Development and evaluation of tomato and pepper genetic resources in the framework of public-private partnerships

Teodoro Cardi
CREA Research Centre for Vegetable and Ornamental Crops
Pontecagnano Faiano (SA), Italy
Research with integrated and multidisciplinary approaches on:

- enhancement and use of plant genetic resources
- plant breeding
- agronomic innovation
- eco friendly plant protection

In partnership with:
- Universities and other public research councils
- Seed companies and other private entities
- National and regional governments
“Improve performance of organic agriculture by boosting organic seed and plant breeding efforts across Europe” - LIVESEED

H2020 SFS-07-2016: Organic breeding – Increasing the competitiveness of the organic breeding and farming sectors
Support participatory tomato breeding in Italy and Spain

CREA-OF
Monsampolo del Tronto

Partners
ISI Sementi
ARCOIRIS
Rete Semi Rurali
University of Valencia

"Breeding tomato for organic farming"
Development of new varieties adapted to organic system
Exploring new interesting traits needed for research, breeding and markets
Tomato Multi-parent Advanced Generation Inter-Cross (MAGIC)

7 lines, with interesting agronomic traits (ISI Sementi)
1 wild accession of Solanum cheesmaniae (LA 1407), TGRC

Molecular characterization by GBS (Genotype By Sequencing)

20k new SNPs (Single Nucleotide Polymorphisms) anchored on tomato genome and evenly distributed across all chromosomes

100 crosses cultivated at CREA-OF on MOVE-LTE (Monsampolo del Tronto)

Molecular association with important agronomic traits to follow the allelic frequencies evolution in different environments

Italy
- NORTH Padova
- CENTRE Fermo
- SOUTH Metaponto
- CREA-OF MOVE-LTE

Spain
- Valencia
- Murcia
- Andalucia

+ local varieties

- Fruit quality: pulp softness, shelf life, yellow and orange-coloured pulp, increase of red colour/lycopene content, uniform green shoulder, Brix
- Bio-morphological traits: self-pruning, leaf transparency
- Abiotic stress tolerance: salt, drought and cold
- Resistance to pests and diseases: Verticillium, Fusarium 1 e 2, Alternaria, TSWV, Phytophthora, white flies
- Organoleptic traits
Resistance to *Meloidogyne* spp. (*Mi*-1 gene)

Resistance to *Fusarium oxysporum* f. sp. *lycopersici* (*I*-2 gene)
“Breeding for Resilient, Efficient and Sustainable Organic Vegetable Production” - BRESOV

H2020 SFS-07-2017: Organic breeding – Increasing the competitiveness of the organic breeding and farming sectors

- 22 partners: Universities, Research Councils, Private companies/associations (ESA)
- 11 European countries
- 2 extra-EU countries
Centro di ricerca Orticoltura e Florovivaismo

ECPGR Workshop for the preparation of a European Evaluation Network (EVA) on vegetables, Durres, 2-3 April 2019

Broccoli and Cauliflower, Snap bean, Tomato
A core collection and a breeding set of about 300 tomato genotypes, including Italian and Spanish cvs for fresh market and «da serbo», landraces and wild accessions are being genotypized and phenotypized in growth chambers, greenhouses and organic fields (agronomic, nutritional and organoleptic traits, biotic and abiotic stress tolerance).
“Linking genetics resources, genomes and phenotypes of solanaceous crops” - **G2P-SOL**

**H2020 SFS-07b-2015: Management and sustainable use of genetic resources**

The **G2P-SOL** consortium

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<thead>
<tr>
<th>Acronym</th>
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<tr>
<td>ENEA</td>
<td>Agenzia Nazionale Per Le Nuove Tecnologie, L'Energia e lo Sviluppo</td>
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<td>WUR</td>
<td>Wageningen University*</td>
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<td>JHI</td>
<td>The James Hutton Institute</td>
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<td>HUJI</td>
<td>The Hebrew University of Jerusalem</td>
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<td>IPK</td>
<td>Leibniz Institut fuer Pflanzengenetik und Kulturpflanzenzuchtung</td>
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<td>European Research and Project Office GmbH</td>
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<td>IHAR</td>
<td>Instytut Hodowli i Aklimatyzacji Roślin</td>
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<td>Phenome Networks Ltd.</td>
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<td>SATIVA</td>
<td>Consorzio Sativa</td>
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**COLLABORATORS**

