The QualiTom Team
Diversity Quality and Environment of Tomato

fin 2012

Socio-economic rationales and objective

Tomato : an economically important crop

- Grown all over the world countries
- Large consumption all year long *(France ~ 23 kg/y/cap)*
- Very dynamic and competitive breeding sector but for intensive greenhouse production

Tomato : a social demand for quality

Sensory quality : The tomato taste is widely accepted but contested
(consumer preference studies)

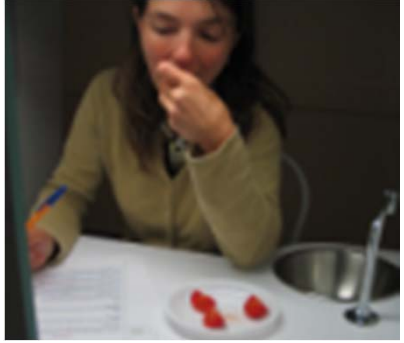
Health value : High content in natural antioxidant compounds *(lycopene & vitamins)*

Fruit quality

Multi-factor : flavor (sugars/acids), aroma and texture, vitamins and 2ary metab.
Highly influenced by environment
Quantitatively inherited

Goal : provide knowledge to create varieties with good quality adapted to low imput conditions

Objectives & approaches



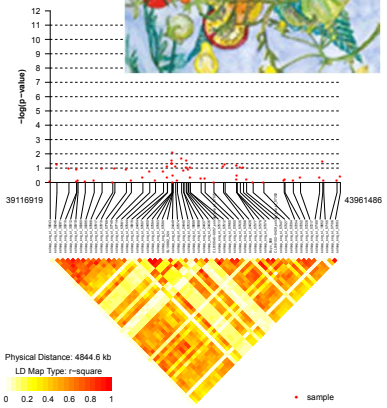
Scientific Objectives :

Identify the genetic, genomic and physiologic factors controlling traits related to sensory and nutritional fruit quality

Study the impact of environment and G x E interactions on fruit development and quality (salt, light, water stress, fruit load, cold)

Approaches :

- ➔ Structuration and valorisation of genetic diversity
- ➔ Genetic determinants (QTL, GWAS, MAGIC populations)
- ➔ Impact of environment at the population and gene levels
- ➔ Multi-scale integration from consumers to genes
- ➔ Functional characterisation of main candidate genes
- ➔ Breeding methods and creation of new varieties

