PhD Workshop 2019

Doctorate School in Agri-Food Sciences, Technologies and Bio-Technologies

Innovative and environment-friendly strategies for processing tomato (*Solanum lycopersicum* L.) production

Federica Caradonia, Reggio Emilia, 22 November 2019

Processing Tomato

- Tomato is the <u>second most cultivated</u> crop in the world
- Tomato has a double attitude: <u>fresh market</u> and <u>processing</u>

Processing tomato Challenges

- ✓ To face up to the increase of incidence of abiotic stresses due to climate changes (mainly chilling and drought stresses)

- ✓ Increase of food production to satisfy the increasing demands of a growing population

- ✓ Reduction of the environmental impacts of agricultural production

Summary of 3-years activity

5 main studies were carried out during the PhD

- Effects of arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria in avoiding the processing tomato leaf damage during chilling stress
- Comparison of processing tomato seedlings inoculated with arbuscular mycorrhizal fungi under reduced irrigation
- Effects of an interspecific rootstock on yield of processing tomato yield (*Solanum lycopersicum* L.) in the organic farming
- Effects of a cherry rootstock inoculated with biostimulants (based on microorganisms) on processing tomato growth, yield and quality in sustainable farming systems
- Effects of different type of nitrogen fertilisers on the composition of the microbiota of field-grown processing tomato plants

Experiments 1 and 2

Experiment 1

Microbial inoculation

Funneliformis mosseae (*F. m.*)
mixed with peat

or /plus

Paraburkholderia graminis (P. g.)

Chilling treatment

24 hours

Effects

Control F. m. P. g. F. m. + P. g.

Experiment 2

Microbial inoculation

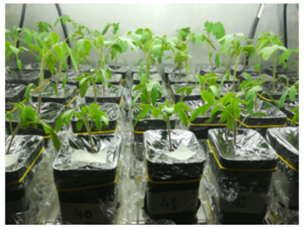
Funneliformis mosseae mixed with peat

or

Rhizophagus intraradices mixed with peat

water irrigation regime

12 days



Pearson (realised in mid-1930) H3402 (realised in 2002) Everton (realised in 2008)

Results – Abiotic stresses

- *Funneliformis mosseae* was the most effective in reducing the chilling damage and in mitigating of the effects of drought stress
- After chilling stress, modern genotypes (Everton and H3402) inoculated with microorganisms showed a better seedling regrowth
- Pearson (old) and Everton (modern), inoculated *with F. mosseae*, recorded the highest values of root, leaf and total dry weights under reduced water regime.
- Pearson (old) and H3402 (modern) inoculated with *F. mosseae* displayed the highest values of water use efficiency under reduced irrigation regime
- Specific genotype x microorganism x stress interactions were also revealed

Caradonia et al., 2019. Agronomy
Ronga et al., 2019. Horticulturae

Experiment 3

Grafting

TC266 non-grafted

TC266 self-grafted

TC266 grafted on RT1

La Collina, Reggio Emilia (Organic farm)

Results – Interspecific rootstock RT1

The use of the interspecific rootstock RT1 was a good strategy for improving processing tomato production in the organic farming

Full flowering

Harvest time

Caradonia et al., submitted to Biological Agriculture & Horticulture

Experiment 4

Grafting

H3402 x Tomito

Microbial inoculation (alone and consortia)

