Genetic determinants of response to water deficit in cultivated tomato fruits – QTL x E analysis

Elise Albert, Claire Duffes, Julien Bonnefoi, Justine Gricourt, Yolande Carretero, Esther Pelpoir, Mathilde Causse

Genetic determinants of response to water deficit in cultivated tomato fruits – QTL x E analysis

Albert E., Duffes C., Bonnefoi J., Gricourt J., Carretero Y., Pelpoir E., Causse M.

INRA, UR1052 Génétique et Amélioration des Fruits et Légumes F-84143 Montfavet, France

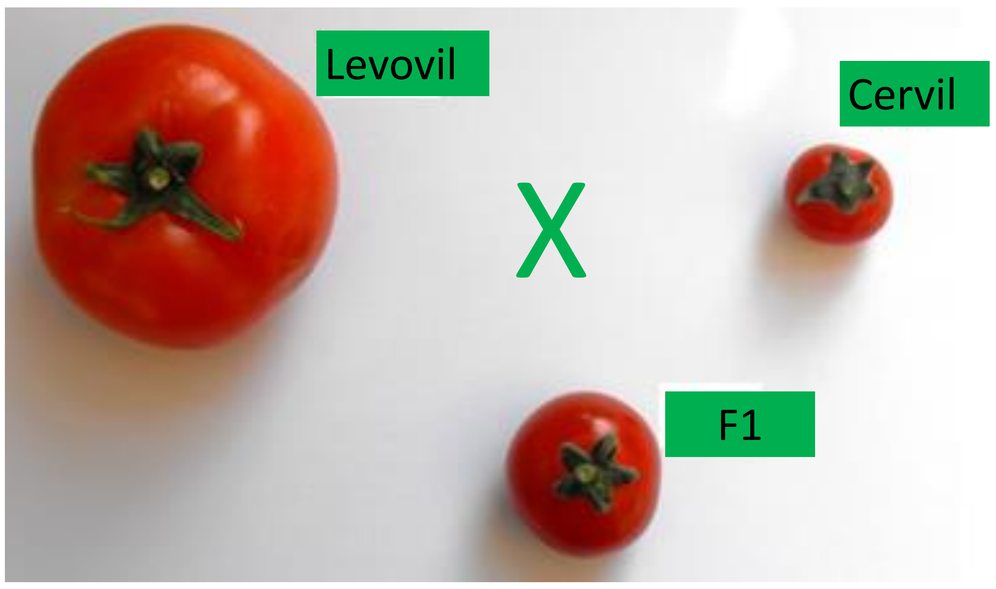
Context

- Tomato, grown in drought areas, **requires a large amount of water** for its production.
- A slight limitation of water input can have a positive impact on tomato **fruit quality** by increasing the concentration in **taste and nutritional compounds.** But the right balance must be found **to limit yield loss**.
- Only a small part of the genomic regions involved in tomato behavior under water deficit (WD) have been identified.

➢ This study aims to i) **describe the pattern of genotype (G) by water regime (WR) interaction** at the phenotypic levels and ii) **reveal the genetic architecture of** response to WD in tomato fruits.

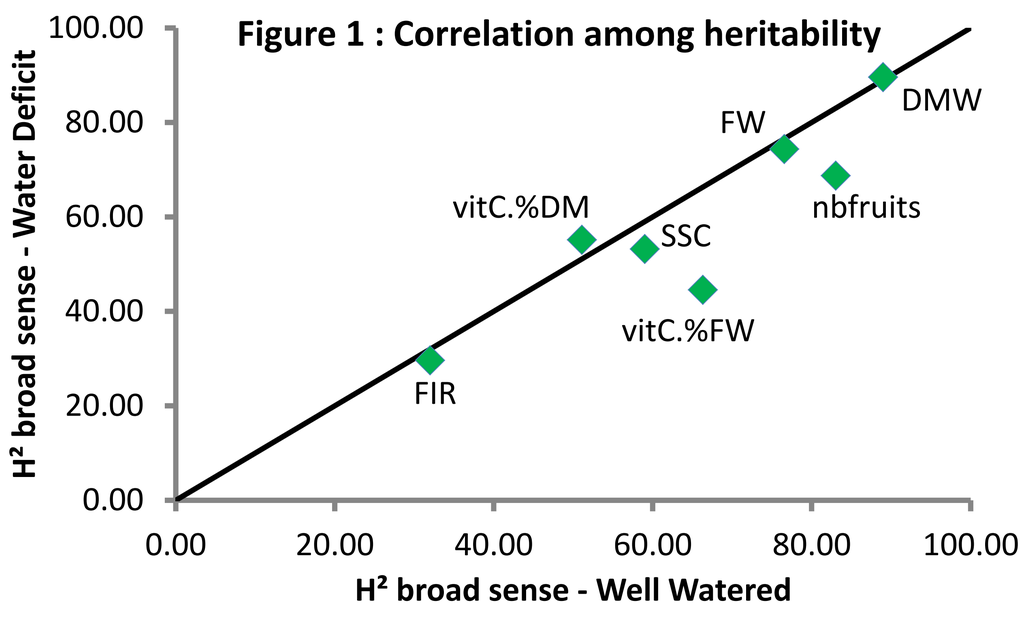
Materials & Methods

- **119 RILs** from a cross between Levovil (sensitive to WD) and Cervil were grown in greenhouse under **two WR** : well watered (WW) and water deficit (WD = 50% WW).
- Fruits were phenotyped for **their number per plant** (nbfruits), **fresh weight** (FW), **firmness** (FIR), **dry matter** (DMW), **soluble sugar** (SSC) and **total vitamin C** (vitC) contents. **Yield** (fruit fresh weight per plant) was estimated as the product FW x nbfruits.
- RILs were genotyped for 501 SNPs covering **98% of the tomato genome**. A QTL analysis was performed using **QTLNetwork-2.0** software, with a **multi-environment analysis approach** ($p < 0.05$ and threshold with 1,000 permutations).



