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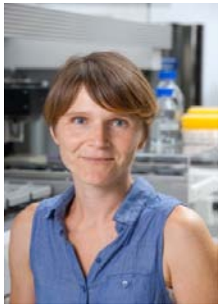
Muhammad NAVEED



Birgit MITTER

Maria TOUCEDA GONZALEZ

Günter BRADER

From lab to field: *Burkholderia phytofirmans* PsJN ameliorates (drought) stress tolerance in maize and wheat

M. Naveed, B. Mitter, M. Touceda-Gonzalez, G. Brader, L. Antonielli, W. Friesl-Hanl, A. Sessitsch

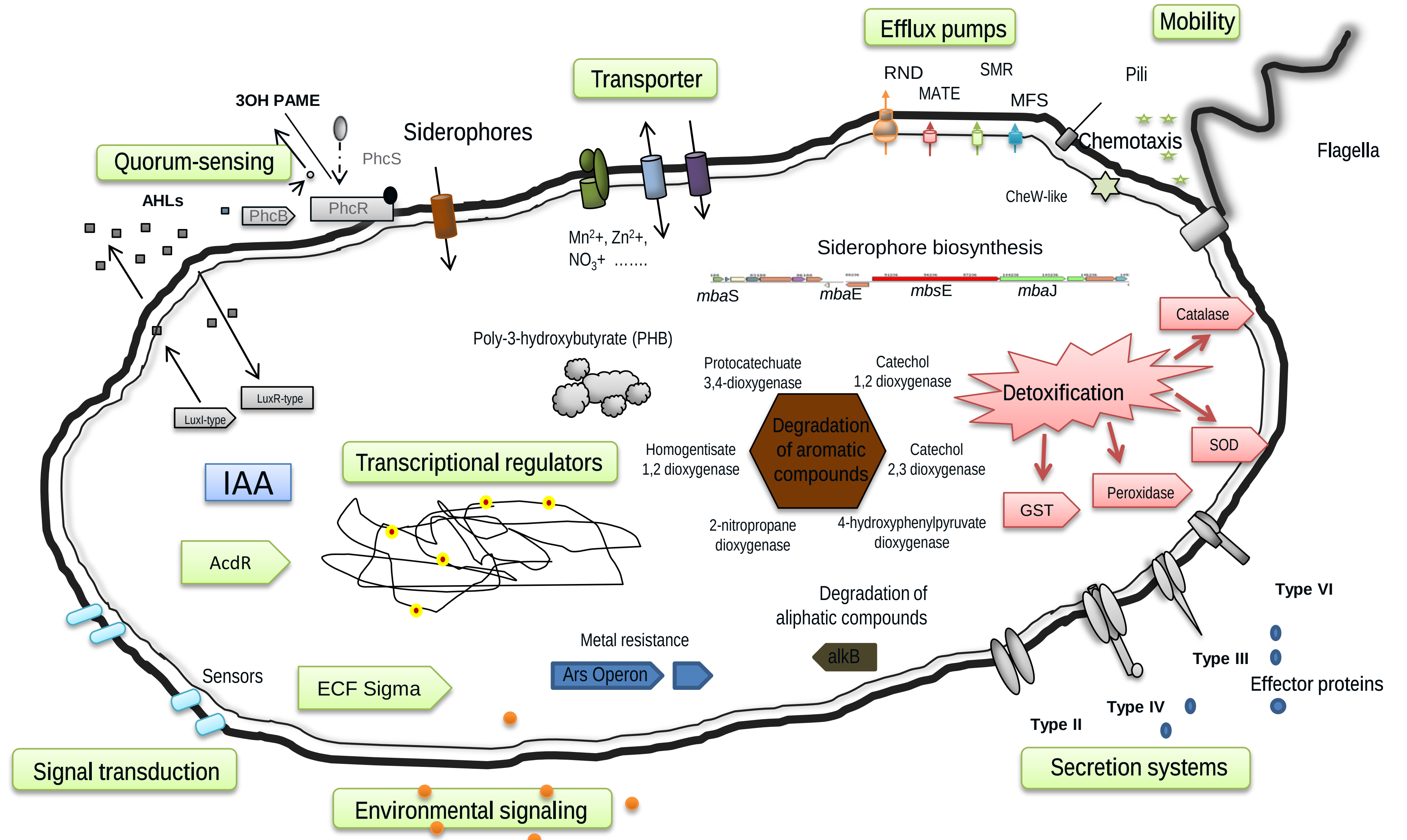
Burkholderia phytofirmans PsJN

- originally isolated from surface-sterilized onions
- rhizosphere competent, good plant colonizer
- strong plant growth promoter (more root hairs, more and bigger plant hairs, higher lignin contents, increased photosynthesis, cytokinin and PAL contents....)
- antagonistic effects by ISR > effects on plant response