Funneliformis mosseae
mixed with peat

Paraburkholderia graminis
and/or
Azospirillum brasiliensis

Greenhouse

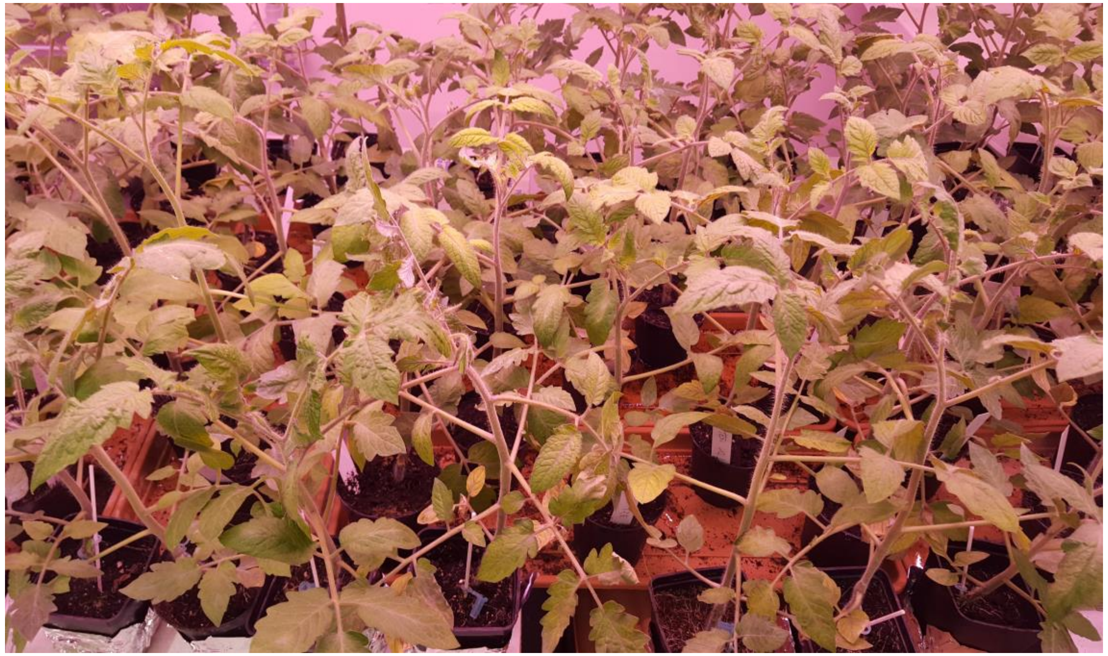
La Collina, Reggio Emilia (Organic farm)

Results – Cherry tomato rootstock + beneficial microorganisms

In the greenhouse experiment:

- The use of 'Tomito' as rootstock increased plant height and leaf chlorophyll content

- *Azospirillum brasiliensis* induced early flowering and increased the number of flowers *per* plant



Caradonia et al., submitted to Italian Journal of Agronomy

Results – Cherry tomato rootstock + beneficial microorganisms

In field experiment:

- all the investigated treatments reduced the number of fruits affected by blossom-end rot.
- *A. brasiliensis* improved also the fruit solid soluble content and Brix t ha^{-1}

Paraburkholderia graminis C4D1M

Bacterial consortium

g $plant^{-1}$

Caradonia et al., submitted to Italian Journal of Agronomy

Experiment 5

Bezzi, Ravenna

✓ 7 treatments:

