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Soluzioni idroponiche per colture fuori suolo: opportunità e limitazioni

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International Journal of
Environmental Research and Public Health
ISSN 1660-4601
www.mdpi.com/journal/ijerph

Article

Comparison of Land, Water, and Energy Requirements of Lettuce Grown Using Hydroponic *vs.* Conventional Agricultural Methods

Guilherme Lages Barbosa [1], Francisca Daiane Almeida Gadelha [1], Natalya Kublik [2], Alan Proctor [1], Lucas Reichelm [1], Emily Weissinger [1], Gregory M. Wohlleb [1] and Rolf U. Halden [1,2,*]

Benefici della coltivazione in idroponica:

- *Efficiente uso della risorsa acqua*
- *Limitato uso di pesticidi*
- *Più alti livelli di produttività*
- *Possibilità di produrre su un arco temporale più ampio*
- *Utilizzo di aree marginali*

opportunità e limitazioni

Opportunità 1

Modificare le qualità organolettiche del prodotto sulla base delle richieste del mercato

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Scientia Horticulturae 109 (2006) 248–253

SCIENTIA HORTICULTURAE

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Effects of NaCl application to hydroponic nutrient solution on fruit characteristics of tomato (*Lycopersicon esculentum* Mill.)

Suguru Sato *, Sachi Sakaguchi, Hajime Furukawa, Hideo Ikeda

College of Agriculture and Biological Science, Osaka Prefecture University, 1-1 Gakuen-cho, Sakai, Osaka 599-8531, Japan

Received 16 March 2005; received in revised form 23 December 2005; accepted 3 May 2006

Tra i consumatori cresce la domanda di pomodori più dolci (Aoki, 2003), che vengono persino etichettati come *pomodoro dessert*

Per questa specifica richiesta si applicano sali o uno stress idrico prima del raccolto per migliorare la dolcezza del frutto

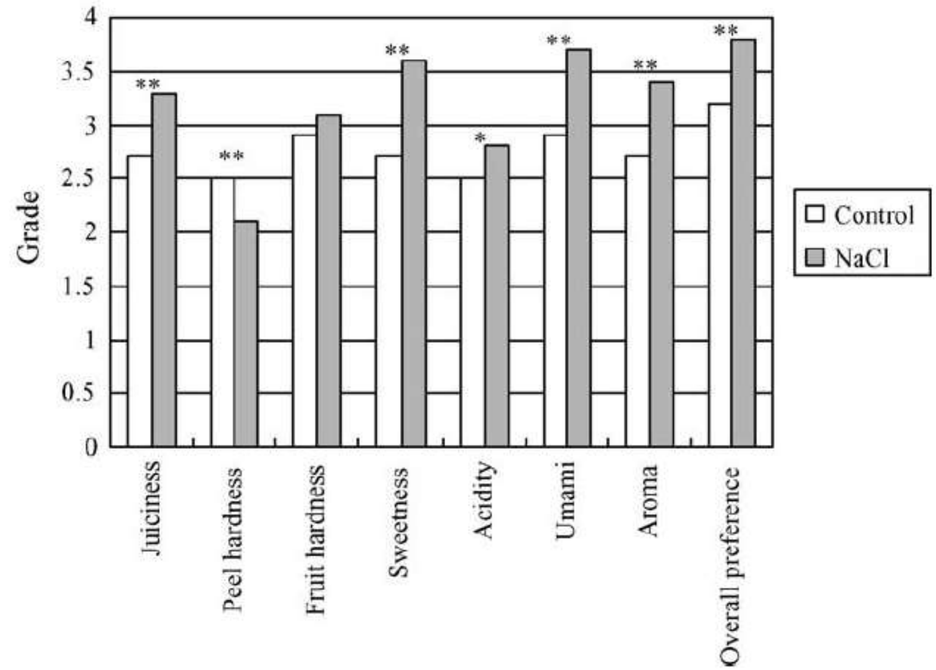

Fig. 1. The effect of NaCl application to nutrient solution on taste of tomato fruit. Sweetness, acidity, umami, aroma, and overall preference were graded between 1 and 5, 5 as the strongest. Grades obtained were statistically analyzed in Wilcoxon's signed rank test. Asterisk (*) and double asterisk (**) indicate significant differences of 5 and 1% level, respectively, between the treatments by Wilcoxon's signed rank test. The taste panel was comprised of 66 people.

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Effects of NaCl application to hydroponic nutrient solution on fruit characteristics of tomato (*Lycopersicon esculentum* Mill.)

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Received 16 March 2005; received in revised form 23 December 2005; accepted 3 May 2006

La concentrazione di zuccheri è aumentata significativamente in frutti di piante trattate con NaCl

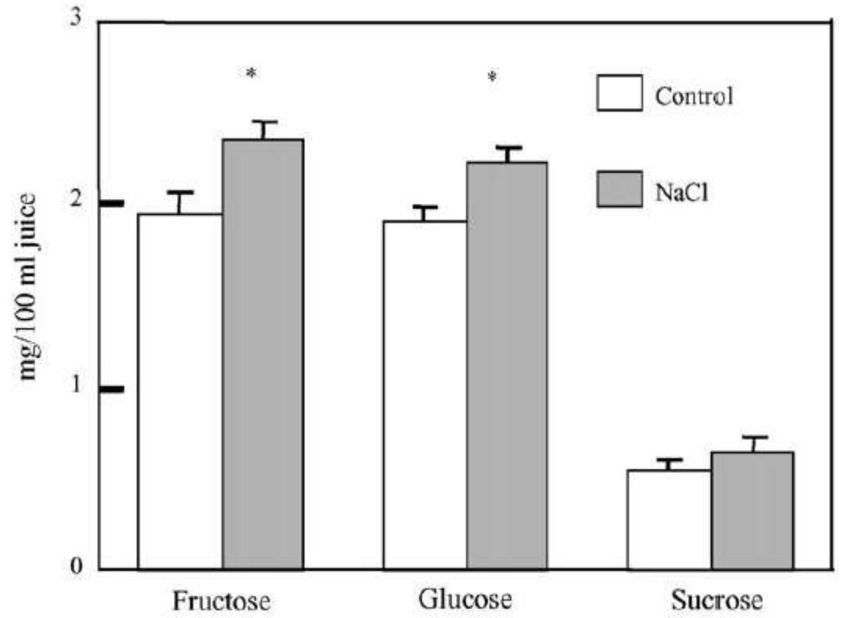


Fig. 2. Effect of NaCl application to nutrient solution on 6- and 12-carbon sugar contents of tomato fruit. Asterisk (*) indicates significant difference by *t*-test at 5% levels. Data are expressed as averages from five observations with standard error bars.

Table 1
The effect of NaCl application to nutrient solution on the characteristics of tomato fruit

Treatment	FW[a] (g/fruit)	Firmness (kg/cm^2)	SS[b] (%)	Titratable acid (mg citrate/100 ml)	Chloride concentration (mg/100 ml)
Control	188.4 a[c]	15.7 b	6.12 b	368.1 b	0.55 b
NaCl	133.7 b	20.6 a	7.78 a	552.2 a	1.52 a

[a] Fresh weight.
[b] Soluble solids.
[c] Different letters represent significant differences at 5% (FW and firmness) or 1% level (SS, titratable acid, and chloride concentration) by *t*-test.

Opportunità 2

Modificare la shelf life del prodotto

Contents lists available at SciVerse ScienceDirect

Plant Physiology and Biochemistry

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

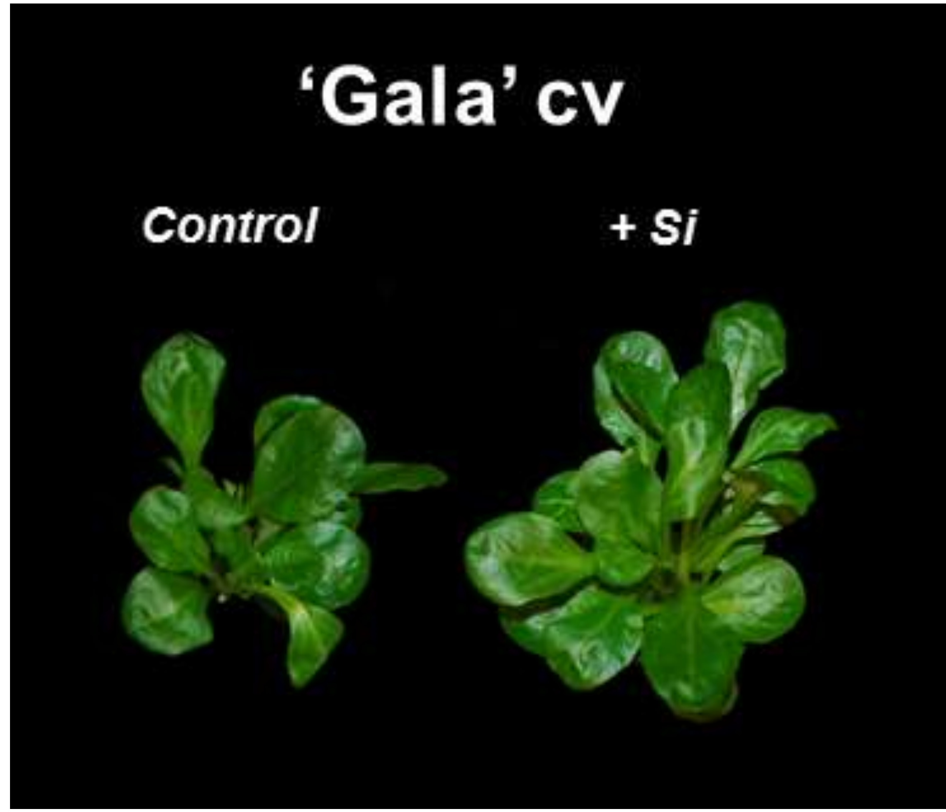
Research article

Beneficial effects of silicon on hydroponically grown corn salad (*Valerianella locusta* (L.) Laterr) plants