Impact of WR & heritability

- **Strongly significant interactions G x DH** were observed ($p < 10^{-5}$), representing between 6 and 21% of the total SCE and resulting from **rank (~ 90%) and scale changes (~ 10%).**
- High negative correlation between the ratio $(FW_{WD} – FW_{WW})/FW_{WD}$ and FW_{WW} (pearson = -0.49) **indicate higher losses of FW under WD for large fruit genotypes**, mainly due to **important water loss**.
- **Broad sense heritability** per trait and watering regime ranged **from 30%** (FIR) **to 90%** (DMW).
- Heritability among the watering regimes were strongly correlated (0.89), as well as the genetic variance (0.99), suggesting **a conserved genetic variability in the two treatments** [Figure 1].



QTL detection & QTL x WR

- **30 QTL were detected**. They **explained between 2 (FW_{WD} & $yield_{WW}$) and 35 % (FW_{WW})** of the phenotypic variability (PVE).
- **5 QTL showed a significant interaction QTL x WR**, two with **opposite effect** according to the watering regime (for DMW & SSC) and three with **reduced effect** according treatment (Yield and FW) [Figure 2].
- Two different QTL for vitamin C were detected on linkage groups 4 and 8, according the expression of the content in percentage of dry mater weight or fresh mater weight. It suggests that **dilution effect is important in tomato fruit under WD.**

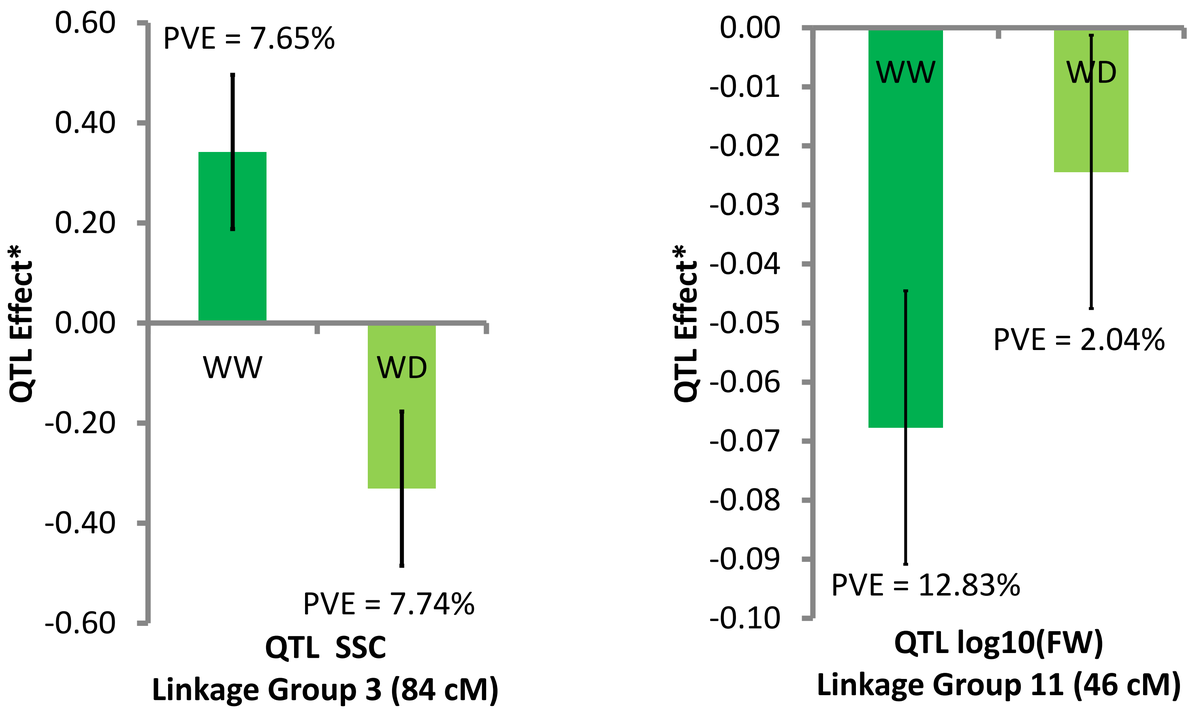


Figure 2 : Two examples of QTL x WR

** QTL effect = (mean allele Cervil – mean allele Levovil)/2*

Conclusion & prospects

- High **genetic variability** for response to WD in tomato
- Important **dilution effect** in tomato fruits under WD
- **20% QTLs** showed significant **interaction with water regime**

➢ Parallel GWAS analysis in the same conditions with a more genetically diversified population

➢ Screen for the underlying genes (RNAseq and gene expression…)

Funding : INRA SCIENCE & IMPACT · CTPS · Agence Nationale de la Recherche ANR