1) Pelleted digestate

N (%)	P (%)	K (%)	TOC (%)	H_2O (%)
1.5	2.5	2	39.7	7.8

2) Liquid digestate

N (%)	K (%)	TOC (%)
0.3	1	3.74

3) Slow-acting liquid digestate

N (%)	K (%)	TOC (%)
0.3	1	3.74

+

4) Organo-mineral fertilizer based on digestate

N (%)	P (%)	K (%)	TOC (%)	H_2O (%)
10	5	15	10.5	7

5)No fertilization

6) Synthetic fertilizer

	N (%)
Ammonium nitrate	26
Calcium nitrate	15

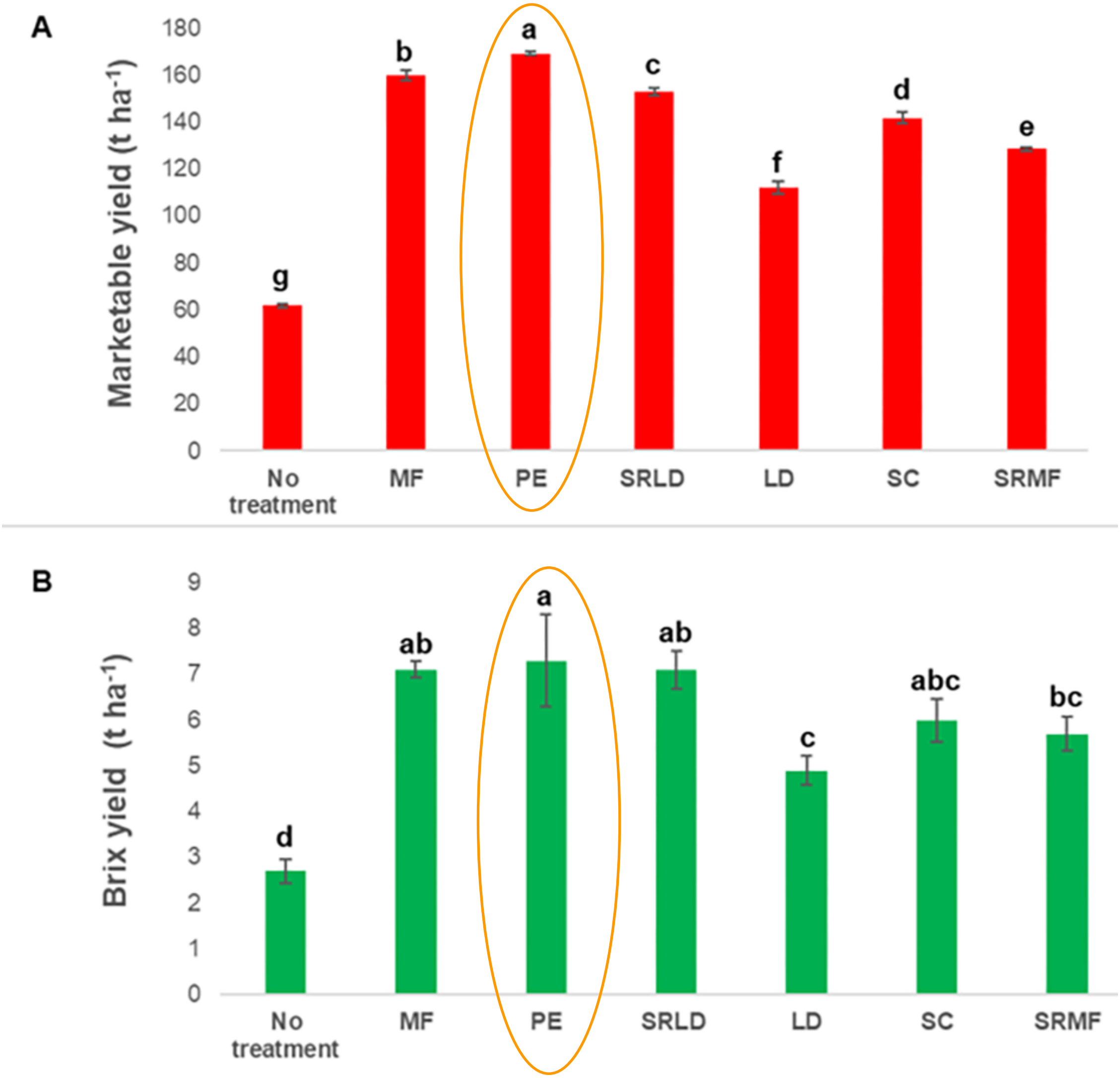
7) Slow-acting synthetic fertilizer

N (%)	P (%)	K (%)	Mg (%)	S (%)	Fe (%)	B (%)	Cu (%)
15	15	15	3	36	0.3	0.01	0

METABARCODING ANALISIS (16S rRNA gene)

FRUIT YIELD AND QUALITY

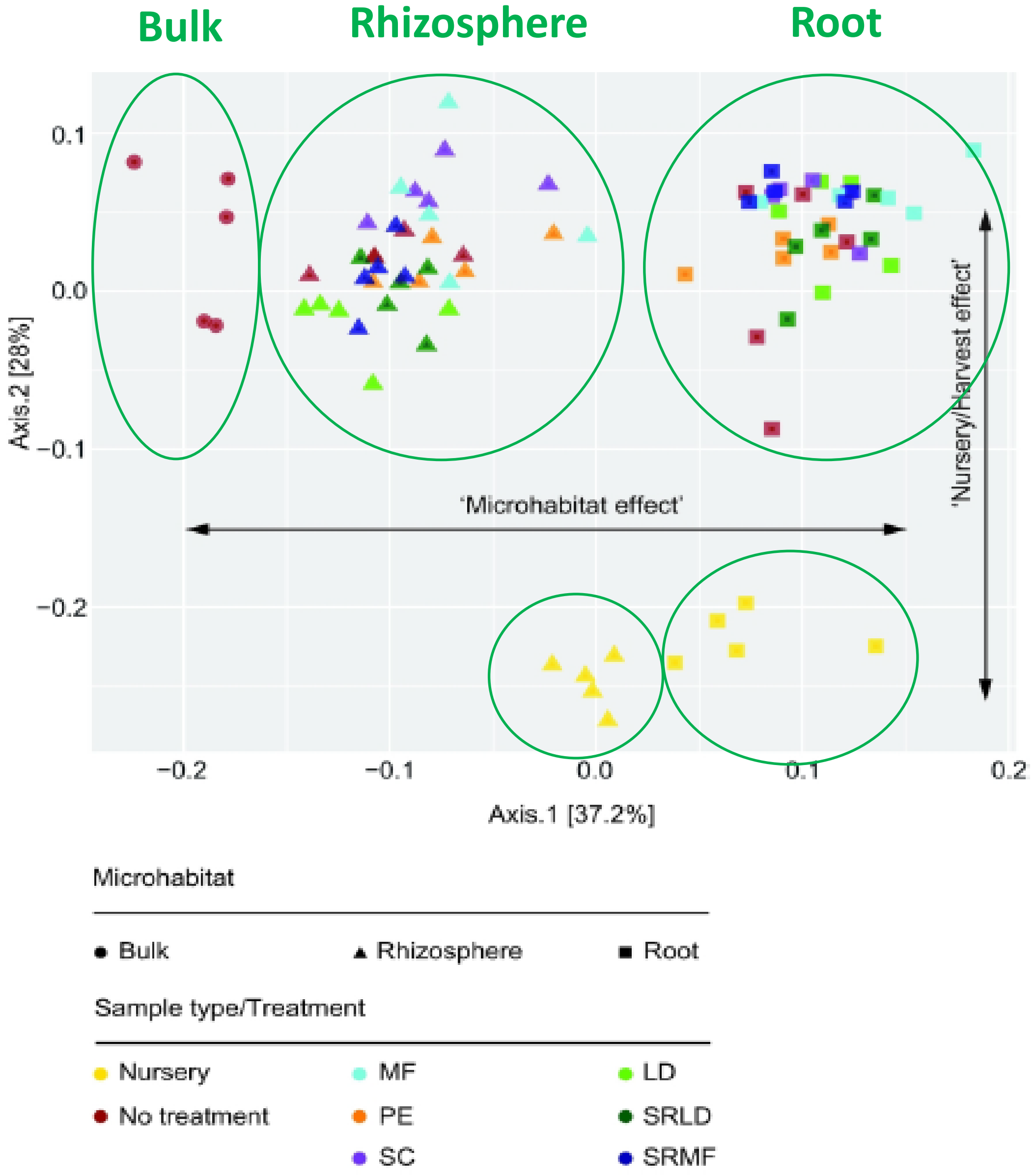
Results – Effect of different type of nitrogen fertilisers on processing tomato production