Stefano Gottardi[a,1], Francesco Iacuzzo[a,1], Nicola Tomasi[a,*], Giovanni Cortella[b], Lara Manzocco[c], Roberto Pinton[a], Volker Römheld[d], Tanja Mimmo[e], Matteo Scampicchio[e], Luisa Dalla Costa[a], Stefano Cesco[e]

Cultivar	Gala	
Growth conditions	*Control*	+*Si*
Leaf yield[a] (g FW m^{-2})	1313 ± 91 C	2118 ± 195 A

Cultivar	Gala	
Growth conditions	*Control*	+*Si*
NO_3^- [a] (g kg^{-1} leaf FW)	3.82 ± 0.15 A	3.18 ± 0.23 B



Shelf life

Cultivar	Control	+Si
	Days	
Gala	4.45 ± 0.59 B	9.00 ± 1.35 A

STAYFRESH

Opportunità 3

Modificare le proprietà nutrizionali del prodotto sulla base di specifiche esigenze

Licopene: riduce i rischi di cancro e limita disturbi cardiovascolari

ELSEVIER
Available online at www.sciencedirect.com
ScienceDirect
Scientia Horticulturae 116 (2008) 122–129
SCIENTIA HORTICULTURAE
www.elsevier.com/locate/scihorti

Aumento dei contenuti di Licopene con elevati livelli di EC

Effects of high electrical conductivity of nutrient solution and its application timing on lycopene, chlorophyll and sugar concentrations of hydroponic tomatoes during ripening

Min Wu, Chieri Kubota *
Department of Plant Sciences, The University of Arizona, Tucson, AZ 85721-0036, USA

Received 19 May 2007; received in revised form 11 November 2007; accepted 30 November 2007

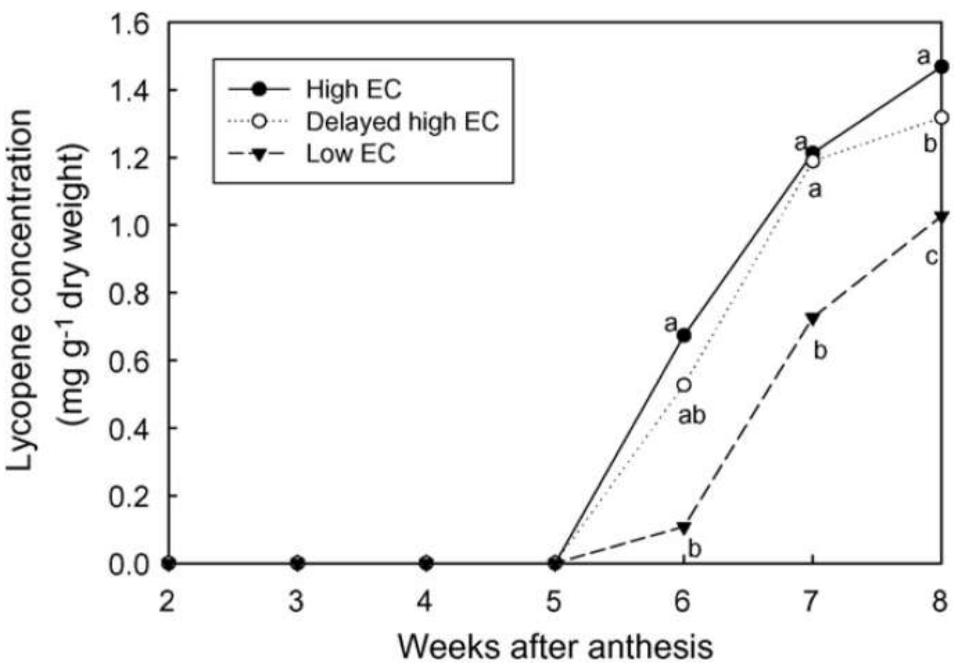


Fig. 5. Effect of high EC treatment and its application timing on lycopene concentration of tomato fruits during fruit development. Low and high EC were 2.3 and 4.5 dS m^{-1}. The high EC and the delayed high EC treatments were applied immediately after anthesis and 4 weeks after anthesis, respectively.

by adding 957 mg/L NaCl and 80 mg/L $CaCl_2$ to the solution

Opportunità 3

Modificare le proprietà nutrizionali del prodotto sulla base di specifiche esigenze

Silicio: promuove la formazione del tessuto osseo e incrementa la sua densità minerale

SCIENTIFIC REPORTS

OPEN

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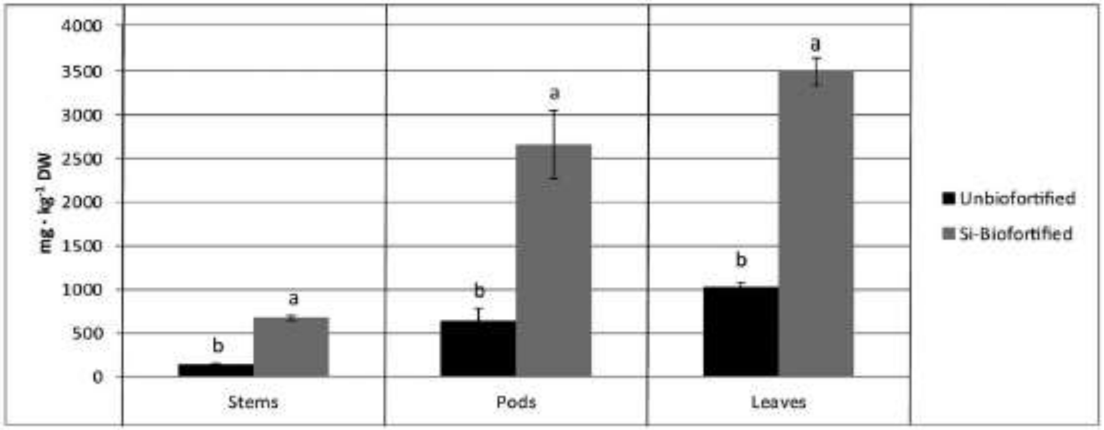
Accepted: 21 July 2016
Published: 17 August 2016

Green bean biofortification for Si through soilless cultivation: plant response and Si bioaccessibility in pods

Francesco Fabiano Montesano[1], Massimiliano D'Imperio[1], Angelo Parente[1], Angela Cardinali[1], Massimiliano Renna[1,2] & Francesco Serio[1]

Biofortificazione con 3.5 mM K_2SiO_3



La concentrazione di Si è stata quasi triplicata a seguito del processo di biofortificazione

Figure 2. Si concentration in stem, pods and leaves of soilless green bean subjected or non-subjected to Si-enriched nutrient solution ('Biofortified' and 'Unbiofortified', respectively).

Opportunità 3

Modificare le proprietà nutrizionali del prodotto sulla base di specifiche esigenze

Selenio: proprietà anticarcinogeniche di suoi composti (e.g. Se-metilselenocisteina)

JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

Article

pubs.acs.org/JAFC

Assessment of the Anticancer Compounds *Se*-Methylselenocysteine and Glucosinolates in Se-Biofortified Broccoli (*Brassica oleracea* L. var. *italica*) Sprouts and Florets

Fabrício William Ávila,[†,‡,∥] Valdemar Faquin,[‡] Yong Yang,[†] Silvio Junio Ramos,[§] Luiz Roberto G. Guilherme,[‡] Theodore W. Thannhauser,[†] and Li Li[*,†,∥]

[†]Robert W. Holley Center for Agriculture and Health, USDA-ARS, Cornell University, Ithaca, New York 14853, United States

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[∥]Department of Plant Breeding and Genetics, Cornell University, Ithaca, New York 14853, United States

dx.doi.org/10.1021/jf4016834 | J. Agric. Food Chem. 2013, 61, 6216−6223

Broccoli biofortificati per il Se accumulo composti chemiopreventivi SeMSCys

Table 1. Total Se and SeMSCys Content in 7-Day-Old Sprouts of Broccoli cv. GYPSY Exposed to Different Forms (Selenate and Selenite) and Various Dosages of Se

Se form	Se dose (μM)	total Se (μg g^{-1} DW)[a]	SeMSCys (μg g^{-1} DW)[a]	conversion (%)[b]
selenate (Na_2SeO_4)	10	31.6 ± 1.4	29.2 ± 3.4	40.1
	25	80.0 ± 0.1	62.1 ± 2.7	33.7
	50	178.9 ± 0.9	105.8 ± 2.3	25.7
	75	214.5 ± 0.9	149.2 ± 5.5	30.2
	100	263.2 ± 6.0	157.3 ± 2.2	25.9
selenite (Na_2SeO_3)	10	19.9 ± 6.3	19.2 ± 0.5	41.8
	25	50.0 ± 0.2	68.9 ± 4.5	59.9
	50	97.8 ± 1.3	112.7 ± 5.9	50.0
	75	146.1 ± 2.0	149.8 ± 3.3	44.5
	100	185.3 ± 2.1	167.4 ± 10.6	39.2
ANOVA[c]	Se form	****	NS	
	Se dose	****	****	
	Se form × Se dose	****	NS	
25 μM selenate + 25 μM selenite	50	124.7 ± 2.5[d]	103.9 ± 3.4	36.2

[a]Values are averages of three replicates ± SD (standard deviation). [b]Calculated using only the Se (atomic weight = 79) from SeMSCys (molecular weight = 182). [c]NS and "****" indicate nonsignificance and significance at $p \leq 0.0001$, respectively. [d]Significant difference ($p \leq 0.05$) between 25 μM selenate + 25 μM selenite treatment and 50 μM Se (either selenate or selenite) treatment.

JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY
Article
pubs.acs.org/JAFC

Selenium Fertilization Alters the Chemical Composition and Antioxidant Constituents of Tomato (*Solanum lycopersicon* L.)

Michela Schiavon,[†] Stefano dall'Acqua,[‡] Anna Mietto,[†] Elizabeth A. H. Pilon-Smits,[§] Paolo Sambo,[†] Antonio Masi,[†] and Mario Malagoli*[,†]

[†]DAFNAE, University of Padova, Agripolis 35020 Legnaro PD, Italy
[‡]Department of Pharmaceutical and Pharmacological Sciences, University of Padova, 35131 Padova, Legnaro PD, Italy
[§]Biology Department, Colorado State University, Fort Collins, Colorado 80523, United States

Pomodori biofortificati con Se mostrano un aumento dei livelli di flavonoidi antiossidanti (naringenina chalcone e kaempferolo)

aumento dei livelli di composti neutraceutici

Table 5. Content of Secondary Metabolites in *Solanum lycopersicon* Fruit Flesh of Plants Cultivated in Soil and Treated at the Foliar Level with Se Doses Ranging from 0 (Control) to 20 mg of Se per Plant[a]

	mg kg^{-1} fw		
	control	5 mg of Se per plant	20 mg of Se per plant
phenolic acids			
chlorogenic acid	17.0 ± 7.9a	11.2 ± 3.6a	30.7 ± 19.0a
dicaffeoylquinic acid	4.5 ± 2.0a	1.5 ± 0.5a	5.4 ± 2.7a
tricaffeoylquinic acid	0.0 ± 0.0b	0.3 ± 0.1a	0.5 ± 0.4a
feruloylquinic acid	3.5 ± 1.8a	1.6 ± 0.6a	4.2 ± 2.7a
coumaroyl quinic acid isomer	1.4 ± 0.1a	1.2 ± 0.3a	1.2 ± 0.2a
5-O-caffeoylquinic acid	3.8 ± 1.1a	3.1 ± 0.8a	4.7 ± 2.3a
caffeoyloside hesoside	1.9 ± 0.5a	0.0 ± 0.0b	0.0 ± 0.0b
flavonoids			
rutin	9.1 ± 5.4a	7.4 ± 2.7a	9.5 ± 5.7a
kaempferol rutinoside pentoside	0.8 ± 0.2a	0.4 ± 0.1a	1.1 ± 0.5a
quercetin-dihexose-deoxyhexose pentose	3.9 ± 1.5a	2.9 ± 0.4a	4.5 ± 2.7a
phloretin dihexose	0.9 ± 0.4a	0.0 ± 0.0b	0.0 ± 0.0b
quercetin-hexose-deoxyhexose-pentose-p-coumaric	1.0 ± 0.7a	0.6 ± 0.2a	0.9 ± 0.4a
quercetin-hexose-deoxyhexose pentose glucose	1.4 ± 0.8a	0.6 ± 0.1a	1.9 ± 1.2a
naringenin chalcone	0.0 ± 0.0b	0.7 ± 0.3a	0.7 ± 0.3a
naringenin-dihexose	3.1 ± 1.1a	2.8 ± 0.8a	4.3 ± 1.4a

Controindicazioni 1

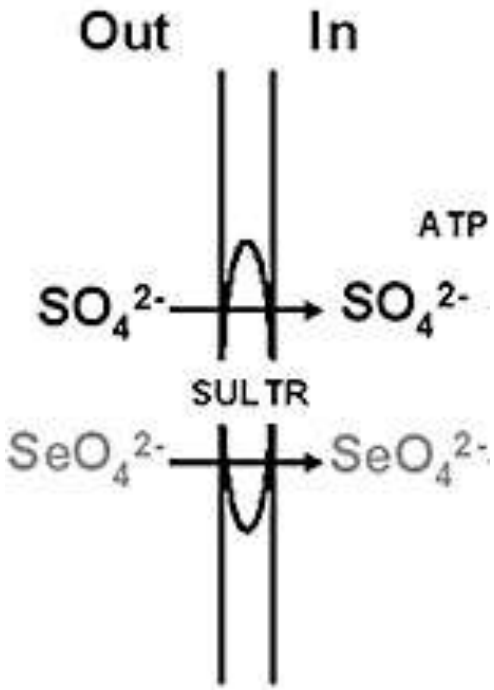
Antagonismo tra nutrienti

Antagonismo Se - S

Per ragioni di competitività, l'assorbimento di selenato può essere fortemente diminuito da alta disponibilità di solfato e viceversa

solfato

selenato



Plant, Cell & Environment

Plant, Cell and Environment (2011) 34, 192–207

doi: 10.1111/j.1365-3040.2010.02235.x

Generation of Se-fortified broccoli as functional food: impact of Se fertilization on S metabolism

FU-CHEN HSU[1], MARKUS WIRTZ[2], SIMON C. HEPPEL[1], JOCHEN BOGS[1,2], UTE KRÄMER[3,4], MUHAMMAD SAYYAR KHAN[1], ACHIM BUB[5], RÜDIGER HELL[2] & THOMAS RAUSCH[1]

Antagonismo Se - S

Plant and Soil **210**: 199–207, 1999.

199

Plant availability of selenite and selenate as influenced by the competing ions phosphate and sulfate

Jennifer L. Hopper & David R. Parker*
Soil and Water Sciences Section, Department of Environmental Sciences, University of California, Riverside CA 92521, USA.

Received 15 June 1998. Accepted in revised form 30 April 1999

Key words: antagonism, bioavailability, phytotoxicity, selenium, speciation

Un aumento della concentrazione di solfato di 10 volte limita l'assorbimento del Se di + del 90%

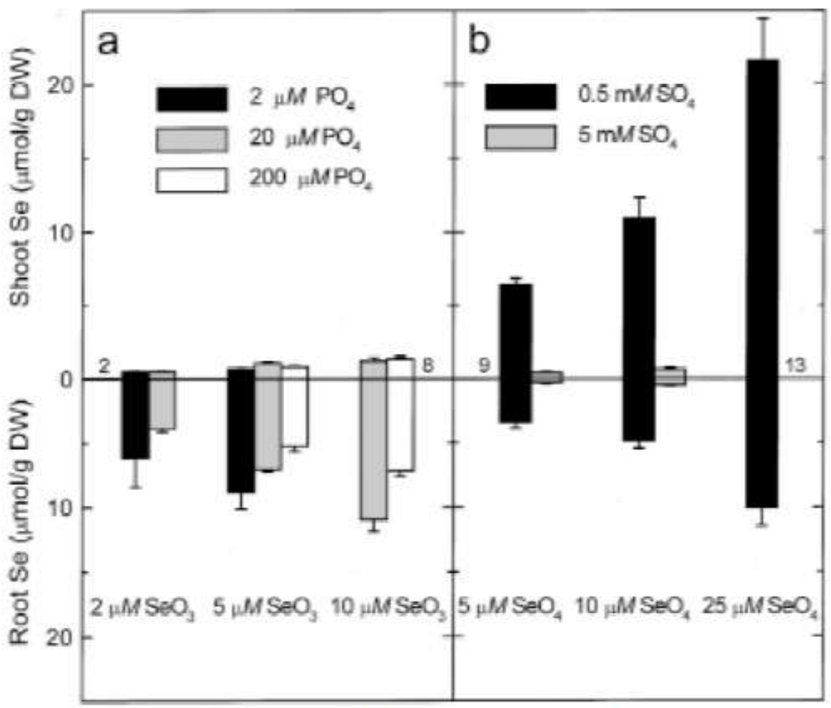


Figure 4. Selenium concentrations in tissue of strawberry clover grown in nutrient solutions with varied SeO_3, PO_4, SeO_4, and SO_4 concentrations The basal SO_4 concentration (0.5 m*M*) was used in all SeO_3 treatments (*a*), and the basal PO_4 level (2 μ*M*) in all SeO_4 treatments (*b*). As indicated, the bars correspond to treatments 2 to 13 (Table 1) when read from left to right. Error bars indicate one SEM ($n = 4$).

Controindicazioni 2

Fenomeni di complessazione/precipitazione

Fenomeni di complessazione/precipitazione

Le soluzioni nutritive per l'allevamento di piante sono soluzioni acquose di ioni inorganici che vengono preparate sciogliendo sali (quindi ioni liberi)

Le reazioni di dissociazione/complessazione /precipitazione possono influenzare fortemente la speciazione elementare e la biodisponibilità degli elementi

Ca^{2+} e Mg^{2+} formano facilmente complessi solubili con bicarbonato e con le diverse forme di dissociazione del fosfato

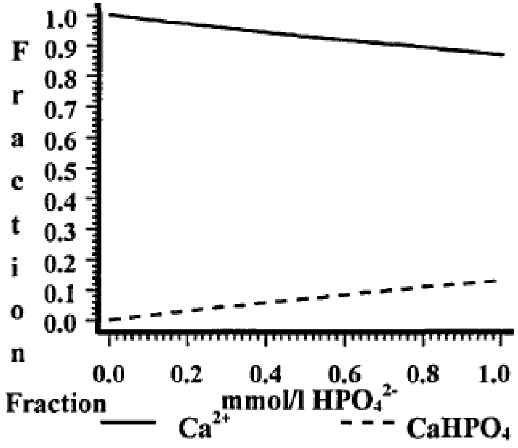


FIGURE 3. Complexation between Ca^{2+} and HPO_4^{2-} (I=30 mmol L^{-1}).

