Gestione della fertilità degli agroecosistemi ispirata dal dialogo tra pianta, suolo e batteri

Caffè Scientifico -15 Dicembre 2021



DIPARTIMENTO DI AGRARIA

Nunzio Fiorentino
Division of Plant Biology and Crop Production
Department of Agricultural Sciences
University of Naples, Federico II

Scuola di Agraria e Medicina Veterinaria dell'Università degli Studi di Napoli Federico II

Study and Research Path

2006	2010	2010-2016	2016 - 2022

MSc
Agricultural sciences and technologies

Soil fertility management of organic cropping systems

PhD
Modeling and Analysis of cropping and forest systems

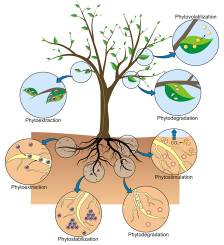
Soil C and N dynamics in eco-friendly cropping systems

Post-doc
Degraded soils
Soil-microbes-plant
Soil GHGs

CSIC

15N isotope tracing - N cycle

Energy-crops and turfgrass
Phytoremediation
Soil C and N management



Temporary researcher (A+B)

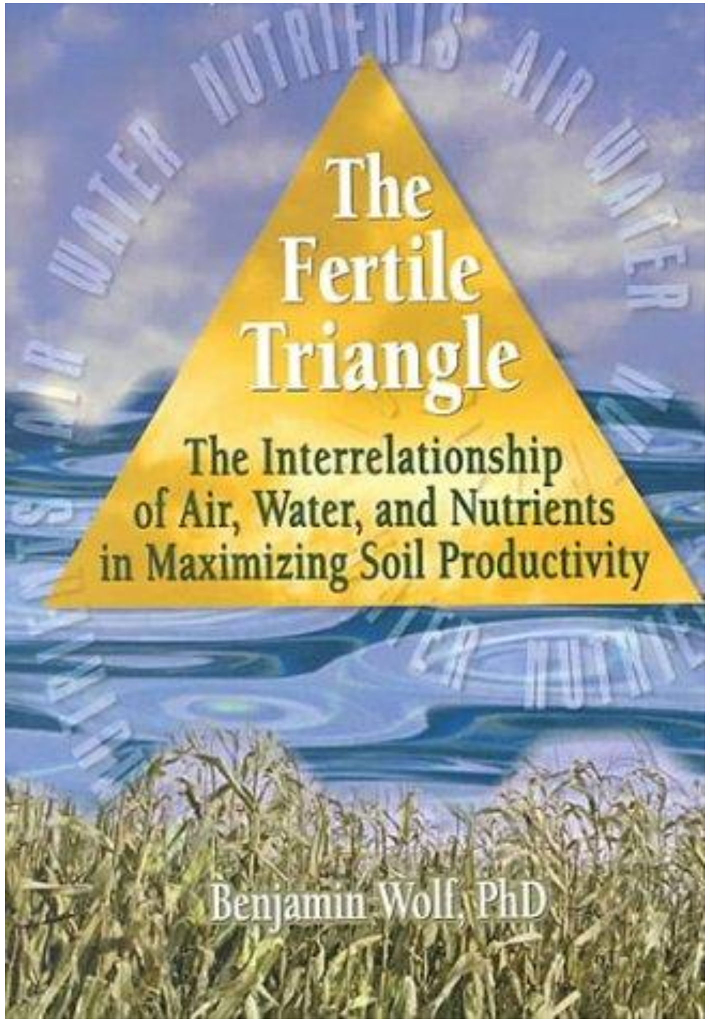
Project FRA - UNINA 2020
Agrocannabinomics

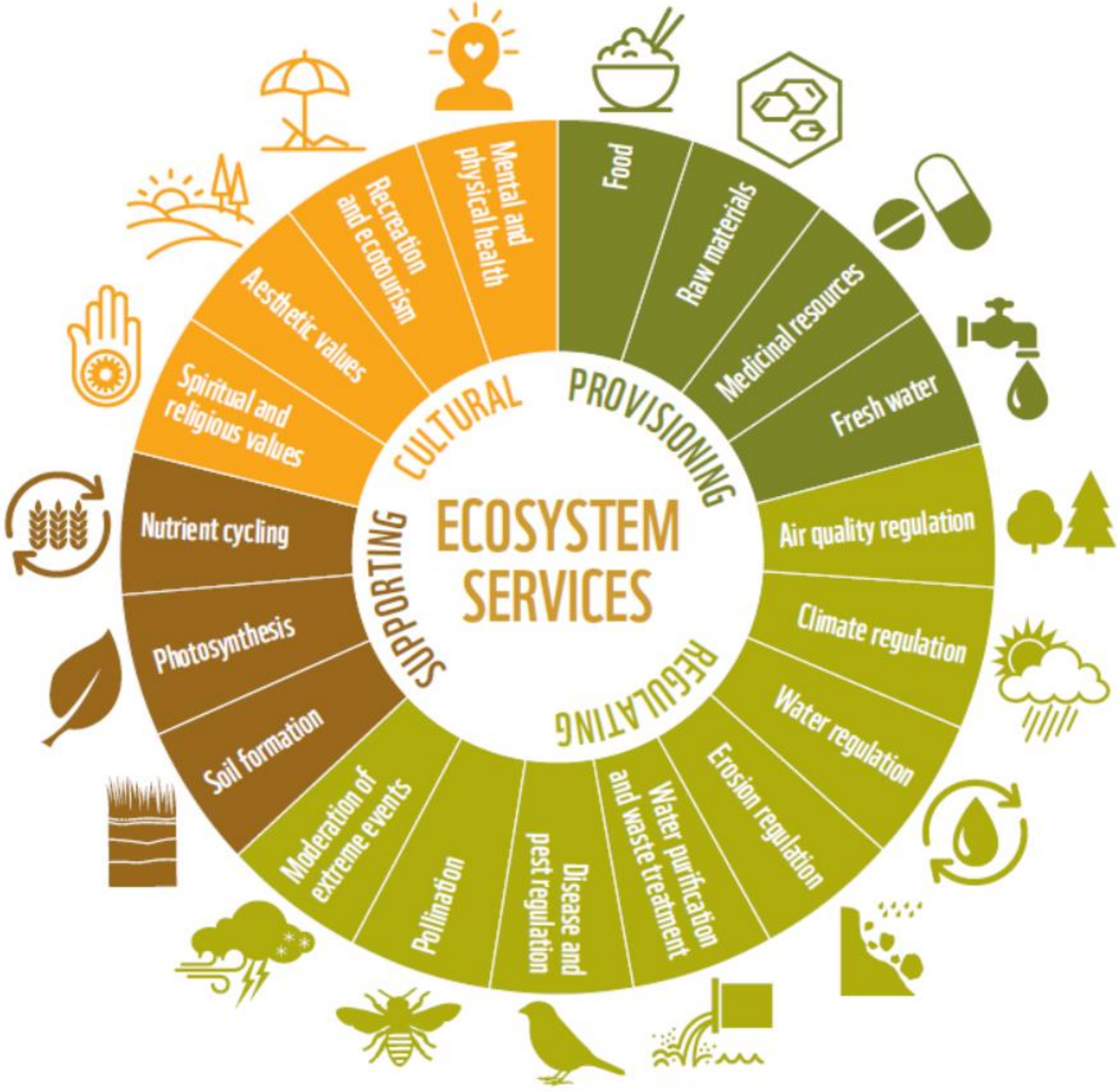
Project LIFE ENV - IT

ECOREMED

Teachings
Agronomy and agroecology (SAFA)
Agronomy (MV)

Soil Fertility and Ecosystem Services

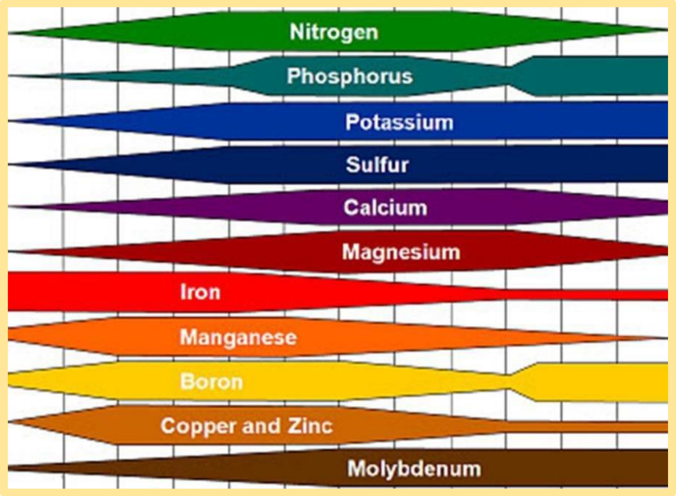




Adapted from the Millennium Ecosystem Assessment, 2005.