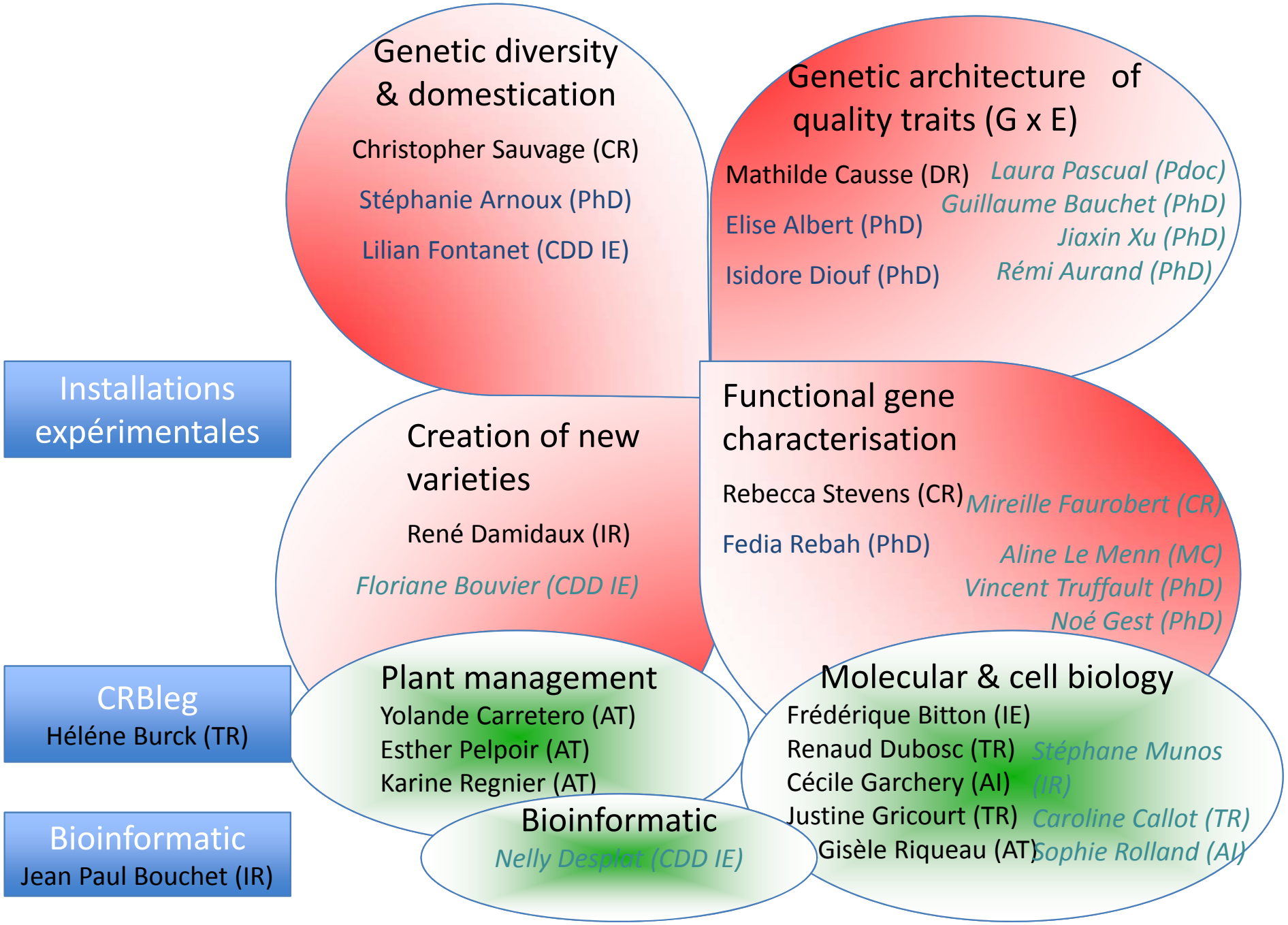


Main Targets: Fruit weight and composition (sugars, vitamin C …), texture

Resources : Collection of +2500 accessions, populations, NILs, trangenic

Genome sequence & 360 re-sequenced

The QualiTom Team
Diversity Quality and Environment of Tomato