JOURNAL OF PLANT NUTRITION, 21(5), 849–859 (1998)

Elemental Bioavailability in Nutrient Solutions in Relation to Complexation Reactions

G. De Rijck and E. Schrevens

Faculty of Agricultural and Applied Biological Sciences, Department of Applied Plant Sciences K.U. Leuven, Willem de Croylaan 42, B-3001 Heverlee, Belgium

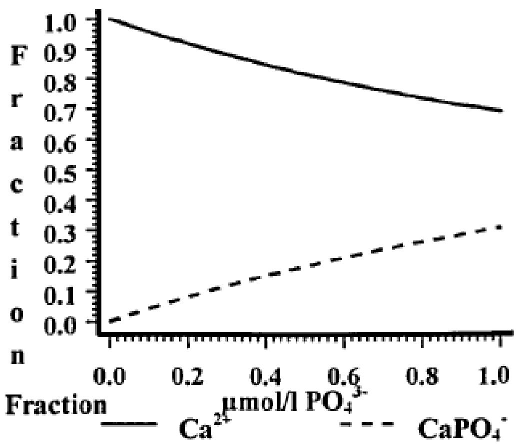


FIGURE 4. Complexation between Ca^{2+} and PO_4^{3-} (I=30 mmol L^{-1}).

Controindicazioni 3

Una fonte di un nutriente non vale l'altra

es. fonti ferriche

Il caso del Fe

List of Iron-containing Commercial Fertilizers:

Source	Formula	Water Solubility	%Fe
Ferrous ammonium phosphate	$Fe(NH_4)PO_4 \cdot H_2O$	Soluble	29
Ferrous ammonium sulfate	$NH_4SO_4.FeSO_4 \cdot 6H_2O$		14
Iron chelates	NaFeEDTA	Soluble	5 – 11
	NaFeHPDTA	Soluble	5 – 9
	NaFeEDDHA	Soluble	6
	NaFeDTPA	Soluble	10
	FeHEDTA	Soluble	5 – 9
	FeEDDHA	Soluble	6
Iron polyflavonoids	Organically Bound Fe		9 – 10
Ferrous sulfate	$FeSO_4 \cdot 7H_2O$	Soluble	20
Ferric sulfate	$Fe(SO_4)_3 \cdot 4H_2O$	Soluble	23

Specificità del meccanismo di acquisizione

Il caso del Fe

List of Iron-containing Commercial Fertilizers:

Source	Formula	Water Solubility	%Fe
Ferrous ammonium phosphate	$Fe(NH_4)PO_4{\cdot}H_2O$	Soluble	29
Ferrous ammonium sulfate	$NH_4SO_4.FeSO_4{\cdot}6H_2O$		14
Iron chelates	NaFeEDTA	Soluble	5 – 11
	NaFeHPDTA	Soluble	5 – 9
	NaFeEDDHA	Soluble	6
	NaFeDTPA	Soluble	10
	FeHEDTA	Soluble	5 – 9
	FeEDDHA	Soluble	6
Iron polyflavonoids	Organically Bound Fe		9 – 10
Ferrous sulfate	$FeSO_4{\cdot}7H_2O$	Soluble	20
Ferric sulfate	$Fe(SO_4)_3{\cdot}4H_2O$	Soluble	23

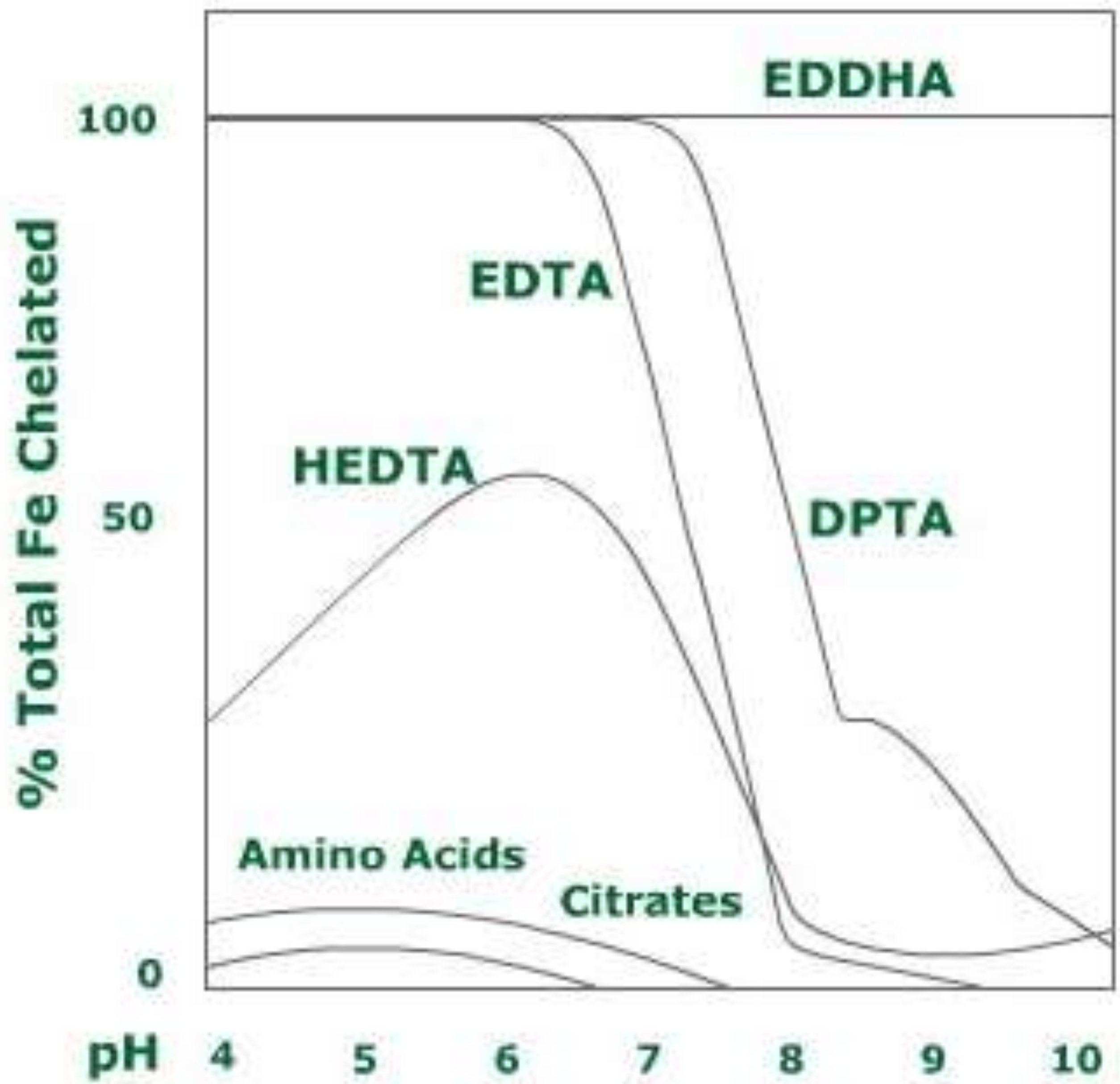
Stabilità del complesso

Efficienza d´uso delle fonti

Il caso del Fe

List of Iro

Source	Fo
Ferrous ammonium phosphate	Fe
Ferrous ammonium sulfate	N
Iron chelates	N
	N
	N
	N
	Fe
	Fe
Iron polyflavonoids	O
Ferrous sulfate	Fe
Ferric sulfate	Fe