Fertility is strongly correlated to Soil Organic Matter (SOM) content

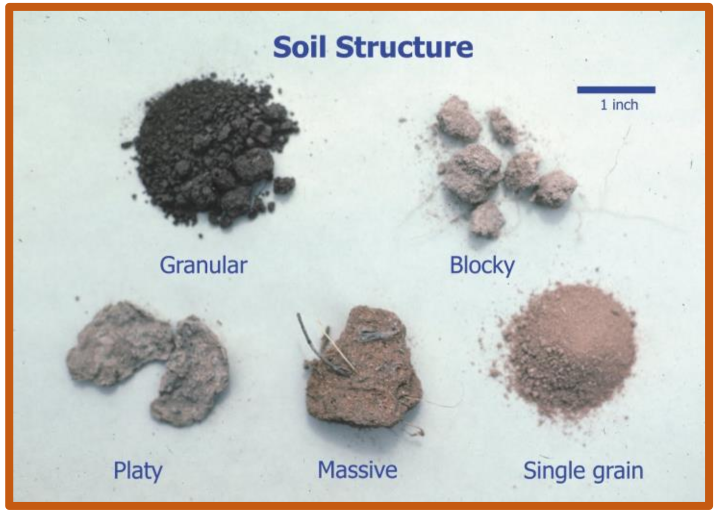
Chemical fertility



Modified by https://www.terravesco.com/soil-health/

Biological fertility

Phisical fertility



AGROECOSYSTEM MANAGEMENT

DECREASE SOIL DISTURBANCE

NO TILLAGE

Mazzoncini et al., 2001

Hernanz et al., 2009

MINIMUM TILLAGE

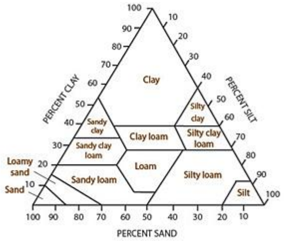
Morris et al., 2010

Fagnano et al., 2004

OXIGEN REDUCTION

Lower mineralization

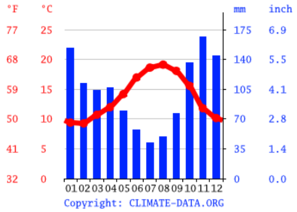
NATIVE N FERTILITY



Soil texture

SOM and SON

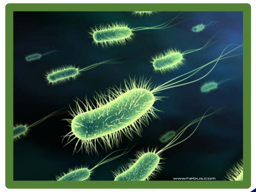
Nutrient content



Temperature

Moisture

Biological fertility



INCREASE C INPUT

STABILIZED ORGANIC AMENDMENTS

Bertora et al., 2010

Spaccini et al., 2002

Fortuna et al., 2003

SOM BUILD UP

humification

AGROECOSYSTEM MANAGEMENT

DECREASE SOIL DISTURBANCE

NO TILLAGE

Mazzoncini et al., 2001

Hernanz et al., 2009

MINIMUM TILLAGE

Morris et al., 2010

Fagnano et al., 2004

INCREASE C INPUT

STABILIZED ORGANIC AMENDMENTS

Bertora et al., 2010

Spaccini et al., 2002

Fortuna et al., 2003

Biol Fertil Soils (2016) 52:523–537
DOI 10.1007/s00374-016-1095-7

CrossMark

ORIGINAL PAPER

Changes in soil mineral N content and abundances of bacterial communities involved in N reactions under laboratory conditions as predictors of soil N availability to maize under field conditions

Nunzio Fiorentino[1] · Valeria Ventorino[2] · Chiara Bertora[3] · Olimpia Pepe[2] · Moschetti Giancarlo[4] · Carlo Grignani[3] · Massimo Fagnano[1]

Europ. J. Agronomy 45 (2013) 114–123

Contents lists available at SciVerse ScienceDirect

European Journal of Agronomy

journal homepage: www.elsevier.com/locate/eja

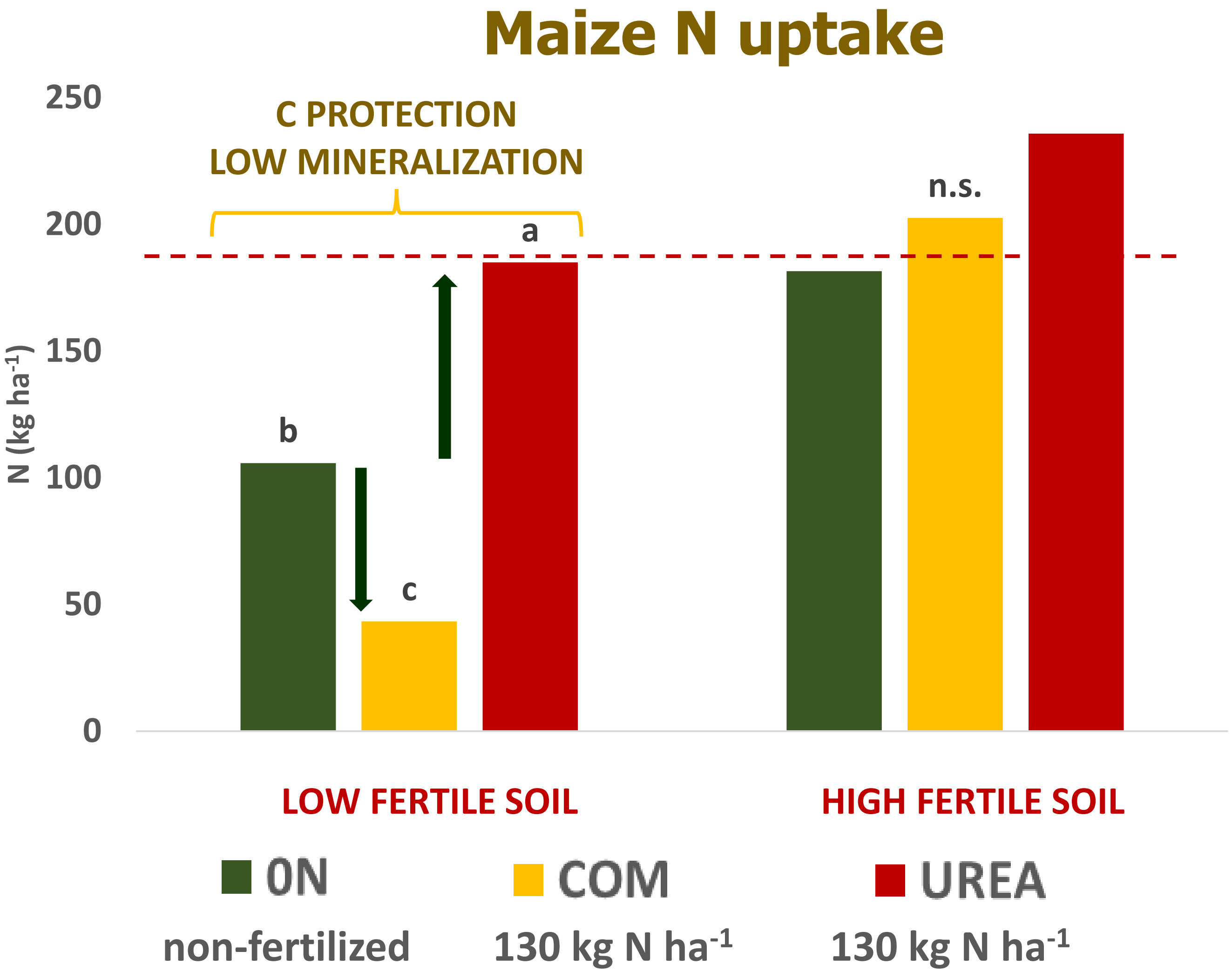
ELSEVIER

Short-term crop and soil response to C-friendly strategies in two contrasting environments

Francesco Alluvione[a], Nunzio Fiorentino[b,*], Chiara Bertora[a], Laura Zavattaro[a], Massimo Fagnano[b], Fabrizio Quaglietta Chiarandà[b], Carlo Grignani[a]

[a] Dipartimento di Agronomia, Selvicoltura e Gestione del Territorio – Università di Torino, Italy
[b] Dipartimento di Ingegneria Agraria e Agronomia del Territorio – Università di Napoli Federico II, Italy