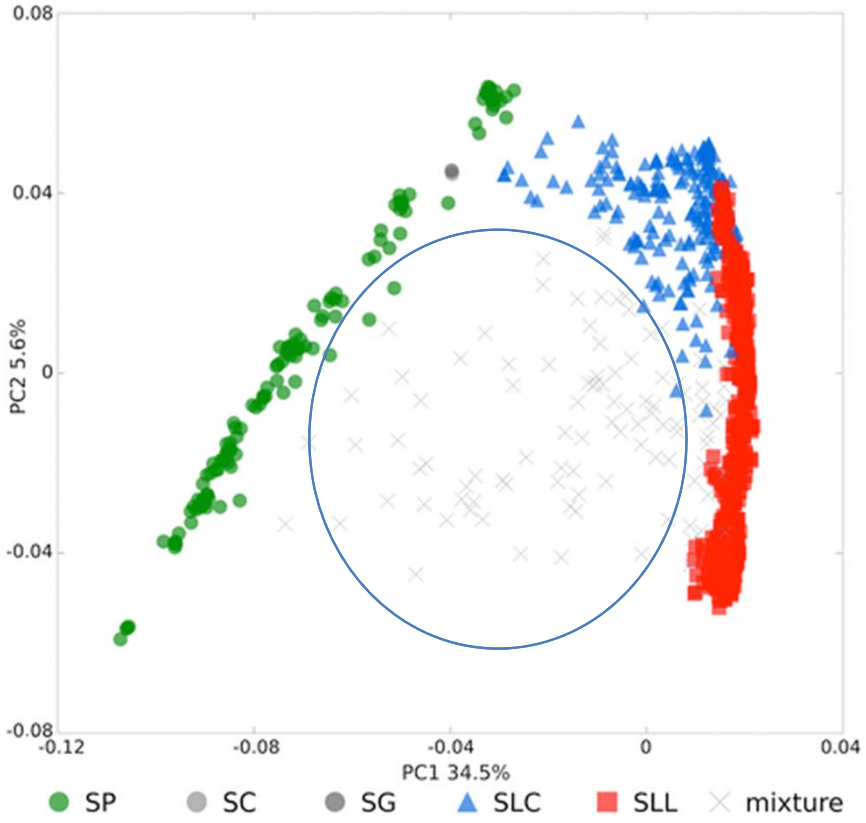


Genetic diversity

Genetic resource structuration

160 acc° : admixture cherry

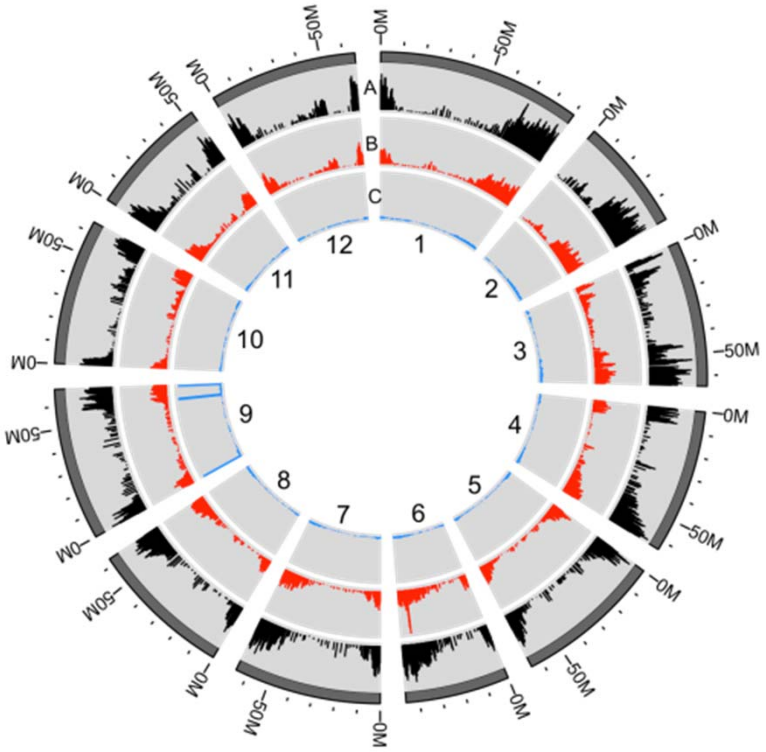
➔ Combine + 1000 acc°



Diversity and domestication in Solanaceae

RNAseq 10 cultivated vs 10 wild :