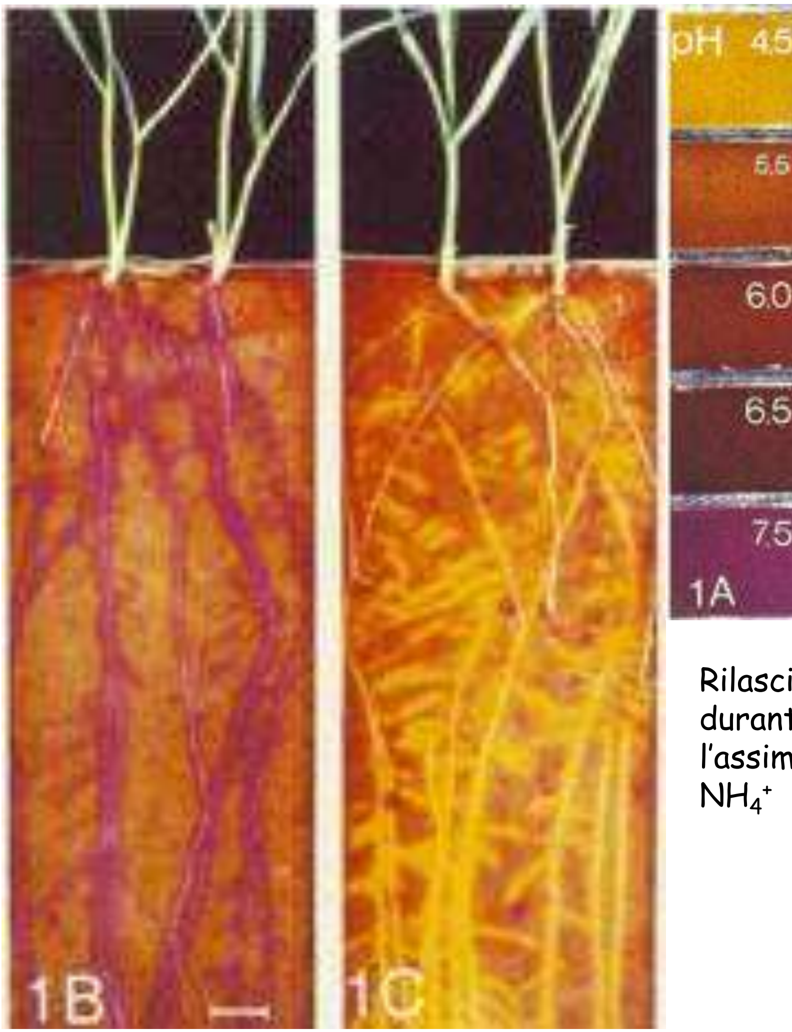
Stabilità del complesso

Il caso del Fe

Effetto della forma di fertilizzante Azotato sul pH alla rizosfera di orzo

200 kg N/ha

Consumo di H^+ durante l'assimilazione di NO_3^-



NO_3^- NH_4^+

Rilascio di H^+ durante l'assimilazione di NH_4^+

Römheld 1986

Marschner's Mineral Nutrition of Higher Plants
Third Edition

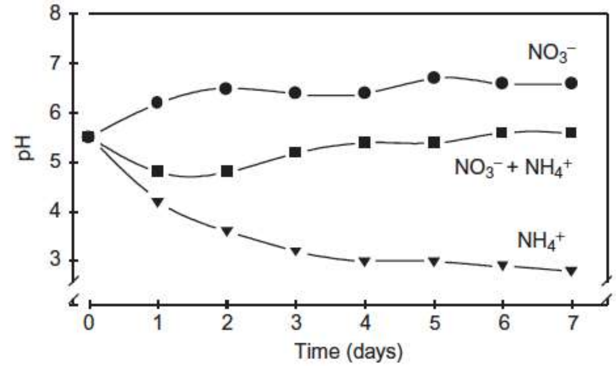


FIGURE 2.23 Time course of changes in the pH of the external solution in sorghum plants supplied with 300 mg l^{-1} total N as only NO_3^-, only NH_4^+, or both at a ratio of 8 NO_3^- to 1 NH_4^+ as their N source. *Redrawn from Clark (1982b).*

Effect of nitrogen source on pH of the growth medium (imp. for Fe nutrition)

Controindicazioni 4

Interazioni tra nutrienti

Piante: organismi complessi che richiedono appropriate quantità dei diversi elementi/nutrienti per una crescita e sviluppo equilibrati

Interazione tra nutrienti

Nitrato versus Solfato

Journal of Experimental Botany, Vol. 52, No. 354, pp. 113–121, January 2001

Interazione tra nutrienti

S versus N

Rapid disruption of nitrogen metabolism and nitrate transport in spinach plants deprived of sulphate

Ian M. Prosser[1], Judith V. Purves, Leslie R. Saker and David T. Clarkson

Treatment	Rate of uptake (μmol g^{-1} root DW h^{-1})	
	SO_4^{2-} (*ln*)	NO_3^-
Control +S	10.2 (*2.33*)	208
–*S* d	34.6 (*3.54*)	138
–*S* 4 d	47.0 (*3.85*)	141
–*S* 6 d	62.5 (*4.14*)	128

Journal of Experimental Botany, Vol. 52, No. 354, pp. 113–121, January 2001
Journal of Experimental Botany

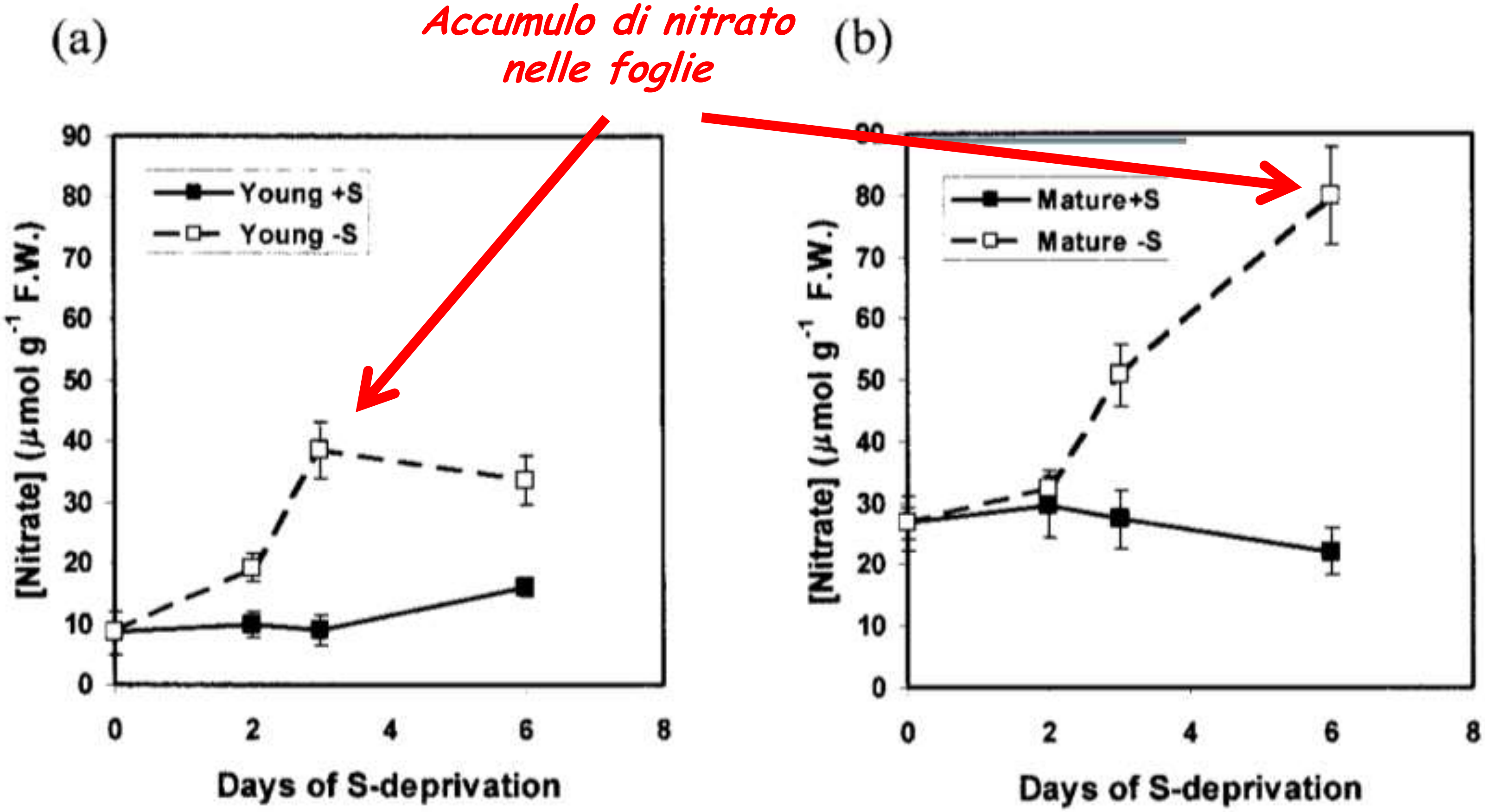
Rapid disruption of nitrogen metabolism and nitrate transport in spinach plants deprived of sulphate

Ian M. Prosser[1], Judith V. Purves, Leslie R. Saker and David T. Clarkson

Interazione tra nutrienti

S versus N

Accumulo di nitrato nelle foglie



Ferro versus Nitrato

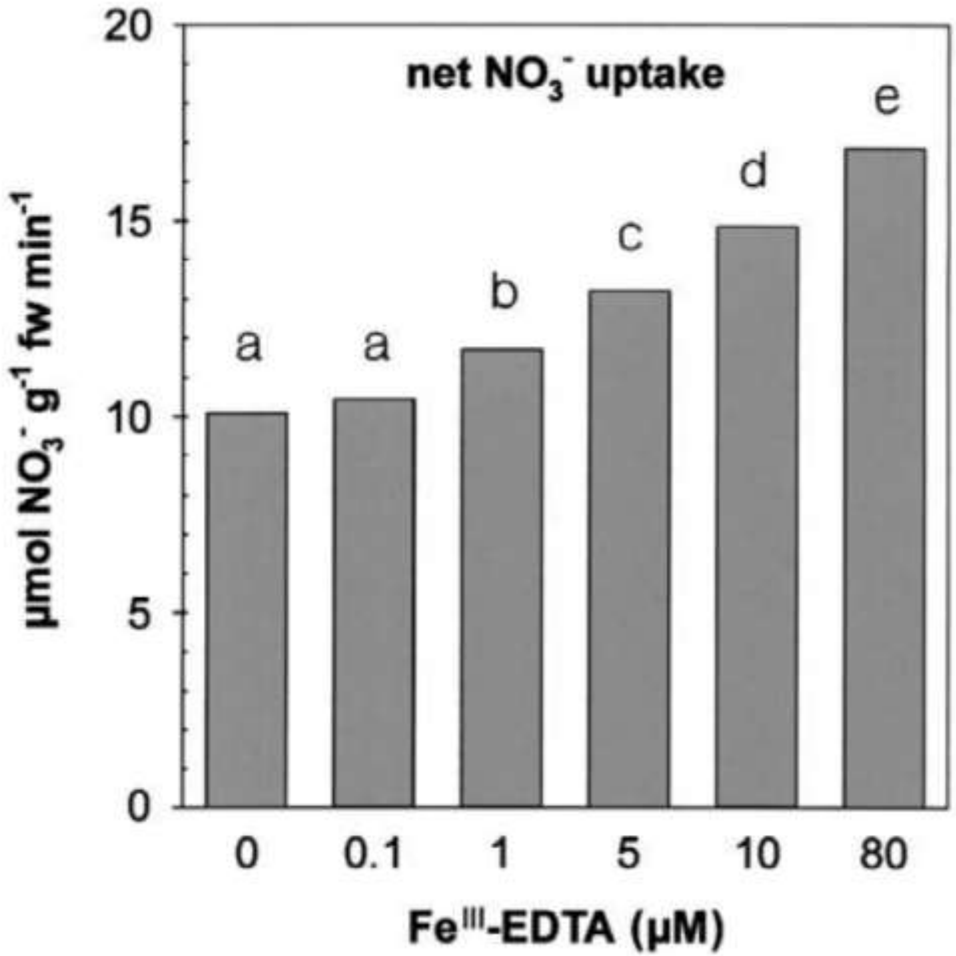
Plant and Soil **241**: 35–41, 2001.