MF = Synthetic fertiliser; PE = pelleted digestate; SRLD = Slow acting liquid digestate; LD = Liquid digestate; SC = Organo-mineral fertilizer based on digestate; SRMF = slow acting synthetic fertiliser

Caradonia et al., 2019. Phytobiomes

Results – Variability of microbiota in processing tomato



Adult plants
in open field

Seedlings
in nursery

MF = Synthetic fertiliser; PE = pelleted digestate; SRLD = Slow acting liquid digestate; LD = Liquid digestate; SC = Organo-mineral fertiliser based on digestate; SRMF = slow acting synthetic fertiliser

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Dr. Davide Bulgarelli, School of Life Science

Caradonia et al., 2019. Phytobiomes

Results – Effect of different type of nitrogen fertilisers on microbiota of processing tomato

Slow acting synthetic fertilisers

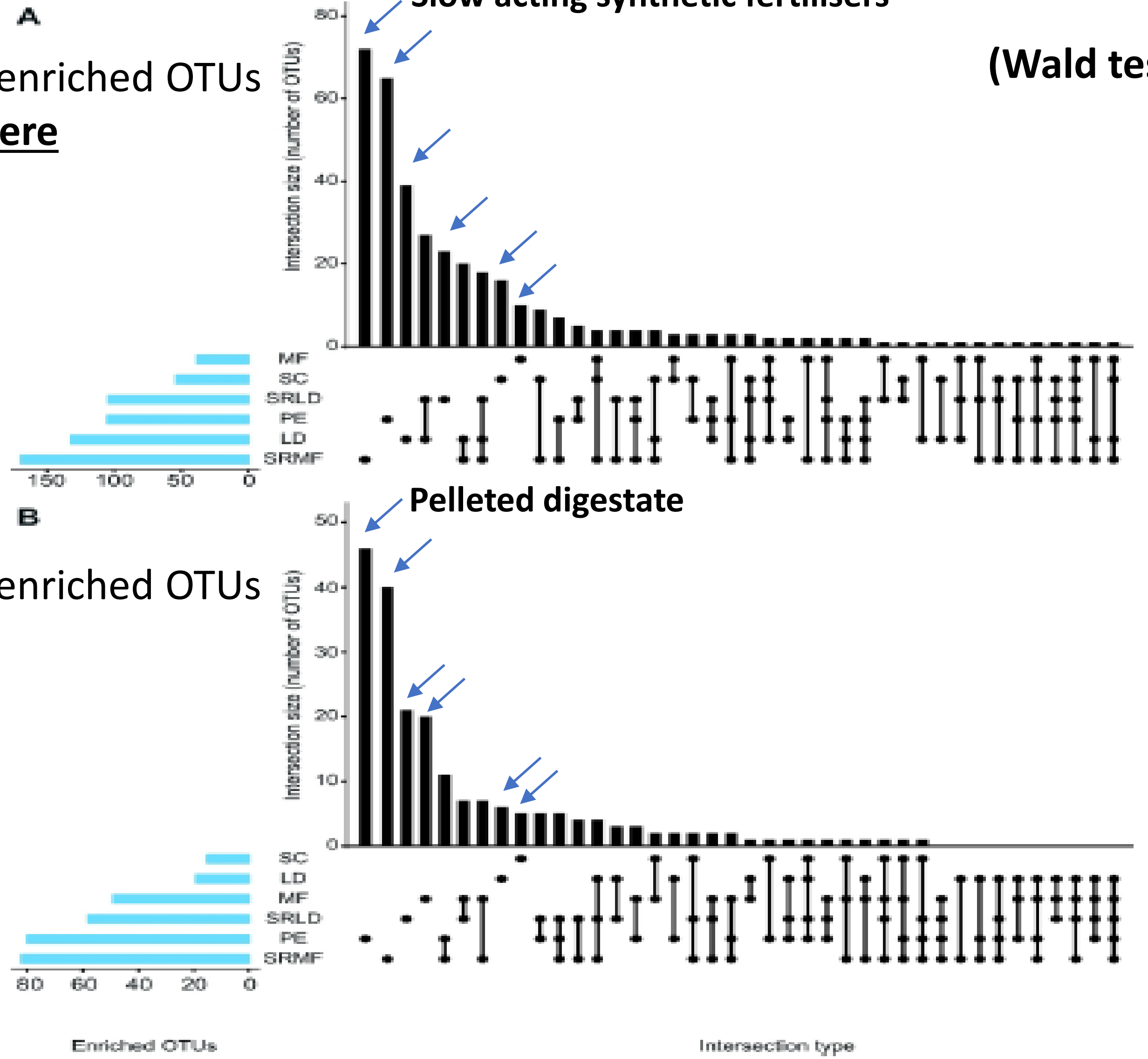
(Wald test, P value < 0.01, FDR corrected)

Number of enriched OTUs in **Rhizosphere**

Fertilisers:

Number of enriched OTUs in **Root**

Fertilisers:



Number of OTUs significantly enriched in the indicated treatment versus untreated controls in (A) rhizosphere and (B) roots. In each panel, blue bars denote the total number of enriched OTUs for a given treatment, the black bars denote the magnitude of the enrichment in either the individual treatment or among two or more treatments highlighted by the interconnected dots underneath the panels. MF = Synthetic fertiliser; PE = pelleted digestate; SRLD = Slow acting liquid digestate; LD = Liquid digestate; SC = Organo-mineral fertiliser based on digestate; SRMF = slow acting synthetic fertiliser

Caradonia et al., 2019. Phytobiomes

Conclusions and prospective

- *Funneliformis mosseae* was the most effective beneficial microorganism in reducing the damaged caused by chilling and drought stresses

- Processing tomato responses depended on specific interactions among genotype, beneficial microorganisms and abiotic stress confirming the importance to develop ad *hoc* formulates

- *Paraburkholderia graminis* C4D1M, *Azospirillum brasiliensis* sp. 245 and their consortium were the most effective treatments on yield, growth and quality of processing tomato in organic farming system

- *A. brasiliensis* sp. 245 might be used to induce an early flowering and an higher flower production, reducing the growing season and increasing the productivity of processing tomato

Conclusions and prospective

- Grafting could be an interesting technique to improve fruit yield and quality of processing tomato when grown in the organic farming system

- As a future prospective, the bacteria differentially enriched in processing tomato microbiota could be isolated and studied in order to evaluated their effectiveness as artificial inoculations

- Finally, all the new acquired knowledges should be transferred to nursery growers and seed and fertilisers companies in order to produce strengthened processing tomato seedlings grafted and inoculated with microorganisms and to produce *ad hoc* fertilisers enriched with microorganisms

Thank you for your attention....

Acknowledge

crea
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SOLO POMODORO MUTTI PARMA

la COLLINA

CIB CONSORZIO ITALIANO BIOGAS

ISI SEMENTI s.p.a.

tomato colors Soc. Coop.

correggio cat COOPERATIVA AGROENERGETICA TERRITORIALE

Habitat

SCAM MEZZI E TECNICHE PER L'AGRICOLTURA