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<tr>
<td>Chinese Academy of Agricultural Sciences</td>
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<td>Seoul National University</td>
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<td>Boyce Thompson Institute</td>
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<td><strong>Tomato Genetics Resource Center</strong></td>
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<td><strong>Michigan State University</strong></td>
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<td>Limagrain Vegetable Seeds</td>
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<td>Association de créateurs de variétés nouvelles de pommes de terre</td>
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<td>Enza Zaden</td>
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<td>Hodowla Ziemniaka Zamarte</td>
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<td>Ramiro Arnedo Semillas</td>
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<td>Benson Hill Ltd</td>
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**ECPGR Workshop for the preparation of a European Evaluation Network**
WP4 -> Phenotyping

Core collection

~ 10,300 accessions low density GBS
> available phenotyping data

WP5 -> Pre-breeding

- BIL 140 *C. annuum* x *C. frutescens*

- BIL 120 *C. annuum* x *C. chacoense*

- MAGIC 650 lines *C. annuum*
"Harmonization of resistance tests to diseases for DUS testing - 3" - HARMORES 3

- official variety description in the framework of the DUS (Distinguibility, Uniformity, Stability) tests for national listing and plants breeder’s rights

Partners

- Geves - Groupe d'Etude et de contrôle des Variétés Et des Semences (FR) – coordinator
- Naktuinbouw - the Netherlands Inspection Service for Horticulture (NL)
- INIA - Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (SP)
- CISTA - Central Institute for Supervising and Testing in Agriculture, National Plant Variety Office (CZ)
- SASA - Science and Advice for Scottish Agriculture (UK)
- NEBIH – National Food Chain Safety Office (HU)
- CREA - Consiglio per la Ricerca in agricoltura e l’analisi dell’economia agraria (IT)
- CTIFL – French Technical Institute for Fruit and vegetables (FR)
- Seed Companies belonging to ESA - European Seed Association (Bayer, Monsanto, HM Clause, Enza Zaden, Gautier, Ramiro, Sakata, Rijk Zwaan)
**harmonization of the resistance tests in terms of:**

- reference material (isolates and varieties)
- test conditions (temperature, light, humidity, stage of inoculation, ...)
- notation scales

**Fusarium/tomato**

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<th>Level</th>
<th>Description</th>
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<tr>
<td>0</td>
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<tr>
<td>1</td>
<td>Level 1</td>
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<tr>
<td>2</td>
<td>Level 2</td>
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<tr>
<td>3</td>
<td>Level 3</td>
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**Fusarium/melon**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>1: no symptoms</td>
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<tr>
<td>2</td>
<td>2: slightly wilted yellow cotyledons (with brown vessels under the cotyledons)</td>
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<tr>
<td>3</td>
<td>3: internal vessel browning, wilted plant</td>
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<tr>
<td>4</td>
<td>4: appearance of aerial mycelium on dying plants</td>
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<tr>
<td>5</td>
<td>5: death of plant</td>
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**proposal of new harmonized and robust protocols to CPVO**

**Protocol for tests on distinctness, uniformity and stability**

**Solanum lycopersicum L.**

**TOMATO**

UPOV Code: SOLAN_LYC

Adopted on 21/03/2018

Entry into force on 01/01/2018
Seven host/race/pathogen combinations are being studied:

1. *Meloidogyne incognita* / tomato
2. *Erysiphe* sp / pea
3. Powdery mildew / melon
4. *F. oxysporum* f. sp. *lycopersici* race 0 and 1 / tomato
5. *F. oxysporum* f. sp. *melonis* race 1.2 / melon
6. *F. oxysporum* f. sp. *melonis* race 2 / melon
7. *F. oxysporum* f. sp. *melonis* race 0 and 1 / melon

Future perspectives and follow-up

- a database that could be used by examination officers and breeders
- a collection of reference materials (pathogens/plant genotypes) to be used in resistance tests
Collection, characterization, multiplication and conservation of local PGRFA

- National Ministry of Agriculture → Implementation of the International Treaty (RGV-FAO)
- Regional government Marche Region → Collection, characterization, support for registration to regional/national variety lists, seed distribution to farmers (BanGe5, CARBIO)
- Regional government Campania Region → same as above (ABC)
Acknowledgements

✓ LIVESEED$^a$ → Gabriele Campanelli$^1$, Sara Sestili$^1$, Massimiliano Beretta$^3$
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✓ G2P-SOL$^c$ → Pasquale Tripodi
✓ HARMORES$^d$ → Loredana Sigillo$^2$
✓ RGV-FAO$^e$ → Pasquale Tripodi, Nadia Ficcadenti$^1$
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✓ ABC$^g$ → Massimo Zaccardelli$^2$, Pasquale Tripodi

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$^c$ EU H2020 grant agreement No 677379
$^d$ CPVO
$^e$ FAO - Italian Ministry of Agriculture
$^f$ Marche Region
$^g$ Campania Region

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$^2$ CREA OF Pontecagnano
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