- Gain/Loss of diversity
- Selection footprint
- Transcriptome variations



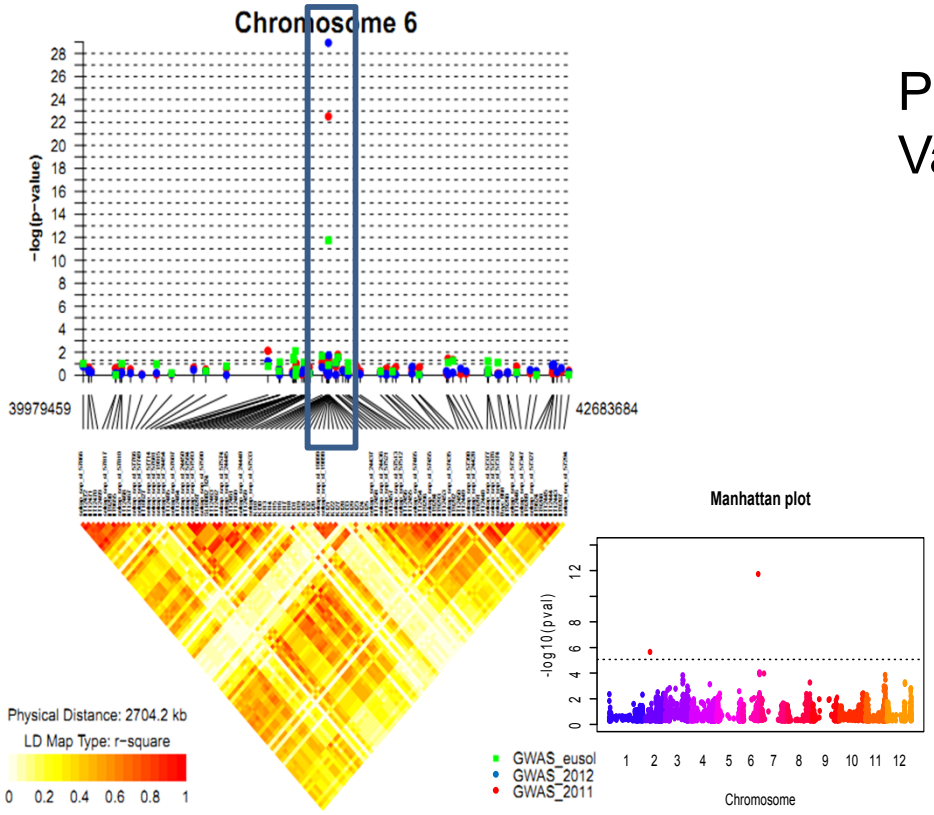
Sim et al. 2012 Plos One
Blanca et al 2015 BMC genomics
Sarah et al 2016 Mol Ecol res

PhD J Xu; S Arnoux

FP7 Marie Curie SOLUTION
INRA SelGen
Agropolis ARCAD

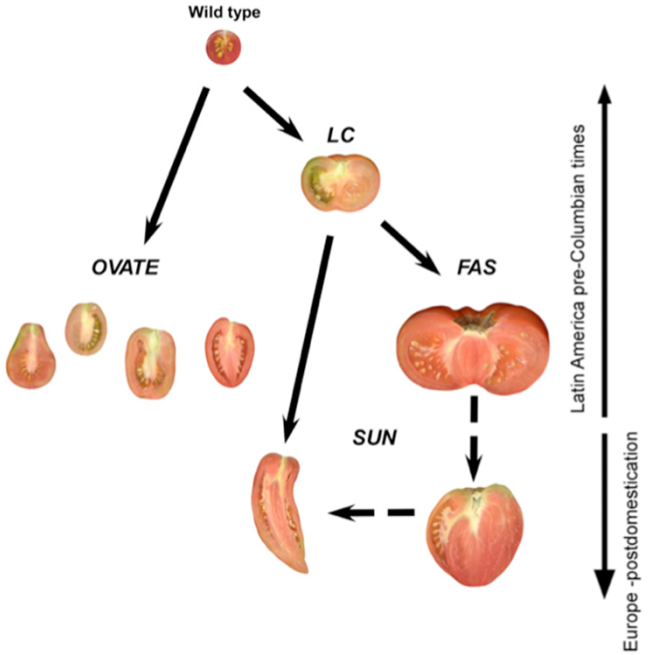
Genetic control of fruit quality components

- GWAS is possible with the admixed structure of cherry tomatoes
- Collection of 160 acc. X metabolites ➔ + 50 CG for 20 metabolites