Plant - bioindicator of soil N availability



Soil - N mineralization kinetics

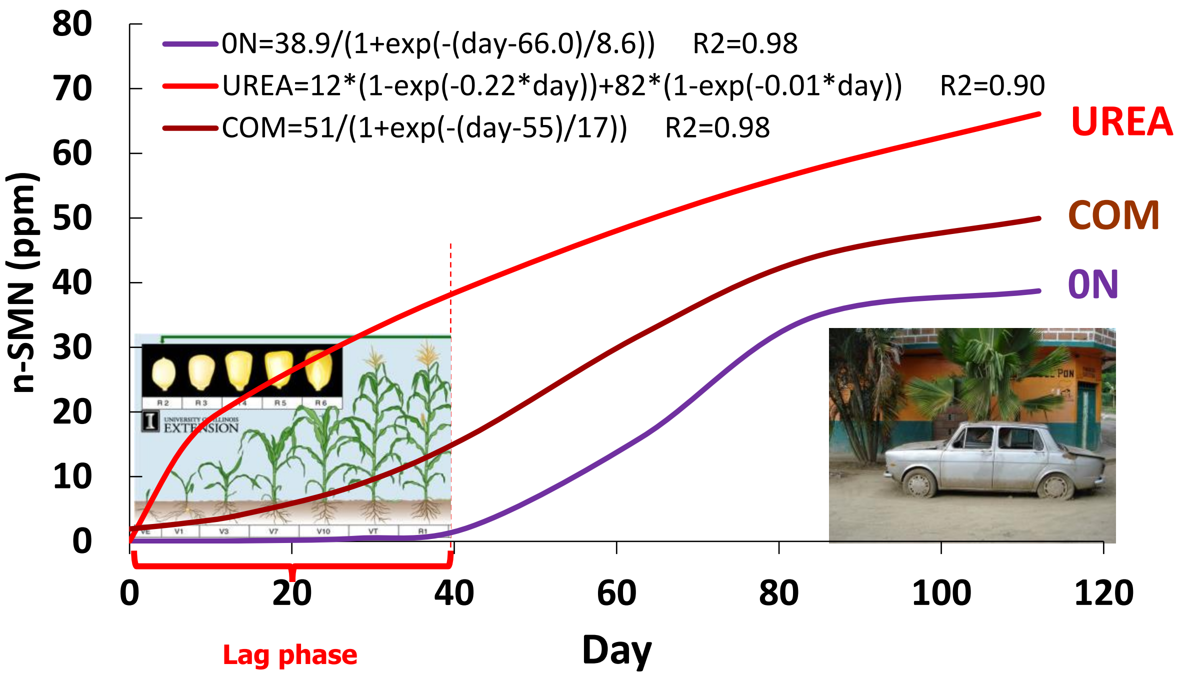
SOIL INCUBATION

Optimal conditions for N cycling bacteria

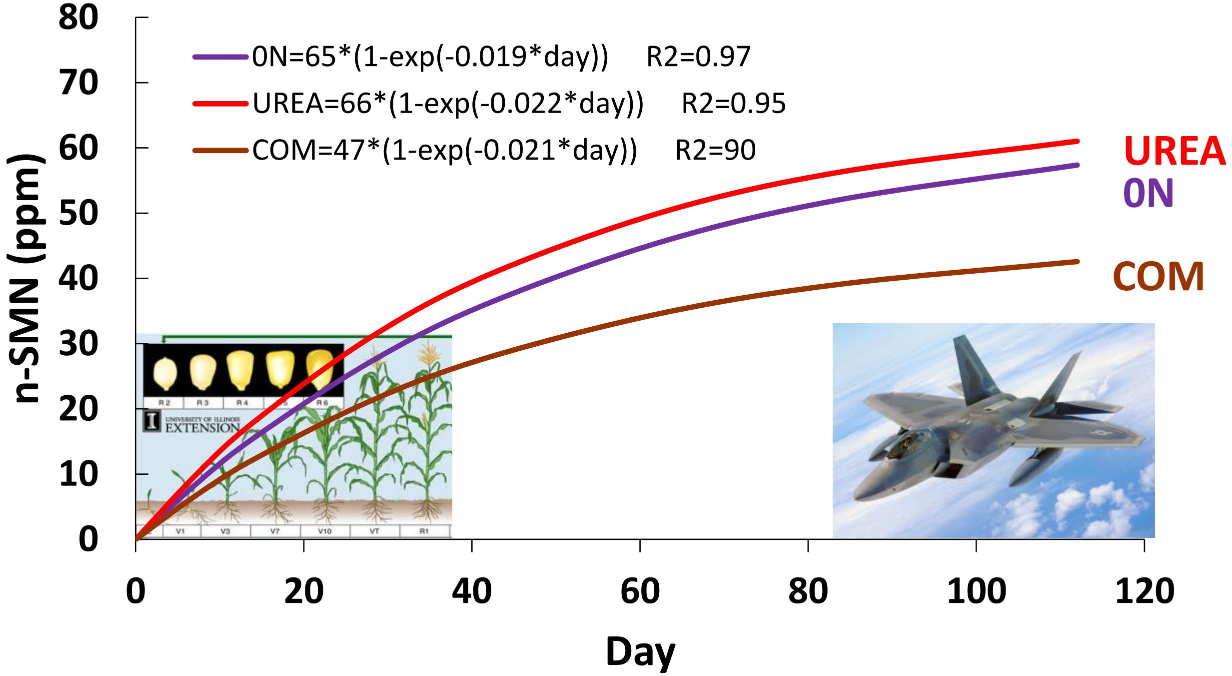
T °C = 25 °C

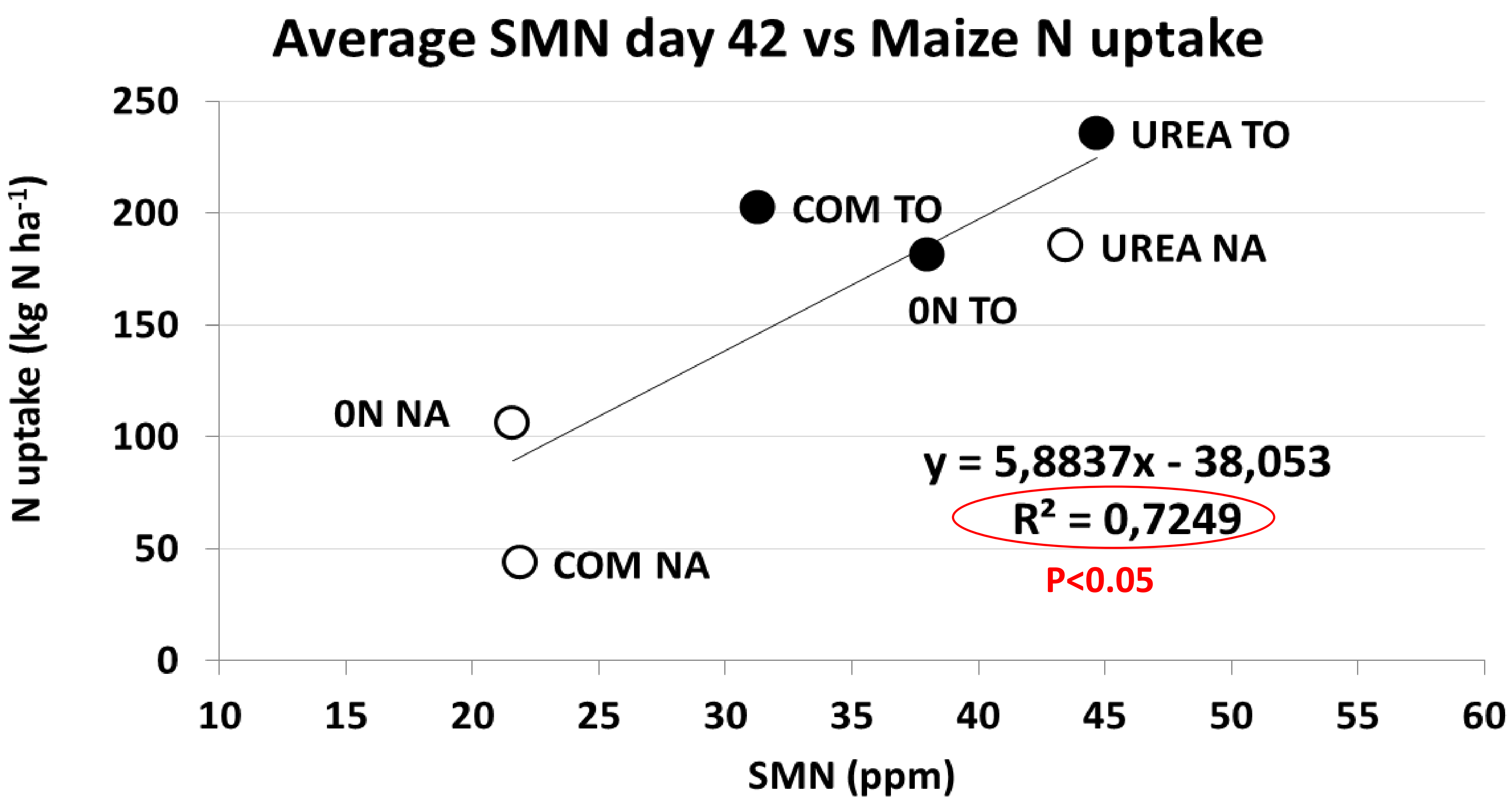
Soil Moisture: field capacity

Low fertile soil



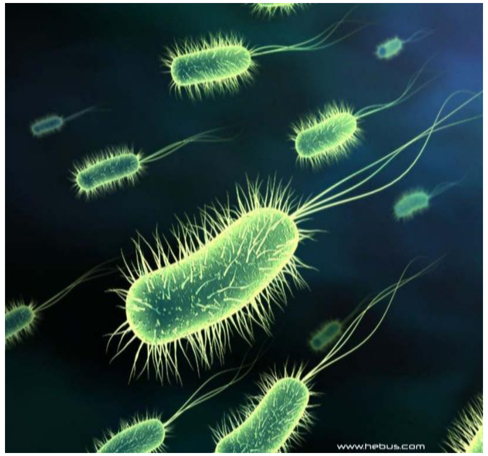
High fertile soil



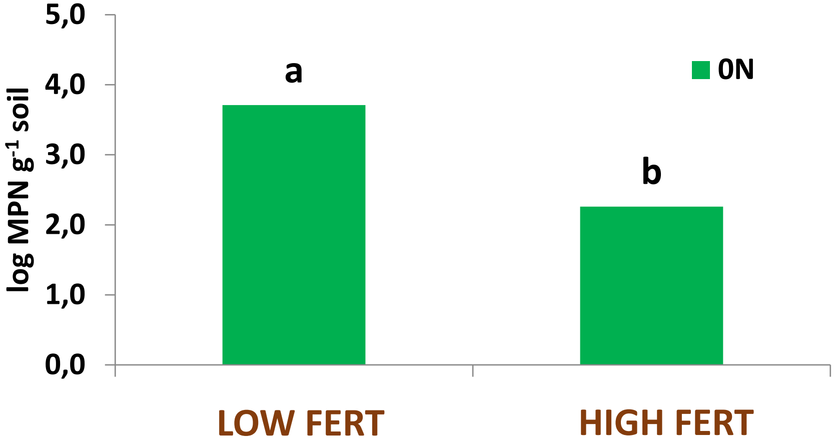


Average SMN day 42 vs Maize N uptake
N uptake (kg N ha-1)
250
200
150
100
50
0
10
15
20
25
30
35
40
45
50
55
60
SMN (ppm)
UREA TO
COM TO
UREA NA
0N TO
0N NA
COM NA
y = 5,8837x - 38,053
R² = 0,7249
P<0.05

N cycling bacteria – a proxy of N availability



Free Living N-Fixing Bacteria



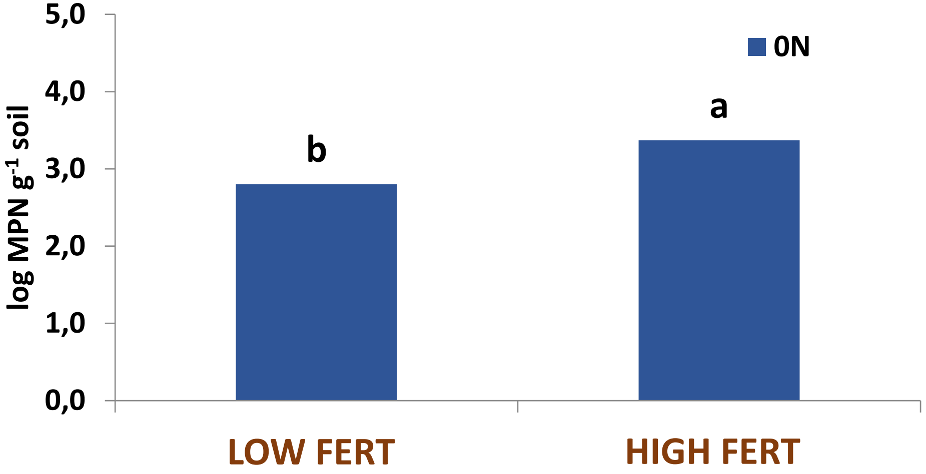
Higher values recorded in low fertile soil

