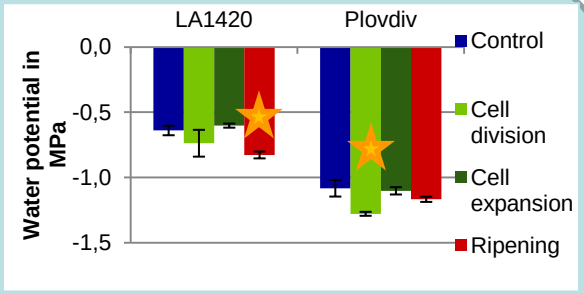


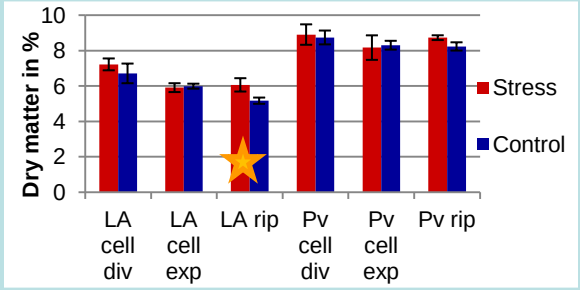
Fig 2: WCM Control device in 4L pot with compost

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

Results

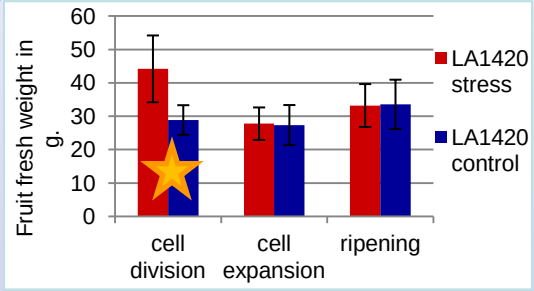
Yellow stars correspond to significant differences at p <0.05
Green stars correspond to significant differences at p <0.1

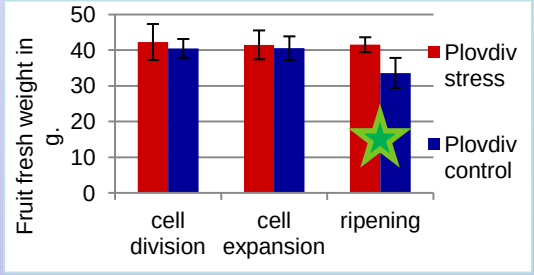




Fruit water potential was lower under WD at the ripening stage in LA 1420 and at the cell division stage in Plovdiv

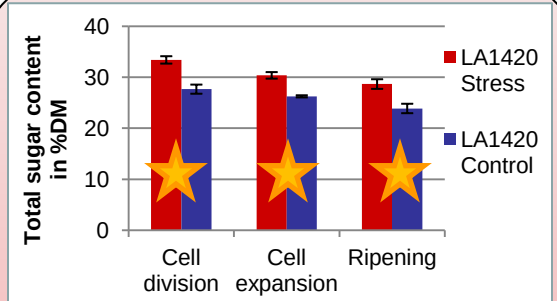
WD significantly increased the fruit dry matter content of LA1420 when applied during ripening.

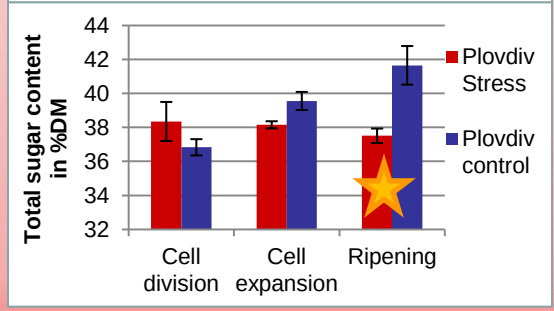




LA1420 was most sensitive to WD during fruit cell division with an increase in fresh weight, whereas Plovdiv was most sensitive during ripening with a decrease of fresh weight.

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



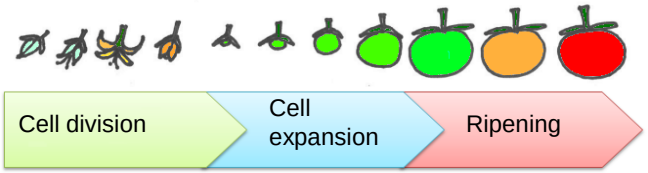


Total sugar content on a dry matter (DM) basis of LA1420 fruits was improved at all stages. Total sugar content was diminished in Plovdiv when WD was applied during ripening.

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	-	-	↘

References

- Barbagallo RN, Silvestro Id, Patane C. 2013. Yield, physicochemical traits, antioxidant pattern, polyphenol oxidase activity and total visual quality of field-grown processing tomato cv. Brigade as affected by water stress in Mediterranean climate. *Journal of the Science of Food and Agriculture 93, 1449-1457*

- Gomez L, Rubio E, Auge M. 2002. A new procedure for extraction and measurement of soluble sugars in ligneous plants. *J Sci Food Agric 82, 360-369.*

- Ripoll J., Urban L., Staudt M., Lopez-Lauri F., Bidel L.P.R., Bertin N. (2014). Water shortage and quality of fleshy fruits – making the most of the unavoidable. *Journal of Experimental Botany, 2014, 1-21.*

- Veit-Köhler U, Krumbein A, Kosegarten H. 1999. Effect of different water supply on plant growth and fruit quality of Lycopersicon esculentum. *Journal of Plant Nutrition and Soil Science 162, 583-588.*

Acknowledgements

- We thank the SFR Tersys for their financial support

tersys
l'intelligence du vivant
structure fédérative de recherche