- ACC deaminase, IAA, siderophores, QS, novel LPS

- closely related to *B. xenovorans* and *B. phymatum*
- 8.2 Mbp; 2 chromosomes, 1 plasmid (121 kbp)

Sessitsch et al., 2005; Compant et al., 2005; Compant et al., 2008; Weilharter et al., 2011.; Mitter et al., 2013

Burkholderia phytofirmans PsJN



Mitter et al., 2013

PsJN ameliorates drought stress of maize under greenhouse conditions

- Pot experiment with agricultural soil
- Two maize cultivars – Mazurka, Kaleo
- Seed inoculation with 10^8-10^9 cells PsJN::*gusA*10 and *Enterobacter* FD17::*gusA*10
- Irrigation and drought stress treatment - +/- water after 45 DAP

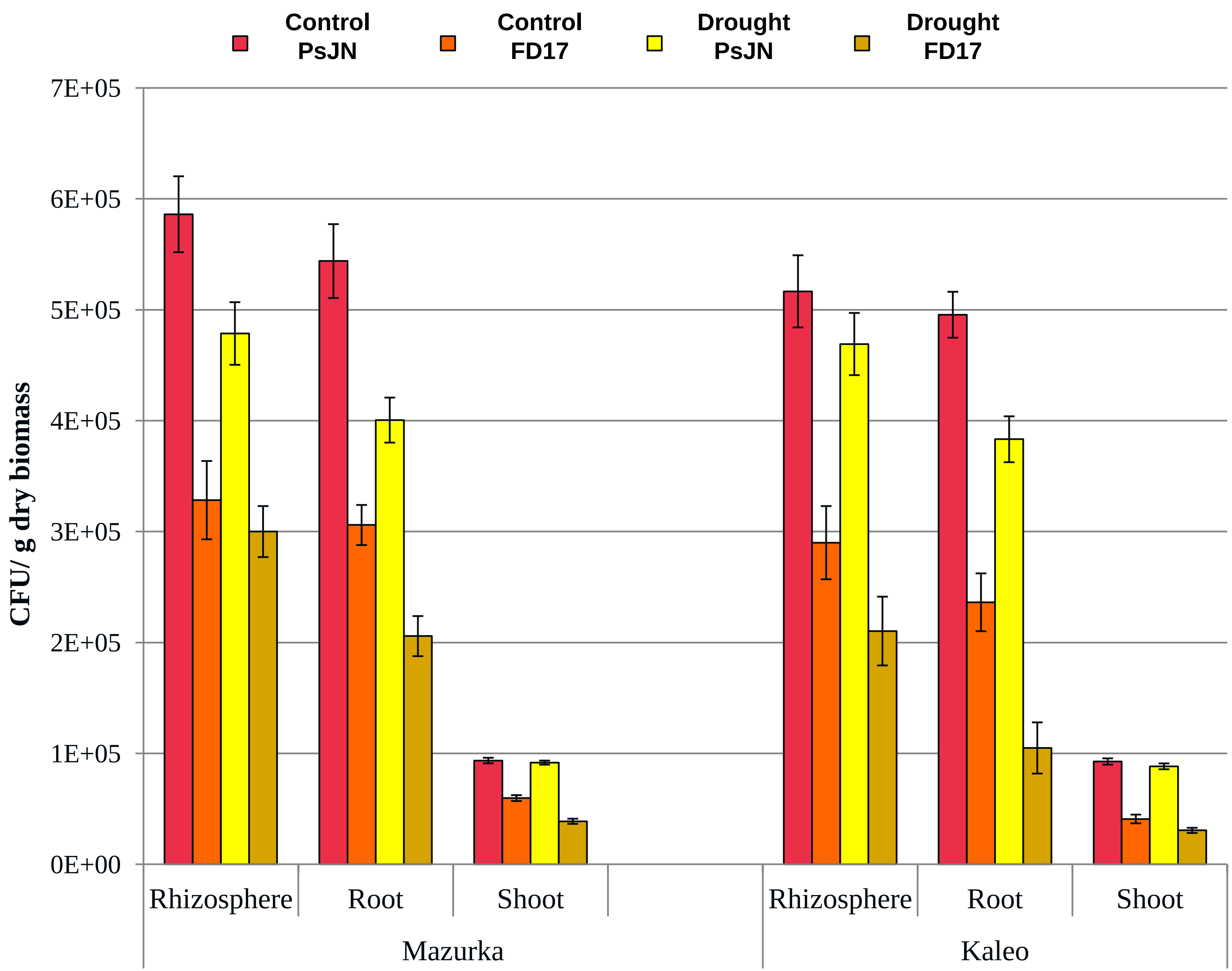
- Plant biomass
- Chlorophyll content and leaf area
- Chrophyll fluorescence
- Relative water content
- Colonization of strain PsJN::*gusA*10