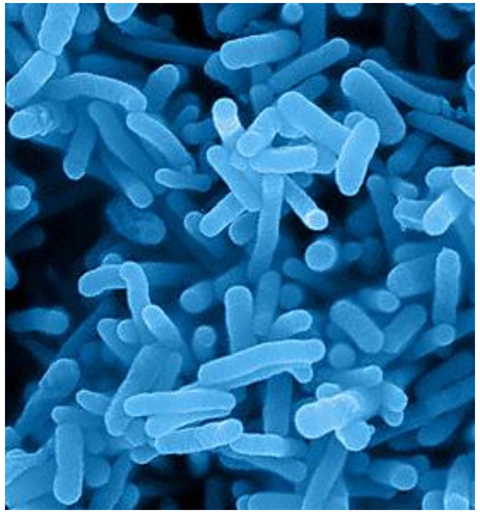
NFB inversely correlated to N availability (Poly et al., 2001; Tan et al., 2003)

Ammonia oxidizing bacteria

Lower values recorded in soils with low N mineralization rates(lack of O_2)

Higher C build up





Short term soil N dynamics in open field

Agriculture, Ecosystems and Environment 141 (2011) 100–107

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

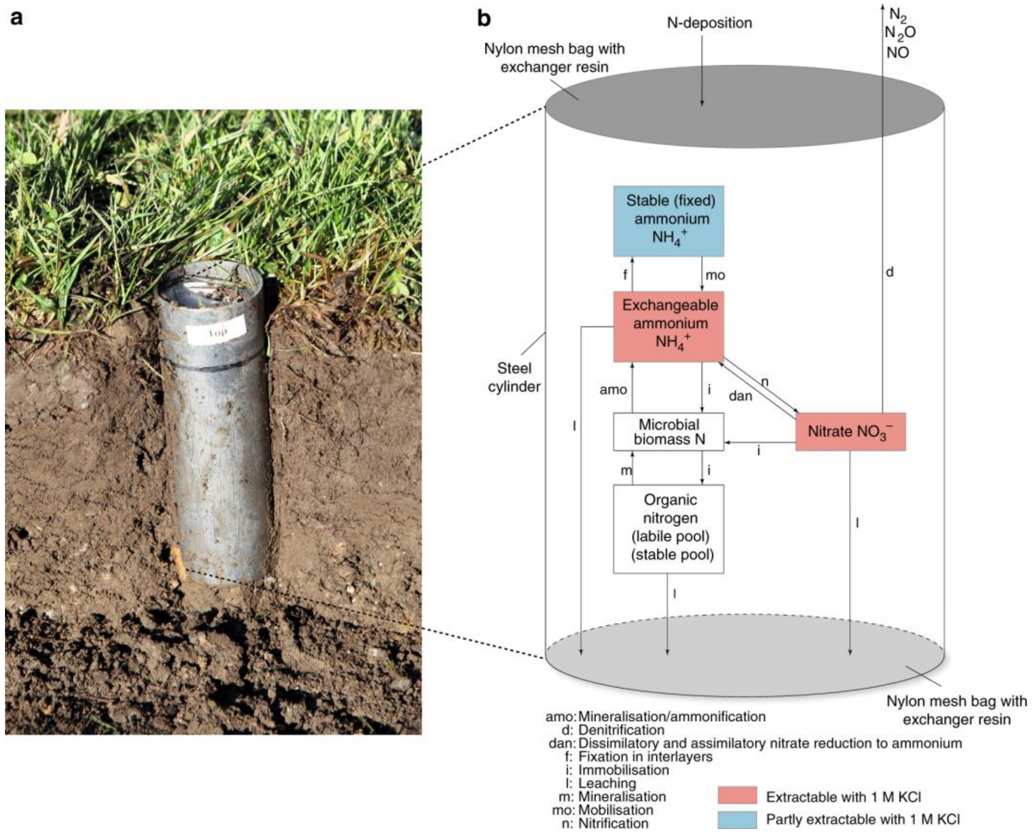
Environmental and agronomic impact of fertilization with composted organic fraction from municipal solid waste: A case study in the region of Naples, Italy

Massimo Fagnano[a,*], Paola Adamo[b], Mariavittoria Zampella[b], Nunzio Fiorentino[a]

[a] Dipartimento di Ingegneria agraria e Agronomia, Università di Napoli Federico II, Via Università 100, 80055 Portici, Italy
[b] Dipartimento di Scienze del Suolo, della Pianta, dell'Ambiente e delle Produzioni Animali, Università di Napoli Federico II, Via Università 100, 80055 Portici, Italy

Open field measurement of N availability

Field incubation approach



Rish et al 2009 – Nature communications **10**, 4981

Crop based approach

N BALANCE EQUATION

N inputs - N uptake + Soil N at transpl. - Soil N at harvest + N mineraliz ≠ 0

SYSTEM N AVAILABILITY

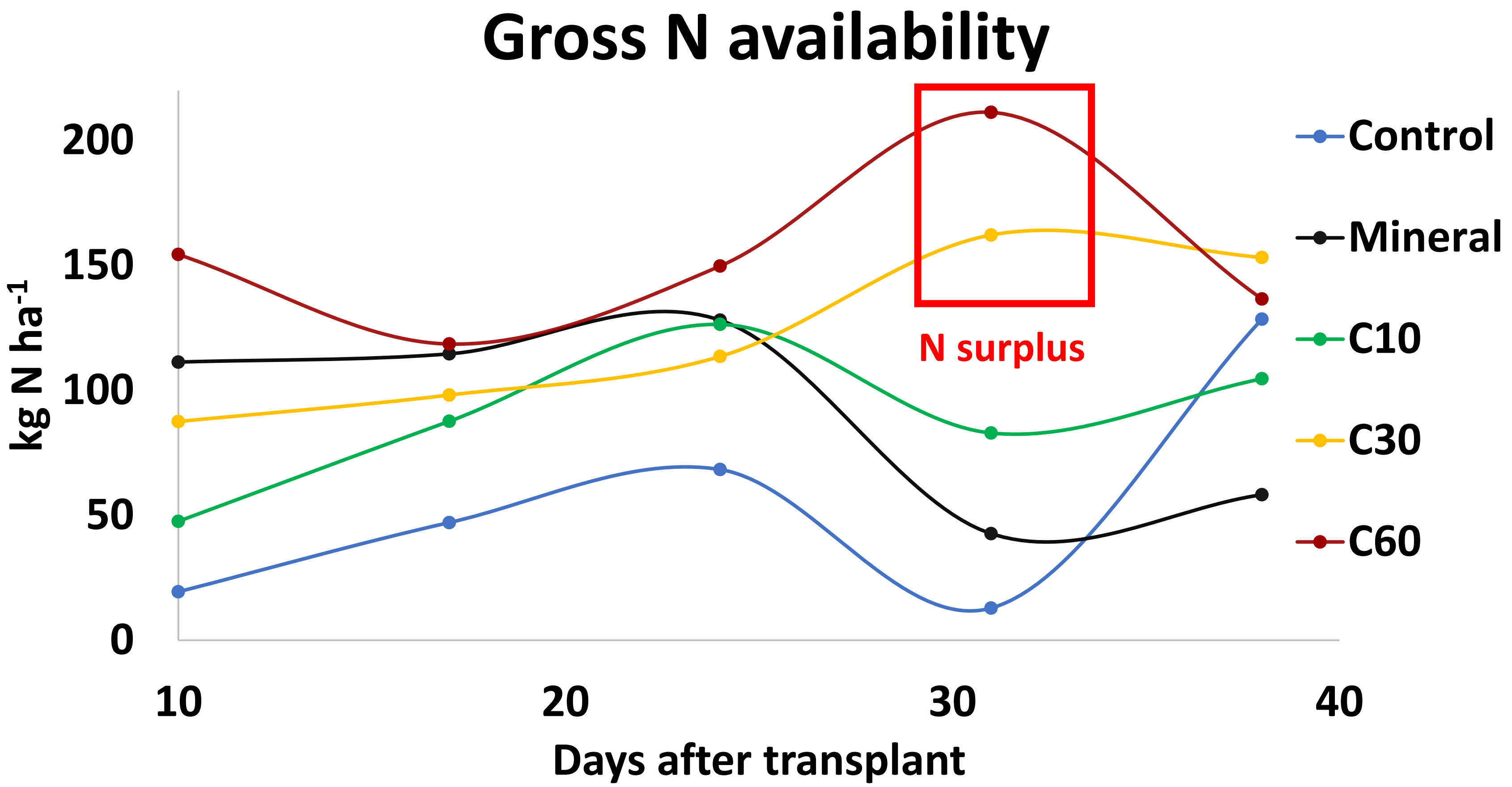
N uptake + Soil N at harvest - Soil N at transpl. =

N inputs + N mineraliz

- N inputs → Native Mineral N (unfertilized soil)
- N mineraliz → Native + Available From fertilizers (fertilized soils)

Meisinger, J.J., 1984. Nitrogen in Crop Production, Madison, pp. 391–416.

Short term effects on soil mineral N



N balance of the two lettuce cycles.

Treatment	N balance (kg N ha^{-1})
NF	–111.2 c
CF10	–81.1 c
CF30	21.8 b
CF60	153.3 a
MF	10.6 b
Significance	*0.01*

Potential N losses

Modification of the plant-soil rhizospheric interactions

frontiers in Plant Science

ORIGINAL RESEARCH
published: 05 June 2018
doi: 10.3389/fpls.2018.00743

Trichoderma-Based Biostimulants Modulate Rhizosphere Microbial Populations and Improve N Uptake Efficiency, Yield, and Nutritional Quality of Leafy Vegetables

Nunzio Fiorentino[1,2]*, Valeria Ventorino[1,3], Sheridan L. Woo[3,4,5], Olimpia Pepe[1,3], Armando De Rosa[1], Laura Gioia[1], Ida Romano[1], Nadia Lombardi[5], Mauro Napolitano[1], Giuseppe Colla[6] and Youssef Rouphael[1]

agronomy

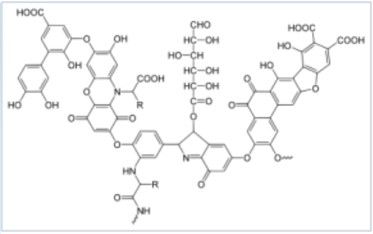
MDPI

Article

Can *Trichoderma*-Based Biostimulants Optimize N Use Efficiency and Stimulate Growth of Leafy Vegetables in Greenhouse Intensive Cropping Systems?