➔ Associations CG x phenotypes

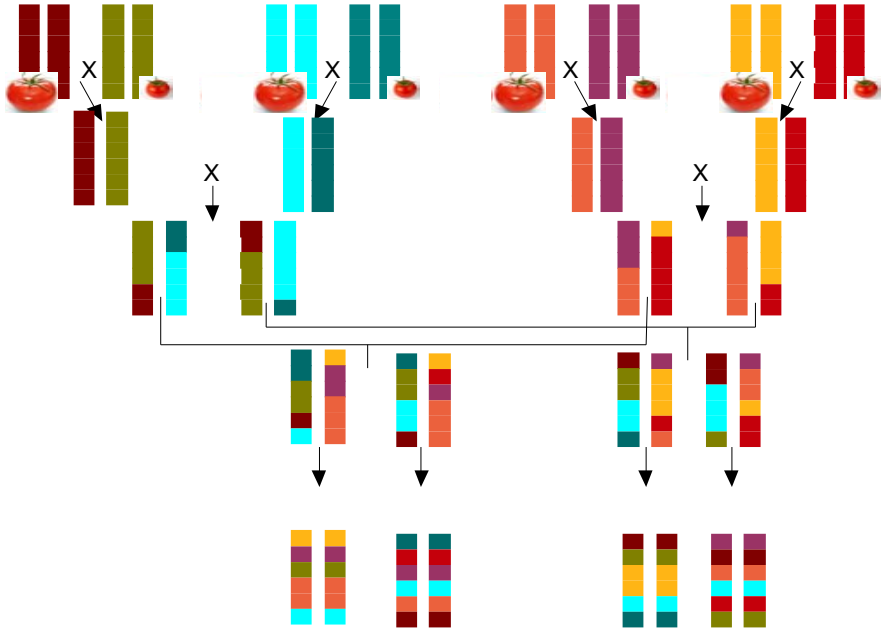
Positional cloning of Lcn and shape evolution
Validation of fw3.2 gene (positional cloning)



Munos et al, 2011; Rodriguez et al, 2011 Plant Physiol
Xu et al. 2013 TAG
Tomato G Consortium 2012 Nature
Chakrabarti et al. 2013 PNAS ; Sauvage et al, 2014 Plant Physiol

PhD G Bauchet

Multi-scale analysis : integration of omic levels



Creation of a multi-allelic MAGIC pop. (highly recombinant)

Many QTL for fruit traits

Strategy to identify candidate SNPs

Multi scale, multi trait analysis

- Phenotype — plant &fruit development
- Metabolome — 32 metabolites + 26 act. enzym.
- Proteome — 500 variable protein spots
- Transcriptome — +4000 genes diff. expressed
- Genome — ~ 4 millions SNP