Fe versus N

Root response to Fe supply

Enzymatic responses of cucumber roots to different levels of Fe supply

Fabio Agnolon, Simonetta Santi, Zeno Varanini & Roberto Pinton[1]



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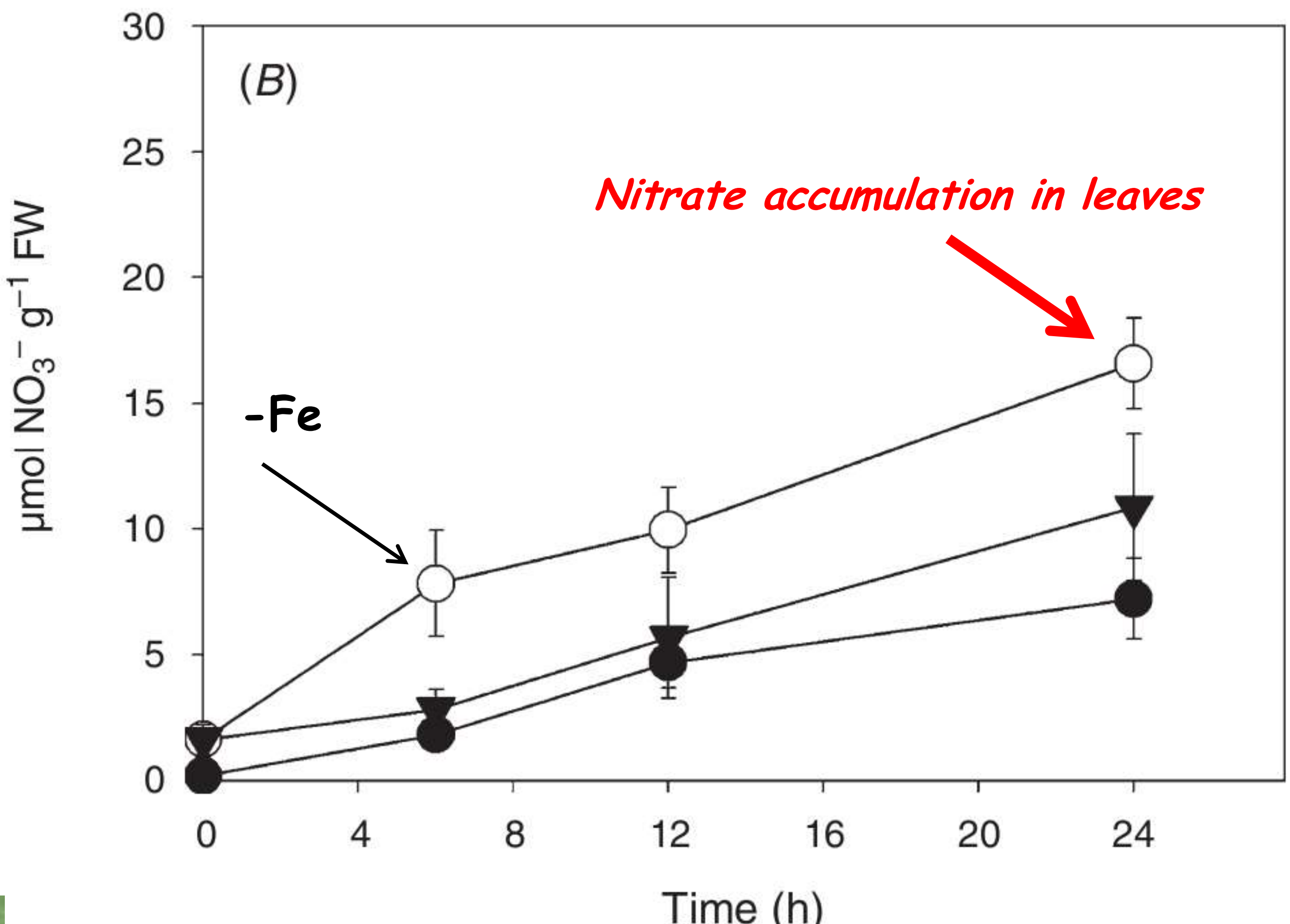
Functional Plant Biology, 2007, 34, 402–408

Fe versus N

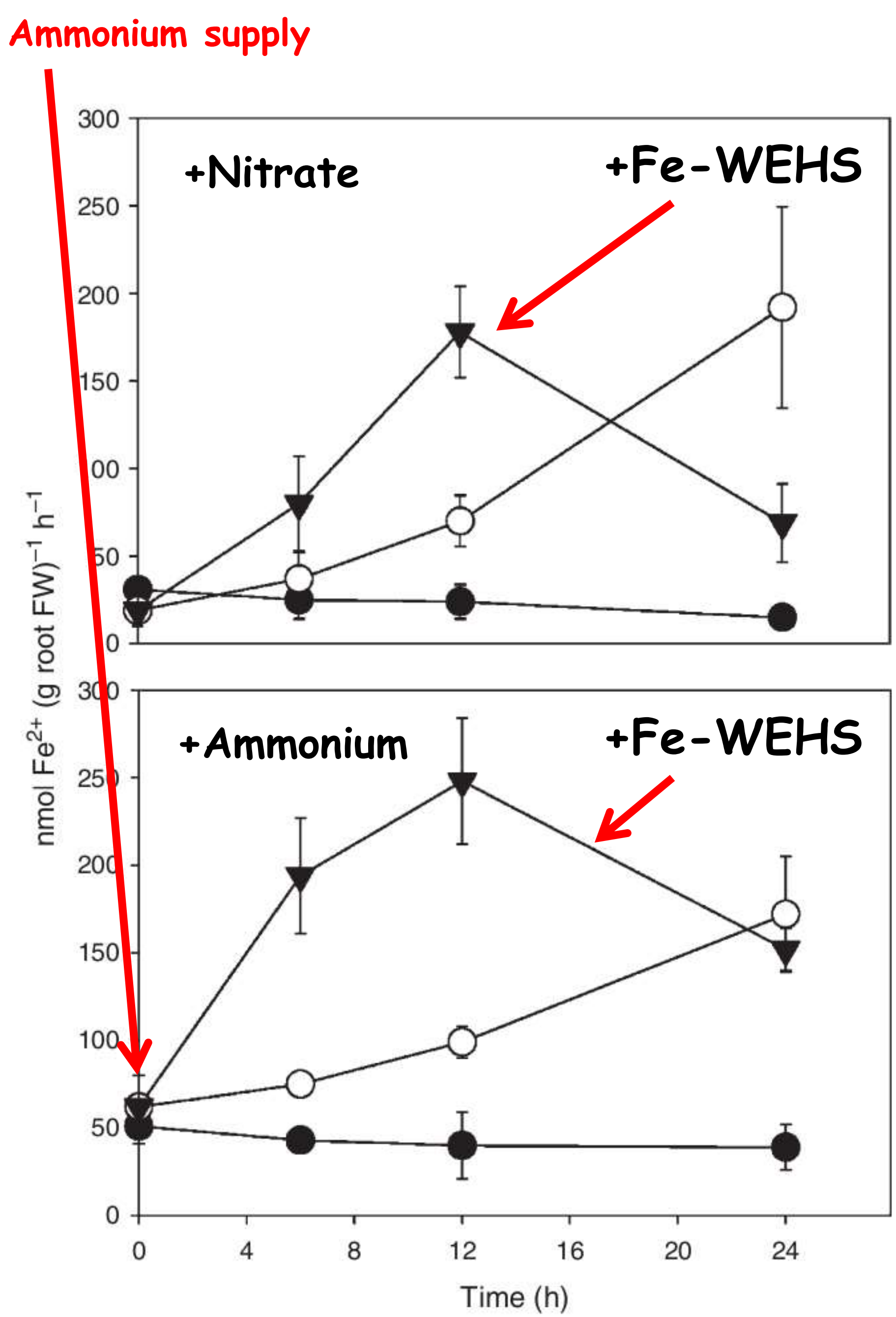
Short-term interactions between nitrate and iron nutrition in cucumber

Miroslav Nikolic[A,E], Stefano Cesco[B], Volker Römheld[C], Zeno Varanini[D] and Roberto Pinton[B]

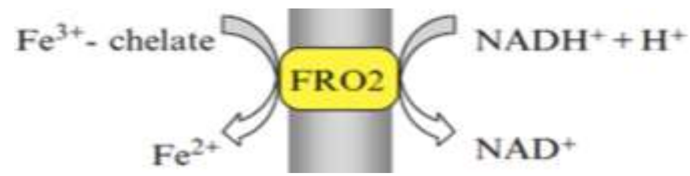


Azoto (nitrato e ammonio) versus Ferro

N versus Fe



Effects of N and Fe supply on Fe(III)-reduction capacity by roots of cucumber plants grown with (●) or without (○) 10µMFe supply



Recovery of the Fe(III)-chelate reductase activity dependent on nitrogen supply

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Functional Plant Biology, 2007, 34, 402–408

Short-term interactions between nitrate and iron nutrition in cucumber

Miroslav Nikolic[A,E], Stefano Cesco[B], Volker Römheld[C], Zeno Varanini[D] and Roberto Pinton[B]