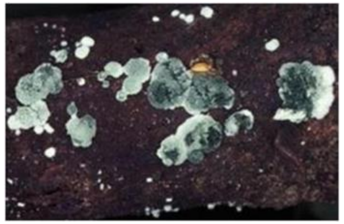
Donato Visconti [1], Nunzio Fiorentino [1,*], Eugenio Cozzolino [2], Sheridan Lois Woo [3,4], Massimo Fagnano [1] and Youssef Rouphael [1]

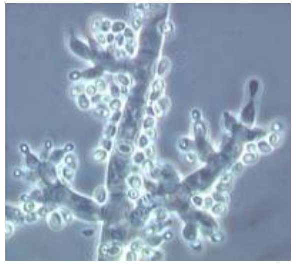
Biostimulants (EBIC 2012): “A plant biostimulant is any substance or microorganism applied to plants with the aim to enhance nutrition efficiency, abiotic stress tolerance and/or crop quality traits, regardless of its nutrients content”



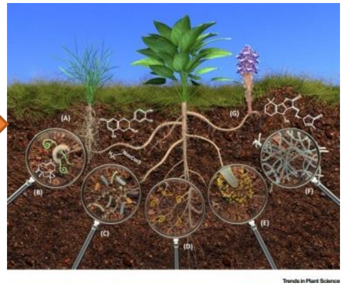
Trichoderma spp

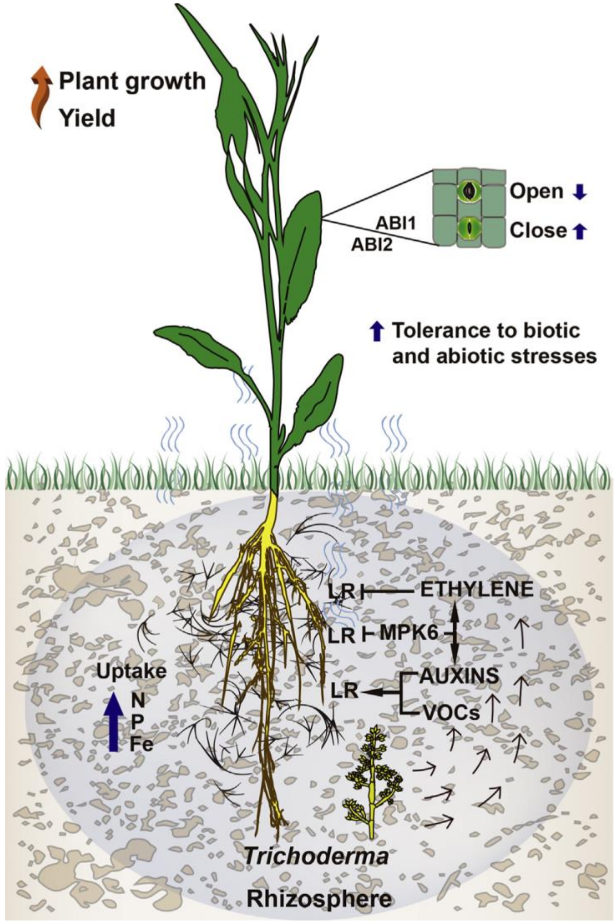
Saprophytic activity





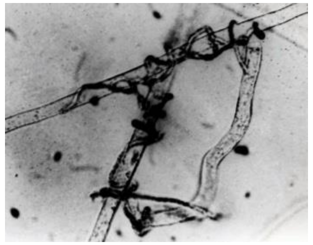
“rizosphere-competent”





Lopez-Bucio et al. 2015
Scientia Horticolturae

Mycoparasitism and biocontrol agents



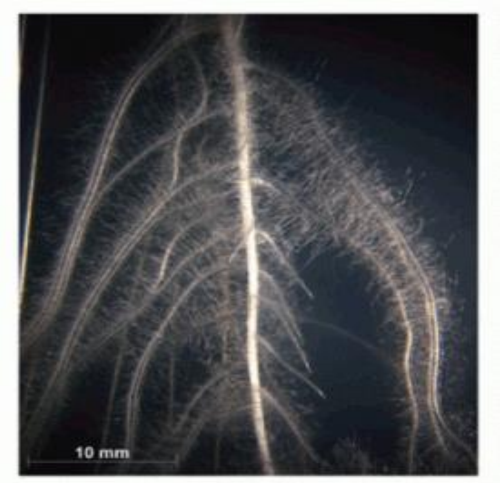
Results overview

	Non-fertilized Trichoderma	Fertilized Trichoderma
Yield		X
NPKCa	X	X
Ascorbic Acid		
Phenols		X
HAA	X	X
FAA		X

	Non-fertilized Trichoderma	Fertilized Trichoderma
Yield	X	
NPKCa	X	
Ascorbic Acid		X
Phenols		X
HAA		
FAA		

Species-specific interaction with Trichoderma

Rizosphere depends upon species/genotype



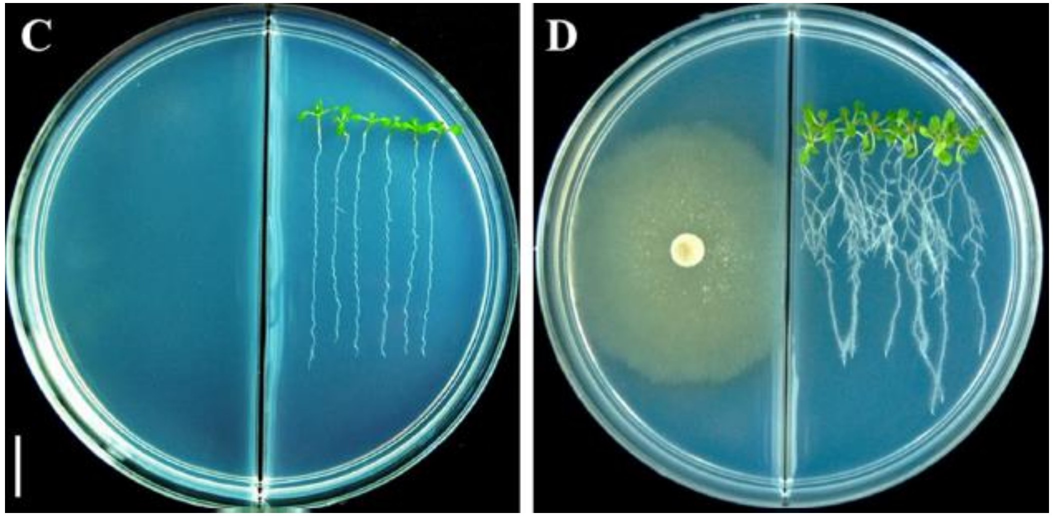
Crop cycle lenght

60 days

30 days

Effective under sub-optimal conditions (low Nutrient availability; drought/saline stress)

- Modification of root architecture (Samoldky et al., 2012)

