UNRAVELING ASPECTS RELATED TO TOLERANCE OF TOMATO ACCESSIONS UNDER CADMIUM-INDUCED STRESS

Marcia E.A. Carvalho[1], F.A. Piotto[1], M.R. Franco[1], K.L. Reis[1], A. Cuypers[2], R.A. Azevedo[1]
[1]University of São Paulo, Genetics Department, Piracicaba (SP), Brazil
[2]Hasselt University, Centre for Environmental Sciences, Diepenbeek, Belgium
marcia198811@usp.com

Keywords: oxidative stress; heavy metal; leaf temperature; transpiration, *Solanum lycopersicum*.

Introduction

Understanding the mechanisms related to plant tolerance to abiotic stresses is important so strategies can be adopted in order to maintain or even increase plant productivity under adverse environmental conditions. Contamination of agricultural land by heavy metals has been growing rapidly since the first industrial revolution, especially near urban and industrial centers (Loganathan et al., 2012), where a range of vegetables are commonly grown. However, the amount of crop plant species that have some tolerance degree to cadmium (Cd) is extremely limited. In plants, Cd usually triggers oxidative stress, disturbs nutrient uptake, decreases biomass production and can impairs fruit quality and yield (Gratão et al., 2005; Kumar et al., 2015; Cuypers et al., 2016). In this context, the discovery of tomato accessions tolerant to certain Cd concentrations is a relevant issue (Piotto, 2012). Tomato is the most economically important plant species among vegetables (FAOSTAT, 2016); furthermore, it is also a model plant to be used in research (The Tomato Genome Consortium, 2012). Therefore, the aim of this study was to evaluate Cd effects on tomato accessions with different tolerance level to this heavy metal, in order to find out the main mechanisms responsible for reduced sensitivity to Cd.

Methods

We evaluated 9 tomato accessions: *Solanum pimpinellifolium* (1 - pimp), *S. lycopersicum* var. *cerasiforme* (2 - cer), and some cultivars of *S. lycopersicum* var. *esculentum* (6 - esc) with different tolerance levels (sensitive, semi-tolerant and tolerant) to cadmium (35 µM $CdCl_2$) through physiological parameters. Twenty four-day-old seedlings were exposed to Cd, and after 5 days of the stress onset, we assessed leaf temperature and transpiration. The evaluations were performed during the morning, from 9:15 to 11:25 am, using a porometer. The experiment was carried out in a completely randomized design in a 2 x 9 factorial scheme (presence/absence of Cd *vs* tomato accessions). Data were subjected to analysis of variance ($P<0.05$).

Results

The accession-related factor presented a significant effect on both variables, leaf temperature and transpiration. A tolerant accession (cer1) exhibited the highest mean leaf temperature (24.9 °C), however, it was statistically similar to a sensitive accession (cer2 - 24.4 °C; Figure 1A). These results indicate a probable role of plant breeding/domestication on leaf temperature, since *S. lycopersicum* var. *esculentum* (esc) exhibited the lowest values (from 22.3 to 23.7), when compared to *S. lycopersicum* var. *cerasiforme* (cer). In general, the accessions used exhibited a similar transpiration rate under both, stressful and non-stressful conditions. However, two of the sensitive accessions showed changes due to Cd stress –

transpiration of *S. pimpinellifolium* (pimp) was increased by 22.7%, whereas *S. lycopersicum* var. *esculentum* (esc6) exhibited a decrease of 10.8% in this parameter.

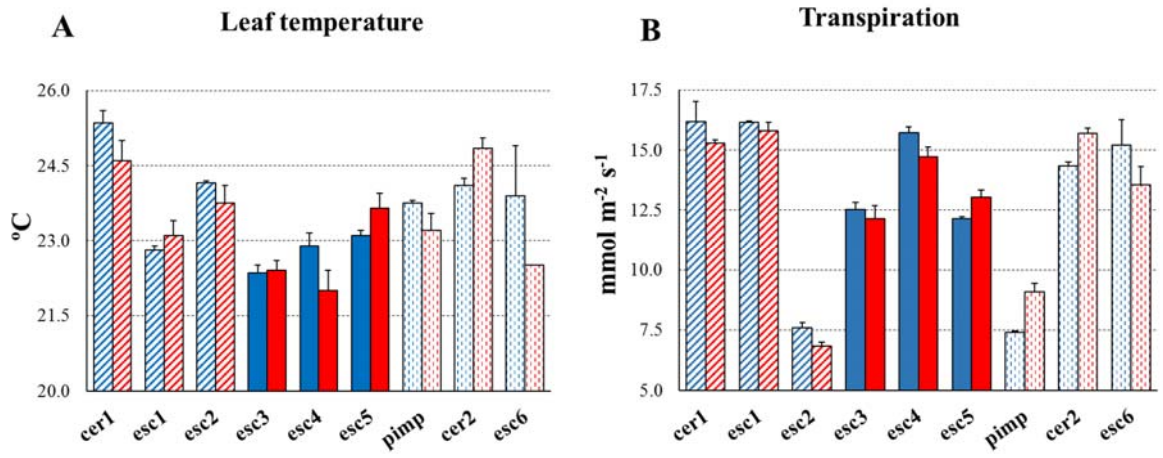

Figure 1. Leaf temperature (A) and transpiration rate (B) of tomato accessions after 5 days in a solution containing $CdCl_2$ (0, blue or 35 µM, red). Crosshatched columns: tolerant accessions; completely filled columns: semi-tolerant accessions; checkered columns: sensitive accessions.

Conclusions

These results indicate a possible role of plant breeding/domestication on leaf temperature. Furthermore, leaf temperature and transpiration are not suitable parameters to be used as indicator of tomato tolerance to Cd-stress.

Acknowledgements

We would like to thank to Fapesp and CNPq for the grant of scholarships and financial support to the research (project numbers: 2009/54676-0, 2013/15217-5 and 2015/26640-1).

References

Cuypers, A.C.; Hendrix, S.; Reis, R.A.; Smet, S.; Deckers, J.; Gielen, H.; Jozefczak, M.; Loix, C.; Vercampt, H.; Vangronsveld, J.; Keunen, E. (2016). Hydrogen peroxide, signaling in disguise during metal phytotoxicity. Front. Plant Sci., 7, 470.

FAOSTAT. Available in: http://faostat3.fao.org/browse/rankings/commodities_by_regions/E. Accessed on: May 24 2016.

Gratão, P.L.; Polle, A; Lea, P.J.; Azevedo, R.A. (2005). Making the life of heavy metal-stressed plants a little easier. *Funct. Plant Biol., 32*, 481-494.

Kumar, P.; Edelstein, M.; Cardarelli, M.; Ferri, E.; Colla, G. (2015). Grafting affects growth, yield, nutrient uptake, and partitioning under cadmium stress in tomato. *HortScience, 50*, 1654-1661.

Loganathan, P.; Vigneswaran, S.; Kandasamy, J.; Naidu, R. (2012). Cadmium sorption and desorption in soils: a review. *Crit. Rev. Environ. Sci. Technol., 42*, 489-533.

Piotto, F.A. (2012). Avaliação de tolerância ao Cádmio em tomateiro (*Solanum lycopersicum* L.). *Ph.D. thesis*, Genetics Department, University of São Paulo, Piracicaba, Brazil.

The Tomato Genome Consortium. (2012). The tomato genome sequence provides insights into fleshy fruit evolution. *Letters to Nature, 485*.