Solfato versus Ferro

Planta (2009) 230:85–94
DOI 10.1007/s00425-009-0919-1

Interazione tra nutrienti

S versus Fe

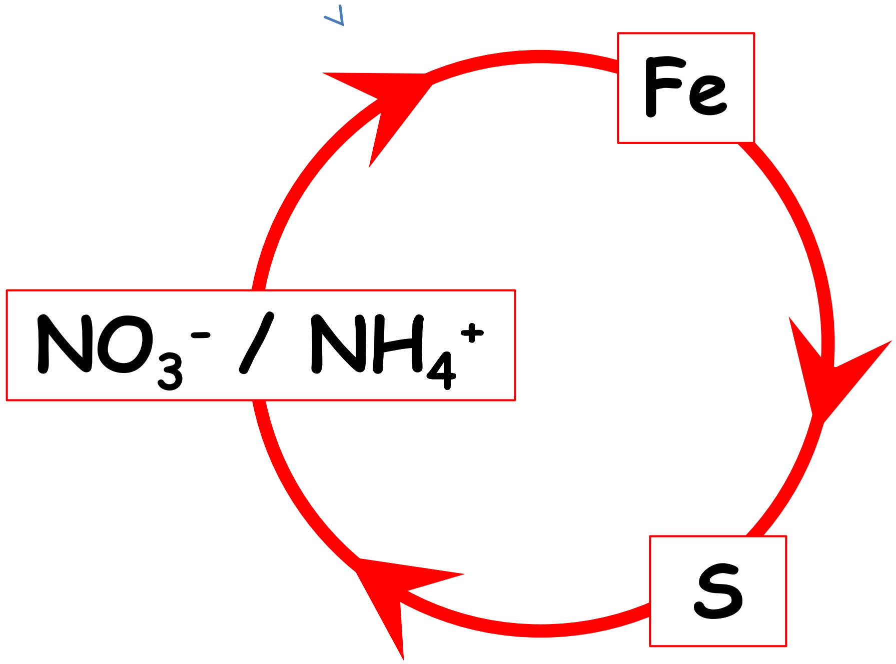
ORIGINAL ARTICLE

Sulphur deprivation limits Fe-deficiency responses in tomato plants

Sabrina Zuchi · Stefano Cesco · Zeno Varanini · Roberto Pinton · Stefania Astolfi

Table 1 Uptake and translocation to the shoot of ^{59}Fe from $^{59}Fe(III)$-hydroxide, and uptake of $^{59}Fe^{2+}$, in S-sufficient and S-deficient tomato plants grown for 4 days with (+Fe) or without (−Fe) 40 μM Fe(III)–EDTA

	Treatment			
	+S+Fe	+S−Fe	−S+Fe	−S−Fe
^{59}Fe uptake rate from $^{59}Fe(III)$-hydroxide (nmol g^{-1} root DW h^{-1})	5.57 ± 2.13[b]	14.93 ± 4.12[a]	4.86 ± 1.76[b]	7.58 ± 1.70[b]
As $^{59}Fe^{2+}$ (μmol g^{-1}root DW h^{-1})	3.37 ± 0.03[c]	18.27 ± 1.60[a]	2.39 ± 0.57[c]	10.30 ± 2.44[b]
^{59}Fe translocation from $^{59}Fe(III)$-hydroxide (nmol ^{59}Fe g^{-1} root DW h^{-1})	2.42 ± 1.32[b] (43.4%)	5.65 ± 1.71[a] (37.8%)	1.50 ± 0.94[b] (30.8%)	1.93 ± 0.43[b] (25.5%)
$^{35}SO_4^{2-}$ uptake (μmol g^{-1} root DW h^{-1})	12.9 ± 1.3[b]	12.0 ± 1.8[b]	34.4 ± 6.9[a]	47.7 ± 13.2[a]



Relevant for the use efficiency of nutrients and the quality of edible tissues

Controindicazioni 5

Temperatura della soluzione idroponica

influenza notevolmente la crescita delle radici (temp opt sotto controllo genetico)

più bassa per la crescita delle radici

Marschner's Mineral Nutrition of Higher Plants
Third Edition

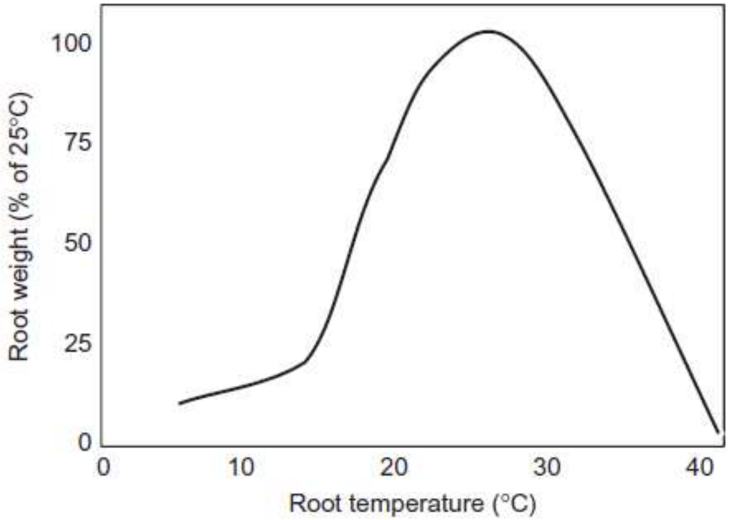


FIGURE 13.17 Root biomass of 24-day-old maize seedlings at different temperatures. *Based on Kaspar and Bland (1992). With permission from Soil Science.*

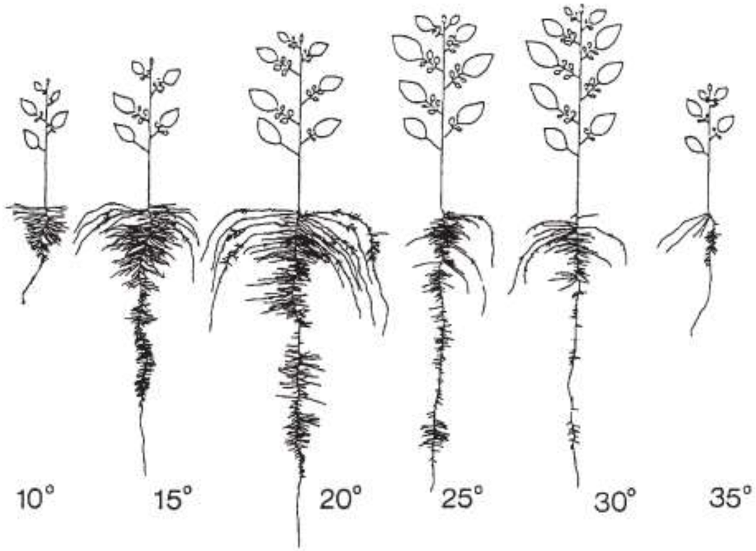


FIGURE 13.18 Root morphology and shoot growth of potato seedlings at different root zone temperatures. *From Sattelmacher* et al. *(1990c). With permission from Oxford University Press.*

Temperatura della soluzione

Applied Thermal Engineering 73 (2014) 1055–1065

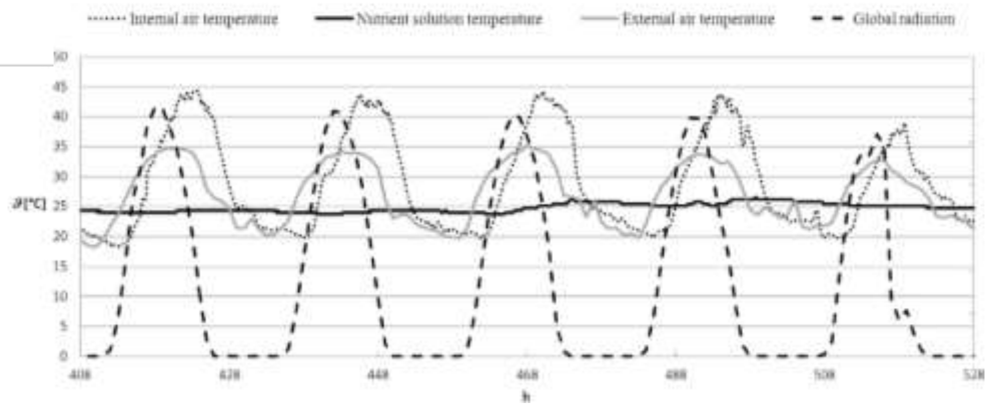
Contents lists available at ScienceDirect

Applied Thermal Engineering

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

Temperature control of nutrient solution in floating system cultivation

Giovanni Cortella [d,*], Onorio Saro [a], Alessandra De Angelis [a], Luca Ceccotti [a], Nicola Tomasi [b], Luisa Dalla Costa [b], Lara Manzocco [c], Roberto Pinton [b], Tanja Mimmo [d], Stefano Cesco [d]



aumento del contenuto di nitrati con una temperatura della soluzione nutritiva di 20° C

HortScience 46(12):1619–1625. 2011.

The Effect of Growth Medium Temperature on Corn Salad [*Valerianella locusta* (L.) Laterr] Baby Leaf Yield and Quality

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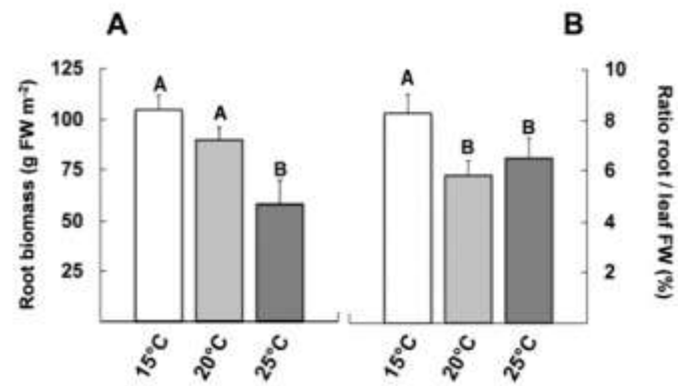

Fig. 4. Effect of the nutrient solution temperature on root biomass of corn salad [*Valerianella locusta* (L.) Laterr., cultivar Gala] grown as described in Figure 3. Data of root biomass (**A**) and root FW/leaf FW ratios (**B**) are reported. Data are means ± SD of three independent experiments; capital letters refer to statistically significant differences among the samples (analysis of variance, Fisher's least significant difference, $P < 0.05$). FW = fresh weight.