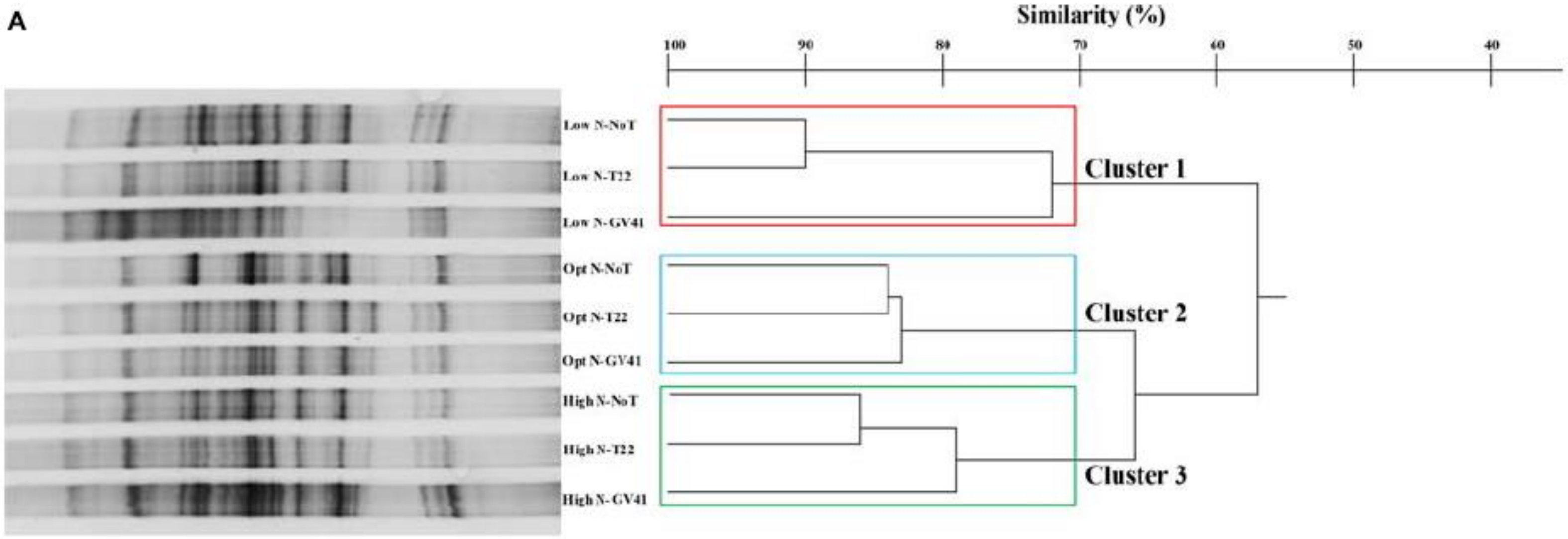


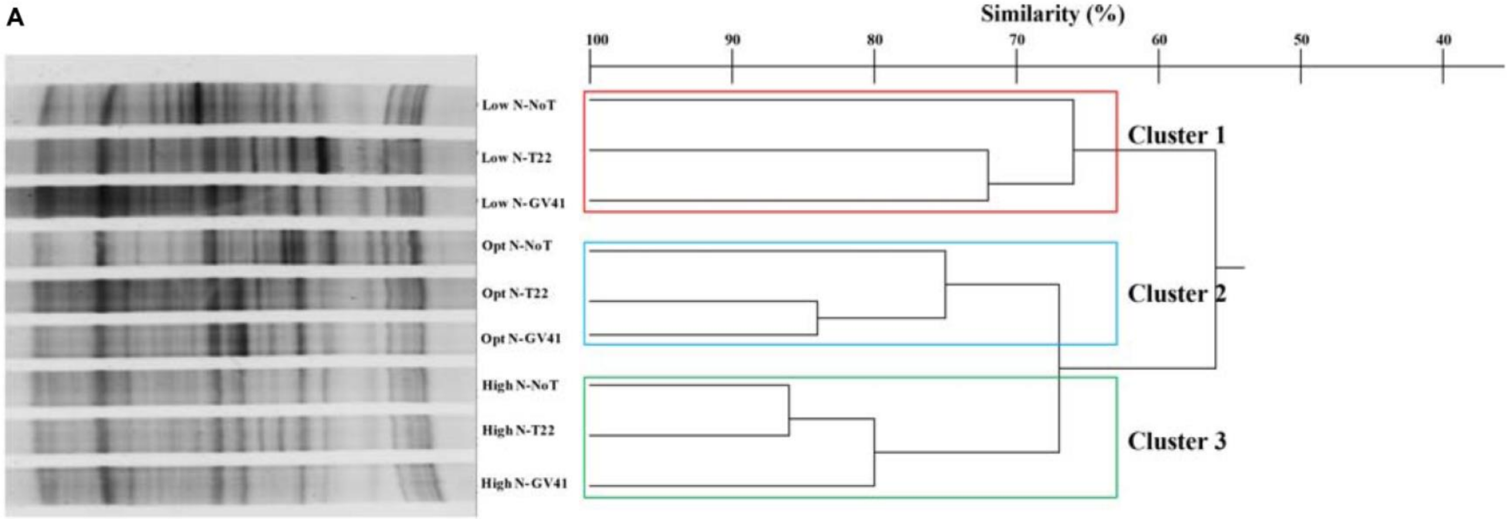
Lopez-Bucio et al. 2015 Scientia Horticolturae

Limited *Trichoderma* effect on nutrient uptake of *Brassicaceae* known as hyper-accumulating species (Santamaria et al., 2002 *J. Plant Nutr*) for PO_4 e Ca.

Implications of Trichoderma-Based Biostimulants for Modulating Soil Microbial Communities

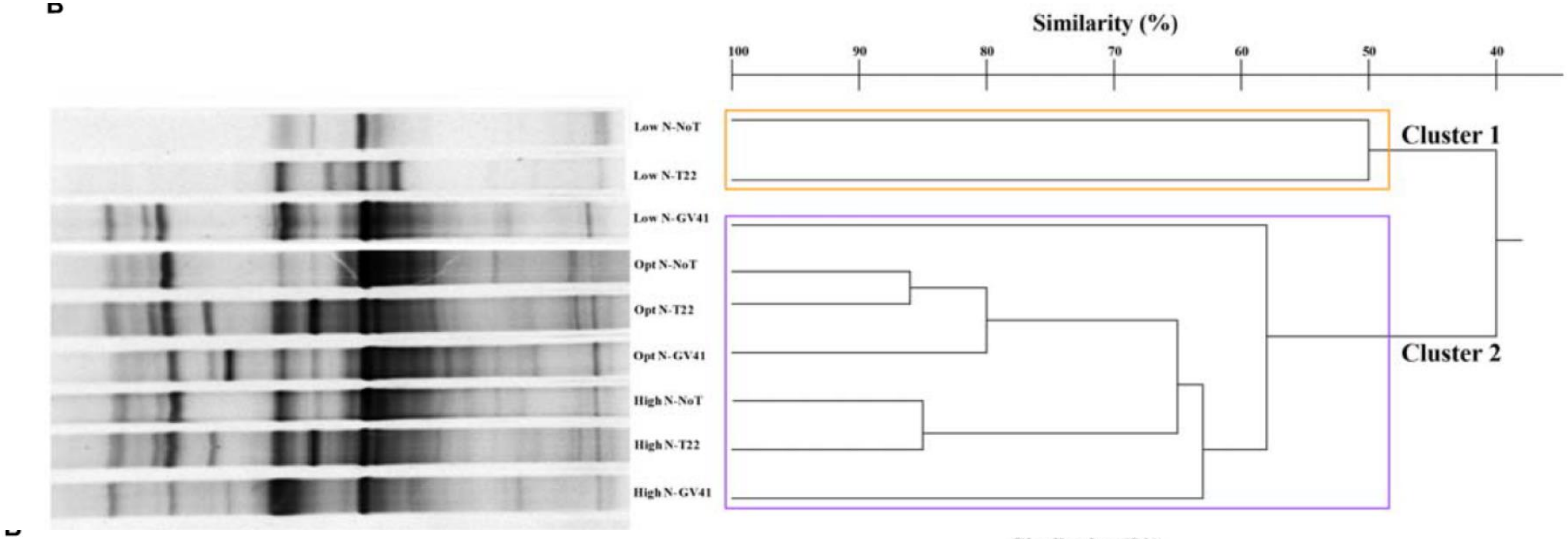
DGGE profiles and dendrogram showing the degree of similarity (%) of the PCR-DGGE **profiles of the prokaryotes**