Networks & inheritance

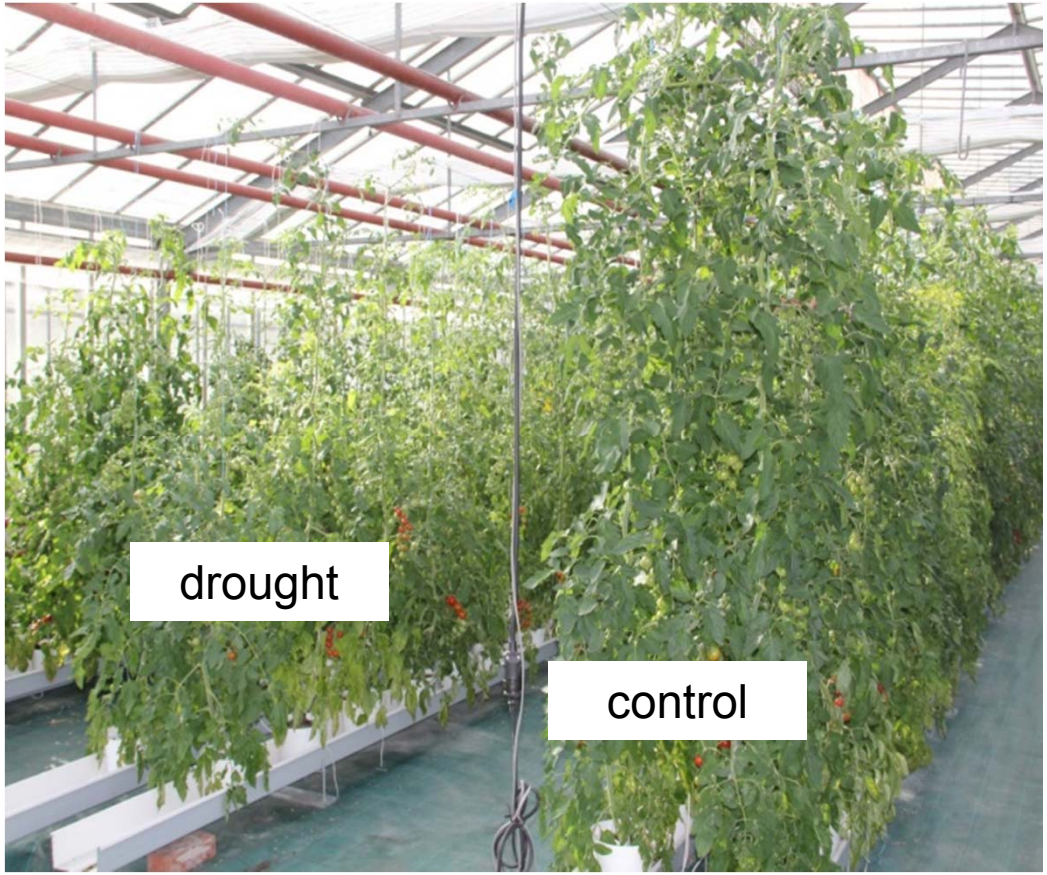
Xu et al, 2013 Proteomics
Pascual et al 2013 J Exp Bot
Causse et al, 2013 BMC Genomics
Pascual et al, 2014; 2016 Pl Sci

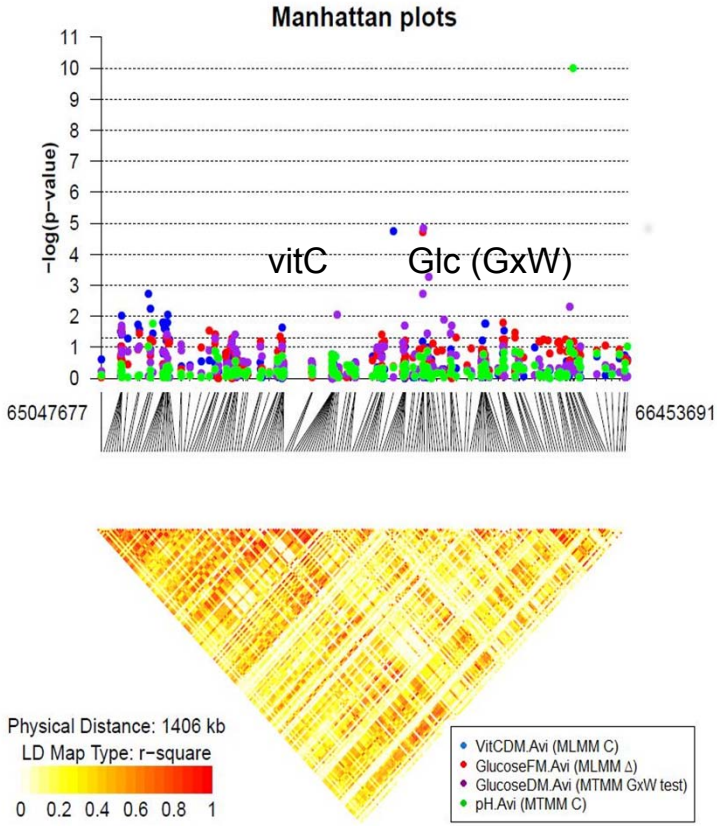
PhD J. Xu (2012)
CDD N Desplat (2012)
PDoc (L Pascual)