Naveed et al. 2014, Environ. Experiment. Bot.

PsJN ameliorates drought stress of maize under greenhouse conditions

Treatment	Mazurka		Kaleo		Mazurka		Kaleo	
	control	drought	control	drought	control	drought	control	drought
	No. of leaves per plant				Leaf area (cm^2)			
Control	10.66 ± 0.54^{cd}	9.67 ± 0.58^{d}	11.33 ± 0.57^{bc}	10.67 ± 0.58^{cd}	332.60 ± 7.34^{c}	309.94 ± 7.24^{d}	315.77 ± 3.47^{d}	294.10 ± 5.63^{e}
PsJN	13.00 ± 1.00^{a}	12.00 ± 0.43^{abc}	13.00 ± 1.00^{a}	12.33 ± 0.57^{ab}	379.90 ± 6.20^{a}	370.57 ± 6.40^{a}	369.04 ± 5.84^{a}	356.38 ± 7.53^{b}
FD17	12.33 ± 1.52^{ab}	11.33 ± 0.58^{bc}	12.67 ± 0.57^{ab}	11.67 ± 1.15^{abc}	377.46 ± 9.23^{a}	370.79 ± 6.64^{a}	348.91 ± 3.19^{b}	331.91 ± 6.35^{c}
	Shoot dry matter (g)				Root dry matter (g)			
Control	24.07 ± 1.93^{ef}	18.40 ± 1.77^{g}	26.63 ± 1.83^{cd}	21.70 ± 1.57^{f}	2.49 ± 0.11^{d}	1.41 ± 0.11^{f}	2.46 ± 0.22^{d}	1.55 ± 0.12^{f}
PsJN	35.60 ± 1.93^{a}	30.57 ± 1.66^{b}	33.98 ± 1.87^{ab}	31.60 ± 1.68^{b}	3.66 ± 0.23^{a}	2.40 ± 0.15^{d}	3.45 ± 0.12^{ab}	2.45 ± 0.08^{d}
FD17	32.00 ± 1.91^{b}	26.03 ± 1.98^{cd}	30.70 ± 2.09^{b}	28.67 ± 1.77^{c}	3.38 ± 0.21^{bc}	2.31 ± 0.10^{d}	3.16 ± 0.15^{c}	2.08 ± 0.09^{e}

Naveed et al. 2014, Environ. Experiment. Bot.



Naveed et al. 2014, Environ. Experiment. Bot.