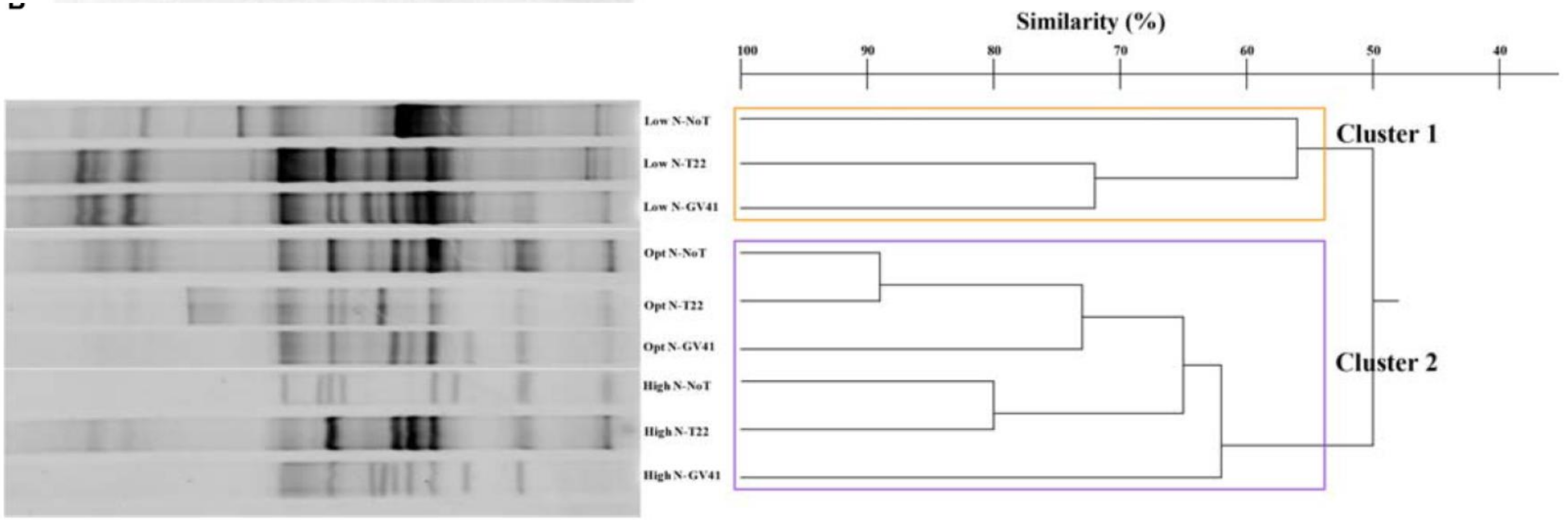


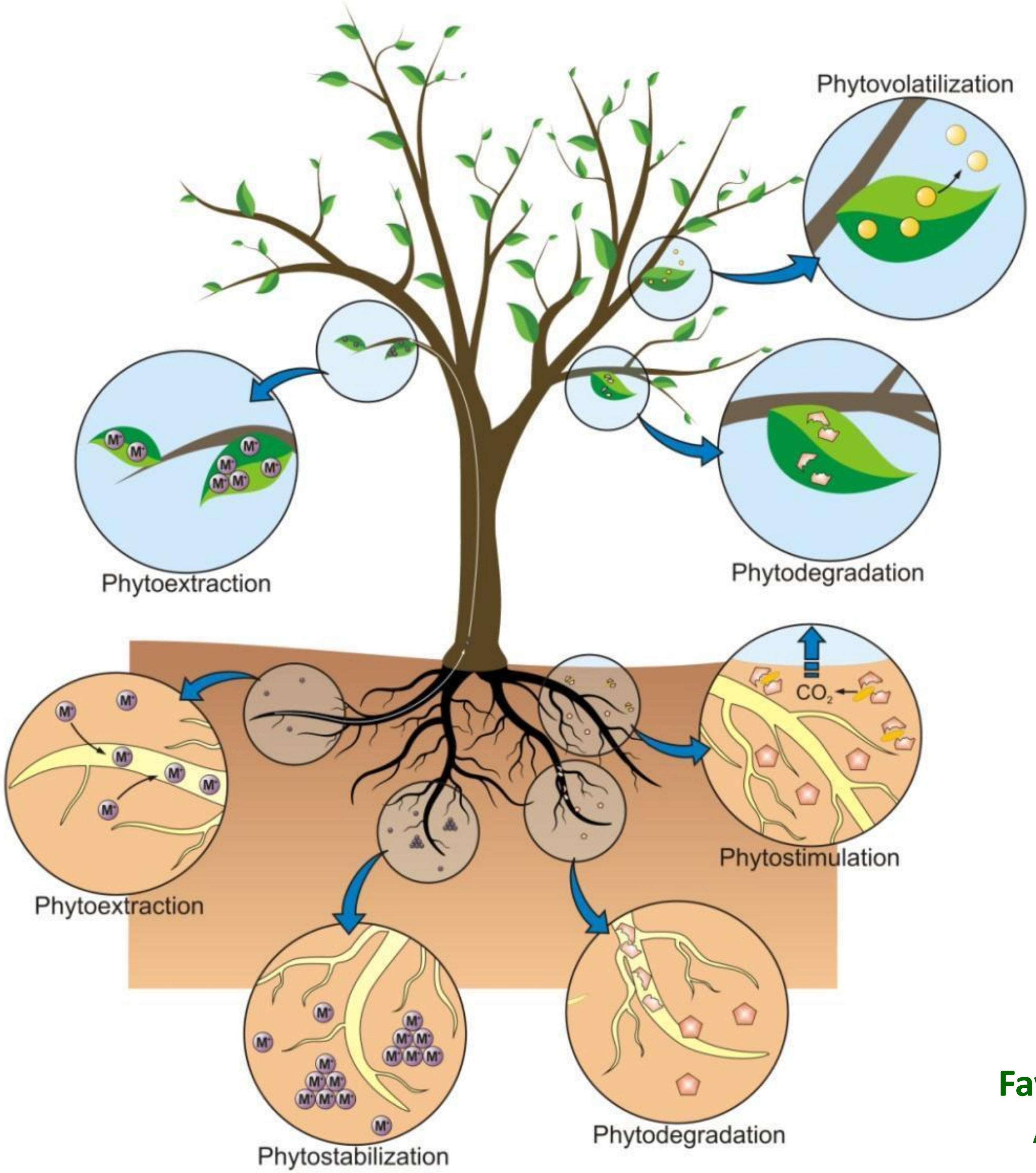


Implications of Trichoderma-Based Biostimulants for Modulating Soil Microbial Communities

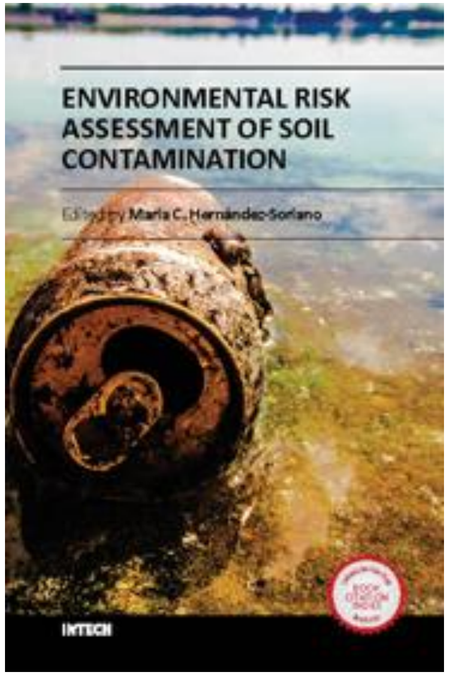
DGGE profiles and dendrogram showing the degree of similarity (%) of the PCR-DGGE **profiles of the eukaryotes**







Phyto
plant
Remedium
remediation



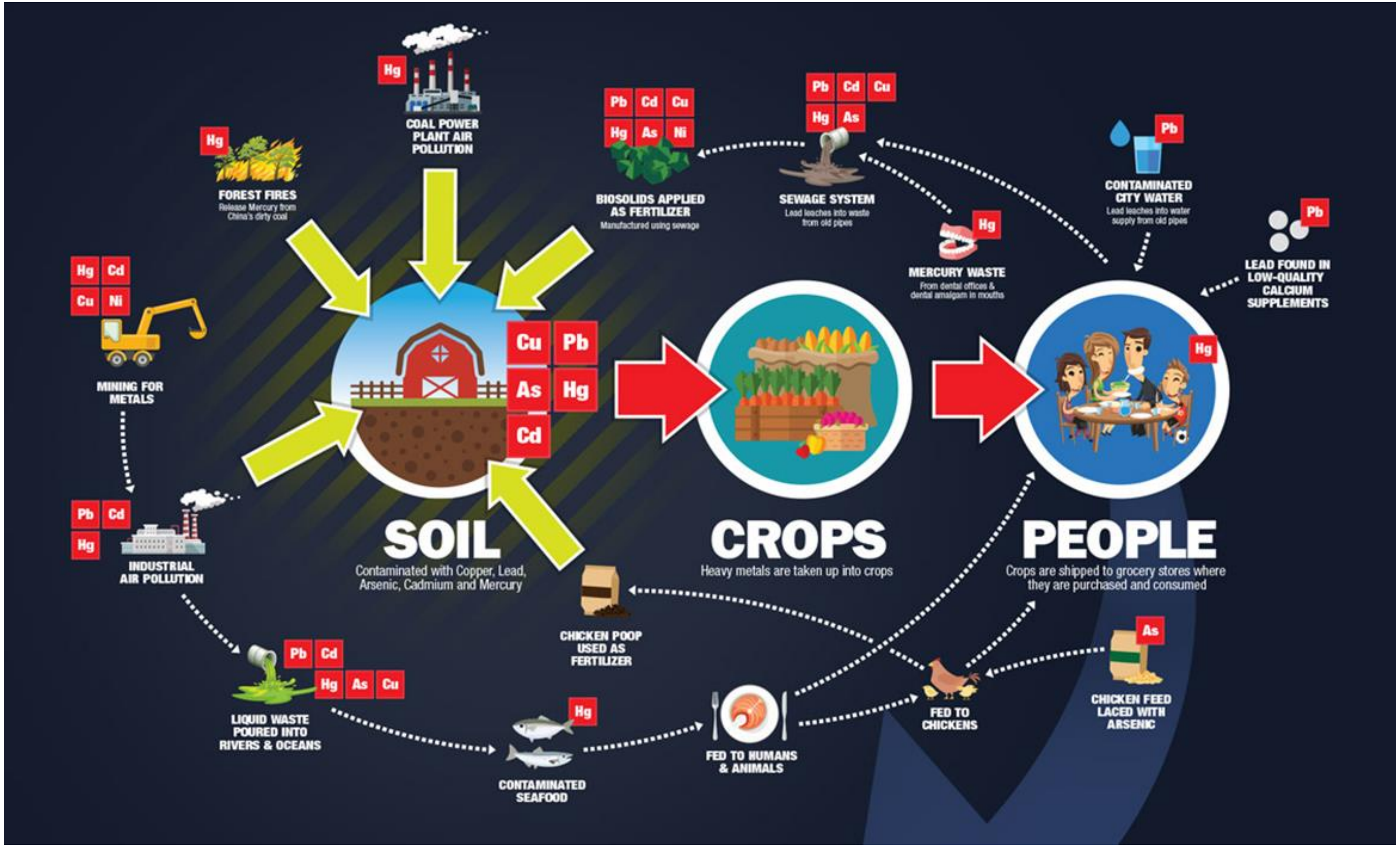
Favas et al 2014 in Environmental Risk Assessment of Soil Contamination

Plant and PTEs interaction

Metal	Essential	Functions in plants (toxicity thereshold mg kg^{-1})
As	No	(20)
Cd	No	(5-10)
Co	Yes	Cofactor **enzymatic activities**; essential for **Rhizobium** (60-170)
Cr	No	(1-2)
Cu	Yes	Constituent of enzymes; **role in photosynthesis**; **yield and quality** (15-20)
Mn	Yes	Constituent and activator of enzymes; photosynthesis; reproductive phase; **resistance biotic and abiotic stress** (170-2000)
Ni	Yes	Constituent of enzymes; activation of urease (20-30)
Pb	No	(10-20)
Zn	Yes	Constituent of cell membranes; activation of enzymes; DNA transcription; involved in reproductive phase and in determining yield and quality of crops; resistance against biotic and abiotic stress; legume **nodulation and nitrogen fixation** (150-200)

Modified from Vamerali et al Environ Chem Lett (2010) 8:1–17

Transfer to food chain



Italian Journal of Agronomy 2013; volume 8:e29

Assisted phytoextraction of heavy metals: compost and *Trichoderma* effects on giant reed (*Arundo donax* L.) uptake and soil N-cycle microflora

Nunzio Fiorentino, Massimo Fagnano, Paola Adamo, Adriana Impagliazzo, Mauro Mori, Olimpia Pepe, Valeria Ventorino, Astolfo Zoina

Dipartimento di Agraria, Università di Napoli Federico II, Portici (NA), Italy

Arundo donax

Biomass crop

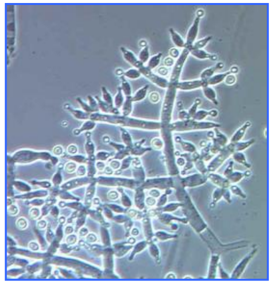
Hypertolerant

Non-edibile

Acerra (Naples)	Cd (mg kg^{-1})
Measured values	3.4
legal threshold Agric. Soils	2.0

High fertile soil potentially contaminated by Cd
(source low quality MSW compost)

***Trichoderma* inoculation**



increase Giant Reed root uptake and growth

Compost (10 Mg ha^{-1} FW)

increases Nitrogen and PTEs bioavailability

Bioindication of Cd availability

Factors	Abg. Biomass	Rhizomes	BAF	BAF'
	(g Cd ha^{-1})		shoots	roots
Inoculation				
NT	52.0 b	6.9 b	**1.23**	1.00
T	61.1 a	8.7a	**1.22**	**1.14**
Fertilization				
NC	48.9 b	7.1	**1.14 b**	0.95 b
C	64.2 a	3.9	**1.32 a**	**1.19 a**