ANR MagicTom SNP
DGAP PF metabolome

Impact of environment on fruit quality and production

Water limitation consequences : RIL and GWAS population ➔ QTL x E





Data were integrated into a “virtual fruit model” & QTL for model parameters identified

Albert et al, 2015 (TAG)
Albert et al, 2016 (J Exp Bot)
Constantinescu et al 2016 (Frontiers Pl Sci)

PhD E Albert (2017)

ANR Adaptom
CTPS Tomsec

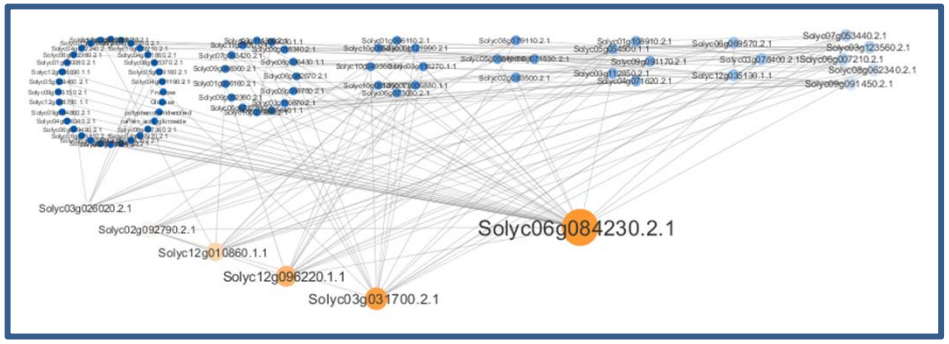
Ascorbate : an essential molecule affecting plant physiology

- **Yield stability**
  - ❖ Yield Yield is **maintained** in ascorbate oxidase RNAi lines under stress
  - ❖ Yield and yield stability are reduced in monodehydroascorbate reductase RNAi lines

- Ascorbate redox changes lead to changes in **sugar** metabolism and post-harvest behaviour

- Degradation of ascorbate pool in tomato

- Network analysis of 182 differentially expressed genes + 22 metabolites and 40 proteins in transgenic lines show hubs related to **ribosome biogenesis, protein stability and ATP/GTP binding**



Gest 2013, Plant Biotech J.
El Airaj 2013, Post harvest Bio & Tech.
Garchery 2013, Plant Cell & Env.

Truffault 2016, Plant Cell & Env.
Truffault (accepted), Plant J.