Heavy metal bioavailability, plant growth and microbiome characteristics due to *B. phytofirmans* strain PsJN

Greenhouse experiment

- Arnoldstein soil (Zn, Cd)
- 2 maize varieties (Falkone, Fuxxol)
- Immobilizer (gravel sludge with iron oxide)
- *Burkholderia phytofirmans* PsJN

- Treatments:
  - Control
  - Immobilizer
  - PsJN
  - Immobilizer + PsJN
- Parameters:
  - Heavy metal uptake
  - Biomass
  - Microbial diversity by 16S rRNA-based NGS

Touceda-Gonzalez et al. submitted.

Heavy metal bioavailability, plant growth and microbiome characteristics due to *B. phytofirmans* strain PsJN

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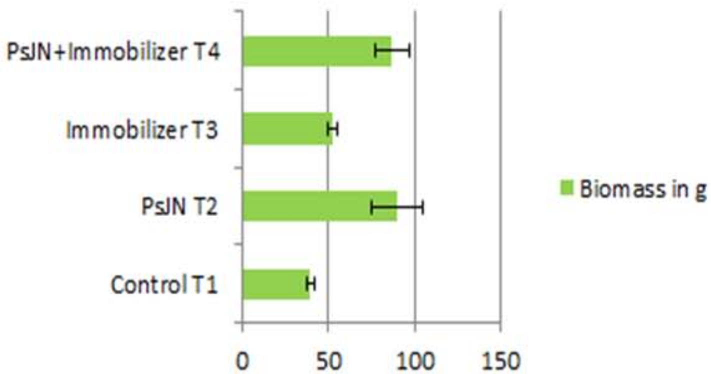
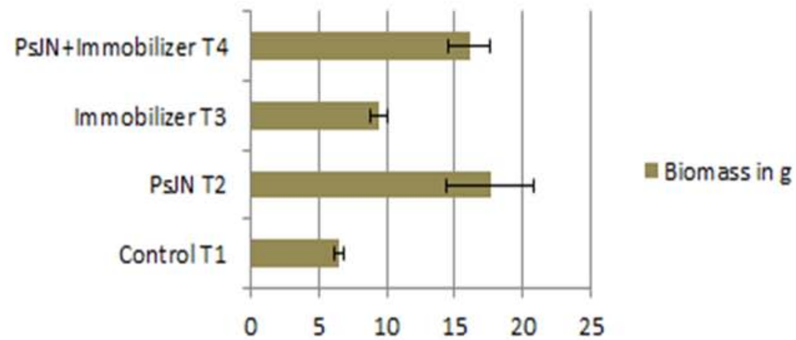
GREENLAND