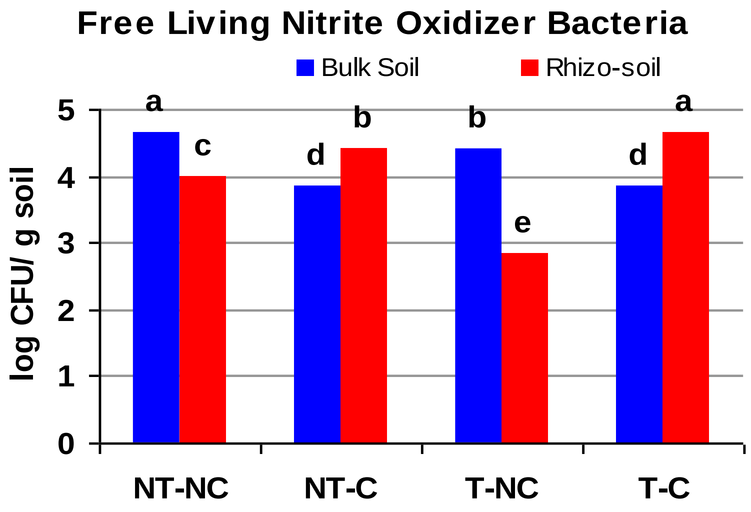
BAF_{root} = PTEs mg kg^{-1} roots / PTEs mg kg^{-1} soil

>1 : suitable for phytostabilization and securing of the site

BAF_{shoot} = PTEs mg kg^{-1} shoots / PTEs mg kg^{-1} soil

>1 : suitable for phytoextraction and remediation of the site

Microbial response to PTEs availability



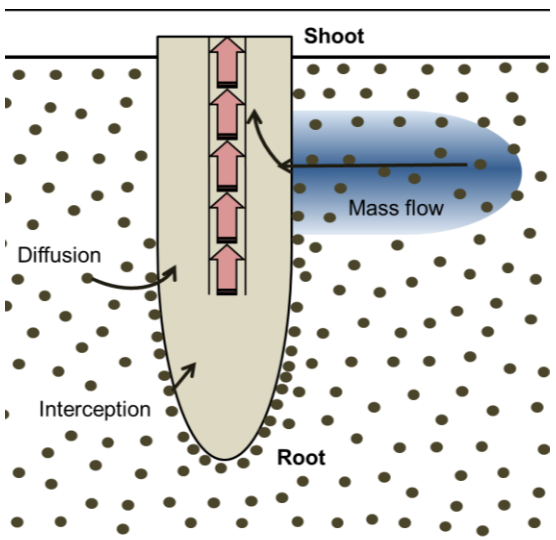
Free living Nitrite Oxidizers Bacteria (NOB):

- sensitive to heavy metals

- used to monitor the quality of contaminated soils

Plant effect: NOB lower in rhizo-soil due to higher **PTEs** concentration

Compost effect: NOB lower in bulk soil when compost was added (PTEs bio-availability was not balanced by Arundo donax uptake)



Based on Marschner and Rengel 2012

Mass flow of PTEs
driven by the transpiration rate of the plants

Compost amendment
Limits passive PTEs flows
Promotes active PTEs flows

STOTEN-21046; No of Pages 9

Science of the Total Environment xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

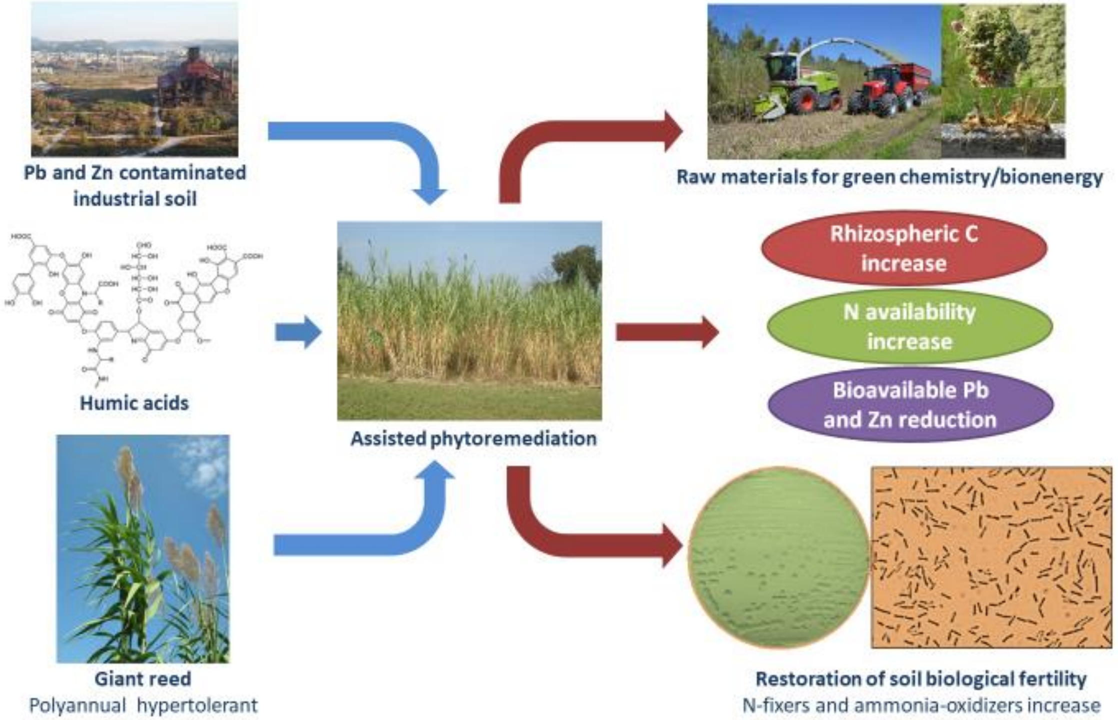
Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Giant reed growth and effects on soil biological fertility in assisted phytoremediation of an industrial polluted soil

N. Fiorentino *, V. Ventorino, C. Rocco, V. Cenvinzo, D. Agrelli, L. Gioia, I. Di Mola, P. Adamo, O. Pepe, M. Fagnano

Department of Agricultural Sciences, University of Naples Federico II, via Università, 100, 8055 Portici, Italy



ANALYSIS OF NATIVE VEGETATION FOR A DETAILED CHARACTERIZATION OF SOIL CONTAMINATION

Environmental Pollution 252 (2019) 1599–1608

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

ELSEVIER

Analysis of native vegetation for detailed characterization of a soil contaminated by tannery waste☆

Donato Visconti [a,*], Nunzio Fiorentino [a], Antonio G. Caporale [a], Adriano Stinca [b], Paola Adamo [a], Riccardo Motti [a], Massimo Fagnano [a]

[a] Department of Agricultural Sciences, University of Naples Federico II, via Università 100, 80055 Portici, Naples, Italy
[b] Department of Environmental, Biological and Pharmaceutical Sciences and Technologies, University of Campania Luigi Vanvitelli, via Vivaldi 43, 81100 Caserta, Italy

pagepress

Italian Journal of Agronomy 2018; volume 13(s1)

Use of the native vascular flora for risk assessment and management of an industrial contaminated soil

Donato Visconti,[1] Nunzio Fiorentino,[1] Adriano Stinca,[2] Ida Di Mola,[1] Massimo Fagnano[1]

[1]Department of Agricultural Sciences, University of Naples Federico II, Portici (NA); [2]Department of Environmental, Biological and Pharmaceutical Sciences and Technologies, University of Campania Luigi Vanvitelli, Caserta, Italy

The study-site:

3,5 ha close to an industrial plant

Pb (1405-18688 ppm) and Cd (21-99 ppm) (concentrations above Italian Screening Values and Risk Thresholds)

Source: battery storage

Floristic survey

Setup of 9 plots representative of vegetation types

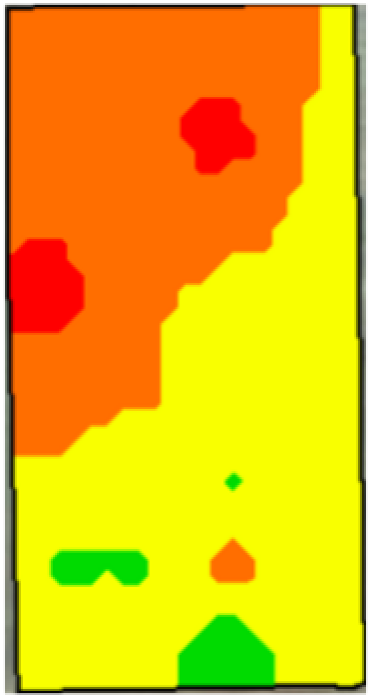
Identification of species, soil cover and frequency

Sampling of plants (shoots and roots) and rhizo-soils for PTE analyses

PTEs effects on plant communities and identification of contaminated areas

	Shannon index	Pielou index	Species number	Poaceae	Fabaceae	Asteraceae	Miscellaneous species	Plant soil cover
ERI	**-.84****	**-.88****	**-.71***	-.47	-.33	-.54	**-.68***	.37
Pb (mg Kg^{-1})	**-.82****	**-.84****	**-.68***	-.46	-.30	-.51	**-.65***	.37
Zn (mg Kg^{-1})	**-.80****	**-.79***	**-.81****	-.66	-.23	-.59	**-.73***	.32
Cd (mg Kg^{-1})	**-.85****	**-.89****	**-.72***	-.47	-.33	-.55	**-.69***	.37

** significant at the 0.01; * significant at the 0.05



- **ERI and PTEs (Cd, Pb and Zn)** had the greatest negative effect on plants diversity and number of species

Indirect risks and PTEs bioindicators

Species	Pb (mg kg^{-1} d.w.)			Cd (mg kg^{-1} d.w.)			Tl (mg kg^{-1} d.w.)		
	Shoots	Roots	Soil	Shoots	Roots	Soil	Shoots	Roots	Soil
Holcus lanatus	**70**	358	1707	**1.2**	4.9	5.8	0.11	0.45	1.5
Silene latifolia	**216**	**3403**	**49647**	**7.7**	**41.1**	**175.6**	**102.54**	**43.99**	**9.4**
Elymus repens	**282**	1407	16084	**5.2**	26.2	59.5	1.00	1.84	5.2
Dactylis glomerata	**323**	590	11795	**3.7**	17.8	50.7	0.28	0.96	2.3
Dittrichia viscosa	**47**	16	609	**1.1**	0.3	2.5	0.10	0.40	1.9
Thresholds for forage (Reg-UE 1275/13)	**34**			**1.06**			**---**		
Thresholds of hyperaccumulators (Van der Ent et al., 2013)	**1000**			**100**			**100**		

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Who is next?