PhD Noé Gest 2012
PhD Vincent Truffault 2015

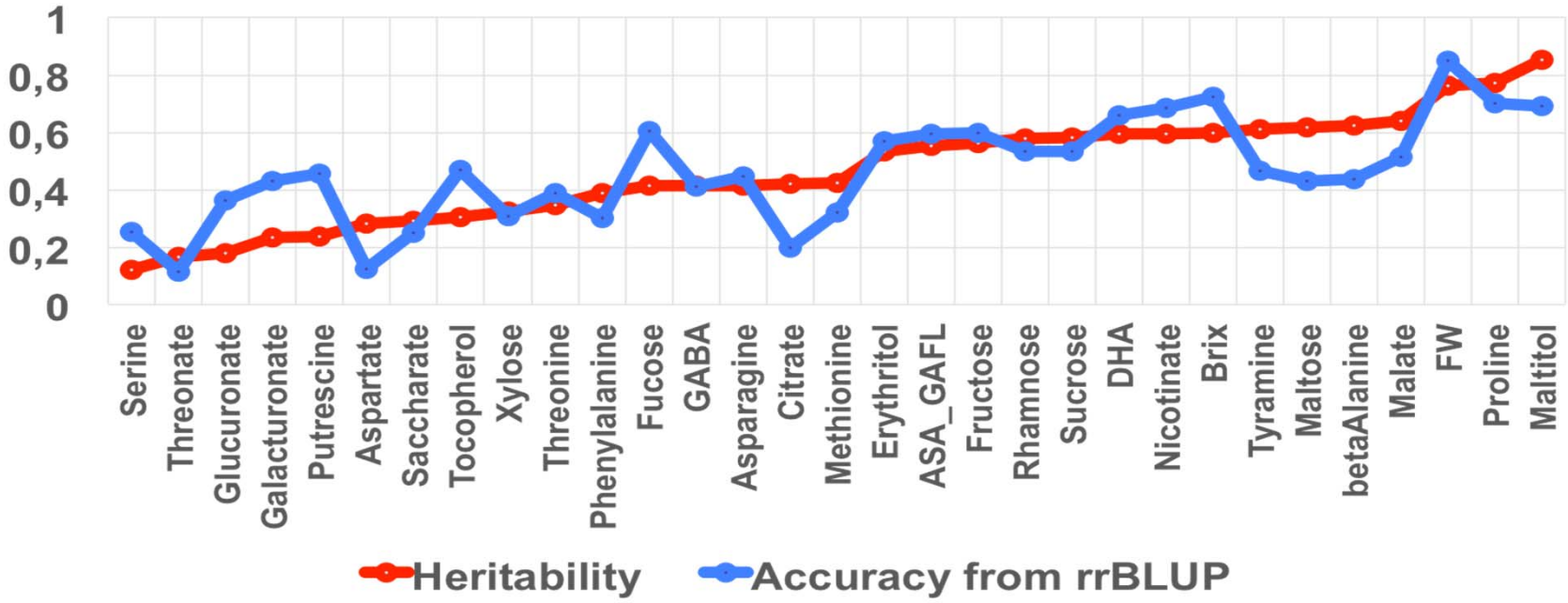
Social & economic impact : Tomato breeding for low input conditions

Development of varieties for organic farming and home gardens cumulating disease resistances and fruit quality

➔ F1 Garance : good quality and adapted to AB

HF1 GARANCE

➔ Towards Genomic selection



Variété GARANCE & TERRADOU
Duangjit et al, 2015 Mol Br

BAP Innov
SelGen Innovartom

Fiche Atelier 1 : Qualité des matières premières

Nom: Albert Prénom: Elise Fonction : doctorante

Organisation (nom et type*) : INRA GAFL, équipe QUALITOM (Mathilde Causse)

Recherche Académique

• Quels moyens d'investigation ou domaine d'expertise applicables aux questions liées à la qualité des fruits frais et des matières premières disposez-vous ?

- Collection de **ressources génétiques** tomate (+2500 accessions) & diverses populations (MAGIC, RIL, IL, NIL, transgéniques)
- Huit **génomes** entièrement re-séquencés & nombreux **marqueurs génétiques** (+ données publiques séquençage tomate)
- **Installations expérimentales** pour phénotyper un grand nombre de plantes en contrôlant l'environnement et les apports en intrants
- Capacité de phénotypage de la **qualité physiques et biochimiques des fruits** de tomate (minolta, durofel, refractomètre, dosages enzymatiques sucres, acides & vitamine C)
- Expertise en **génétique quantitative, génomique et génétique des populations**

• Formulez 1 à 3 questions de recherches qui sont des « sujets chauds » et pour lesquelles vous pensez avoir besoin d'une aide extérieure pour avancer (identifier l'aide autant que faire se peut):

- Identifier les facteurs génétiques, génomiques et physiologiques qui contrôlent la qualité sensorielle et nutritionnelle des fruits de tomate
  → Partenaires capables de **mesurer à haut débit la qualité des fruits de tomates** (métabolomes notamment)
  → Partenaires pour réaliser des mesures **sensorielles** (panels d'experts)

- Etudier l'impact de **l'environnement** sur le développement des plantes et la **qualité des fruits** de tomate (sel, lumière, stress hydrique, charge des fruits, froid)
  → Recherche de partenaires pour réaliser des **mesures physiologiques** (photosynthèse, ajustement osmotique…)