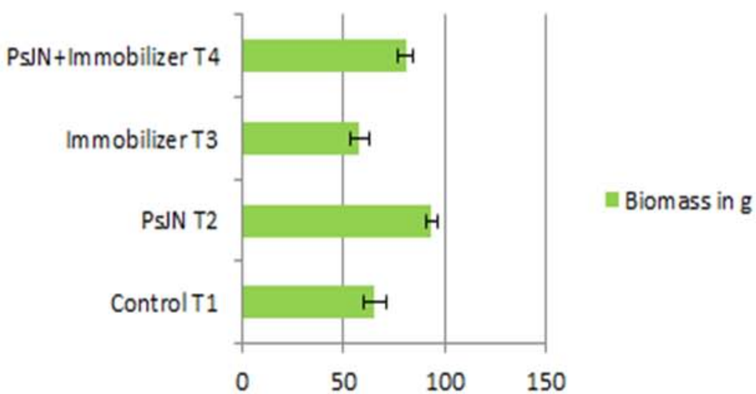
Shoot biomass of FUXXOL



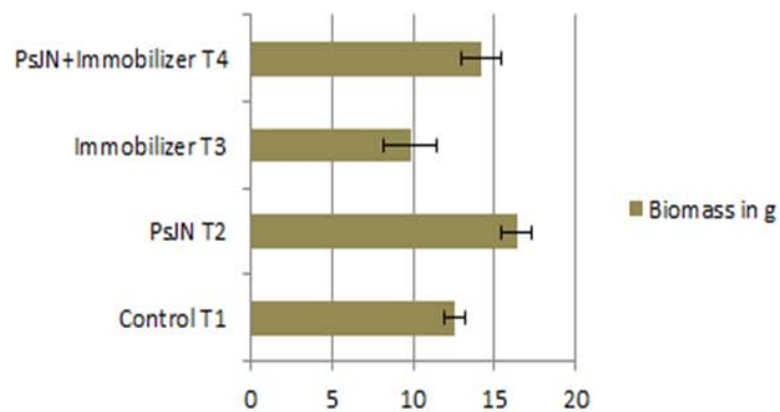
Root biomass of FUXXOL



Shoot biomass of FALKONE



Root biomass of FALKONE



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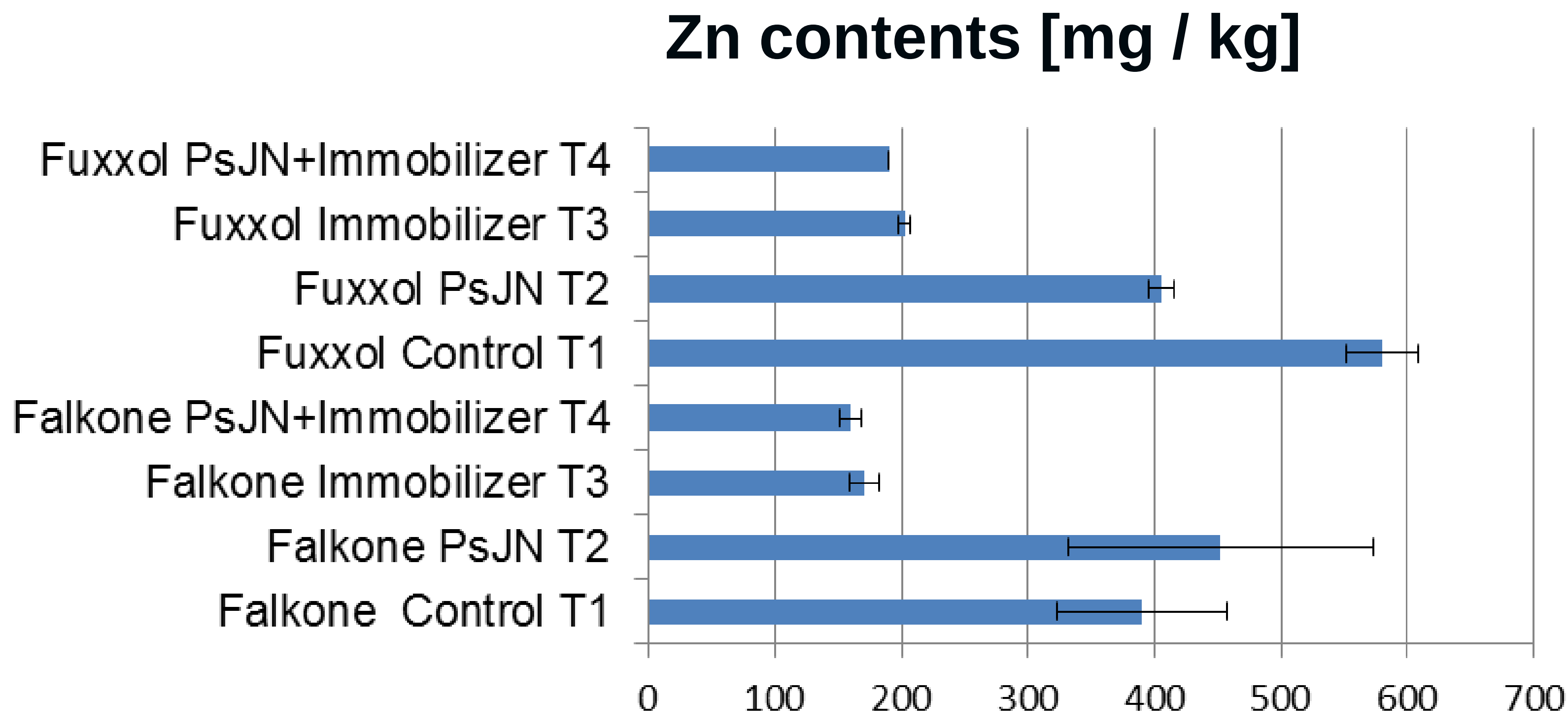