Prospettive

Uso dei PGPR in soluzione idroponica

Environmental and Experimental Botany 130 (2016) 216–225

Contents lists available at ScienceDirect

Environmental and Experimental Botany

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

Modulation of Fe acquisition process by *Azospirillum brasilense* in cucumber plants

Youry Pii[a,*], Laura Marastoni[a], Christian Springeth[a], Maria Chiara Fontanella[b], Gian Maria Beone[b], Stefano Cesco[a], Tanja Mimmo[a]

[a] Faculty of Science and Technology, Free University of Bolzano, I-39100 Bolzano, Italy
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Aggiunti alla SN possono favorire la crescita della radice e l'assorbimento dei nutrienti minerali da parte delle radici

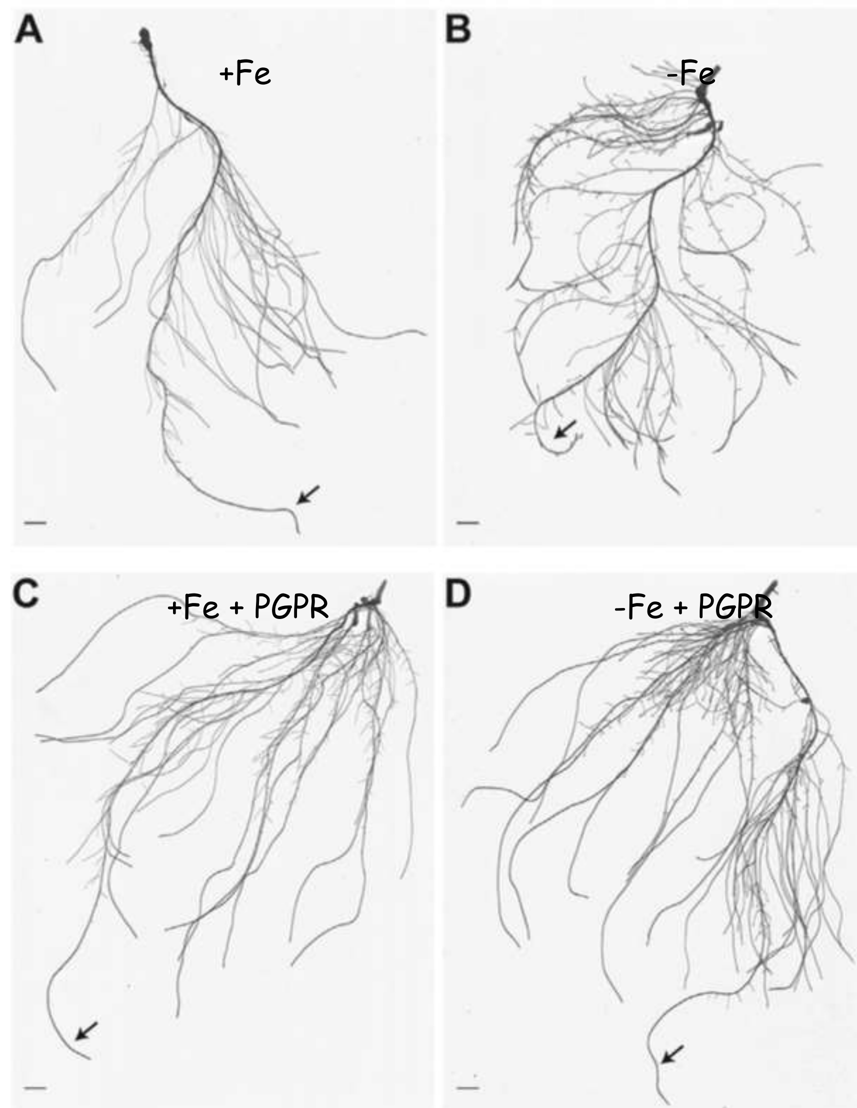

Table 1
^{57}Fe root uptake rate measure in 6 day-old plants. The mean values are expressed as nmol ^{57}Fe g DW^{-1} h^{-1}. The statistical significance was tested by means of ANOVA with Tukey post-test. Different letters indicates statistically different values ($P < 0.001$).

	+Fe			−Fe		
	Mean	SE		Mean	SE	
Non-inoculated	202.93	27.81	a	477.55	54.73	b
A. brasilense	805.25	16.43	c	1458.89	188.71	d

Uso di Sensori multielemento

La misura in tempo reale delle fluttuazioni nella concentrazione di nutrienti potrebbe consentire il monitoraggio dell'esaurimento dei nutrienti minerali/elementi tossici e/o il loro accumulo nelle soluzioni nutritive

Rete di **sensori iono-sensibili**

Proceedings of the 16th International Conference on Nanotechnology
Sendai, Japan, August 22-25, 2016

Multi Ion-Sensor Arrays: Towards an "Electronic Tongue"

K. Melzer, V. D. Bhatt, T. Schuster, E. Jaworska, K. Maksymiuk, A. Michalska, G. Scarpa, P. Lugli, Fellow, IEEE

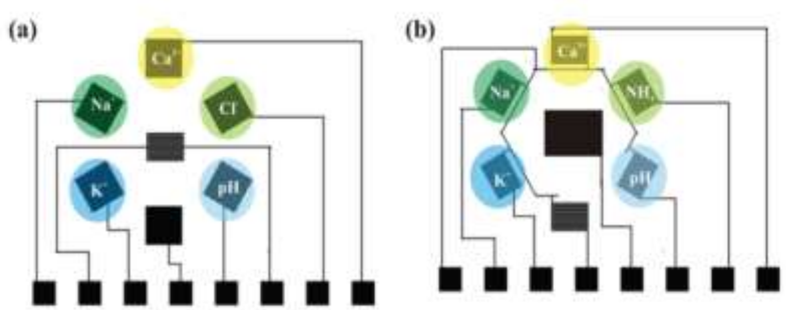

Figure 1. Schematic representation of the (a) ion-selective array with six modified gate structures and one common read-out transistor (b) array with six modified read-out transistors and one common planar gate electrode.

Uso di Nanoparticelle

Sono disponibili vari tipi di nanofertilizzanti che sono stati progettati per fornire sostanze nutritive per la crescita delle piante

Nanofertilizzanti attualmente disponibili:

- materiali nanoporosi con nutrienti incapsulati
- polimeri/chelati con nutrienti incapsulati
- particelle nutritive o emulsioni di dimensioni nanometriche

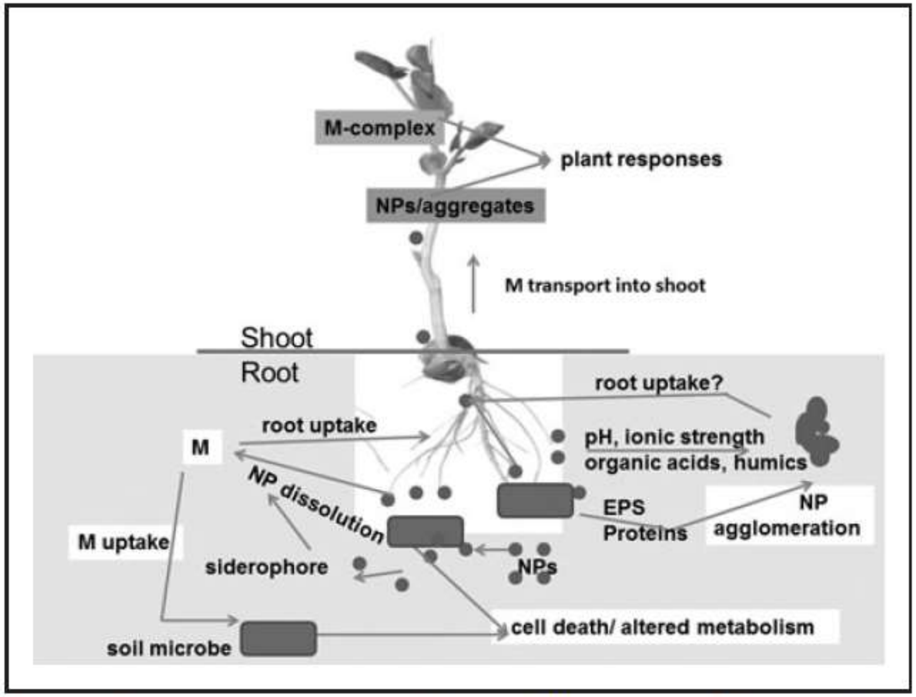

Fig. 5. Illustration of potential fates of NPs in agricultural soil. Interactions between soil microbes (shaded rectangles) and plant roots are shown. M indicates soluble metal, which could be an ion or a chelated species.

I nano-prodotti vengono utilizzati nell'agricoltura per (i) ottenere prodotti agricoli più rapidamente e ad alto rendimento, che a sua volta diminuiranno l'uso dell'acqua e dell'energia e (ii) producono meno spreco. L'obiettivo è quello di fornire pratiche agronomiche e prodotti agricoli più sani, efficienti, convenienti e sostenibili.

Grazie dell'attenzione