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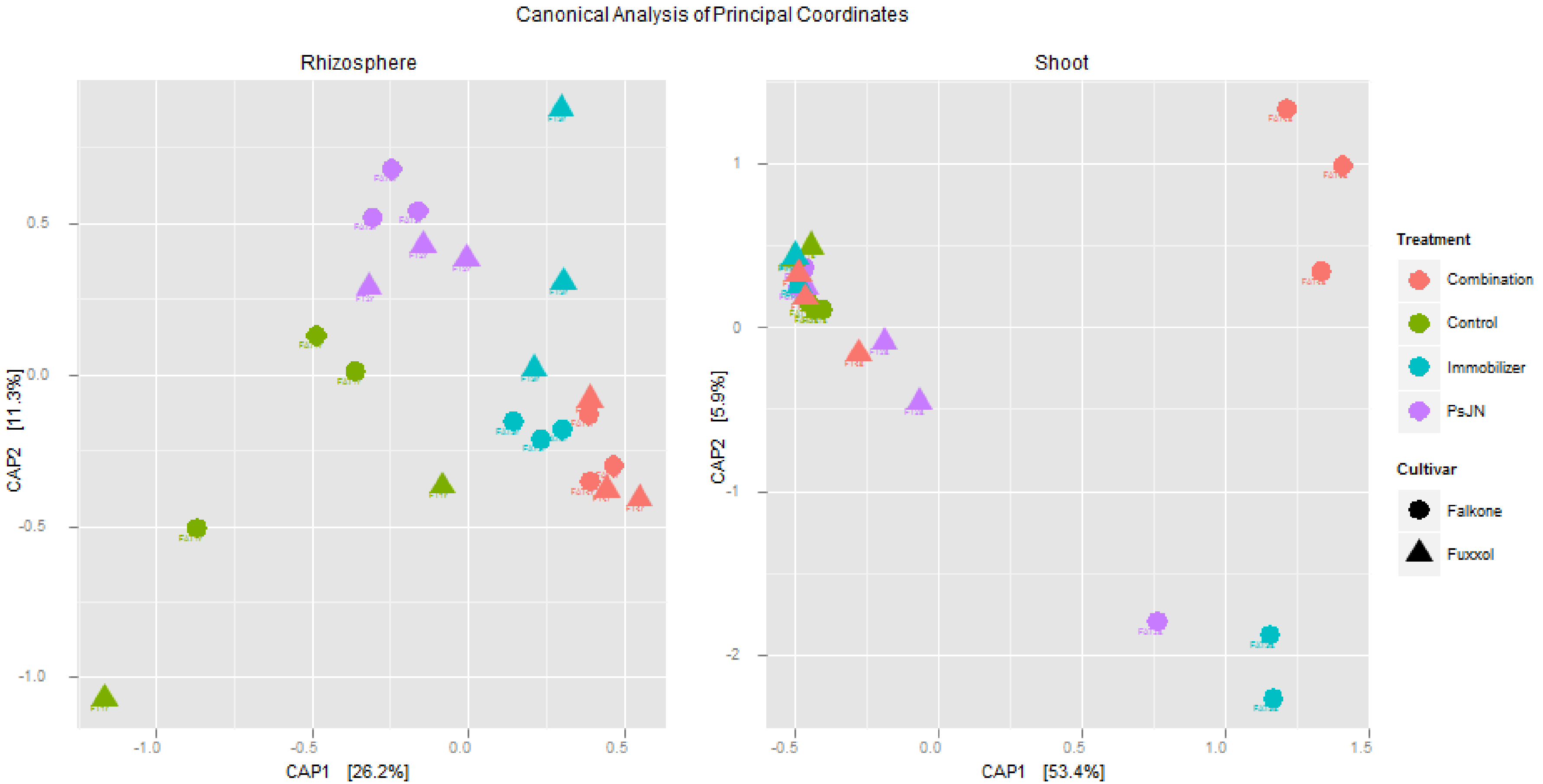

Touceda-Gonzalez et al. submitted.

Drought stress amelioration in wheat through inoculation with *B. phytofirmans* strain PsJN

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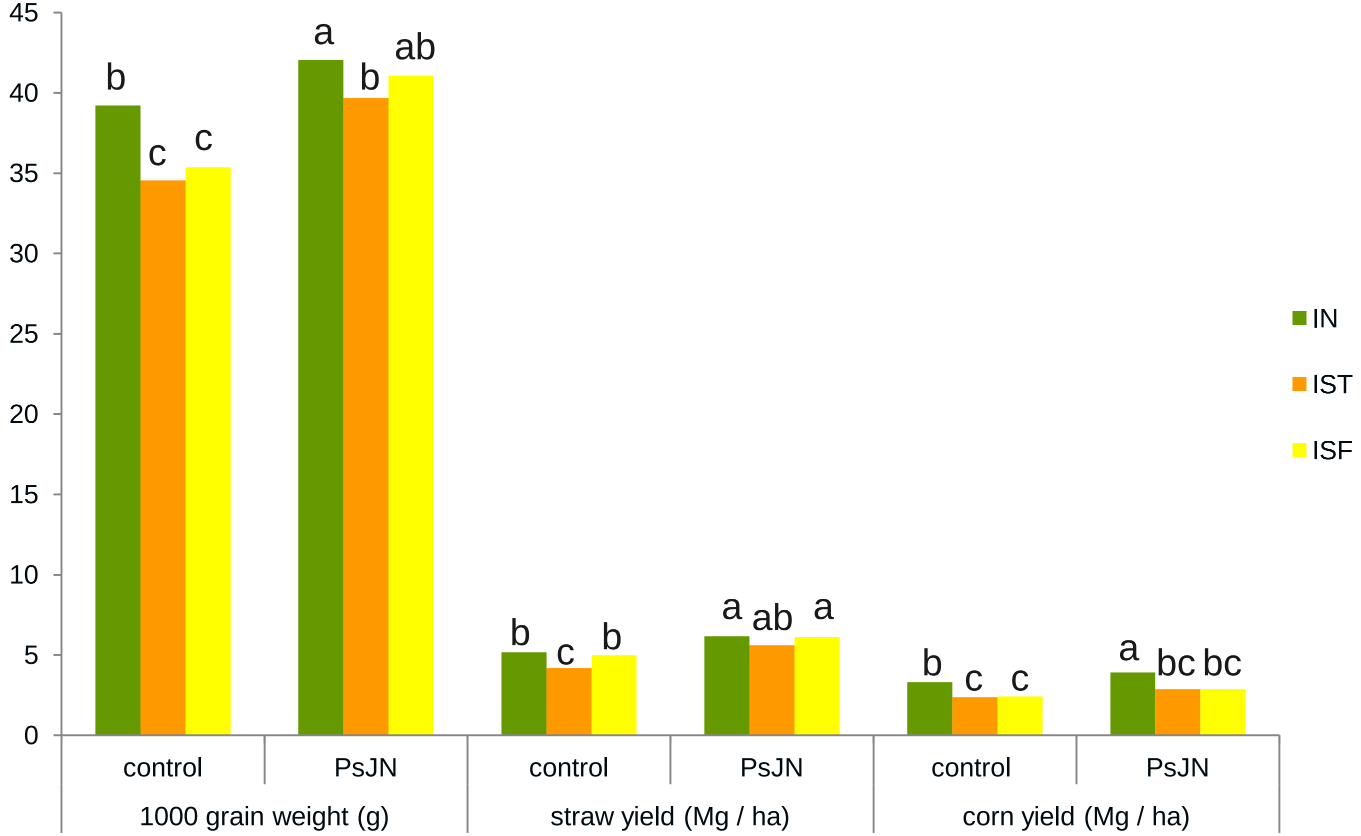
- Field experiment in Faisalabad / Pakistan
- Peat-based seed treatment with PsJN (10^8 – 10^9 CFU/ml; 200 ml inoculum / kg peat)
- Treatments
    - 5 irrigations (IN)
    - Irrigation skipped at tillering (IST)
    - Irrigation skipped at flowering (ISF)

Naveed et al. 2014, Plant Growth Regul

Drought stress amelioration in wheat through inoculation with *B. phytofirmans* strain PsJN



Naveed et al. 2014, Plant Growth Regul

Drought stress amelioration in wheat through inoculation with *B. phytofirmans* strain PsJN

	Glutathione reductase (umol TNB min^{-1} g^{-1} fw)		Catalase (umol H_2O_2 min^{-1} g^{-1} fw)		Ascorbate peroxidase (umol ascorbate min^{-1} g^{-1} fw)	
	control	PsJN	control	PsJN	control	PsJN
IN	4.00 +/- 0.23 e	8.61 +/- 0.29 cd	190 +/- 6.12 d	232 +/- 8.42 d	46 +/- 0.36 e	63 +/- 0.63 de
IST	7.36 +/- 0.56 d	13.07 +/- 0.32 b	317 +/- 7.43 c	482 +/- 6.54 b	95 +/- 1.08 d	405 +/- 1.22 a
ISF	9.79 +/- 0.85 c	15.48 +/- 0.98 a	332 +/- 5.98 c	590 +/- 6.72 a	154 +/- 1.17 c	241 +/- 0.98 b

	Malondialdehyde (umol MDA min^{-1} g^{-1} fw)		Total phenolics (ug g^{-1})		Total soluble sugars (ug g-1)	
	control	PsJN	control	PsJN	control	PsJN
IN	1.44 +/- 0.05 d	3.03 +/- 0.03 c	90.77 +/- 5.12 e	62.83 +/- 5.62 f	3.41 +/- 0.15 a	3.31 +/- 0.13 a
IST	3.66 +/- 0.13 c	6.63 +/- 0.22 a	177.53 +/- 7.61 a	151.75 +/- 6.52 c	3.99 +/- 0.24 a	3.58 +/- 0.31 a
ISF	4.55 +/- 0.29 b	6.35 +/- 0.32 a	162.50 +/- 5.28 b	109.57 +/- 4.98 a	4.03 +/- 0.54 a	3.45 +/- 0.43 a

Naveed et al. 2014, Plant Growth Regul

What do we know (about PsJN) and what do we need to know for achieving success in the field?

PsJN

- Increases biomass production
- Improves stress tolerance (drought, heavy metals, pathogens)
- Supports plant physiology to cope with stress and to better take up nutrients
- IAA production, likely also in-situ
- Other potential mechanisms: ISR, ACCd, siderophores, anti-oxidative effects….
- Microbiome shifts?

General considerations

- Colonization and competition (modes of action)
- Understanding (the regulation of) beneficial modes of actions
- Specific requirements for growth, colonization and beneficial functions
- Dosage effects
- Formulations
- Microbiome interactions?

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Schönbrunn, Vienna, Austria

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Final Conference
COST Action FA1103

Invited speakers:
B. Lugtenberg, J. Kloepper,
F. Feldmann, I. Pertot,
L. Johnson, S. Declerck,
F. Beed, M. Ongena,
C.-M. Ryu, S. Compant,
J. Raaijmakers, K. Smalla,
C. Franco, G. Berg,
Y. Bashan, S. Håkansson

Sessions:
- o Successful microbial products
- o Need for microbial solutions
- o Colonization and mechanisms of beneficial plant-microbe interactions
- o Involvement of multipartite and microbiome interactions
- o Microbial applications from lab to field
- o Application technologies and formulations
- o Registration requirements of microbial products
- o Roundtable discussion: Benefits and potential concerns for consumer and farmer